Eating behavior among women with anorexia nervosa

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ABSTRACT

Background: Disturbed eating and severe caloric restriction are characteristic features of patients with anorexia nervosa (AN). Despite the importance of eating behavior in the presentation of AN, there have been relatively few objective laboratory studies of eating behavior among persons with eating disorders.

Objective: The purpose of the study was to obtain objective measures of eating behavior among patients with AN before and immediately after weight restoration and to compare those measures with measures among control subjects.

Design: Twelve patients hospitalized for AN and 12 control subjects participated in the study. Eleven of the 12 patients were retested at 90% of ideal body weight.

Results: The average meal consumption was 103.97 ± 102.08 g for patients at low weight and 178.03 ± 202.97 g after weight restoration (NS). Control subjects consumed significantly more than did AN patients at both time points, and the average meal size was 489.58 ± 187.64 g. Patients showed significant decreases in psychological and eating-disordered symptoms after weight restoration.

Conclusion: These data suggest that patients with AN show a persistent disturbance in eating behavior, despite the restoration of body weight and significant improvements in eating-disordered symptoms after weight restoration.

INTRODUCTION

Disturbances in eating behavior are defining features of eating disorders. Patients with anorexia nervosa (AN) severely restrict dietary intake, whereas patients with bulimia nervosa (BN) experience recurrent episodes of binge eating. Although disturbed eating is a hallmark of patients with eating disorders, relatively few objective laboratory studies of eating behavior among persons with eating disorders have been conducted.

Most studies of eating behavior in a laboratory setting have focused on patients with BN, and they documented that, when binge eating, patients consume substantially more food and eat faster than do age-, weight-, and sex-matched control subjects (1–4). Findings from studies also suggested abnormalities in meal-related physiologic functioning in BN, including rate of gastric emptying (5–10), release of the satiety hormone cholecystokinin (6, 11, 12), gastric capacity (7), and gastric relaxation (13). In comparison to BN, relatively little is known about disturbances in eating behavior among persons with AN. In addition, although improvements in psychological symptoms and weight have been documented during inpatient hospitalization for AN (14), it is not clear whether a similar normalization occurs for food intake.

The current study was designed to measure total consumption during a laboratory test meal of patients with AN at low weight and after weight restoration in comparison to control subjects. In addition, the study aimed to examine the relation between eating behavior and self-reported clinical characteristics, such as restraint over eating, and the relation between changes in these measures during treatment. Finally, the study aimed to examine the relation between changes in psychological symptoms, measured by interview and self-report, and changes in test meal intake during the course of inpatient hospitalization for patients with AN.

SUBJECTS AND METHODS

Subjects

Twelve women with AN or an eating disorder not otherwise specified, as defined by the Diagnostic and Statistical Manual for Mental Disorders, Fourth Edition (DSM-IV), participated in the study. Six participants were diagnosed with AN, restricting subtype (AN-R), and 4 participants were diagnosed with AN, binge-purge subtype (AN-B/P), by the Structured Clinical Interview for DSM-IV (SCID-IV; 15). The DSM-IV requires the presence of amenorrhea over a 3-mo period for the diagnosis of AN, and, in the current study, 2 persons with an eating disorder not otherwise...
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specified (meeting all of the criteria for AN except amenorrhea) were also included. Persons with an eating disorder not otherwise specified were included in the current study because few differences in illness history, treatment response, levels of eating disorder, and general psychopathology have been observed between women with AN and women meeting all of the DSM-IV criteria for AN except amenorrhea (16–18).

All patients participated in a test meal session shortly after admission to the hospital. Eleven of 12 patients were retested after weight restoration, which was defined as attaining ≥90% of ideal body weight (IBW; 19). The second test meal occurred a mean of 54.18 ± 14.48 d (range: 37.0–84.0 d) after initial testing and a mean of 14.55 ± 6.52 d (range: 6.0–31.0 d) after patients reached 90% IBW. All patients but one were free from medications at the time of testing; that one patient was receiving alendronate for osteoporosis at both test meals but was included in the study because alendronate is not known to influence eating or weight. All patients were between the ages of 18 and 45 y and were receiving treatment on an inpatient unit at the New York State Psychiatric Institute at Columbia University Medical Center (New York City). Patients were required to be free of psychotic illnesses, drug abuse, and significant suicidal ideation.

Twelve women without eating disorder symptoms served as the control group. Control subjects were required to be between 90% and 120% IBW. All control subjects participated in the study in exchange for monetary compensation and were without a current psychiatric diagnosis or significant medical illness. Control subjects participated in only 1 test meal session.

All participants provided written informed consent. This study was reviewed and approved by the Institutional Review Board of the New York State Psychiatric Institute.

Procedures

The procedures were identical for all test sessions. Patients and control subjects consumed a standardized breakfast on the morning of the test meal. For patients at low weight, the standardized breakfast consisted of 4 fluid ounces (118.29 mL) apple juice, 8 fluid ounces (236.59 mL) whole milk, 2 ounces (56.70 g) Special K cereal (Kellogg’s, Battle Creek, MI), one 1.5-ounce (42.5 g) slice of whole-wheat bread, and 2 tablespoons (30 mL) grape jelly (≈580 kcal); for patients at 90% IBW and control subjects, the standardized breakfast was 8 fluid ounces (236.59 mL) apple juice, 8 fluid ounces (236.59 mL) whole milk, 2 ounces (56.70 g) Special K cereal (Kellogg’s), two 1.5-ounce (42.5 g) slices of whole-wheat bread, 1 teaspoon (5 mL) butter, and 1 tablespoon (15 mL) grape jelly (≈855 kcal). Participants did not consume any additional food or liquid, other than water, before reporting to the laboratory for the meal session 4 h later.

The test meal was a strawberry yogurt shake; this test meal was used previously in other eating behavior studies (2). A shake (975 g; 1.04 kcal/g or ≈1014 kcal) was provided to participants in a covered, opaque, 83-fluid-ounce (2454.60-mL) container with a straw. Before each test meal, participants received instructions by tape recorder. The instructions specified that participants should consume as much of the shake as they would like and that the meal would serve as their lunch for the day. The instructions asked participants to avoid touching or manipulating the container in any way. The meal was placed on a modified version of an eating monitor (20), which measured intake (in g) every 5 s. During the meal, participants were observed through a closed-circuit video monitor.

As in previous eating behavior studies (1, 21, 22), participants were asked to make ratings before and after the test meal of hunger, fullness, sickness, loss of control, urge to eat, preoccupation with thoughts of food, and fear of fatness on a 15-cm visual analog scales (VAS). Patients with AN were also asked whether they intended to eat less than, as much as, or more than the amount they were expected to eat for lunch on the inpatient unit. The VAS was anchored by the phrases “Not at all” and “Extremely.” After each 50-g increment during the meal, patients with AN and control subjects rated hunger, fullness, sickness, feelings of loss of control, and liking of the shake on the VAS. Participants were signaled to complete the VAS during the meal at approximately each 50-g increment or after a 5-min interval if 50 g had not yet been consumed. The participant signaled the end of the meal to the experimenter by pushing a button (doorbell). At the conclusion of the meal, patients with AN chose whether they believed they had eaten less than, as much as, or more than they typically ate for lunch on the unit, and they used a VAS to rate the difficulty of stopping eating, hunger, fullness, sickness, loss of control, urge to eat, preoccupation with thoughts of food, and fear of fatness. Time needed to complete the VASs was subtracted from the calculation of the total meal duration.

Measures

Patients (at low weight and 90% IBW) and control subjects completed the Beck Depression Inventory (23), the Beck Anxiety Inventory (24), the Dietary Intent Scale (25), the Eating Disorder Examination Questionnaire (EDE-Q; 26), the Eating Disorder Inventory (27), the Three Factor Eating Questionnaire (TFEQ; 28), the Mizes Anorectic Cognitions Scale (29), and the Rosenberg Self-Esteem Scale (30). Patients with AN were also administered the Eating Disorder Examination (EDE), version 12 (31). For the Beck Depression Inventory, scores were calculated without the weight loss item because of the difficulty in differentiating between weight loss as a symptom of depression and as a symptom of AN.

Statistical analyses

Means and SDs were calculated for the Beck Depression Inventory, Beck Anxiety Inventory, EDE, EDE-Q, Eating Disorder Inventory, Rosenberg Self-Esteem Scale, and Mizes Anorectic Cognitions Scale for control subjects and patients with AN at low weight and after weight restoration. One-way analysis of variance (ANOVA) was used to compare the differences between patients with AN and control subjects at low weight and 90% IBW, and paired t tests were used to compare the scores between low-weight and 90% IBW patients with AN. Because the ANOVAs and paired t tests compared data from the control subjects and the patients with AN, both at low weight and 90% IBW, and between the patients with AN at low weight and 90% IBW, the P values from the ANOVAs and the paired t tests for these comparisons were multiplied by 3 in accord with the Bonferroni correction for multiple comparisons. Effect sizes (d) were calculated as the mean difference between the 2 groups being compared (eg, patients at low weight and patients at 90% IBW) for a given variable divided by the mean SD of the 2 patient groups on that variable.

Pearson’s correlation coefficients were calculated between the changes in psychological symptoms and the change in intake for patients with AN between low weight and 90% IBW. Correlation
coefficients were also used to analyze the relation between self-reported restraint scores from the Dietary Intent Scale, TFEQ, EDE, EDE-Q, and total intake. The TFEQ scoring, as described by Stunkard and Messick (28), was used to derive 3 subscales (restraint, disinhibition, and hunger). In addition, 2 subscales (rigid control and flexible control), derived from a factor analysis of the TFEQ (32), were calculated.

For the test meal sessions, initial VAS ratings and postmeal VAS ratings during the meal were analyzed by using one-way ANOVA to compare AN patients at low weight and 90% IBW with control subjects. Paired t tests were also calculated to compare AN patients at low weight with AN patients at 90% IBW for the premeal or postmeal VAS ratings. Because the average VAS ratings of control subjects were compared with those of patients with AN at both low weight and 90% IBW and the VAS ratings of patients with AN were compared between low weight and 90% IBW testing, the P values from the ANOVAs and paired t tests were multiplied by 3 in accord with the Bonferroni correction. Statistical calculations were performed using SPSS for WINDOWS software (version 11; SPSS Inc, Chicago, IL). All values are means ± SDs.

RESULTS

The mean age of patients with AN was 21.33 ± 2.93 y (range: 18–28 y), and that for control subjects was 23.33 ± 5.03 y (range: 18–37 y) (NS). All participants were white. The mean body mass index (in kg/m²) of all 3 groups is listed in Table 1. One-way ANOVAs indicated that patients at low weight (P < 0.003) and 90% IBW (P < 0.003) had a significantly lower body mass index than did control subjects.

The data on total intake (in g) and the scores on the psychological measures for the 3 groups are presented in Table 1. None of the correlations between changes in psychological measures and changes in intake was significant.

Correlation coefficients were calculated between total intake during the meal and measures of dietary restraint [DIS, TFEQ Restraint Subscale, TFEQ Disinhibition Subscale, TFEQ Hunger Subscale, TFEQ Flexible Control and Rigid Restraint Subscales (32), EDE-Q Restraint Subscale, and EDE Restraint Subscale] for the 3 groups and for the change in restraint scores and the change in intake between low weight and 90% IBW testing in patients with AN. The correlations for the restraint scores and intake at each meal and for the change in restraint scores and change in intake range from −0.016 to −0.561, but none of the correlations was significant.

Patients at low weight overestimated their meal consumption by an average of 460.28 ± 945.03 kcal, and patients at 90% IBW overestimated by an average of 111.66 ± 132.49 kcal. Control subjects underestimated their test meal consumption by an average of 60.60 ± 217.48 kcal. The estimates of caloric intake between patients (at low weight or 90% IBW) and control subjects did not differ significantly. Patients at low weight (P < 0.003) and at 90% IBW (P < 0.003) showed a significantly

### Table 1

| Psychological measures and eating behavior in patients with anorexia nervosa (AN) at low weight and at 90% ideal body weight (IBW) and in control subjects |
|-----------------------------------------|-----------------------------------------|-----------------------------------------|-----------------------------------------|
|                                         | Control subjects                        | Low weight                             | 90% IBW                                |
|                                         |                                         | Value                                  | d            | P        |
| BMI (in kg/m²)                          | 22.25 ± 1.595 ± 6 [12]                | 15.84 ± 1.49 [12] 20.21 ± 0.035 [11] | 4.41 ± 1.73 | <0.003 |
| Eating Disorder Examination             |                                         |                                        |              |          |
| Restraint subscale                      | −4.40 ± 1.24 [12]                     | −1.53 ± 1.36 [11] | −2.95 ± 1.84 | 2.23 <0.003 |
| Eating subscale                         | 4.33 ± 1.01 [12]                      | 2.05 ± 1.24 [11] | −2.31 ± 1.58 | 2.00 0.003 |
| Shape subscale                          | 4.86 ± 0.988 [11]                     | 4.47 ± 1.13 [11] | −0.125 ± 1.01 | 0.120 1.00 |
| Weight subscale                         | −4.32 ± 1.21 [12]                     | 3.22 ± 1.45 [10] | −0.800 ± 1.11 | 0.621 0.144 |
| Eating Disorder Examination Questionnaire|                                         |                                        |              |          |
| Restraint Subscale                      | 0.833 ± 0.906 [12]                    | 5.07 ± 0.985 [12] 1.33 ± 0.608 [9] | −3.62 ± 1.35 | 4.39 <0.003 |
| Eating subscale                         | 0.367 ± 0.8135 ± 6 [12]               | 4.67 ± 1.29 [12] 1.71 ± 0.975 [9] | −2.78 ± 1.40 | 2.28 <0.003 |
| Shape subscale                          | 0.969 ± 1.255 ± 6 [12]                | 5.40 ± 0.755 [12] 3.69 ± 2.38 [9] | −1.65 ± 2.12 | 0.929 0.144 |
| Weight subscale                         | 0.800 ± 1.425 ± 6 [12]                | 5.07 ± 1.20 [12] 2.20 ± 2.53 [9] | −2.80 ± 2.46 | 4.14 0.027 |
| Eating Disorder Inventory               |                                         |                                        |              |          |
| Bulimia subscale                        | 0.250 ± 0.6225 ± 12 [12]              | 5.42 ± 5.30 [12] 1.00 ± 1.95 [11] | −3.64 ± 3.72 | 0.997 0.027 |
| Perfectionism subscale                  | 6.17 ± 3.54 [12]                      | 8.42 ± 5.68 [12] 7.70 ± 5.31 [10] | −0.900 ± 1.52 | 0.157 0.285 |
| Mizes Anorectic Cognitions Scale        |                                         |                                        |              |          |
| Total score                             | 68.92 ± 6.055 ± 12 [12]               | 79.17 ± 4.91 [12] 76.45 ± 8.78 [11] | −2.73 ± 7.52 | 0.379 0.711 |

1 All values are ± SD; n in brackets.
2 Cohen’s d is a measure of effect size.
3 ANOVA between low-weight AN patients and control subjects, P < 0.01 (Bonferroni corrected).
4 ANOVA between low weight and 90% IBW AN patients and control subjects, P < 0.01 (Bonferroni corrected).
slower rate of eating [total intake (in g)/total time eating (in s)] than did control subjects (low weight: 0.532 ± 0.658 g/s; 90% IBW: 0.462 ± 0.593 g/s; control: 1.90 ± 0.928 g/s). Patients with AN-R showed a faster rate of eating during the meal at low weight than did patients with AN-B/P (AN-R: 0.786 ± 0.648 g/s; AN-B/P: 0.408 ± 0.749 g/s), but patients with AN-B/P ate more quickly at 90% IBW than did patients with AN-R (AN-R: 0.460 ± 0.522 g/s; AN-B/P: 0.753 ± 0.872 g/s); none of these differences were significant. The means, SDs, and ANOVAs of the premeal and postmeal VAS ratings of patients at low weight, patients at 90% IBW, and control subjects are presented in Table 2.

**DISCUSSION**

This study found that patients hospitalized for AN consumed substantially less of a single-item test meal than did control subjects, both before and after weight gain. The considerable changes in weight and in psychological and eating-disordered symptoms that occurred during hospital treatment were not paralleled by changes of similar magnitude in food consumption during the test meal. This finding suggests that, immediately after restoration to a normal weight, many patients with AN exhibit a persistent behavioral eating disturbance that may increase vulnerability to relapse.

The few previous studies that explicitly examined the eating behavior of patients with AN under controlled conditions found inconsistent results. Rolls et al (22) found a trend for AN patients to eat less than did control subjects. Halmi and Sunday (21) reported that the average test meal consumption by hospitalized low-weight patients with AN varied considerably and, surprisingly, could be greater than that by control subjects (33). The eating behavior of patients with AN in the current study was more consistent with the total meal consumption of patients with AN in a study by Gwirtsman et al (34), in which inpatients consumed smaller amounts of food than did control subjects when encouraged to eat in a manner similar to their eating before hospitalization.

Previous research has shown a consistent disturbance in the subjective ratings of hunger and fullness of patients with AN during a test meal. Several studies have found that, before the consumption of a test meal, patients with AN-R reported feeling less hungry and more full than did control subjects (21, 22, 33, 35) and that, after the meal concluded, patients with AN continued to report feeling less hungry and more full than did control subjects (21, 33, 35). Weight restoration did not significantly alter subjective satiety ratings, because patients with AN continued to report feeling less hungry and more full than did control subjects after an inpatient hospitalization, which may indicate that these disturbances in hunger and satiety persist even after weight restoration (35). The current study did not find significant differences between patients with AN and control subjects in VAS ratings of hunger or fullness before or after the test meal. Similar to previous research (21), this study did observe that patients with AN at a low weight reported more subjective preoccupation with food than did control subjects. In addition, Halmi and Sunday (21) and Sunday and Halmi (33) found that patients with AN-R ate significantly more slowly at a low weight than did control subjects; this finding was replicated in the current study for the low-weight AN patient group as a whole but not for the AN-R subtype.

Differences in experimental procedures may account for some of the discrepant findings between the current study and those of Halmi and Sunday (21) and Sunday and Halmi (33). For example, in the current study, the test meal occurred in the afternoon, and patients and control subjects were asked to eat the test meal instead of lunch after a 4-h fast. The Halmi and Sunday (21) and Sunday and Halmi (33) studies took place in the morning, instead of breakfast, after a 10-h or overnight fast. In addition, VAS ratings for the meal studies of Halmi and Sunday (33) and Halmi et al (35)
were obtained 14 min after the conclusion of the meal, whereas the current study provided the last VAS immediately after the termination of the meal. In the current study, patients had no prior exposure to the novel food (yogurt shake) used in the test meal and were not allowed to see the contents of the container as they ate. In contrast, the studies of Halmi and Sunday (21) and Owen et al (36) found that the ability to see the test meal while eating did not affect the average amount consumed by patients with AN; however, the food used in those test meals was Sustacal (Mead Johnson, Evansville, IN), which constituted the main source of energy provided to the patients with AN during treatment.

In the current study, the test meal was novel for both control subjects and patients with AN, and patients may have experienced significant anxiety about consuming an unknown type and quantity of food. It is possible that the significant restriction in food intake among patients with AN resulted from an interaction between fear of weight gain and anxiety about a new or unknown food in an unfamiliar environment. Although it is not clear to what extent such concerns affected total meal consumption among patients with AN, the results of the current study are consistent with those of a recently described model of fear conditioning in the maintenance of AN (37).

The current study also compared self-reported measures of dietary restraint with an index of objective behavior. Research with eating-disordered patients often assesses the construct of dietary restraint; however, dietary restraint can refer to several different attitudes or behaviors. The term usually indicates a cognitive set linked to attempts to diet and tends to be associated with unsuccessful dieting (38). The comparison of behavioral and self-reported measures of the same construct provides an opportunity to validate self-reported measures of dietary restraint against objective dietary restraint in a meal paradigm. One previous study examined the agreement between eating behavior, as a measure of behavioral restraint, and self-reported measures of restraint (39) and found no relation between the amount of food consumed and the measures of dietary restraint in either control subjects or persons with a diagnosis of an eating disorder.

The current study similarly found that there was no relation between self-reported measures of dietary restraint and total meal intake in patients with AN, either at low weight or 90% IBW, or in control subjects.

There are several important limitations in the design of this study. The sample size was small, which may have affected the statistical power to detect differences in VAS ratings of hunger or fullness and the correlations between self-reported and behavioral dietary restraint. Some of the patients with AN did not respond to all of the questionnaires, such as the EDE-Q, in which the response rate for patients at 90% IBW was 75%. This may have further reduced our ability to detect differences between patients at low weight and 90% IBW or between control subjects and patients at 90% IBW. In addition, eating behavior in a laboratory may not be generalizable to a naturalistic eating environment, and the presentation of the food in this study, in which the amount and type of food were unknown to the participant, is inconsistent with typical meal consumption.

In summary, the current study compared the test meal intake by patients with AN at low weight and after weight restoration with that by control subjects. Contrary to previous research (21, 33), the current study found that inpatients with AN consumed significantly less of a test meal than did control subjects at both time points. The small changes in eating behavior observed during inpatient treatment contrast with the significant changes found in weight and in psychological and eating-disordered symptoms within the same time period. Although most hospitalized patients with AN in our program and other programs respond to treatment (14, 40, 41), the nutritional restoration that occurs on an inpatient unit does not necessarily resolve the core eating difficulties for patients with AN. This continued vulnerability during the period after inpatient hospitalization is exemplified by significant relapse rates among patients with AN [between 30% and 70% (42, 43)]. Further study of eating behavior in AN may be worthwhile to better understand the maintenance and outcome of the treatment of AN.

RS, BTW, JS, and GTW designed the experiment and wrote the manuscript; RS collected the data; RS, BTW, and JS analyzed the data; and BTW provided significant advice or consultation. None of the authors had a personal or financial conflict of interest.

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