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A randomized controlled trial to study the effects of breakfast on energy intake, physical activity, and body fat in women who are nonhabitual breakfast eaters

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ABSTRACT

Purpose: The purpose of this study was to determine the effects of eating breakfast on energy intake, physical activity, body weight, and body fat in women who are nonhabitual breakfast eaters over a four-week period.
Methods: Forty-nine women who were nonhabitual breakfast-eaters were randomized to one of two conditions: breakfast or no breakfast. Breakfast eaters were required to eat at least 15% of their daily energy requirement before 8:30 a.m. Non-breakfast eaters did not consume any energy until after 11:30 a.m. Weight and body fat were assessed at baseline and after four weeks of intervention. Body fat was measured by dual energy x-ray absorptiometry (DXA). Participants completed seven 24-hour recalls to assess dietary intake during the intervention. Physical activity was measured by accelerometry for 32 consecutive days. RESULTS: On average, the participants randomized to eat breakfast consumed 266 ± 496 ($F = 12.81$; $P < 0.01$) more calories per day over the course of the study and weighed 0.7 ± 0.8 kg ($F = 7.81$; $p < 0.01$) more at the end of the intervention. There was no observed caloric compensation at subsequent meals and no change in self-reported hunger or satiety. There was also no physical activity compensation with the addition of breakfast.
Conclusion: The findings of our study showed that requiring non-breakfast eaters to eat breakfast resulted in higher caloric intake and weight gain. Future research should evaluate this relationship for a longer period of time to see if adding breakfast to the diet of women who generally do not eat breakfast results in adaptive behavior change over time.

1. Introduction

Habitual breakfast consumption is thought to be a good weight management strategy because it may promote satiety, regulate plasma glucose and hormones that control appetite, and is associated with higher physical activity in some observational studies (Abou Samra, Brienza, & Grathwohl, 2008; Farshchi, Taylor, & Macdonald, 2005; Leidy & Racki, 2010; Ratliff et al., 2009; Wyatt et al., 2002). However, the true role of breakfast consumption on weight regulation is still debatable. The majority of cross-sectional and longitudinal studies support a relationship between breakfast consumption and a lower BMI (Barton et al., 2005; Cho, Dietrich, Brown, Clark, & Block, 2003; Deshmukh-Taskar, Radcliffe, Liu, & Nicklas, 2010; Huang, Hu, Fan, Liao, & Tsai, 2010; Kent & Worsley, 2010; Keski-Rahkonen, Kaprio, Rissanen, Virkkunen, & Rose, 2003; Purslow et al., 2008; Summerbell, Moody, Shanks, Stock, & Geissler, 1996). Results from experimental studies are inconsistent with a couple of studies suggesting that breakfast consumption increases daily energy intake (Betts et al., 2014; Martin et al., 2000), other studies that show no relationship between breakfast consumption and energy intake, and another study that found reduced daily

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energy intake with the consumption of breakfast (Farshchi et al., 2005).

The inconsistent results in the literature are likely attributable to the unique design qualities of the various studies. Overall, the number of participants in the experimental studies has been limited, suggesting that the power of some studies may not have been adequate to detect modest changes in energy intake. The studies also have been relatively short in duration (most lasting between 3 and 14 d) and most have not evaluated physical activity, which is an important part of energy balance (Bailey, Tucker, Peterson, & LeCheminant, 2007, 2014a, 2014b).

In addition, studies have tended to recruit both habitual and nonhabitual breakfast eaters. Mixing both habitual and nonhabitual breakfast eaters in the same study has the potential to minimize or exaggerate the impact of the intervention. For example, if a non-breakfast eater is randomized to a no-breakfast-eating condition, it is likely that there would be a much smaller impact on energy balance than if a non-breakfast eater was randomized to a breakfast eating condition. Since the majority of people are habitual breakfast eaters, the above studies have tended to reflect this in their samples. In an acute study of breakfast, Thomas et al. specifically noted that the harmful impact of skipping breakfast on metabolic health and feelings of satiety were limited to habitual breakfast eaters (Thomas, Higgins, Bessesen, McNair, & Cornier, 2015). People who do not eat breakfast self-select this behavior for a reason and are different from those who habitually consume breakfast. (Halsey et al., 2012; Thomas et al., 2015). No study that we are aware of to date has looked exclusively at nonhabitual breakfast eaters. The primary goal of our study was to determine the effect of breakfast consumption, compared to no breakfast consumption, on energy intake over 28 days in women who were nonhabitual breakfast eaters. A secondary goal was to evaluate the effects of breakfast consumption, compared to no breakfast consumption, on physical activity, and body weight/fat. We hypothesized that there would be an increase in daily energy intake, body weight, and body fat, and physical activity level in women randomized to the breakfast condition compared to those randomized to the no-breakfast condition.

2. Methods

2.1. Research design

We performed a randomized controlled (pretest/posttest) trial. We tested 49 premenopausal women to compare the effects of eating breakfast versus not eating breakfast on energy and macronutrient intake and physical activity for a 4-week period. We chose 4 weeks to allow participants time to become accustomed to eating breakfast, while having adequate time to obtain detailed information on diet and physical activity patterns and minimizing participant burden. Each participant was randomized to one of two different conditions: breakfast or no breakfast. Breakfast eaters were required to eat within 1.5 h of awakening and had to be finished eating their breakfast meal ($\geq$15% total energy intake) by 8:30 a.m. There were no eating or snack restrictions after the breakfast meal for the breakfast eating group. Non-breakfast eaters were defined as not consuming a snack or meal (with the exception of noncaloric beverages) until after 11:30 a.m. For consistency, both groups of women were asked to wake up by 8:00 a.m. Participants assigned to the breakfast condition consumed at least 15% of their daily energy requirement for breakfast. Fifteen percent was chosen as the minimum energy intake for breakfast because it was between the 10% used by Astbury et al. and the 24% used by Leidy et al. and represents a meaningful amount of food (Astbury, Taylor, & Macdonald, 2011; Leidy & Racki, 2010). We multiplied the Harris-Benedict equation by an activity factor of 1.4 to estimate total energy needs.

2.2. Participants

Participants were 18–55 years old, habitual non-breakfast eaters (eat breakfast $\leq$ 2 d/wk) and regular sleepers who got at least six hours of sleep a night and woke up consistently before 8:00 a.m. Participants were weight stable for the three months prior to the study and apparently healthy as indicated by a health history questionnaire. Participants were excluded for the following: tobacco or alcohol use, night shift workers, current dieting, eating disorders—including anorexia, bulimia, or instances of binge-eating, digestive disorders, medications that alter metabolism, the presence of a metabolic disease that affects energy balance (e.g., diabetes mellitus, cancers, heart disease, etc.), excessive exercise training (vigorous-intensity activity >4 days/week and 30 min per session), participation in college athletics or any elite sport, inability to exercise at a moderate-intensity level (3.0–6.0 METs) or consumed breakfast more than two times a week. Participants were recruited through flyers, word of mouth, electronic announcements, and Facebook. The institutional review board approved the study and all participants gave informed consent. Participants received a voucher for $100 for completion of the study.

2.3. Measurements

2.3.1. Body composition and anthropometric measures

We assessed body weight, composition, and anthropometric measures prior to the first week of the treatment and at the end of the study. Body weight was measured using a digital scale accurate to ±0.01 kg with participants barefoot and wearing a standardized one-piece swimsuits. Height was obtained using a stadiometer and BMI was calculated as kg/m^2.

Dual energy x-ray absorptiometry (GE Lunar iDXA, Madison, WI) was used to assess fat mass, fat free mass, and body fat percentage. The DXA is a valid measurement of body composition (Haarbo, Gotfredsen, Hassager, & Christiansen, 1991) and repeated measures testing performed in our lab has resulted in an intra-class correlation of 0.99 and a mean absolute measurement error of ±0.3 percent body fat.

2.3.2. Energy and macronutrient intake

Using the National Cancer Institute computerized, multiple-pass ASA24-hour recall (National Cancer Institute Applied Research, Betheseda, MD), we assessed energy and macronutrient intake. This method of diet assessment has been shown to reduce response bias and participant burden compared to food diaries and are a valid measure of energy intake (Arab, Tseng, Ang, & Jardack, 2011; Blanton, Moshfegh, Baer, & Kretsch, 2006; De Keyzer et al., 2011; Kirkpatrick et al., 2014; Moshfegh et al., 2008; Subar et al., 2012). It has also shown excellent agreement with the USDA automated multiple-pass dietary recall method (Kirkpatrick et al., 2014; Thompson et al., 2015).

Each participant completed a total of ten 24-hour food recalls that included two weekdays and one weekend day at baseline and five weekdays and two weekend days during the intervention. The recalls were assigned to random days of the week and participants were not informed which days the recalls were to be completed until the following morning.

2.3.3. Food and sleep logs

Participants were trained on how to complete a food and sleep log for the first meal of the day that was kept for the duration of the study, and the logs were reviewed by research assistants during