RESEARCH
Original Research

Slower Eating Speed Lowers Energy Intake in Normal-Weight but not Overweight/Obese Subjects

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ARTICLE INFORMATION

Article history:
Accepted 28 October 2013
Available online 30 December 2013

Keywords:
Eating speed
Energy intake
Appetite ratings
Normal weight
Overweight

Supplementary materials:
Podcast available at www.andjrnl.org/content/podcast

2212-2672/$36.00
http://dx.doi.org/10.1016/j.jand.2013.11.002

ABSTRACT

Background The effect of eating speed on energy intake by weight status is unclear.

Objective To examine whether the effect of eating speed on energy intake is the same in normal-weight and overweight/obese subjects.

Design The effect of slow and fast eating speed on meal energy intake was assessed in a randomized crossover design.

Participants/setting Thirty-five normal-weight (aged 33.3±12.5 years; 14 women and 21 men) subjects and 35 overweight/obese (44.1±13.0 years; 22 women and 13 men) subjects were studied on 2 days during lunch in a metabolic kitchen.

Intervention The subjects consumed the same meal, ad libitum, but at different speeds during the two eating conditions. The weight and energy content of the food consumed was assessed. Perceived hunger and fullness were assessed at specific times using visual analog scales.

Statistical analyses Effect of eating speed on ad libitum energy intake, eating rate (energy intake/meal duration), energy density (energy intake per gram of food and water consumed), and satiety were assessed by mixed-model repeated measures analysis.

Results Meal energy intake was significantly lower in the normal-weight (804.5±438.9 vs 892.6±330.2 kcal; P=0.04) but not the overweight/obese (667.3±304.1 vs 724.8±355.5 kcal; P=0.18) subjects during the slow vs the fast eating condition. Both groups had lower meal energy density (P=0.005 and P=0.001, respectively) and eating rate (P<0.0001 in both groups) during the slow vs the fast eating condition. Both groups reported less hunger (P=0.01 and P=0.03, respectively), and the normal-weight subjects reported more fullness (P=0.02) at 60 minutes after the meal began during the slow compared with the fast eating condition. There was no eating speed by weight status interaction for any of the variables.

Conclusions Eating slowly significantly lowered meal energy intake in the normal-weight but not in the overweight/obese group. It lowered eating rate and energy density in both groups. Eating slowly led to lower hunger ratings in both groups and increased fullness ratings in the normal-weight group at 60 minutes from when the meal began.
J Acad Nutr Diet. 2014;114:393-402.

OBESITY, DEFINED AS BODY MASS INDEX (BMI) OF ≥30, is a major problem in the United States. According to national surveys, the prevalence of obesity in US adults has increased from 14.5% in the years 1971-1974 to 35.9% in the years 2009-2010.[1,2] The rapid rise in the prevalence of obesity may be partly due to a 12% increase in reported energy intake in the United States from 1971-1975 to 1999-2002.[3]

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One possible behavioral strategy to control energy intake and body weight may be to reduce the speed of eating. According to de Graaf and Kok[4] and de Graaf,[5] a factor that weakens the ability to control energy intake is a high eating rate. The researchers suggest that a high eating rate impairs the congruent relationship between the sensory signals and the metabolic processes that determine how much we eat.

Findings from a number of epidemiologic studies show that eating speed is positively related to body weight.[6-12] However, most of the studies were conducted in subjects with normal or mostly normal weight (BMI 18.5 to 24.9) and from largely Asian populations. These limitations make it difficult to generalize the findings to the US population. In addition, the information on eating rate was self-reported. Melanson and colleagues[13] found that self-reported eating

rate may not be correlated with measured free-living eating rate. Methodologic issues with assessment of eating rate render the epidemiologic results more difficult to evaluate.

A number of investigators have conducted intervention studies on the effect on food intake of eating speed, modified by changing the bite size, bite rate, number of chews per bite, and/or eating duration, or by giving foods with different textures, and the results are controversial. Several studies have found a decrease in energy or food intake with a reduction in eating rate,[14-17] some studies observed lower food intake in response to slower eating in men but not women[18] or in linear (typically eating at a constant rate) but not decelerated eaters,[19] three studies found no relationship between eating rate and energy intake,[20-22] and one study[23] observed a higher energy intake with more pauses within meals. In addition, Forde and colleagues[24] reported a lower eating rate and ad libitum intake when subjects were given a solid-savory meal vs a mashed-savory meal, and Zijlstra and colleagues[25] reported higher ad libitum intake in the highest quartile vs the lowest quartile of eating rate. Moreover, only three of these studies[15,20,21] have examined how eating speed influences energy intake in obese/overweight vs normal-weight subjects. One of these three studies[15] found a reduction in energy intake with increased chewing activity per bite in both the normal-weight and overweight/obese groups, whereas the other two studies[20,21] found no significant effect of ingestion rate on energy intake in either the normal-weight or overweight/obese groups. The controversial results by weight status may be due to the fact that the three studies[15,20,21] had a limited number of subjects (six to 16 normal-weight and six to 14 obese subjects) and did not mention controlling for potential confounding factors such as energy intake and/or physical activity before the study. In addition, two[15,21] of the three studies did not randomly assign the meals. Lastly, Laessle and colleagues[26] reported higher eating rate, bite size, and ad libitum energy intake in overweight compared with normal-weight subjects. Laessle and colleagues[26] did not assess the effect of different eating speeds on energy intake.

The above issues, as well as the fact that some professional organizations[27] and weight loss programs advise obese individuals to reduce eating speed to control energy intake, stress the importance of further examining the relationship between eating speed and energy intake in a well-designed study with a larger group of normal-weight and overweight/obese subjects. We investigated whether eating a meal slowly would lead to lower meal energy intake and less hunger and desire to eat and higher levels of fullness after the meal compared with eating the same meal more quickly in normal-weight and overweight/obese subjects. Subjects were given general instructions on how to change their eating speed. The two eating conditions were implemented in each subject in a randomized crossover design, and physical activity and energy intake before the study were controlled.

MATERIALS AND METHODS

Subjects and Recruitment

Normal-weight (n=35) and overweight/obese (n=35) men and women between the ages of 19 and 65 years were recruited for the study (Table 1). To be classified as overweight, a subject had to meet two of the following three criteria: waist circumference >88 cm for women or >102 cm for men, BMI ≥25.0 for both men and women, and percent body fat >25% for men and >32% for women.[28]

Exclusion criteria included being severely obese (BMI ≥40), dieting, taking medications that affect appetite, participating in >150 minutes per week of vigorous physical activity, smoking, or drinking heavily (men: >14 alcoholic drinks per week; women: >7 alcoholic drinks per week). Other exclusion criteria were self-reported disordered eating, depression, type 1 or 2 diabetes, adrenal disease, or untreated thyroid disease. Severely obese subjects were excluded because binge eating is related to the degree of obesity[29] and the presence of a binge eating disorder may affect the results.

The subjects were recruited from Texas Christian University (TCU) and the surrounding community. The study was conducted in a metabolic kitchen at TCU. Before data collection, each subject signed a consent document approved by the TCU Institutional Review Board. The TCU Institutional Review Board has a Federalwide Assurance with the US Office of Human Research Protection and has committed to comply with the requirements of the US Department of Health and Human Services Protection of Human Subjects regulations.

Experiment Design

The effect of eating condition (slow or fast eating speed) on meal energy intake was assessed in normal-weight and overweight/obese subjects using a randomized crossover design. Following screening, each subject reported to the metabolic kitchen on 2 study days for lunch. The 2 study days were separated by a washout period of at least 4 days (13.8±12.6 days). On the first study day, subjects were randomly assigned to consume a meal at a fast or slow eating speed. On the subsequent study day, subjects consumed the same meal but at the alternative eating speed.

Test Meal

The test meal during each study day was a mixed meal of vegetable pasta. The mixed meal was made with ditalini pasta, tomatoes, olive oil, green onions, garlic, parsley, basil, sugar, salt, pepper, and Parmesan cheese. Women were served 900 g and men were served 1,200 g mixed meal corresponding to 1,300 kcal and 1,734 kcal, respectively, during each study day. The meal contained 50.5% energy from carbohydrate, 38.6% energy from fat, 12.2% energy from protein, and 330 mg sodium per 100 g. The subjects were also given 355 mL (12 fl oz) water with each meal and allowed more water, ad libitum, if they wished.

Study Protocol

Each subject consumed the meal at the same time on the 2 study days. For menstruating women, each study day was scheduled in the follicular phase of the menstrual cycle.

Subjects were instructed to keep their food/drink intake and physical activity levels the same on the day before the study days and the morning of the study days. During the study days, subjects were instructed to consume the same breakfast at least 4 hours before lunch and not to consume any food or drink other than water between breakfast and lunch and any water an hour before lunch. To verify that the above conditions were met, subjects were asked to keep a food record the day before the study days and the morning of