# The role of breakfast in the treatment of obesity: a randomized clinical trial[1,2]

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**ABSTRACT** Fifty-two moderately obese adult women were stratified according to their baseline breakfast-eating habits and randomly assigned a weight-loss program. The no-breakfast group ate two meals per day and the breakfast group ate three meals per day. The energy content of the two weight-loss programs was identical. After the 12-wk treatment, baseline breakfast eaters lost 8.9 kg in the no-breakfast treatment and 6.2 kg in the breakfast treatment. Baseline breakfast skippers lost 7.7 kg in the breakfast treatment and 6.0 kg in the no-breakfast treatment. This treatment-by-strata-by-time interaction effect ($P < 0.06$) suggests that those who had to make the most substantial changes in eating habits to comply with the program achieved better results. Analyses of behavioral data suggested that eating breakfast helped reduce dietary fat and minimize impulsive snacking and therefore may be an important part of a weight-reduction program. *Am J Clin Nutr* 1992;55:645–51.

**KEY WORDS** Obesity, weight reduction, breakfast, dietary fat, eating behavior

## Introduction

Nutritionists and nutrition texts recommend breakfast as an important part of healthy eating habits (1). Despite these recommendations millions of Americans routinely skip breakfast. Zabik (2) reported that 24% of women aged 25–34 y regularly skip breakfast. Many people may believe that by omitting breakfast they are reducing their total calorie intake thereby helping their efforts at weight control.

Eating breakfast is associated with improved strength and endurance, better attitude toward school or work, maintenance of a constant blood glucose concentration, and prevention of hunger and subsequent overeating later in the day (1, 2). Several large survey studies have examined the contribution of breakfast to general nutritional quality of the diet in adults and children. Using data from the Nationwide Food Consumption Survey, Morgan et al (3) concluded that skipping breakfast lowered the nutritional adequacy of adult diets, particularly for adult females. Studies in elderly populations also suggested that breakfast consumption enhances dietary adequacy (4). In general, individuals who eat breakfast regularly have more adequate micronutrient intakes, lower percentage of calories from fat, and higher intake of crude fiber. These findings are more striking for those individuals whose breakfast typically includes ready-to-eat cereals (2, 4, 5).

There were very little data on the role of breakfast in weight control. Zabik (2) reported that breakfast eaters had significantly higher intakes of protein and calories than did breakfast skippers, suggesting that people may be reducing their daily caloric intake by skipping breakfast. Other data suggest that those who skip breakfast select more calorically dense foods later in the day than do those who regularly eat breakfast (3).

The effects of meal skipping, both behaviorally and physiologically, may have an impact on the outcome of weight-loss efforts. However, there are few empirical data supporting this assertion (6). Fabry et al (7) showed in a random population sample of men aged 60–64 y that consuming one's food in a few large meals was associated with hypercholesterolemia, obesity, and higher levels of body fat than was eating frequent small meals. On the basis of animal and human research, Fabry and Tepperman (8) suggested that large infrequent meals in sedentary individuals is a risk factor for obesity, lipid disorders, heart disease, and diabetes.

Meal skipping may influence adherence to a calorie-controlled diet by encouraging overeating later in the day or by increasing between-meal snacking on foods with poor nutrient density. These nonadherent behaviors adversely affect the macronutrient distribution and tend to increase overall caloric intake. Using a sequential analysis of eating-diary data, Schlundt et al (9) showed an association between meal skipping and overeating at subsequent meals.

Physiological variables may be influenced by meal skipping or irregular meal patterning, thus effecting energy utilization and energy balance. Eating one's daily allotment of food in a few large meals may be different metabolically from eating the same amount of calories in several smaller meals (6). Some studies show that rats eating their food in a few large meals have increased glucose synthesis, enhanced lipogenesis, more rapid absorption of fat and glucose, and more body fat (7). However, there is also a report that meal patterning does not affect energy balance in rats (10).

The present study examined the role that eating breakfast plays in a weight-reduction program. The study goal was to evaluate the effects of eating breakfast on changes in body weight,

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body composition, resting metabolic rate, macronutrient intake, psychological adjustment, and eating behaviors.

## Methods

### *Subjects*

Subjects for this study were 52 obese women aged 18–55 y who responded to newspaper articles asking for volunteers to participate in weight-loss research. Subjects were 30–60% above ideal body weight based on the Metropolitan Life Tables (11) with a body mass index of 30.6 ± 0.5 ($\bar{x}$ ± SD). Subjects were eliminated based on self-reports of a history of diabetes, heart, kidney or liver disease, cancer, or any other serious medical problems. Subjects who reported losing > 4.5 kg in the last month or > 9 kg in the last 6 mo were excluded. Subjects who used tobacco, nicotine gum, or any medications (eg, thyroid hormone or prednisone) that might influence resting metabolic rate were also excluded.

### *Design and recruitment*

Potential subjects who did not meet the entry criteria were excluded by an initial telephone interview. Remaining candidates were scheduled to attend a group orientation session during which the study was explained and informed consent was obtained. The protocol and consent form were reviewed and approved by the Vanderbilt University Committee for the Protection of Human Subjects. At this meeting, subjects were taught to keep a behavioral eating diary coding their meals by using a six-food-group exchange system. During the training session subjects practiced coding meals eaten earlier in the day and a dietitian checked their efforts for errors. Subjects were instructed to follow their typical eating pattern and to not make any dietary changes for a 2-wk period. Subjects remaining interested in the study returned for a second group meeting after keeping the diary for 2 wk. Candidates who did not return with completed diaries were excluded from the study. At the second group meeting, subjects also completed psychological questionnaires and were scheduled for individual appointments to obtain baseline physiological assessments.

On completion of the baseline measurements, subjects were stratified according to their self-reported breakfast eating habits by use of a breakfast-habits questionnaire developed for this study. Subjects reporting eating breakfast four or more times per week were considered breakfast eaters and subjects reporting eating breakfast three or fewer times per week were classified as breakfast skippers. Approximately an equal number of subjects from each strata was randomly assigned to each of two experimental diet conditions—breakfast or no breakfast. Seventeen breakfast eaters were assigned to the breakfast group and 19 breakfast eaters were assigned to the no-breakfast group. Eight breakfast skippers were assigned to the breakfast group and eight breakfast skippers were assigned to the no-breakfast group.

### *Weight-loss treatment program*

Two separate 5016-kJ/d (1200 kcal) weight-reduction programs were prepared, each consisting of ≈50–55% of energy from carbohydrates, 15–20% from protein, and 25–30% from fats. Subjects were given 2 wk of detailed sample menus constructed by use of a food-group exchange system and were trained to use the exchange system to make substitutions and modifications to the menu pattern.

The two diets differed only in the number of meals per day. The no-breakfast diet consisted of two meals, lunch (1672 kJ) and supper (3344 kJ), whereas the breakfast diet consisted of three meals, breakfast (1672 kJ), lunch (1254 kJ), and supper (2090 kJ). The energy content of the meals was selected to create as large a separation as possible between the two regimens. To match the fiber intake of the two conditions, subjects in the breakfast group were provided cereal whereas subjects in the no-breakfast group were provided with bran muffins. Subjects were given sufficient quantities of cereal or muffins to allow them to consume these daily. Subjects were told that the goal of the study was to compare two vs three meals per day. The menus were intended to be used as guidelines. Subjects were also taught to use food exchanges to plan meals and were strongly encouraged to adhere to the prescribed number of meals per day as well as the daily calorie goal.

To maximize weight loss, both groups received a 12-wk behavior-modification program consisting of a 90-min group meeting each week for 12 wk. The basic approach of the behavioral program was problem solving and skill training (12). The DIET questionnaire (13) and computer-generated feedback from eating diaries (14) were used as assessment methods to identify each participant's most difficult problem situations for weight control. Feedback during the early part of the program was generated from the baseline eating diaries. As the program progressed subjects were given feedback on the diaries that they had collected during treatment. Subjects were strongly encouraged to record all meals and snacks, even those that did not strictly adhere to the diet. Trained research assistants checked the accuracy of subjects' food-group coding and corrected the coding if necessary. Subjects were given written feedback on their errors to improve coding accuracy. Each session consisted of presentations, discussions, problem solving, rehearsal exercises, and homework related to a specific type of problem situation (eg, resisting temptation, overeating, and social eating). The sessions were individualized by providing subjects with computer-generated feedback from their eating diaries.

Contingency contracts were used to enhance session attendance and participation in follow-up data collection. Subjects could earn up to $50.00 for attending sessions and were paid $50.00 for completing the follow-up assessments. Subjects who missed a group session were mailed handouts and printouts the next day and were contacted by telephone before the next meeting. Subjects having compliance difficulties were invited to schedule one-on-one sessions with a group leader to obtain individualized problem solving.

### *Dependent variables*

*Body weight.* Body weight was measured with a calibrated balance beam scale. Weights were taken at baseline, at weekly group meetings, and at follow-up.

*Body composition.* Body composition was determined at the beginning and end of the study from body density. Body density was determined using underwater weighing (15). Body weights in air and underwater were measured to the nearest 25 g using Heath platform (Detecto Scales, Web City, MO) and Chatillon spring (Kew Gardens, NY) scales, respectively. Residual lung volume was determined simultaneously with underwater weighing using a closed-circuit nitrogen-dilution method. Nitrogen concentration during rebreathing was measured with a Med-

Science 505-D Nitralizer (Med-Science, St Louis). Percent body fat was estimated from body density using the revised equation of Brozek et al (16). Estimates of fat and fat-free mass (FFM) were also calculated.

*Energy expenditure.* Resting metabolic rate (RMR) was measured before and after weight loss. RMR was determined with indirect calorimetry (17) after an overnight fast. After resting quietly for 45 min, subjects breathed through a face mask for ≈15 min. Respired air entered a mixing chamber and was continuously monitored for oxygen and carbon dioxide with Ametek S-3A and CD-3A analyzers (Ametek, Pittsburgh). Oxygen consumption values were converted to energy expenditure with the Weir equation (18).

*Blood pressure.* Blood pressure was measured at baseline and post-treatment using a random-zero sphygmomanometer. Blood pressure was taken sitting upright after ≥ 5 min of rest and was based on the average of two readings taken ≥ 30 s apart.

*Lipids.* Blood was drawn from each subject in the fasted state at the beginning and after the 12-wk study. Blood was analyzed for total cholesterol and total triglycerides.

*Self-monitoring of eating behavior.* Subjects kept a behavioral diary during the 2-wk baseline and during the 12-wk treatment program. The diary was used to record all meals and snacks along with the social, environmental, and emotional context in which the eating occurred. Each bout of physical activity was also recorded in the diaries. Subjects failing to turn in a diary at each group meeting were asked to bring the diary to the investigators within 2 d. The diaries were entered into a microcomputer that was used to generate weekly individual feedback on the relationship between eating behaviors and the psychosocial variables (19). Thus, the diaries were used to collect data on eating behavior pattern, to provide individualized behavioral assessment information, and to enhance compliance and increase total weight loss.

Schlundt et al (20) used cluster analysis to derive a set of eating-behavior-pattern measures from the eating diaries employed in this study. One hundred seventy measures of overeating, impulsive eating, and macronutrient intake in response to a range of environmental and emotional antecedents were extracted from each of 236 2-wk eating diaries. Hierarchical cluster analysis of baseline diary data collected was used to reduce the data to 20 cluster scores that measure different aspects of eating-behavior patterns. Values for each of the 20 cluster variables were calculated from the 2-wk baseline diaries and from the diaries kept during the 12-wk treatment program. In addition macronutrient intakes and probabilities reflecting meal distribution were estimated from the diaries.

*Questionnaires.* The following questionnaires were administered at baseline and at posttreatment: DIET questionnaire (13), the three-factor eating questionnaire (21), the SCL-90 (22), the Hawkins binge scale (23), the body cathexis scale (24), and a 56-item physical-symptoms check list.

### *Six-month follow-up*

All subjects were asked to return 6 mo after the beginning of the program to be weighed and retested on several dependent measures including body composition and RMR. At least three contacts were made with each subject to attempt scheduling follow-up testing.

### *Data analysis*

Data were analyzed with repeated-measures analysis of variance. Between-subjects factors were subject strata (breakfast eaters vs breakfast skippers) and experimental treatment (breakfast vs no-breakfast condition). The repeated-measures factor, time, had two levels, baseline and posttreatment.

## Results

### *Dropouts*

Of the 52 subjects who completed baseline and were randomly assigned, 7 did not complete the weight-loss program, resulting in a dropout rate of 13.5%. Three subjects in the breakfast treatment and four subjects in the no-breakfast treatment did not complete the program. All seven dropouts were from the breakfast-eater strata.

Dropouts were compared with those completing the program on baseline measures by using *t* tests. The dropouts did not differ on any of the physiological measures, questionnaire measures, or any variables derived from the eating diaries.

### *Physiological variables*

For weight loss there was a significant time effect ($P < 0.001$) and a marginally significant strata-by-treatment-by-time interaction effect ($P < 0.06$). Mean weight losses are presented in **Table 1.** These data suggest that the interaction effect occurred because subjects assigned to a treatment different from their prior eating habits did better than those assigned to a treatment involving continuing their prior breakfast habits.

There was a significant time effect ($P < 0.0001$) for body fat percentage showing that weight loss resulted in a reduction in percent body fat. There were no significant strata or treatment effects. Body fat percentage was reduced from a mean of 42.1% at baseline to 38.9% at posttreatment. Analysis of body composition data showed that the mean percent of weight loss due to fat was 75% with 25% of the weight loss due to loss of FFM.

RMR declined by an average of 6% when expressed as kJ/h [from 271.7 ± 5.9 ($\bar{x}$ ± SD) at baseline to 257.9 ± 4.6 at posttreatment; $P < 0.002$] with no differences as a function of strata or treatment. After adjusting RMR for changes in FFM ($kJ \cdot h^{-1} \cdot kg\ FFM^{-1}$), metabolic rate did not decline with weight loss (from 5.52 ± 0.67 to 5.73 ± 1.56; NS).

Significant reductions occurred in systolic and diastolic blood pressure (115/76 to 109/71 mm Hg; $P < 0.004$), total cholesterol (5.59 ± 0.23 to 5.02 ± 0.20 mmol/L; $P < 0.0001$), and serum triglycerides (1.42 ± 0.15 to 1.20 ± 0.15 mmol/L; $P < 0.05$). For total cholesterol there was a significant treatment-by-strata-by-time interaction effect ($P < 0.05$). Breakfast eaters randomly

TABLE 1
Mean weight loss by strata and treatment*

| | Breakfast eaters | Breakfast skippers |
|---|---|---|
| | *kg* | |
| Breakfast | 6.2 ± 3.3 [15] | 7.7 ± 3.3 [8] |
| No breakfast | 8.9 ± 4.2 [14] | 6.0 ± 3.9 [8] |

* $\bar{x}$ ± SD; *n* in brackets.

assigned to the breakfast condition and breakfast skippers randomly assigned to the no-breakfast condition showed the largest reductions in cholesterol although these two subgroups showed the smallest weight loss.

On the DIET questionnaire significant improvements (time main effect) were observed on all scales and for the DIET total scores ($P < 0.0001$). There was also a treatment-by-time interaction effect ($P < 0.009$) on the negative emotional eating subscale. Posttreatment scores did not differ for the two groups but baseline scores were lower for the no-breakfast group, suggesting that these subjects had more difficulty with emotional eating at baseline. There were significant reductions in scores on the binge scale, the body cathexis scale, the physical symptoms check list, the disinhibition scale, and the hunger scale whereas scores on the restraint scale increased significantly ($P < 0.002$). The increase in restraint scores suggests that these subjects showed an understandable increase in behaviors associated with dieting and food restriction whereas the other questionnaires suggest an improvement in overall psychological functioning, satisfaction with the body, and a decrease in problematic eating behaviors.

There were significant reductions in the average energy content of lunch, supper, and snacks from baseline (**Table 2**). For lunch there was only a significant treatment-by-time interaction effect ($P < 0.02$). Subjects in the breakfast group reduced the energy content of their lunches more than did subjects in the no-breakfast group. For supper there were significant treatment-by-time ($P < 0.0001$) and strata-by-time ($P < 0.001$) interaction effects. Subjects in the breakfast treatment group reduced the energy content of their suppers more than did subjects in the no-breakfast group. Pretreatment breakfast skippers made greater reductions in supper energy than did pretreatment breakfast eaters. There were no interaction effects for energy content of snacks. These changes suggest that subjects complied with the dietary pattern associated with their treatment condition.

Significant changes occurred in macronutrient distribution expressed as percent of energy from protein, carbohydrates, and fats. For percent energy from fat there was a significant time effect ($P < 0.0001$) reflecting an overall proportional reduction in dietary fat with a significant treatment-by-time interaction effect ($P < 0.0001$). Subjects in the breakfast condition reduced the proportion of fat in their diet to lower levels than did subjects in the no-breakfast condition. For percent of energy from carbohydrates, there was also a significant treatment-by-time interaction effect ($P < 0.003$) with only subjects in the breakfast condition showing an increase on this variable. There was a significant time effect ($P < 0.0001$) reflecting an overall increase in proportion of energy from protein.

Meal distribution was examined by looking at the probability distribution of meals at baseline and during treatment. For breakfast there were significant time ($P < 0.0001$), treatment-by-time ($P < 0.0001$), and strata-by-time ($P < 0.05$) effects. These data reflect excellent compliance with the independent variable, with breakfast subjects showing increased proportion of meals that were classified as breakfast and no-breakfast subjects eating breakfast < 3% of the time. For lunch there were time ($P < 0.0001$) and treatment-by-time ($P < 0.0001$) effects. The proportion of meals classified as lunch increased for both groups with a greater proportion of meals classified as lunch in the no-breakfast group. For supper there were significant time ($P < 0.0001$), treatment-by-time ($P < 0.0001$), and strata-by-time ($P < 0.001$) effects. These data also reflect compliance with the treatment program (*see* Table 2). For snacking there was only a significant time effect ($P < 0.0001$), with a substantial reduction of the percentage of meals classified as snacks from 28% at baseline to 6% during treatment.

TABLE 2
Meal patterns and macronutrient distributions

| | Baseline | | | | Posttreatment | | | |
|---|---|---|---|---|---|---|---|---|
| | Breakfast | | No breakfast | | Breakfast | | No breakfast | |
| | Eat | Skip | Eat | Skip | Eat | Skip | Eat | Skip |
| Total energy (kJ) | | | | | | | | |
| Lunch | 2834 ± 1152 | 2913 ± 732 | 2575 ± 616 | 2529 ± 487 | 1517 ± 175 | 1354 ± 227 | 1898 ± 269 | 3026 ± 374 |
| Supper | 2872 ± 738 | 3616 ± 1176 | 2692 ± 741 | 3168 ± 918 | 2031 ± 290 | 1680 ± 391 | 2638 ± 585 | 2353 ± 587 |
| Snack | 1404 ± 731 | 2023 ± 755 | 1436 ± 578 | 1404 ± 525 | 849 ± 390 | 915 ± 420 | 1129 ± 809 | 941 ± 654 |
| Macronutrient distribution (%) | | | | | | | | |
| Fat | 40 ± 4 | 41 ± 9 | 39 ± 6 | 38 ± 6 | 29 ± 3 | 28 ± 3 | 31 ± 4 | 33 ± 4 |
| Protein | 17 ± 3 | 16 ± 3 | 17 ± 3 | 17 ± 2 | 22 ± 1 | 24 ± 2 | 23 ± 2 | 23 ± 4 |
| Carbohydrate | 42 ± 3 | 42 ± 10 | 43 ± 6 | 43 ± 6 | 49 ± 2 | 48 ± 2 | 46 ± 5 | 43 ± 8 |
| Probabilities | | | | | | | | |
| Breakfast | 0.25 ± 0.05 | 0.21 ± 0.09 | 0.26 ± 0.06 | 0.19 ± 0.06 | 0.32 ± 0.02 | 0.33 ± 0.02 | 0.03 ± 0.04 | 0.01 ± 0.01 |
| Lunch | 0.23 ± 0.06 | 0.26 ± 0.04 | 0.26 ± 0.06 | 0.26 ± 0.07 | 0.32 ± 0.02 | 0.32 ± 0.02 | 0.47 ± 0.04 | 0.46 ± 0.04 |
| Supper | 0.24 ± 0.04 | 0.31 ± 0.08 | 0.24 ± 0.05 | 0.26 ± 0.04 | 0.31 ± 0.02 | 0.31 ± 0.02 | 0.46 ± 0.04 | 0.44 ± 0.04 |
| Snack | 0.29 ± 0.10 | 0.24 ± 0.09 | 0.26 ± 0.14 | 0.30 ± 0.12 | 0.05 ± 0.04 | 0.04 ± 0.04 | 0.05 ± 0.06 | 0.09 ± 0.07 |
| Overeat† | 0.28 ± 0.24 | 0.25 ± 0.11 | 0.30 ± 0.20 | 0.20 ± 0.14 | 0.09 ± 0.09 | 0.09 ± 0.07 | 0.12 ± 0.11 | 0.11 ± 0.11 |
| Impulsive‡ | 0.30 ± 0.17 | 0.22 ± 0.13 | 0.29 ± 0.15 | 0.22 ± 0.15 | 0.09 ± 0.09 | 0.05 ± 0.04 | 0.10 ± 0.11 | 0.09 ± 0.08 |

* $\bar{x} \pm$ SD.
† Subjects answered yes or no to the question, "Did you overeat for each eating episode?"
‡ Subjects answered yes or no to the question, "Was the meal unplanned or impulsive for each eating episode?"

*Eating-behavior patterns*

Changes in eating-behavior patterns were evaluated by analyzing the cluster-analysis–derived behavioral variables extracted from the eating diaries (19). These variables reflect macronutrient distribution, overeating, and impulsive eating in a variety of daily situations and are based on means and probabilities from the diary data. Two sets of scores were extracted, one from the baseline diaries and another from the treatment diaries. The values of the baseline variables were calculated from 2663 meal observations whereas the treatment values were based on 8117 meal observations. Results presented are from 52 subjects who provided complete baseline diaries and sufficient data during treatment to allow extraction of the microanalysis variables. The average rate of compliance with treatment record keeping was 0.71 ± 0.23. Thus, on average, the treatment diaries contained records for 9 of 12 wk of treatment. There was no significant difference in record-keeping compliance as a function of treatment group or strata.

Repeated-measures analyses of variance were conducted on 20 variables extracted from the eating diaries. **Table 3** presents the results of the *F* tests for the treatment group main effect, the strata main effect, and the treatment-by-strata interaction. A treatment-by-strata interaction effect was present for three variables. The impulsive snacking variable reflects the nutritional contribution of unplanned and uncontrolled snacking. The interaction effect occurred because the breakfast skippers in the breakfast group showed a reduction in impulsive snacking whereas the breakfast skippers in the no-breakfast group showed a slight increase. There was also a main effect for treatment group with subjects in the breakfast condition showing greater reduction in calories and fat from impulsive snacking.

The meal size variable showed a significant interaction effect. This was primarily because of the breakfast skippers in the breakfast group showing a greater reduction in meal size than the breakfast skippers in the no-breakfast group. There were also strata effects with breakfast skippers reducing meal size more than did breakfast eaters and a group effect with subjects in the breakfast group showing a greater reduction in meal size than did the no-breakfast group. The eating-at-work variable also showed an interaction effect. Again, the breakfast skippers in the breakfast group showed greater reductions in uncontrolled eating and high calorie-high fat intake at work than did the breakfast skippers in the no-breakfast group who essentially did not change on this behavioral measure.

There were additional treatment group main effects on several variables. The main effect for social meals was because subjects in the breakfast group showed greater reductions in calorie and fat intake at social meals than did subjects in the no-breakfast group. The same pattern was found for the variable named large meals, showing that subjects in the breakfast group showed greater reductions in the frequency of eating very large meals. There was also a main effect for impulsive eating, with the breakfast subjects showing greater reduction in this behavior than did the no-breakfast subjects.

For the most part there were not many changes on the variables reflecting emotional eating. The exceptions were a great reduction in eating in response to boredom that occurred for both treatment groups and a reduction in depression-induced eating that also showed a treatment-group main effect. The subjects in the breakfast group showed a slight increase in depression-induced eating whereas the subjects in the no-breakfast group showed a slight decrease. However, overall rates of depression-induced eating were low, suggesting that this difference is not of great importance. The other variable that showed a treatment-group main effect was social adjustment. This variable measures the degree to which a person's calories are mainly associated with regular meals and family situations. The no-breakfast subjects mainly limited their food intake to lunch and supper, which are usually the most social meals of the day.

TABLE 3
Analysis of behavior changes: *F* ratios for testing each effect

| Variable | Time | Treatment × time | Strata × time | Treatment × strata × time |
|---|---|---|---|---|
| Social meals | 21.2* | 11.6* | 2.0 | 1.0 |
| Social events | 1.9 | 2.8 | 0.0 | 0.5 |
| Impulsive snacks | 12.6* | 23.0* | 1.1 | 6.1† |
| CHO intake | 18.5* | 0.0 | 2.8 | 0.6 |
| Large meals | 15.1* | 17.2* | 7.7† | 0.8 |
| Meal size | 36.1* | 27.4* | 10.6† | 4.6‡ |
| Overeating | 25.7* | 0.4 | 1.3 | 1.1 |
| Impulsive eating | 53.1* | 4.8‡ | 1.2 | 2.4 |
| In the car | 8.1‡ | 2.7 | 1.0 | 0.6 |
| At work | 4.2‡ | 11.3† | 1.0 | 5.4‡ |
| − Emotional eating | 5.2‡ | 1.3 | 0.0 | 1.4 |
| + Emotional eating | 1.5 | 0.3 | 1.2 | 0.1 |
| Illness eating | 2.3 | 1.9 | 1.7 | 0.1 |
| Stimulus exposure | 2.2 | 3.0 | 1.1 | 0.0 |
| Depression eating | 0.7 | 6.8† | 3.6 | 2.9 |
| Boredom eating | 102.0* | 3.4 | 1.1 | 0.5 |
| Somatic eating | 1.6 | 0.6 | 0.1 | 0.1 |
| Negative moods | 0.5 | 1.8 | 0.0 | 1.0 |
| Alcohol | 1.4 | 0.5 | 0.9 | 0.2 |
| Social adjustment | 51.9* | 4.9‡ | 1.7 | 2.7 |

* $P < 0.001$.
† $P < 0.01$.
‡ $P < 0.05$.

*Six-month follow-up*

Overall, 70% (32 of 46) of the subjects completing the study returned for measurements 6 mo later. Better compliance with follow-up was obtained in the no-breakfast group (17 of 21 or 81%) than in the breakfast group (15 of 25 or 60%). **Table 4** shows the average body weight, resting metabolic rate, and body composition of subjects at the 6-mo follow up. There were no differences between the two experimental groups on any measure. In general subjects regained some body weight but remained below starting weight at 6 mo after completion of the study. Body fat increased only slightly during the 6 mo after study completion. RMR was restored to pre-weight-loss values at the 6-mo follow up. This was the case despite body weight remaining below that at the beginning of the study. However, RMR did not change at any time during the study or follow-up when it was expressed per kg FFM.

## Discussion

This study examined the impact of eating breakfast in a behavioral weight-control program using a randomized design

TABLE 4
Six-month follow-up*

| | Breakfast | | | No breakfast | | |
|---|---|---|---|---|---|---|
| | Before | After | 6 mo follow-up | Before | After | 6 mo follow-up |
| Body weight (kg) | 86.3 ± 2.8 | 74.8 ± 6.0 | 80.9 ±3.6 | 85.2 ± 2.8 | 78.8 ± 2.5 | 81.8 ± 2.7 |
| Body fat (%) | 41.5 ± 1.3 | 38.1 ± 1.6 | 38.4 ± 1.4 | 43.1 ± 1.1 | 39.5 ± 1.1 | 40.6 ± 1.0 |
| RMR (kJ/h) | 266 ± 9.2 | 248 ± 7.1 | 271 ± 12.1 | 280 ± 11.7 | 264 ± 8.8 | 280 ± 10.0 |
| RMR ($kJ \cdot FFM^{-1} \cdot h^{-1}$) | 5.31 ± 0.13 | 5.10 ± 0.08 | 5.39 ± 0.17 | 5.81 ± 0.17 | 5.56 ± 0.17 | 5.77 ± 0.17 |

* $\bar{x}$ ± SD.

controlling for initial breakfast-eating habits. Neither treatment provided an advantage in total weight loss. However, subjects who changed their pretreatment eating pattern (ie, changes from eating breakfast to not eating breakfast or vice versa) were marginally more successful in losing weight than subjects who did not.

Eating breakfast did provide some advantages over eating only two meals a day. The major advantage was that breakfast eaters showed a lower fat intake and higher carbohydrate intake. These results confirm the findings that eating breakfast is associated with improved nutrient density and general dietary adequacy (2–5). It is possible that similar results could be achieved by eating two main meals each day with one or two low-fat snacks. To achieve the daily calorie intake goal, the addition of low-fat snacks might have the same effect as eating breakfast by forcing people to reduce the size and fat content of their major meals while simultaneously boosting the percentage of calories from carbohydrates.

The other major advantage of eating breakfast was a greater reduction in unplanned, impulsive snacks and a larger reduction in calories and fats associated with impulsive snacking. Adding low-fat snacks later in the day might not have had the same impact as eating breakfast because dieters would still have to endure a long time interval between their last food intake on one day and lunch the next day.

There was a small difference in depression-induced eating that favored the no-breakfast group. However, this difference may be partially due to an association between depression and time of day, giving those eating breakfast a greater opportunity to be eating when they were experiencing dysphoric moods first thing in the morning.

The breakfast condition was not without its drawbacks, however, despite the advantage in dietary fat intake and reduced impulsive snacking. Eating breakfast forced these subjects to endure greater caloric restriction at the rest of their meals. The differences appeared most prominent in situations such as social gatherings and suppers with families and friends. Those who typically skipped breakfast before treatment and were assigned to the breakfast condition had to make the most substantial behavior changes. The social adjustment variable also suggests that the larger meal size of the no-breakfast group caused less disruption of the meal patterns and social life than did the smaller meal sizes in the breakfast condition. The price paid, however, may have been worthwhile because this group was more successful at losing weight than were the breakfast skippers who continued to skip breakfast.

The weight-loss program resulted in measurable improvements in blood pressure, serum lipids, and body composition. Despite the improvements in risk factors, this group of subjects was still overweight after treatment and could benefit from additional weight loss.

The decline in RMR was small (6%) and explainable by the reduction in FFM. There is disagreement concerning the degree of RMR reduction that occurs during food restriction and its impact on body weight. Some have reported that a reduction in RMR produced by food restriction may be an impediment in achieving and maintaining weight reduction (25) whereas others report that the decline in RMR with food restriction is small and completely explainable by a loss of lean body mass (26). It appears from this and similar studies that a mixed diet with moderate caloric restriction does not have major effects on RMR and that the consumption of food in two vs three meals per day makes no difference.

Compliance with the number of meals per day was excellent. On the basis of data from the eating diaries, subjects showed excellent compliance with the breakfast and no-breakfast manipulation. Compliance with record keeping during the treatment period was less than perfect. However, the data obtained cover on average 9 of the 12 wk of treatment, giving us a very good sample of how the two treatments affected eating habits. Snacking, impulsive eating, and overeating were greatly reduced. Other variables measuring dietary adherence problems, such as eating in the car, negative emotional eating, and eating when bored, also showed improvements because of treatment. Even though the treatment program explicitly addressed how to change and eliminate these problem behaviors, some of these problems were not eliminated and adherence difficulties during treatment were common. Adhering to a calorie-restricted diet in social situations was especially difficult for subjects.

Subjects who returned for 6-mo follow-up measures had regained some of their lost body weight but had maintained about a 3% reduction in body fat percentage. RMR, which had declined slightly during the initial weight-loss program, increased during the 6 mo after the weight-loss program.

We recommend that individuals attempting a weight-loss program include a breakfast that is low in fat and high in carbohydrates as part of their weight-loss regimen. People who regularly skip breakfast may benefit from the addition of breakfast to their eating plan. Eating breakfast also may help protect the individual from unplanned snacking later in the day and can help reduce the amount of calories and fats in these snacks when they do occur. Although subjects who initially ate breakfast lost

more weight in the no-breakfast group, we do not believe that these individuals should be advised to stop eating breakfast because breakfast is associated with a reduction in total fat intake and a reduced impact of impulsive eating. Obese individuals who regularly eat breakfast may need additional counseling to help them modify other aspects of their diet to enhance the success of their weight-loss efforts. Counseling efforts should focus on behavior patterns not affected by this program, such as eating at social events, eating in response to positive and negative emotions, and eating in response to pain, fatigue, and feeling sick (somatic eating).

The conclusions about advantages or disadvantages of eating breakfast drawn from this study must be considered in light of the short-term nature of the evaluation. The follow-up period was only 6 mo, there was a loss of subjects to follow-up, and we did not assess eating patterns at follow-up. In the short term there appears to be some advantage to recommending that breakfast skippers begin eating breakfast. The opposite recommendation, that breakfast eaters begin skipping breakfast, does not seem appropriate given the main effects for breakfast on macronutrient composition and because of the fat and calories associated with impulsive snacking. The long-term impact of changing breakfast habits on weight-control efforts still remains unknown.

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