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Dietary Energy Density and Diet Variety as Risk Factors for Relapse in Anorexia Nervosa: A Replication

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Abstract

Objective—To replicate our previous findings of an association between energy density and diet variety in recently weight-restored patients with anorexia nervosa (AN) and clinical outcome in the year following treatment.

Method—Nineteen hospitalized, weight-restored women with AN completed a food record, from which a diet energy density score (DEDS) and a diet variety score (DVS) were calculated. After hospital discharge, patients were contacted regularly; at the end of one year, clinical outcome was determined using modified Morgan-Russell criteria. As in our previous study, outcome was dichotomized into “full, good, or fair” and “poor” groups.

Results—Data from 16 subjects were available. The DEDS was significantly lower ($p < .05$) in the poor outcome group (0.7 ± 1) compared with the “full, good, or fair” outcome group (0.9 ± 1). Although the DVS was also lower in the poor outcome group (13.9 ± 2) compared with the “full, good or fair” outcome group (15.7 ± 1.8), this difference was not statistically significant.

Discussion—In recently weight-restored patients with AN, a lower DEDS, but not DVS, is associated with poor clinical outcome after inpatient treatment. This finding may be important in the assessment of risk for relapse in patients with AN.

Keywords

anorexia nervosa; dietary energy density; diet variety; relapse

Introduction

Disturbances in eating behavior are hallmark clinical features of anorexia nervosa (AN). Established goals of nutritional rehabilitation in AN include the restoration of a healthy body weight and normalization of eating patterns.¹ Specialized inpatient treatment programs are

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largely successful at weight restoration; however, the persistence of dysfunctional eating behavior persist.

In a laboratory study of eating behavior, Sysko et al.² compared intake of a novel food (i.e., yogurt shake) in hospitalized patients, before and after weight restoration, and healthy controls. Despite improvement on psychological measures of eating behaviors and attitudes, there was no significant increase in beverage consumption before and after weight gain, and at both time points, patients consumed significantly less than controls. Steinglass et al.³ reported that recently weight-restored inpatients with AN ate significantly less than healthy controls at a single-item (i.e., macaroni and cheese) meal. Similarly, Mayer and coworkers (private communication) studied the eating behavior of hospitalized patients at a multi-item buffet-style lunch meal, before and after weight restoration. After weight normalization, patients demonstrated a modest increase in total calories and percent of calories from fat. However, patients with AN, regardless of weight status, consumed significantly fewer total calories and a significantly reduced percent of calories from fat compared with healthy controls.

Surprisingly few longitudinal studies have been conducted on the relationship between the eating behavior of weight-restored patients and long-term outcome. A recent study⁴ reported that, when compared to healthy controls, weight-restored outpatients with AN chose diets that were significantly lower in energy, carbohydrate, protein, and fat content. A 20-year outcome study⁵ found that, even among AN patients with generally good outcome, one-third still ate restricted diets, described by some as “very rigid,” and one-third avoided the intake of regular meals. In a 10-year follow-up study of previously hospitalized AN patients, Eckert et al.⁶ found abnormal eating behaviors in the month prior to follow-up. These included eating low-calorie foods (71%), eating small meals (80%), and skipping meals (67%). Eckert et al.⁶ concluded that the high rate of relapse within one year of hospital discharge suggested the need for intensive interventions aimed at decreasing abnormal eating and weight control behaviors.

We recently reported that energy density and diet variety were associated with clinical outcome.⁷ Specifically, recently weight-restored patients consuming a diet of lower energy density or of a limited variety of foods were more likely to relapse in the year following hospital discharge compared to those individuals with more varied diets and a higher overall energy density. The aims of this study were to replicate, in a new sample, the previous finding of an association between dietary energy density and diet variety and clinical outcome.

Method

Participants were 22 women with AN between the ages of 18–45 years participating in a longitudinal study examining changes in body composition in the year following inpatient treatment on an eating disorders unit. Participants met DSM-IV-TR criteria for AN, with the exception of the amenorrhea criterion.^{8,9} The Institutional Review Board of the New York Psychiatric Institute and Columbia University Department of Psychiatry approved this study. All participants documented consent in writing.

Inpatient Treatment

All participants received inpatient treatment on the Eating Disorders Service of the General Clinical Research Unit (GCRU) at the New York State Psychiatric Institute at the Columbia University Medical Center. Treatment consisted of a structured behavioral program aimed at normalizing weight and eating behavior.^{10,11} Patients were prescribed three meals and one snack daily with sufficient caloric content to gain at least one kilogram per week. If they were unable to gain weight with food alone, additional calories in the form of a liquid nutritional supplement (Ensure Plus) were added. 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, three-to-five times weekly, as well as group and family therapy. Weight restoration continued until the patient reached 90% ideal body weight (IBW), as defined by Metropolitan Life actuarial tables,¹² approximately equal to a body mass index (BMI) of 20 kg/m².

Initially, all patients were provided with a diet containing ~30% fat that was selected by the hospital Registered Dietitian (RD); all meals and snacks were consumed in a supervised setting. Patients were started on 1,800 kcal/d; this was gradually increased to a maximum of 3,000 kcal/d. At ~80% IBW, patients continued to receive a calorie-prescribed diet, eaten under supervision, but they were 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 assured.

Nutrient Intake

Participants completed a prospective 4-day food record after maintaining 90% IBW for 2 to 4 weeks. Verbal and written instruction on estimation of food portions and examples of food portions were provided. Completed food records were reviewed for accuracy. A Registered Dietitian (JS) entered data into Nutritionist Pro© software (version 1.2.207, First DataBank, Inc.). 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-day food records. Energy density, defined as caloric intake (in kcal) divided by the total weight (in g) of food and beverages consumed,¹³ 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 (e.g., carbonated beverages, juice, sweetened fruit drinks, coffee, and tea with caloric additives such as milk and sugar, and alcohol) and noncaloric beverages (e.g., water, diet beverages, and unsweetened black

coffee and tea).¹⁴ Non-nutritive sweeteners contribute minimally to 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-day food record. The DVS was defined as the cumulative number of different foods and beverages consumed^{15–17} divided by the total number of food record days. An RD reviewed and manually coded each food record. Foods eaten on multiple occasions were counted only once^{15,16} and a food item was included regardless of quantity.^{15,18} A specific food was counted as a distinct item if it was prepared in an obviously different manner (e.g., baked potato, mashed potato) or was of a different variety (e.g., brown rice, white rice). Each vegetable was counted as a distinct item; however, it was counted once if prepared in a fat-free manner (e.g., boiled, micro-waved) and counted a second time if prepared with the addition of fat (e.g., deep fried, sautéed). Likewise, a specific cut of meat or poultry or specific type of fish was counted once if prepared in a fat-free manner (e.g., grilled, broiled) and counted a second time if prepared with the addition of fat (e.g., deep-fried, stir-fried). Different varieties of juice were distinct, as were different forms of the same fruit (e.g., fresh peach, canned peach). Different flavors of the same type of yogurt were counted only once because the hospital food service department determined the type of fruit yogurt provided. Combination foods were counted as a complete unit (e.g., pizza) and were not broken down to component ingredients (e.g., crust, cheese, and tomato sauce). Noncaloric fluids (i.e., diet beverages, water, plain unsweetened coffee and tea), non-nutritive sweeteners, (e.g., aspartame, saccharin), and condiments (e.g., salt, pepper, ketchup and mustard) were not included in the DVS.

Posthospitalization Follow-Up

Upon completion of the inpatient program, patients were discharged to treatment in the community. Follow up information regarding eating disorder symptoms and weight status was obtained during monthly phone calls by research staff, and in-person evaluations were conducted every 3 months for up to one year following hospital discharge.

Clinical outcome was evaluated at the end of one year or at the point of last contact. Clinical outcome was determined using modified Morgan-Russell criteria¹⁹: full, good, fair, and poor (Table 1). As in the previous study,⁷ outcome was dichotomized into Morgan-Russell classification of “full, good, or fair” and “poor.”

Statistical Analysis

Clinical characteristics and nutrient intake of “full, good, or fair” and “poor” outcome groups were compared using independent samples *t*-tests. Effect size (Cohen’s *d*) was calculated to assess the magnitude of the difference between the groups. In an exploratory analysis, a standard multiple linear regression model was constructed to determine if macronutrient intake (i.e., carbohydrate, protein, fat) and beverage intake (i.e., caloric and noncaloric) predicted the DEDS. All analyses were performed with SPSS for Windows (version 17.0, SPSS, Chicago). Means are reported $\pm$ standard deviation. Significance level was set at $p < .05$.

Results

Follow-up was obtained on 21 of the 22 subjects, as one participant did not return phone calls after hospital discharge. Nineteen of the 21 participants completed follow-up assessments 9 to 12 months after hospitalization and provided sufficient information to determine Morgan-Russell criteria. One participant provided information at 3 months post-discharge, but did not return phone calls after that visit. Another participant remained in contact with the clinic for 7 months, but was then lost to follow-up. For these two patients, Morgan-Russell classification was determined by information collected at the point of last contact.

Food records, completed during inpatient weight maintenance (90% IBW for a 2- to 4-week period), were available for 19 of the 21 participants. Typically, up to 8 fl. oz per day of Ensure Plus, which provides 360 kcal, is prescribed during weight maintenance. Sixteen patients consumed up to 8 fl. oz/day (44 ± 91 kcal) of Ensure Plus; they were included in the final analysis. Three patients consumed more than 8 fl. oz/day (576 ± 264 kcal) of Ensure Plus; they were excluded from further study.

Demographic and clinical characteristics of the outcome groups are presented in Table 2. Of the 16 participants, outcome for eight patients was categorized as “full ($n = 4$), good ($n = 2$), or fair ($n = 2$)” and for eight patients as “poor” outcome. One subject was maintaining a BMI of 18.2 and was menstruating regularly, and thus was included in the fair category. There were no significant differences between the outcome groups on age or weight-restored BMI; however, as expected by outcome classification, mean BMI at follow-up was significantly different between the “full, good or fair” and “poor” outcome groups.

Total energy, macronutrient intake, DEDS, and DVS are presented in Table 2. Although energy intake was significantly higher in the “full, good, fair” outcome group compared with the “poor” outcome group, intake of carbohydrate, protein, and fat did not differ significantly between the outcome groups. The DEDS ranged from 0.51 to 1.1, with higher scores observed in the “full, good, fair” group and lower scores observed in the “poor” group; this difference was statistically significant. The DVS ranged from 11 to 18, with higher scores observed in the “full, good, fair” group and lower scores observed in the “poor” group; however, this difference failed to reach statistical significance.

Although the outcome groups failed to differ in their consumption of caloric beverages, a statistically significant difference in the consumption noncaloric beverages was observed: the “poor” outcome group consumed more and the “full, good, fair” group consumed less (Table 2). Noncaloric beverages consumed by the “poor” outcome group consisted of water (773 ± 591 g), unsweetened black coffee and tea (702 ± 391 g), and diet carbonated and noncarbonated drinks (315 ± 302 g). In comparison, the “full, good, fair” group consumed less water (376 ± 450 g), a similar amount of coffee and tea (619 ± 564 g), and less of the diet drinks (144 ± 259 g).

The multiple linear regression model identified two significant predictors of the DEDS [$F(5,10) = 29.341, p < 0.001$] that explained 93.6% of the variance in that score. As indicated in Table 3, noncaloric fluid was a statistically significant negative predictor, while fat intake

a statistically significant positive predictor of the DEDS. Carbohydrate, protein, and caloric fluid intake failed to predict the energy density score.

Discussion

The results of this study provide additional data supporting our previous finding⁷ that, among women with AN, weight-restored on an inpatient unit, there is a significant association between dietary energy density and longer-term outcome. Specifically, a lower DEDS prior to hospital discharge is associated with worse outcome in the year following inpatient treatment.

The DEDS in the “poor” outcome group was nearly identical to that (0.7 ± 0.3) previously reported.⁷ In contrast, the DEDS in the “full, good, fair” group was modestly lower than previously observed (1.0 ± 0.2),⁷ but similar to the DEDS (0.94; calculated by the same methodology) reported in adult female NHANES participants.²⁰

Dietary energy density is substantially influenced by fat and fluid consumption.²¹ Fat avoidance is well documented in patients with AN.^{22–26} In our previous study, fat intake differed significantly between the outcome groups. In this study, fat intake was higher in the “full, good, fair” group and lower in the “poor” group. Although this difference was not statistically significant, it is notable that a large effect of fat intake was observed, and that dietary fat was a significant positive predictor of the DEDS.

The “full, good, fair” and “poor” groups differed significantly in their consumption of noncaloric beverages. Noncaloric beverage was a significant negative predictor of the DEDS. In contrast, caloric beverage consumption did not differ between the groups, nor did it predict the DEDS. Hart and colleagues²⁷ assessed 7-day retrospective fluid intake in 81 patients with eating disorders (48 AN, 17 EDNOS, 16 BN) upon hospital admission. For the group as a whole, noncaloric beverage accounted for 84% of total daily fluid consumption. Albeit fluid consumption was not reported separately for each diagnostic groups, it is noteworthy that patients with a lower BMI (less than 17.5) consumed significantly more non-caloric beverages than patients with a higher BMI (greater than 17.5). Hart et al.²⁷ reported that water was the preferred noncaloric fluid, accounting for 55% of mean daily fluid intake. Similarly, we observed that water was the major source of noncaloric fluid in the “poor” outcome group, but not in the “full, good, fair” group. Water intake in both outcome groups was, however, higher than the mean reported daily intake ($167.9 \text{ g} \pm 268$) of adult female participants in the Nurses’ Health Study II.²⁸

In contrast to our prior study,⁷ we failed to replicate an association between diet variety and treatment outcome. Consistent with prior findings,⁷ the “full, good, full” group had a higher and the “poor” group a lower DVS, but this difference was not statistically significant. The large effect size observed, however, suggests that lack of significance may be due to sample size.

Study limitations

There are several limitations to this study. First, this study was a secondary analysis of data. The small sample size clearly increased the risk of a Type II error; a finding supported by several instances of a moderate or large effect size in the absence of statistical significance.

Second, food records are subjective, and the potential effects of misreporting food intake on energy density values should be considered. Normal-weight²⁹ and overweight³⁰ persons tend to underreport food intake; conversely, patients with AN have been observed to either over-report^{25,26} or accurately report^{31–33} food intake. Several approaches to calculation of energy density are also reported in the literature: food only, food plus caloric beverages, and food plus caloric and non-caloric beverages. To best capture the food and beverage choices of patients with AN, food, caloric beverages, and noncaloric beverages, including water, were included in the DEDS calculation¹⁴. A standardized approach to categorizing foods into diet variety groups is also lacking. Hence, methodological differences limit comparisons across studies. The diet variety groups used in the current study were derived from NYSPI's menu planning protocol; other food-grouping approaches may have led to different results.

Third, there is no universally accepted definition of recovery or of relapse in AN. Previous studies on relapse and relapse prevention in AN have successfully used Morgan-Russell criteria to define outcome.^{10,11} However, a significant limitation of the Morgan-Russell criteria is the primary emphasis on weight status and the relative lack of consideration of other important aspects of the symptoms of AN, for example binge eating, purging, or body image concerns.

Finally, it is noteworthy that neither age nor duration of illness, differed significantly between the treatment outcome groups; this finding is surprising. This may be due to our small sample. However, it may also be because patients admitted to the NYSPI tend to be older, with a more chronic course of illness. Thus, these findings may not be generalizable to younger patients, or those with shorter duration of illness.

Conclusion

These data suggest that a lower DEDS, and possibly a lower DVS, may be associated with poor outcome in recently weight-restored women with AN. It is premature to recommend specific goals for DEDS and DVS during nutritional rehabilitation. However, results of the current study largely replicate previous findings, and together they suggest three specific eating behaviors that may be related to relapse in recently weight-restored patients with AN: limited dietary fat intake, consumption of water and noncaloric beverages, and limited variety in the diet. Given the high rate of relapse in patients with AN, it appears both practical and clinically relevant to monitor these behaviors throughout the weight restoration and weight maintenance phases of treatment.

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TABLE 1

Definition of modified Morgan-Russell criteria for patients with AN

Outcome	Definition
Full	No DSM-IV ^a criteria for a minimum of 8 weeks
Good	BMI ≥ 18.5; normal menses. May have some binge eating or purging behaviors, or psychological symptoms of AN
Fair	BMI ≥ 18.5; amenorrhea
Poor	BMI < 18.5

^a American psychiatric association, 1964.

Clinical characteristic, average nutrient intake, and diet in treatment outcome groups prior to hospital discharge ($N = 16$)

TABLE 2

	Mean $\pm$ SD					
	Full, Good, or Fair Outcome (N = 8)	Poor Outcome (N = 8)	<i>t</i>	df	<i>p</i>	Cohen's <i>d</i>
Clinical characteristics						
Age (years)	26.1 $\pm$ 5.6	25.6 $\pm$ 2.1	0.235	14	.82	0.12
Duration of Illness (years)	5.8 $\pm$ 3.2	6.9 $\pm$ 4.8	-0.513	14	.62	-0.26
Length of follow-up (months)	9.6 $\pm$ 3.0	11.4 $\pm$ 3.9	-0.999	14	.34	-0.50
Body mass index (kg/m ²)	20.3 $\pm$ 0.4	20.1 $\pm$ 0.4	1.199	14	.25	0.60
Nutrient intake and diet						
Dietary energy density score	0.9 $\pm$ 0.1	0.7 $\pm$ 0.1	2.862	14	.01	1.43
Diet variety score	15.7 $\pm$ 1.8	13.9 $\pm$ 2.0	1.815	14	.09	0.91
Energy (kcal)	2,839.6 $\pm$ 398.3	2,443.1 $\pm$ 352.9	2.108	14	.05	1.05
Carbohydrate (g)	390.3 $\pm$ 49.4	353.5 $\pm$ 49.4	1.491	14	.16	0.75
Protein (g)	119.6 $\pm$ 23.7	100.2 $\pm$ 17.2	1.870	14	.08	0.94
Fat (g)	97.2 $\pm$ 28.3	77.0 $\pm$ 16.5	1.743	14	.10	0.87
% kcal Carbohydrate	53.1 $\pm$ 5.5	55.9 $\pm$ 3.6	-1.236	14	.24	-0.62
% kcal Protein	16.9 $\pm$ 1.9	16.5 $\pm$ 2.6	0.378	14	.71	0.19
% kcal Fat	30.0 $\pm$ 6.1	27.6 $\pm$ 2.4	1.067	14	.30	0.53
Caloric beverages (g)	714.8 $\pm$ 215.4	661.1 $\pm$ 222.5	0.491	14	.63	0.25
Noncaloric beverages (g)	1,138.0 $\pm$ 652.5	1,789.8 $\pm$ 544.8	-2.169	14	.05	-1.08

TABLE 3

Macronutrient and beverage intakes as predictors of the dietary energy density score in weight-restored patients with anorexia nervosa ($N = 16$)

	Unstandardized Coefficients		Beta	<i>t</i>	<i>p</i>
	β	Std. Error			
Carbohydrate (g)	0.001	0.000	0.177	1.849	.09
Protein (g)	−0.001	0.001	−0.156	−1.338	.21
Fat (g)	0.003	0.001	0.451	4.335	.001
Caloric beverage (g)	−5.70E-5	0.000	−0.078	−0.772	.46
Noncaloric beverage (g)	0.000	0.000	−0.861	−9.315	.00