Dietary energy density and diet variety as predictors of outcome in anorexia nervosa

Janet E Schebendach, Laurel ES Mayer, Michael J Devlin, Evelyn Attia, Isobel R Contento, Randi L Wolf, and B Timothy Walsh

ABSTRACT
Background: Anorexia nervosa (AN) is a serious psychiatric illness associated with significant morbidity and mortality. Successful treatment results in weight restoration, but recidivism is common, and the rate of relapse is estimated to be as high as 50%. Maintenance of a healthy diet is central to the recovery process, but the relation between diet and relapse has not been investigated in AN patients.

Objective: The objective of the study was to determine whether diet energy density and diet variety in recently weight-restored women with AN predict outcome.

Design: After gaining weight to a body mass index (BMI; in kg/m²) of ≥20, 47 hospitalized women completed 4-d food records, from which a mean diet energy density score (DEDS) and a mean diet variety score (DVS) were calculated. Outcome was determined at study end by using modified Morgan-Russell criteria, and it was dichotomized as “treatment success” or “treatment failure.” Data were analyzed by using Student’s t test. A logistic regression model was constructed to evaluate the effects of DEDS, DVS, and caloric intake on outcome.

Results: Groups did not differ significantly in mean measures of age, admission and weight-restored BMI, or caloric intake. However, DEDS and DVS were significantly higher in the success group than in the failure group. The success and failure groups were followed for a mean of 240 and 170 d, respectively. In the logistic regression model, DEDS (P = 0.016) and DVS (P = 0.048) but not caloric intake (P = 0.585) significantly predicted outcome.

Conclusion: In recently weight-restored women with AN, lower DEDS and DVS but not caloric intake were associated with poor outcome.


INTRODUCTION
Anorexia nervosa (AN) is a serious psychiatric illness associated with significant morbidity (1) and a mortality rate that is among the highest for psychiatric illnesses (2, 3). Specialized treatment programs are largely successful in the restoration of body weight; however, recidivism is common, and the rate of relapse is estimated to be as high as 50% (4). The relation between relapse and psychological (5, 6) and physiologic (7) factors has been examined in AN, but few reliable predictors of relapse have been identified.

A key clinical feature of AN is reduction of food intake, yet relatively little is known about the food selection practices of weight-restored AN patients. Before treatment, AN patients characteristically avoid high-calorie foods (8–11) and eat a limited variety of foods (10, 12, 13). To promote weight restoration, hospitalized patients are typically provided with a varied diet that includes energy-dense foods (eg, peanut butter, bagels, raisins, and whole milk); however, the degree to which weight restoration is maintained is largely unknown.

Maintenance of a healthy diet is central to the recovery process in AN, because the resumption of a low-calorie diet is likely to result in weight loss and relapse. Although diet and food choice appear to be key to both recovery and relapse, diet-specific predictors of relapse have not been identified in AN.

The present study was a secondary analysis of data collected from 2 studies: the Energy Homeostasis in Anorexia Nervosa study, a longitudinal study involving the examination of changes in body composition (7, 14), and the Fluoxetine for Relapse Prevention in Women with Anorexia Nervosa trial [15 (New York site only)]. The specific aims of the present study were 1) to quantify food choice in a group of hospitalized, recently weight-restored women with AN by using objective measures of dietary energy density and diet variety and 2) to determine whether measures of energy density and diet variety in hospitalized, weight-restored AN patients predicted outcome within 1 y of discharge.
SUBJECTS AND METHODS

Subjects

The subjects were 47 women 18–45 y old who were hospitalized for treatment at the inpatient Eating Disorder Service of the General Clinical Research Unit of the New York State Psychiatric Institute (NYSPI), Columbia University Medical Center, between June 2000 and July 2005. Of the women, 43 were white, 2 were Hispanic, 1 was African American, and 1 was Asian. No subject was excluded on the basis of race or ethnicity.

Subjects met the AN criteria (except amenorrhea) of the Diagnostic and Statistical Manual of Mental Disorders, 4th Edition (DSM-IV) (16). The amenorrhea criterion of DSM-IV for AN was not strictly applied, because patients who report some menstrual activity appear clinically similar to those with full-criteria AN (17). In our patient sample, 37 were amenorrheic and 10 were not. Patients were excluded if they had comorbid substance abuse or significant DSM-IV Axis I psychiatric disorders other than major depression or if they were taking psychotropic medications or medications known to affect body composition.

Written informed consent was obtained from participants in the body composition study and the relapse prevention study. The Institutional Review Board of the NYSPI/Columbia University approved both studies. Separate NYSPI/Columbia University institutional review board approval was obtained for the secondary analysis of data used in the current study. Study findings from the secondary analysis have not been reported elsewhere.

Inpatient treatment

Treatment consisted of a structured behavioral program aimed at normalizing weight and eating patterns. The daily prescription for patients was 3 meals and 1 snack that together had sufficient caloric content for patients to gain ≥1 kg/wk. If patients were unable to gain weight with food alone, additional calories in the form of a liquid nutritional supplement were prescribed. Formal exercise was not permitted on the unit at any time during weight gain. In addition to the behavioral protocol, patients were seen in individual therapy, with supportive and cognitive-behavioral elements, 3–5 times/wk, and also participated in group and family therapy. Weight restoration continued until the patient reached 90% of ideal body weight (IBW), as defined by the Metropolitan Life actuarial tables (18); this weight would be approximately equal to a body mass index (BMI; in kg/m²) of 20.

Initially, all patients were provided a calorie-prescribed diet with 30% of energy from fat that was selected by the hospital’s Registered Dietitian (RD); all meals and snacks were consumed in a supervised setting. Patients were started at an intake of 1800 kcal/d, which was gradually increased to a maximum of 3000 kcal/d, as permitted to choose foods from the hospital menu. After attaining and maintaining 90% IBW, patients were eligible for and encouraged to eat meals during therapeutic passes outside the hospital. Meal passes were reviewed in advance by the staff dietitian and approved by the treatment team; however, compliance with the prescribed diet was not monitored when meals were eaten outside the hospital.

Assessments

Assessments of the diet and of the eating attitudes and behaviors of study participants were completed after the participants had maintained ≥90% IBW for 2–4 wk. Menstruating patients were assessed during the follicular phase of the cycle. In the subset of patients who also participated in the relapse prevention study, random assignment to medication or placebo occurred after completion of the diet assessment in all but one patient. In that case, only 1 d of the 4-d food record was completed before random assignment to study medication.

Nutrient intake

Participants completed a prospective 4-d food record. Verbal and written instructions on the estimation of food portions and pictorial examples of food portions were provided. Completed food records were reviewed for accuracy. An RD (JES) entered data into NUTRITIONIST PRO software (version 1.2.207; First DataBank Inc, San Bruno, CA). Nutrient analysis included energy (kcal); carbohydrate (g), protein (g), and fat (g) content; percentage of calories provided by carbohydrate, protein, and fat; and the gram weight of food and all beverages, both caloric and noncaloric. In addition, data were analyzed for energy density and diet variety.

Dietary Energy Density Score

Calorie content and weight of all food and beverage consumed was determined from the nutrient analysis of the 4-d food records. Energy density, defined as caloric intake (in kcal) divided by the total weight (in g) of food and beverages consumed (19), was calculated separately for each day of the food record. Daily scores were averaged to obtain the mean daily dietary energy density score (DEDS).

The DEDS calculation included food, caloric beverages (eg, carbonated beverages, juice, sweetened fruit drinks, coffee and tea with caloric additives such as milk and sugar, and alcohol) and noncaloric beverages (eg, water, diet carbonated beverages and fruit drinks, and unsweetened black coffee and tea) (20). Nonnutritive sweeteners contribute minimally to the gram weight of food intake; nevertheless, they were also included in the calculation.

Diet Variety Score

A mean daily diet variety score (DVS) was calculated from the 4-d food record. The DVS was defined as the cumulative number of different foods and beverages consumed (21–23) divided by the total number of food record days. An RD (JES) reviewed and manually coded each food record. Foods eaten on multiple occasions were counted only once (21, 22), and a food item was included regardless of quantity (21, 24). A specific food was counted as a distinct item if it was prepared in an obviously different manner (eg, baked potato, mashed potato, or French fried potato) or was of a different variety (eg, brown rice, white rice, or wild rice). Each vegetable was counted as a distinct item; however, it was counted once if prepared in a fat-free manner (eg, boiled, steamed, or microwaved) and counted a second time if prepared with the addition of fat (eg, deep-fried, sautéed, or stir-fried). Likewise, a specific cut of meat or poultry or a specific type of fish was counted once if prepared in a fat-free manner (eg, grilled, broiled, or steamed) and counted a second time if prepared with the addition of fat (eg, deep-fried, sautéed, or stir-fried). Different varieties of juice were distinct, as were different...
forms of the same fruit (eg, fresh peach, canned peach, or dried peach). Different flavors of the same type of yogurt (eg, low-fat strawberry or low-fat blueberry) were counted only once because the hospital food service department determined the type of fruit yogurt provided. Combination foods (eg, pizza) were counted as a complete unit and were not broken down to component ingredients (eg, pizza crust, cheese, and tomato sauce). Noncaloric fluids (ie, diet beverages or water), nonnutritive sweeteners (eg, aspartame or saccharine), and condiments (eg, salt, pepper, spices, herbs, ketchup, and mustard) were not included in the DVS.

Posthospitalization follow-up

Patients were assessed at the point of inpatient weight restoration (>90% IBW for a period of 2–4 wk) and then followed for a period of up to 1 y after hospital discharge. Nine of 47 subjects (90% IBW for a period of 2–4 wk) and then followed for a period of up to 1 y after hospital discharge. Nine of 47 subjects were weighed weekly, and psychological measures of eating behavior and cognitions were assessed monthly. If patients withdrew or were withdrawn from that study, the point of last contact was defined as the study termination visit.

For the subset of patients participating only in the body-composition study (n = 15), treatment was received in the community. Follow-up information (ie, weight, eating disorder symptoms, and current treatment) was obtained by monthly telephone interviews and in-person evaluations 3, 6, 9, and 12 mo after hospital discharge. The point of last contact for these patients was defined as the last completed follow-up assessment. For 6 of the 15 subjects, the point of last contact was an in-person visit, and, for the remaining 9 subjects, it was a telephone assessment that included a self-reported body weight.

Subject outcome at study termination was determined by a research psychiatrist using modified Morgan-Russell criteria—ie, full, good, fair, poor, or other (2, 12, 15). Subjects were classified as “other” if they did not meet the time criterion (ie, remaining in the study for ≥8 wk) for Morgan-Russell determination (7, 15).

Two approaches were used to classify treatment outcome. The primary analysis, which dichotomized outcome according to the classification schema used in the body-composition (7, 14) and relapse prevention (15) studies, defined treatment success as a Morgan-Russell categorization of a full, good, or fair outcome and treatment failure as a Morgan-Russell categorization of a poor outcome. All between-group comparisons were based on this method of dichotomizing treatment outcome. In a second analysis, treatment outcome was reclassified, whereby a Morgan-Russell categorization of full or good corresponded to treatment success, and a Morgan-Russell categorization of fair or poor corresponded to treatment failure. To attempt to minimize issues related to the relatively small sample size, an additional analysis was conducted with termination BMI as a continuous outcome variable.

Statistical analysis

Student’s t test was used to compare age, duration of illness, duration of follow-up, BMI, diet scores (DVS and DEDS), and nutrient intake [energy (kcal), carbohydrate (g), protein (g), fat (g), and the percentage of energy from carbohydrate, protein, and fat] in the treatment success and treatment failure groups. Effect size was calculated by using Cohen’s d.

Median length of follow-up was calculated, and outcome groups were compared by using chi-square analysis of the median split. In addition, a chi-square test of independence was calculated to compare AN subtype, type of final weight assessment (ie, measured or self-reported), and the proportions of relapse prevention study participants in the treatment success and failure groups. In the subset of relapse prevention study participants, a chi-square test of independence was also calculated to compare the effect of randomization to drug or placebo on treatment outcome.

Primary and secondary binary logistic regression models were constructed to evaluate the effects of energy density and diet variety on treatment outcome (ie, success or failure). Because caloric restriction is a hallmark behavior of patients with AN, caloric intake was also included in the model. In the primary model, success was defined as a full, good, or fair Morgan-Russell outcome, and failure was defined as a poor Morgan-Russell outcome. In the second model, success was defined as a full or good Morgan-Russell outcome, and failure was defined as a fair or poor Morgan-Russell outcome. A linear regression model using DEDS, DVS, and intake (kcal) as predictors of termination BMI was also constructed.

Analyses were performed by using SPSS for WINDOWS software (version 15; SPSS Inc, Chicago, IL). Means ± SDs are reported; t tests were 2-tailed. Statistical significance was set at 0.05.

RESULTS

Forty-one of the 47 patients were categorized as a treatment success (n = 29) or a treatment failure (n = 12). Six patients with <8 wk of follow-up were not included in the final analysis. Of the 41 subjects, 23 met criteria for the AN-restricting subtype, and 18 met criteria for the AN-binge eating/purging subtype. No significant association between AN subtype and treatment outcome was found (chi-square = 0.873, P > 0.05). Likewise, no significant associations were found between treatment outcome and the type of final assessment (chi-square = 0.911, P > 0.05) or participation in the relapse prevention study (chi-square = 0.336, P > 0.05). Among relapse prevention participants, random assignment to fluoxetine or placebo was not significantly associated with treatment outcome (chi-square = 0.864, P > 0.05).

Follow-up ranged from 77 to 397 d (median: 238 d) in the success group and from 58 to 385 d (median: 170 d; median: 117 d) in the failure group. Between-group differences in mean (t = −1.754, P > 0.05) and median (chi-square = 0.301, P > 0.05) duration of follow-up were not significant.

Clinical characteristics of the treatment success and failure groups are presented in Table 1. There were no significant differences between the groups in age, admission BMI, or weight-restored BMI. There was, however, a significant difference in BMI at the point of treatment termination. A significant difference in the mean duration of illness was also found: the success group had a longer duration of illness, and the failure group had a shorter duration of illness.

Total energy, macronutrient intake, DEDS, and DVS are presented in Table 2. Although total caloric intake was higher in the

Statistical analysis

Student’s t test was used to compare age, duration of illness, duration of follow-up, BMI, diet scores (DVS and DEDS), and nutrient intake [energy (kcal), carbohydrate (g), protein (g), fat (g), and the percentage of energy from carbohydrate, protein, and fat] in the treatment success and treatment failure groups. Effect size was calculated by using Cohen’s d.

Median length of follow-up was calculated, and outcome groups were compared by using chi-square analysis of the median split. In addition, a chi-square test of independence was calculated to compare AN subtype, type of final weight assessment (ie, measured or self-reported), and the proportions of relapse prevention study participants in the treatment success and failure groups. In the subset of relapse prevention study participants, a chi-square test of independence was also calculated to compare the effect of randomization to drug or placebo on treatment outcome.

Primary and secondary binary logistic regression models were constructed to evaluate the effects of energy density and diet variety on treatment outcome (ie, success or failure). Because caloric restriction is a hallmark behavior of patients with AN, caloric intake was also included in the model. In the primary model, success was defined as a full, good, or fair Morgan-Russell outcome, and failure was defined as a poor Morgan-Russell outcome. In the second model, success was defined as a full or good Morgan-Russell outcome, and failure was defined as a fair or poor Morgan-Russell outcome. A linear regression model using DEDS, DVS, and intake (kcal) as predictors of termination BMI was also constructed.

Analyses were performed by using SPSS for WINDOWS software (version 15; SPSS Inc, Chicago, IL). Means ± SDs are reported; t tests were 2-tailed. Statistical significance was set at 0.05.

RESULTS

Forty-one of the 47 patients were categorized as a treatment success (n = 29) or a treatment failure (n = 12). Six patients with <8 wk of follow-up were not included in the final analysis. Of the 41 subjects, 23 met criteria for the AN-restricting subtype, and 18 met criteria for the AN-binge eating/purging subtype. No significant association between AN subtype and treatment outcome was found (chi-square = 0.873, P > 0.05). Likewise, no significant associations were found between treatment outcome and the type of final assessment (chi-square = 0.911, P > 0.05) or participation in the relapse prevention study (chi-square = 0.336, P > 0.05). Among relapse prevention participants, random assignment to fluoxetine or placebo was not significantly associated with treatment outcome (chi-square = 0.864, P > 0.05).

Follow-up ranged from 77 to 397 d (median: 238 d) in the success group and from 58 to 385 d (median: 170 d; median: 117 d) in the failure group. Between-group differences in mean (t = −1.754, P > 0.05) and median (chi-square = 0.301, P > 0.05) duration of follow-up were not significant.

Clinical characteristics of the treatment success and failure groups are presented in Table 1. There were no significant differences between the groups in age, admission BMI, or weight-restored BMI. There was, however, a significant difference in BMI at the point of treatment termination. A significant difference in the mean duration of illness was also found: the success group had a longer duration of illness, and the failure group had a shorter duration of illness.

Total energy, macronutrient intake, DEDS, and DVS are presented in Table 2. Although total caloric intake was higher in the
The inclusion in the treatment group significantly predicted outcome, but the Morgan-Russell classification of treatment outcome was used, caloric intake as the predictor variables. When the primary success or failure as the outcome and with DEDS, DVS, and the mean DVS was significant.

were observed in the success group and lower scores in the failure group. The mean DEDS ranged from 0.404 to 1.455; higher scores differed significantly between the groups. Although there was no significant difference in total protein intake, patients in the failure group had a significantly higher percentage of energy from protein than did those in the success group.

The mean DEDS ranged from 0.404 to 1.455; higher scores were observed in the success group and lower scores in the failure group. The mean DVS ranged from 7.75 to 15.75; higher scores were observed in the success group and lower scores in the failure group. The between-group difference in both the mean DEDS and the mean DVS was significant.

Binary logistic regression models were constructed with treatment success or failure as the outcome and with DEDS, DVS, and caloric intake as the predictor variables. When the primary Morgan-Russell classification of treatment outcome was used, both the DEDS and the DVS significantly predicted outcome, but caloric intake did not (Table 3). The inclusion in the treatment failure group of 6 subjects with <8 wk of follow-up did not change the pattern of results (data not shown). When Morgan-Russell dichotomization of treatment outcome was redefined, similar results were found; that is, the DEDS and DVS were significant predictors, but caloric intake was not (Table 3). Finally, when termination BMI was used as the exclusive measure of treatment outcome, DVS continued to be a significant predictor, DEDS approached significance as a predictor, and caloric intake failed to predict treatment outcome (Table 3).

**DISCUSSION**

Among a group of recently weight-restored women with AN, the selection of a diet characterized by low energy density and limited variety was associated with a poor outcome. To our knowledge, the present study is the first to describe a significant relation between diet and treatment outcome in weight-restored patients with AN. On average, the weight-restored patients treated at the NYSPI are prescribed an energy intake of 2600 kcal/d for weight maintenance. In the current study, patients’ food records indicated a mean energy intake of 2345 ± 495 kcal/d, and there was no significant difference between the treatment outcome groups. Although total caloric intake did not differ between the outcome groups, a significant difference in fat intake was observed: the treatment failure group reported a lower fat intake before discharge than did the success group. Fat avoidance is well documented

### TABLE 1

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Treatment success group</th>
<th>Treatment failure group</th>
<th>Analysis2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 29)</td>
<td>(n = 12)</td>
<td>P</td>
</tr>
<tr>
<td>Age (y)</td>
<td>22.2 ± 3.64</td>
<td>21.5 ± 3.4</td>
<td>0.56</td>
</tr>
<tr>
<td>Duration of Illness (y)</td>
<td>6.3 ± 2.9</td>
<td>4.0 ± 2.5</td>
<td>0.02</td>
</tr>
<tr>
<td>Duration of follow-up (d)</td>
<td>240.0 ± 118.7</td>
<td>170.0 ± 111.0</td>
<td>0.09</td>
</tr>
<tr>
<td>Admission BMI (kg/m²)</td>
<td>15.5 ± 1.4</td>
<td>14.6 ± 1.3</td>
<td>0.07</td>
</tr>
<tr>
<td>Weight-restored BMI</td>
<td>20.6 ± 0.8</td>
<td>20.4 ± 0.8</td>
<td>0.61</td>
</tr>
<tr>
<td>Termination BMI (kg/m²)</td>
<td>19.6 ± 1.3</td>
<td>16.1 ± 1.1</td>
<td>0.00</td>
</tr>
</tbody>
</table>

1 Morgan-Russell criteria for success were a full, good, or fair outcome; for failure, they were a poor outcome (see references 2 and 12).

2 P values were obtained with Student’s t test. Cohen’s d refers to effect size.

3 x ± SD (all such values).

4 Includes water.

success group than in the failure group, the difference was not significant. Compared with the success group, the failure group consumed significantly less total fat and had a diet that was significantly lower in the percentage of energy from fat. Carbohydrate intake, both total and as a percentage of energy, did not differ significantly between the groups. Although there was no significant difference in total protein intake, patients in the failure group had a significantly higher percentage of energy from protein than did those in the success group.

### TABLE 2

Dietary energy density (DEDS), diet variety (DVS), and nutrient intake by treatment outcome group

<table>
<thead>
<tr>
<th></th>
<th>Treatment success group</th>
<th>Treatment failure group</th>
<th>Analysis2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(n = 29)</td>
<td>(n = 12)</td>
<td>P</td>
</tr>
<tr>
<td>DEDS</td>
<td>1.0 ± 0.24</td>
<td>0.7 ± 0.3</td>
<td>0.002</td>
</tr>
<tr>
<td>DVS</td>
<td>12.8 ± 1.6</td>
<td>11.1 ± 2.4</td>
<td>0.01</td>
</tr>
<tr>
<td>Calories (kcal)</td>
<td>2415.5 ± 532.4</td>
<td>2175.1 ± 355.5</td>
<td>0.16</td>
</tr>
<tr>
<td>Carbohydrate (g)</td>
<td>362.4 ± 89.5</td>
<td>337.9 ± 56.7</td>
<td>0.39</td>
</tr>
<tr>
<td>Protein (g)</td>
<td>97.0 ± 23.5</td>
<td>98.8 ± 19.4</td>
<td>0.81</td>
</tr>
<tr>
<td>Fat (g)</td>
<td>68.5 ± 19.1</td>
<td>52.2 ± 14.7</td>
<td>0.012</td>
</tr>
<tr>
<td>Carbohydrate (% of kcal)</td>
<td>58.7 ± 5.1</td>
<td>60.9 ± 2.8</td>
<td>0.17</td>
</tr>
<tr>
<td>Protein (% of kcal)</td>
<td>15.8 ± 2.1</td>
<td>18.0 ± 5.3</td>
<td>0.05</td>
</tr>
<tr>
<td>Fat (% of kcal)</td>
<td>32.5 ± 5.1</td>
<td>21.0 ± 3.8</td>
<td>0.012</td>
</tr>
<tr>
<td>Noncaloric beverages (g)</td>
<td>495.9 ± 719.6</td>
<td>1201.5 ± 881.4</td>
<td>0.011</td>
</tr>
</tbody>
</table>

1 Morgan-Russell criteria for success were a full, good, or fair outcome; for failure, they were a poor outcome (see references 2 and 12).

2 P values were obtained with Student’s t test. Cohen’s d refers to effect size.

3 x ± SD (all such values).

4 Includes water.
in patients with AN (8, 9, 11, 13, 25). Although our program emphasizes a well-balanced diet that provides ≈30% of calories from fat, it is notable that many of these patients reduced their fat intake during treatment in a structured nutrition rehabilitation program.

Measures of energy density have been used to characterize food intake in obese and normal-weight adults (26–31) and in children and adolescents (32, 33). To best capture the typical food and beverage choices of patients with AN, we included food, caloric beverages, and noncaloric beverages, including water, in the DEDS calculation (19, 20).

On the basis of the primary and secondary approaches to Morgan-Russell treatment dichotomization, DEDS but not total caloric intake predicted outcome. The reasons for this are unclear. It is likely, however, that the inpatient program focused on ensuring total caloric intake more than on specific food and beverage choices. Such a focus would potentially contribute to limited variability in caloric intake relative to energy density. We can also speculate that, while hospitalized, patients with low DEDS purposefully consumed large amounts of low-energy-density foods to meet their weight-maintenance caloric prescription. However, once discharged from the hospital, these patients may have been less motivated to consume the large portions of low-energy-density foods needed to maintain their caloric requirement. Reductions in portion size and energy density have independent and additive effects that result in sustained decreases in the energy intake of normal-weight and overweight women (27).

In the long run, it is likely that a diet containing both energy-dilute foods and smaller portions would result in reduced total energy intake, which would lead to weight loss and relapse in patients with AN.

Greater variety in the diet is associated with greater food intake (34–39), whereas restricted variety is likely to result in less food intake and possible weight loss (37, 40, 41). Clinical observation suggests that patients with AN eat a relatively narrow repertoire of foods; however, no objective measure of diet variety has been reported in the literature, and the relation between diet variety and chronicity of illness has not been explored. In the current study, the DVS was a significant predictor of treatment outcome, and this finding was consistent across the 2 approaches to Morgan-Russell treatment outcome dichotomization. The DVS also was a significant predictor of BMI at the point of treatment termination.

It is interesting that there was a significant between-group difference in the duration of illness. Typically, a longer duration of illness is considered a risk factor for relapse. In this sample, however, treatment success was associated with a longer duration of illness. A satisfactory explanation for this finding is lacking.

**Study limitations**

Food records are subjective, and the potential effects of misreporting food intake on energy density values should be considered. Normal-weight (42) and overweight (43) persons tend to underreport food intake; conversely, patients with AN tend to overreport intake (11, 13). It is notable, however, that many patients recorded food items that were not permitted during inpatient meals—ie, artificial sweeteners, caloric-reduced foods, caloric-free beverages, and, in some cases, substantial amounts of water. Food records also indicated that many patients did not comply with inpatient menu-planning guidelines that required the inclusion of desserts and snacks, energy-containing beverages such as juice and whole milk, and added fats such as salad dressing and butter. Food records, therefore, indicated that several patients consumed disallowed foods and eliminated required foods. We may speculate that this “honesty” stemmed from the fact that patients were routinely reassured that research participation was distinct from inpatient clinical care, and that research findings would not be conveyed to the clinical team. This distinction may have made it easier for patients to indicate what they actually were eating rather than what they felt they were expected to eat, and this, perhaps, resulted in more accurate reporting of food intake.

There is no universally accepted definition of relapse or recovery in AN. Morgan-Russell criteria are well established as a useful classification for categorizing clinical outcome in patients with AN, but there are limitations to their use. Our primary method of Morgan-Russell dichotomization included patients with a fair outcome in the treatment success category. A fair Morgan-Russell outcome includes patients with a BMI in the range of 17.5 to 18.5. Arguably, many clinicians would not consider this BMI range to be consistent with a successful AN treatment outcome. For this reason, we conducted the second logistic regression analysis, in which patients with a fair Morgan-Russell outcome were reclassified into the treatment failure group. Although patterns of results varied slightly, the DEDS and DVS were significant predictors of treatment outcome, regardless of the approach to Morgan-Russell dichotomization of treatment outcome. Similar findings were observed when the termination BMI was the exclusive measure of treatment outcome.

---

**TABLE 3**

<table>
<thead>
<tr>
<th>Morgan-Russell criteria</th>
<th>DEDS</th>
<th>DVS</th>
<th>Energy intake (kcal)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Model 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>-5.059</td>
<td>-0.532</td>
<td>0.001</td>
</tr>
<tr>
<td>p</td>
<td>0.016</td>
<td>0.048</td>
<td>0.585</td>
</tr>
<tr>
<td><strong>Model 2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>-3.710</td>
<td>-0.903</td>
<td>0.001</td>
</tr>
<tr>
<td>p</td>
<td>0.051</td>
<td>0.004</td>
<td>0.331</td>
</tr>
<tr>
<td><strong>BMI at study termination</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>β</td>
<td>0.304</td>
<td>0.386</td>
<td>-0.920</td>
</tr>
<tr>
<td>p</td>
<td>0.054</td>
<td>0.028</td>
<td>0.374</td>
</tr>
</tbody>
</table>

1 Morgan-Russell criteria are from references 2 and 12.

2 Success group (full, good, or fair outcome), n = 29; failure group (poor outcome), n = 12.

3 Success group (full or good outcome), n = 23; failure group (fair or poor outcome), n = 18.
After hospital discharge, relapse prevention trial participants received weekly cognitive behavioral therapy; all others received various types of community-based interventions. Because treatment was not standardized, it is possible that the type and quality of psychotherapy influenced outcomes.

Another limitation that must be acknowledged is that patients with comorbid substance abuse and other major DSM-IV Axis I disorders were not included in this sample. The predictive value of the DEDS and DVS may differ in AN patients with significant comorbid psychiatric disorders.

Finally, the present study was a secondary analysis of data collected from 2 independent studies. Thus, this study may have been limited by a relatively small sample size. As indicated in Tables 1 and 2, there were instances when significant differences were not found, despite moderate effect sizes.

Conclusions

Whereas inpatient treatment programs vary in their approach to the nutritional rehabilitation of persons with AN, it is well established that AN patients typically require high energy intakes to restore and maintain a healthy body weight (1). To meet this high caloric requirement, patients will have to eat either smaller amounts of energy-dense foods or larger amounts of energy-dilute foods; although the latter is possible within a structured, supervised setting, it may be more difficult to maintain this behavior after discharge. In addition, whereas programs vary in the amount of control that patients have over food selection, most provide for a transition to self-selection. It is possible that a greater emphasis on selecting a wide variety of foods would have a positive effect on outcome.

There are few evidence-based guidelines for the nutritional management of weight-restored patients with AN. Although patients with AN typically find the consumption of energy-dense foods to be emotionally challenging, the results of the present study suggest that the intake of energy-dense foods and a greater variety of foods may be crucial to relapse prevention; therefore, the consumption of a varied diet that includes energy-dense foods must be continually reinforced and practiced throughout the course of treatment.

We thank the staff of the General Clinical Research Unit at the New York State Psychiatric Institute, Columbia University Medical Center.

The authors’ responsibilities were as follows—JES, LESM, IRC, and RLW: study design; BTW: significant advice or consultation; JES and LESM: drafting of manuscript; and BTW, MJD, and EA: critical revision of manuscript. None of the authors had any personal or financial conflict of interest.

REFERENCES


