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Increasing the Number of Chews before Swallowing Reduces Meal Size in Normal-Weight, Overweight, and Obese Adults

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ABSTRACT

Eating slowly contributes to a lower risk of obesity, probably because it could aid appetite control. Chewing thoroughly is an effective strategy to reduce eating rate; however, insufficient data are available to demonstrate the relationship between such an eating behavior and energy intake. To investigate the effect of increasing the number of chews before swallowing on meal size, a randomized cross-over trial was conducted in 18- to 45-year-old normal-weight, overweight, and obese participants (n=45) who were recruited from the local community (Ames, IA). After assessment of baseline number of chews, participants were asked to attend three test sessions to eat pizza for lunch until comfortably full by chewing each portion of food either 100%, 150%, or 200% of their baseline number of chews before swallowing. Two-way analysis of variance was used to test the effect of treatment and body-weight status, as well as their interactions on food intake, meal duration, eating rate, and appetite at meal termination. Appetite data during 60 minutes were analyzed by repeated measures analysis of variance. Food intake in the sessions with 150% and 200% of their baseline number of chews was reduced significantly, by 9.5% and 14.8%, respectively, compared with the 100% session. Increasing the number of chews also prolonged meal duration and reduced eating rate. However, subjective appetite at meal termination or during the immediate postprandial period did not differ. These data indicate that increasing the number of chews before swallowing might be a behavioral strategy to reduce food intake and potentially aid body-weight management.
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RECENT STUDIES SUGGEST THAT EATING SLOWLY IS associated with a lower body mass index[1-3] or reduced risk of weight gain.[4] These data raise the possibility that therapeutic behavioral interventions to slow eating rate can be beneficial for body-weight management. Several studies have shown that a slower eating rate reduces meal size[5-7] or increases postprandial satiety,[8,9] but inconsistent results also exist.[10,11] In those studies,[5-11] various methods were used to reduce eating rate, such as introducing within-meal pauses, decreasing amount of food with each mouthful, using computerized devices, or a combination of those methods. However, it is unknown whether other methods, such as increasing the number of chewing cycles before swallowing, have a more robust effect on meal size.

The idea that chewing food more thoroughly can reduce food intake was popularized by Horace Fletcher, who proposed that food should be chewed until it turns into liquid or swallows itself.[12] To date, few studies[13,14] have evaluated his claims, although accumulating evidence suggests they might have some merit. A study using 11 participants found that chewing pasta 35 times rather than 10 times before swallowing reduced meal size by 12%.[13] However, the sample size was too small to test potential response differences due to body weight. Li and colleagues reported a similar finding in Chinese males, when chewing pork pie 40 times rather than 15 times before swallowing resulted in meal size being reduced by 11.9%.[14] In these studies, the number of chewing cycles before swallowing was the same for all participants and prespecified by the investigators. Considering the large inter-individual variation in the number of chews for a given food,[15,16] the degree that this intervention altered participants' normal eating behavior is not known. Additional studies are warranted to determine whether increasing the number of chews based on participant's normal chewing behavior reduces meal size and whether there is a dose−response relationship.

In the present study, the effect of increasing the number of chews before swallowing on meal size in adults with different body-weight status was determined. It was hypothesized that increasing the number of chews will reduce eating rate and reduce food intake in a dose-dependent manner.

METHODS

Test Food

Totino's cheese pizza rolls (General Mills, Inc) were used as the test food in this study. Nutrient labeling by the manufacturer reported that a serving size of 85 g (six pizza rolls) provided 837 kJ (200 kcal) energy with 14% from protein, 51% from carbohydrate, and 35% from fat. Every six pizza rolls were microwaved on high power for 55 seconds and kept in a food warmer at 60°C before serving.

Participants

This study was advertised using an e-mail sent to Iowa State University faculty, students, and staff and by fliers distributed throughout the local community. Individuals interested in taking part in the study were invited to attend a screening session to determine their eligibility. In this session, participants were interviewed, and their weight and height were measured using a calibrated weighing scale (Detecto 758C, Cardinal Scale Manufacturing Company) and a wall-mounted stadiometer (Model S100, Ayrton Corp) with a standard procedure provided by the user's manual. Body mass index (BMI) was calculated as weight (kg) divided by the square of height (m^2). Inclusion criteria for this study were age 18 to 45 years, a full set of natural teeth, and a willingness to eat the test foods. Participants were excluded from the study if they had used or were using tobacco products, were underweight (BMI <18.5), had a history of or current gastrointestinal disease, currently had any disease, were using a medication that influences appetite, were dieters or restrained eaters (>13 on the restraint section of the Three-Factor Eating Questionnaire[17]), had an allergy or intolerance to the test foods, or rated the palatability of any of the test foods <6 on a 9-point scale. In addition, pregnant or lactating women were excluded.

During this screening session, participants also consumed five portions of pizza rolls in their usual eating manner. For each portion of pizza rolls, they were asked to count and report the number of chews made before swallowing. An investigator sat with the participant to observe jaw movements, to check the accuracy of his or her report, and to measure duration of chewing for each portion using a stopwatch. Chewing rate was calculated by dividing the number of chews by chewing duration. For each participant, the average number of chews from five replicates was calculated and used as the baseline number of chews in order to determine the chewing cycles specified for the treatment conditions for him/her (100%, 150%, and 200% of the baseline number of chews).

General Procedure on Test Session

This study used a randomized cross-over design. Participants attended three test sessions at their usual lunch time, with each session being separated by a 7-day washout period. To reduce potential bias, participants were told the study was "a study on effects of eating rate on hand-to-eye coordination task performance." To maintain this ruse, participants were required to complete tasks relating to hand-to-eye coordination (typing speed and accuracy) before and after eating.

On each test day, participants were asked to consume the same breakfast at their habitual breakfast time and avoid alcohol consumption or strenuous exercise/activity for 24 hours before the test session. They were instructed not to eat or drink any food except water after breakfast until the test session. Participants were required to report to the laboratory at their usual lunch time for the test session. An appetite questionnaire was then completed to assess baseline appetite ratings. The questionnaire posed four questions: How hungry do you feel right now? How full do you feel right now? How palatable do you find the food right now? What is your desire to eat right now? Responses were captured using a 100-mm visual analog scale. The visual analog scale was anchored with diametrically opposed statements in each end (eg, not hungry at all; as hungry as I have ever felt). The participant was instructed to draw a vertical marker on the scale at the position they felt reflected the current strength of their appetitive feeling. Sixty pizza rolls were then provided (t0) and the participant was told the number of chewing cycles that they were required to make before swallowing. The participant was asked to consume one pizza roll in each mouthful and count the number of chews before they swallow. They were instructed to eat until comfortably full and informed they could request more pizza rolls if required. An investigator sat with the participant and observed jaw movements to confirm protocol compliance. No beverage consumption was allowed during the test session.

Meal duration was measured using a stopwatch and appetite questionnaires were completed at t0 +5, 10, 15, 20, 25, 30, 45, 60 minutes, and at meal termination. Participants were allowed to leave the laboratory after completing the last appetite questionnaire. Appetite questionnaires were collected for 60 minutes after meal initiation to collect data on participant's appetite sensations and to ensure that all participants remained in the laboratory for the same amount of time so there was no advantage to eat less in order to leave the laboratory quicker.

The amount of food eaten was determined by weighing the plate before and after serving. Participants were not aware of this measurement. Average eating rate was calculated by dividing the weight of food consumed by meal duration.

The study protocol was approved by the Iowa State University Institutional Review Board and all participants signed an informed consent form before being included in the study.

Statistical Analysis

All data are presented as mean±standard error of the mean. SAS v9.2 software (2009, SAS Institute) was used to perform the statistical analysis. Participants were categorized into three groups based on their BMI (18.5 to 24.9 as normal weight, 25.0 to 29.9 as overweight, and ≥30 as obese). A power calculation indicated that 16 participants in each group were required to maintain a power of 80% at a significance level of 0.05. This sample size can detect a difference of 50 kcal in food intake and a difference of 10 mm in subjective appetite. The initial model using sex as a covariate found no significant sex effect, so the data were pooled. One-way analysis of variance was used to test for differences among different weight groups in the baseline mastication parameters. A repeated measure analysis of variance was used to test overall treatment effect (100%, 150%, and 200% of baseline number of chews), time effect, and their interactions on subjective appetite ratings using baseline appetite value as a covariate. Food intake, meal duration, average eating rate, and appetite ratings at meal termination were tested using a two-way analysis of variance to assess the effect of treatment and BMI, as well as their interactions. Least square means were computed and compared using the Bonferroni correction for post hoc comparison.