Diet and Physical Activity in Women Recovered from Anorexia Nervosa: A Pilot Study

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ABSTRACT

Objective: After recovery, women with anorexia nervosa (AN) tend to maintain lower body mass indices (BMI) than women in the general population. Reasons for this are unknown as little is known about diet, food choices, physical activity levels (PAL), and reasons for exercise in women recovered from AN.

Method: Diet, reasons for food choice, PAL, and reasons for exercise were measured in an exploratory study of 15 women recovered from AN and 22 women with no eating disorder history.

Results: In these hypotheses generating analyses, mean BMI in recovered women was numerically lower than control women [21.4 kg/m^2 (2.0) and 23.6 kg/m^2 (4.4); respectively ($p < .06$)]. Recovered women were more likely to base food choice on health benefits ($p < .04$) compared with control women.

Discussion: Pathological behaviors that are pathognomonic of AN may resolve into healthy food and activity choices that help maintain BMIs lower in the healthy range in recovered individuals.

Keywords: anorexia nervosa; recovery; body mass index; diet; physical activity; reasons for food choice

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Introduction

Women recovered from anorexia nervosa (AN) appear to maintain a lower body mass index (BMI) compared with comparably aged women with no history of an eating disorder.[1–4] Diet and physical activity level (PAL) are two factors that are important in the attainment and maintenance of BMIs; however, little is known about the long-term diet and PAL of individuals who have recovered from AN.

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Dietary Intake

Several studies suggest that dietary fat intake comprises a lower percent of total energy intake[5–11] and dietary protein a higher percent of total energy intake[5,10,12] in women with AN compared with women without an eating disorder. Both lower[5,13] and higher[6,8] percent of total calories from carbohydrates were reported in individuals with AN relative to those without an eating disorder.

Few studies have addressed diet in women after recovery from AN. In a study of 14 women in treatment for AN, macronutrient composition of the diet did not change from intake to 1 year follow-up, at which time the participants were still below 85% of ideal body weight, and the women's diets were not compared with diets of individuals without a history of an eating disorder.[14] In a separate study, following hospitalization for AN, 29 women deemed to have "successful" outcomes consumed a higher percent of energy from fat than 12 women considered "treatment failures."[15] This study was conducted less than 1 year posthospitalization and diet was not compared with diets of control women nor to the patient's diet while acutely ill with AN.[15] Therefore it remains unknown if dietary intake differs in women who are long-term recovered from AN compared with women without a history of an eating disorder. A related heretofore unaddressed question, concerns factors that influence food choice in women recovered from AN. Although food choice might be directly related to macronu-

trient content of food items, it could also reflect alternative motivations (i.e., eating less trans fat, less saturated fat, or eating fewer processed food items), which might have health benefits.

Physical Activity

PAL is another possible mechanism that could contribute to low BMIs in women recovered from AN. In several studies, PAL was higher in individuals who were acutely ill with AN compared with control participants.[16–19] PAL might remain relatively stable during initial recovery from AN[20] and persist after recovery.[16]

Women with AN report different reasons for exercise than women without eating disorders. In a study of 59 women with AN and 53 women without an eating disorder, using the Reasons for Exercise Inventory (REI), women with AN were less likely to cite health/fitness and more likely to cite negative affect regulation as reasons for exercise.[21] However, when applying a different set of subscales to the REI, 102 women with an eating disorder were more likely to cite weight control, attractiveness, body tone, and mood and less likely to cite enjoyment as reasons for exercise compared with 184 women without an eating disorder.[22]

The reasons for increased PAL during acute AN are not entirely clear. It is often assumed that increased PAL is consciously motivated to increase energy expenditure with a resolute goal of facilitating weight loss or maintenance of low weight, but alternative explanations have also been posited including thermoregulation,[23,24] anxiolysis,[25,26] and mood regulation.[21,22] If recovery is characterized by improved thermoregulation, and reduced anxiety and negative affect these motivators could cease to be operative and reasons for physical activity after recovery could differ from reasons for physical activity during the acute phase of the illness. Therefore it is important to explore reasons for exercise in women who are long-term recovered from AN.

Diet, reasons for food choice, PAL, and reasons for exercise are all items which might independently be important to BMI maintenance along with the long-term health of women recovered from AN, but to the best of the authors' knowledge, no study has examined these items in recovered women. The aim of the current study is to further understand characteristics of women recovered from AN for three or more years by determining whether they differ from control women on energy intake, dietary macronutrient intake, reasons for food choice, PAL, and reasons for exercise.

Method

Participants

All recovered and control participants were recruited from university list-serves and advertisements. Participants were women between the ages of 18 and 65 years with no current medical conditions which would influence weight, diet, or PAL. All women in the recovered group met lifetime diagnostic criteria for AN, including amenorrhea, and had not met diagnostic criteria for any eating disorder during the 3 years before the study. Women also reported not having BMIs below 17.5 kg/m^2 nor engaging in any binge eating or purging in the last 3 years. Control women reported never having met diagnostic criteria for any eating disorder and not having a BMI below 17.5 kg/m^2 in the 3 years before the study. Participants were not excluded based on maximum BMI. All but one participant were nonsmokers. Following initial screening, three potential recovered women and 10 potential control participants declined participation in this study.

Complete data for questionnaires were available for 15 women recovered from AN and 22 control women. Of these, two control women did not complete food journals and two control women did not complete a weekend day food journal and were removed from dietary analyses yielding a final sample of 15 women recovered from AN and 18 control women for dietary analyses. Sufficient hours of wear time for the physical activity monitors were not logged on 3-week days and 1 weekend day for two women recovered from AN and five control women; these women were removed from physical activity analyses yielding complete physical activity data for 13 women recovered from AN and 15 control women. One control woman was a BMI outlier, but left in analyses given the small sample size and removal of the participant did not impact results.

Assessments

Eating Disorder Diagnosis. Module H of the Structured Clinical Interview for DSM-IV Axis I Disorders—Patient Edition (SCID-I/P)[27] was used to establish presence or absence of current and lifetime eating disorders. The SCID-I/P is a semistructured interview which was conducted over the telephone by a trained clinical interviewer.

Anthropometric Data. Current height was measured in meters and weight was measured in kilograms, on a calibrated Scale-Tronix 50220 scale, while the participant was wearing light clothing and socks. Current, measured, height and weight were used to calculate BMI.

Dietary Intake. Women were instructed to keep detailed food journals for 3 weekdays and 1 weekend day. Women were asked to indicate items consumed, brand

names, and amounts of each item consumed. For combination food items, such as salads and sandwiches, women were asked to list each component separately and to the give precise amount of each item consumed. Women were instructed to use common household items as a guide to how much was consumed (i.e., a fist is approximately one cup) and asked to measure items when possible. All data were entered into the Nutritionist Pro Software™ Version 4.3.0.[28] This program generated the total kilocalorie (kcal) and macronutrient data used for analyses.

Food Choice Questionnaire. The food choice questionnaire (FCQ) was used to determine what factors impact the participants' food choices. The FCQ is a 36-item self report questionnaire that has the following subscales: convenience, ethical concern, familiarity, health, mood, natural content, price, sensory, and weight control and is used to assess different factors that influence food preferences.[29] The FCQ has been shown to have test-retest reliability and internal consistency; Cronbach's α scores for each subscale are as follows: convenience = 0.84; ethical concern = 0.74; familiarity = 0.72; health = 0.81; mood = 0.83; natural content = 0.86; price = 0.83; sensory appeal = 0.72; and weight control = 0.85.[29]

Physical Activity. Participants were asked to wear an Actigraph℠ activity monitor for 3 weekdays and 1 weekend day. The epoch length of the monitors was set to 1 minute and 60 consecutive zero counts was considered indicative of the monitor not being worn. In order to be considered worn for a day the participant needed to log 10 hours of wear time. Participants were instructed to not wear the monitors while swimming or showering. Data reduction programs were used to determine wear time and number of counts per day; these were based on programs used by the National Health and Nutrition Examination Survey.[30]

Reasons for Exercise Inventory. The REI was used to access reasons for exercise. This questionnaire contains 24 questions and subscales to assess weight control, fitness, mood, health, attractiveness, enjoyment, and tone.[31] Cronbach's α scores for each subscale are as follows: weight control = 0.81; fitness = 0.71; mood = 0.79; health = 0.73; attractiveness = 0.78; enjoyment = 0.67; and tone = 0.74.[31]

Statistical Analyses

All data were cleaned and analyzed in SAS/STAT® 9.2.[32] Means and standard deviations are presented for all continuous measures. Student's *t*-tests were used to determine differences between group for total energy intake, percent total intake from fat, percent total intake from carbohydrate, percent total intake from protein, subscales from the FCQ, total physical activity counts, and subscales from the REI. A general linear model was used to determine if group differences in BMI existed after controlling for age. Age was included as a covariate given the broad age range of participants in the current study and the established relation between age and BMI.[33]

Proc TTEST was used for student's *t*-tests and Proc GLM was used for the general linear model. All significance tests were two-tailed and p value of $<.05$ was considered significant. Given that this was a pilot hypothesis-generating study and our statistical power was low we did not correct for multiple testing.

TABLE 1. Average daily dietary intake of women recovered from anorexia nervosa (AN) and control women

	Recovered AN	Control	
Macronutrient	Mean (SD)	Mean (SD)	*p* Value
Total kilocalories	1942 (543)	1915 (460)	.89
Percent fat	29.5 (7.1)	30.1 (6.5)	.80
Percent protein	14.3 (2.9)	14.0 (1.9)	.69
Percent carbohydrate	54.1 (9.0)	54.2 (8.1)	.97

Notes: Percentages do not add to 100 due to a small amount of alcohol consumption not included. SD, standard deviation

Results

Age did not differ significantly between recovered and control women [32.5 (14.3) years vs. 28.9 (10.7) years, respectively]. Recovered women were recovered for a mean of 12.9 (9.0) years; (range: 3.0 years to 32.0 years) (data not shown).

BMI

BMI was over two units lower in recovered women compared with control women [21.4 kg/m^2 (2.0) vs. 23.6 kg/m^2 (4.4), respectively]. However, when controlling for age the small group comparison was not significantly different ($p < .06$). Of the women in this study, one recovered woman (6.7%) and four control women (18.2%) had a BMI in the overweight range ($25.0 \leq$ BMI < 30.0) and no recovered women (0.0%) and two control women (9.1%) had a BMI in the obese range (BMI ≥ 30.0).

Energy Intake and Macronutrient Content of Diet

Table 1 presents energy intake and macronutrient breakdown of reported diet. Reported macronutrient intake for both groups is within suggested ranges and groups did not differ on total energy intake or macronutrient composition of the diet.

Reasons for Food Choice

Reasons for food choice are presented in **Table 2**. Women recovered from AN were significantly more

TABLE 2. Reasons for food choice in women recovered from anorexia nervosa (AN) and control women

	Recovered AN	Control	
Reason Food Choice	Mean (SD)	Mean (SD)	*p* Value
Convenience	14.5 (3.1)	14.5 (3.2)	1.00
Ethical concern	5.2 (1.6)	5.1 (2.2)	.82
Familiarity	5.9 (2.2)	6.1 (2.2)	.79
Health	19.3 (3.2)	16.9 (3.4)	.04
Mood	13.1 (3.0)	11.4 (3.3)	.11
Natural content	5.9 (2.6)	6.8 (2.7)	.35
Price	8.1 (2.3)	8.4 (2.2)	.70
Sensory	10.7 (2.6)	10.8 (2.2)	.85
Weight control	7.9 (2.6)	7.4 (2.2)	.58

Notes: SD, standard deviation.

TABLE 3. Average daily total activity and reasons for exercise in women recovered from anorexia nervosa (AN) and control women

	Recovered AN	Control	*p* Value
Activity	Mean (SD)	Mean (SD)	
Counts	91,762 (34,575)	85,397 (25,070)	.58
Reason for exercise	Mean (SD)	Mean (SD)	
Weight	14.5 (4.0)	14.1 (5.6)	.82
Fitness	20.1 (5.2)	21.3 (3.5)	.42
Mood	19.3 (5.2)	18.1 (5.3)	.50
Health	22.0 (4.4)	23.5 (3.3)	.26
Attractiveness	12.9 (4.9)	13.9 (5.3)	.58
Enjoyment	10.9 (5.4)	11.0 (4.9)	.96
Tone	11.3 (4.1)	13.1 (4.7)	.24

Notes: Means and standard deviations (SD) are presented.

likely than control women to report selecting food items based on perceived health benefits ($p < .04$). Between group differences were not found for the other scales of this questionnaire.

Physical Activity and Reasons for Exercise

Total daily activity and reasons for exercise did not differ between groups as shown in **Table 3**.

Discussion

Overall, we found that energy intake, macronutrient composition of the diet, and PAL did not significantly differ in women recovered from AN compared with women without an eating disorder history. This was, however, a pilot investigation, and we were underpowered to find between group differences for the variables observed in this study.

This pilot study provides a preliminary glimpse into eating and activity behaviors of individuals who have recovered from AN. Our data suggest that after recovery, women with histories of AN focus on health benefits of foods more than non eating disordered peers, although overall energy intake did not differ between the groups. Women recovered from AN had BMIs over 2 units lower than women without a history of an eating disorder and a numerically lower percent of recovered women were considered overweight or obese. If our observations regarding lower BMIs in the presence of nonsignificantly different energy intake and PAL were to be replicated in a larger sample, there are several alternative biological, genetic, and behavioral explanations for lower BMIs that would be worthy of further exploration. If biologic or genetic mechanisms are the operative factors in the maintenance of lower BMIs postrecovery, it would also be important to determine whether the same biological or genetic mechanisms might also have contributed to the ability to attain low BMIs during acute AN in the first place.

Considering potentially relevant biological mechanisms, previous research indicated women recovered from AN have higher fat oxidation than women without a history of an eating disorder.[34] In Pima Indians, low fat oxidation is associated with weight gain,[35] and obese individuals who lost weight have lower fat oxidation than individuals of the same BMI who were never obese.[36] Therefore it follows that high fat oxidation, present in women recovered from AN, might be associated with an ability to attain and maintain a lower BMI.

A second biologically plausible explanation for the ability to maintain a lower healthy BMI might result from differences in uncoupling proteins (UCPs). UCPs are positively associated with resting metabolic rate and negatively associated with fat mass;[37–40] higher than expected resting metabolic rate could account for lower BMIs. Lower percent fat mass would contribute to higher resting metabolic rate and therefore also contribute to lower BMIs. To add further support to this notion, obese women who are "diet responsive" have higher mRNA expression of UCP3 compared with obese women who are "diet resistant."[38] In addition, individuals with AN might be more likely to have a mutation in UCPs 2 and 3[41] and this could result in an ability to attain and maintain a lower BMI compared with their peers in the general population. It is also possible that AN is associated with other genetic variations that influence the development and maintenance of a low BMI before, during, and following acute AN.

Third, nonexercise activity thermogenesis (NEAT) may be higher in recovered individuals than in individuals without a history of an eating disorder. NEAT

shows interperson variation by up to 2,000 kcal/day[42] and would include such factors as fidgeting and sitting as opposed to standing, items unable to be measured by the current study. Therefore differences in NEAT could contribute to the differences in BMI.

An alternative, behavioral explanation for the ability of women recovered from AN to maintain lower BMIs than women without a history of an eating disorder could result from subtle and sustained nonstatistically significant differences in energy balance (energy intake relative to energy expenditure). For example, albeit in this small study, both energy intake and PAL were slightly higher in women recovered from AN compared with control women. Despite the higher values for both energy intake and PAL, even a sustained 50 kcal/day difference in energy balance would result in considerable differences in BMI over time. Therefore, even with apparent similarities in energy intake and PAL, an energy deficit might be present in recovered women and contribute to lower BMIs.

In addition, it has been hypothesized that the pathology of AN may resolve into healthy behaviors which may be protective against obesity.[43] In the current study, recovered women did indicate a higher preference for food choice selection based on health benefits compared with control women. Selecting food items based on perceived health benefits could result in lower consumption of unhealthy, unnecessary components of food items (i.e., trans fat and added sugars). Higher importance of food selection based on health benefits in recovered women might serve as an indication that individuals who are able to recover from AN develop healthy eating and lifestyle habits that may be protective against obesity and obesity related chronic diseases.

Limitations

Due to small sample size, both the significant and nonsignificant results must be interpreted with caution. First, the overall sample size for this study was small and was further reduced by the ability to obtain useable diet and physical activity data from those data collected in this study. Therefore this study was underpowered to find significant differences between groups. For example, this study had approximately 39% power to find a 2.2 kg/m^2 difference in BMI. Although mean values for energy intake and percent macronutrient composition of the diets did not differ significantly between groups, it should be noted that more control than recovered participants were removed from analyses due to incomplete food journals or physical activity data. We are unable to determine how this may have impacted our results. Second, it is probable that participants did not accurately estimate dietary consumption. It is also possible that women altered diet and physical activity habits on the days that records were kept. It is unknown whether accuracy and alterations would differ between groups. Third, there are inherent short-comings in using activity monitors for measurement of PAL including failure of monitors to detect motion in all directions, failure of monitors to detect certain types of activity (i.e., lifting weights), failure to detect NEAT, and failure to detect other factors associated with activity (i.e., running with weights or while pushing a stroller). In addition, swimming was unable to be included in total counts; few participants reported swimming during the data collection period. Fourth, it is possible that women who were satisfied with diet and physical activity habits were more likely to respond to advertisements for this study. Therefore, results of this study might not generalize to all women who are recovering from AN; especially those who are less comfortable with their current diet and physical activity patterns. Fifth, results of this study might not generalize to other populations. Participants in this study were highly educated, largely Caucasian, and largely nonsmokers.

Conclusion

The current study provides additional evidence to support the hypothesis that pathologic behaviors of AN resolve into healthy and adaptive behaviors after recovery. The preliminary results of this exploratory study encourage future, larger, investigations examining differences in diet, PAL, and overall energy balance using more precise methodology (i.e., multiple methods to assess usual diet, multiaxial and water-proof activity monitors accompanied by activity logs to assess PAL, devises that can estimate NEAT, and doubly labeled water to assess total energy expenditure), in order to help better understand factors associated with recovered women's tendency to maintain lower BMIs. Further exploration of biological mechanisms and genetic variants which may contribute to lower BMIs in recovered women would also be useful and provide a better understanding of long-term health in individuals recovered from AN.

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