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Psychological, nutritional, and energy expenditure differences in college females with anorexia nervosa vs. comparable-mass controls

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ABSTRACT
This is the first study to examine psychological and behavioral variables in nonhospitalized college females with subclinical anorexia nervosa (AN) as compared to healthy college females of comparable body mass (i.e., body mass index (BMI)<19). Participants who met all DSM-IV [Diagnostic and statistical manual of mental disorders, 4th ed. (1994). Washington, DC: APA.] criteria for AN-restrictive type (except for BMI<17.5; n=11) and control participants (n=15) with comparable body mass completed psychological, nutritional, and exercise assessments. Results suggested that those with AN evidenced more general psychopathology, more eating disorder symptoms, more dieting, more compulsive exercise, and less consumption of calories compared to participants in the control group. There was no difference in macronutrient consumption. There was no significant difference in expenditure of energy, despite differences in reports of compulsive exercise. Given similar body mass, this suggests that the women with AN were experiencing an energy deficit consistent with the disorder's defining features of “fear of gaining weight or becoming fat” and provides us with more understanding of individuals with AN in their natural environment.

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1. Introduction

The enthusiasm for exercise and nutrition in western culture has sparked an interest in the topics of dieting, obligatory exercise, and the development of eating disorders. Of the eating disorders, anorexia nervosa (AN) results in significant morbidity and mortality (American Psychiatric Association (APA). The DSM-IV's criteria for AN require reduced weight (<85% of expected), fear of gaining weight or becoming fat, body image disturbance, and amenorrhea in females. This definition of AN implies achievement of a negative energy balance through either food restriction alone or in combination with excessive exercise. Experts readily acknowledge this notion in both etiology of and rehabilitation from the disorder; however, there is negligible empirical evidence demonstrating caloric restriction or excessive exercise in these individuals. Furthermore, existing research is flawed in that it often examines these behaviors in individuals with AN in an inpatient hospital program and none of the studies have compared these behaviors in individuals with AN vs. comparable-weight controls.

1.1. Nutritional studies

Beumont, Chambers, Rouse, and Abraham (1981) studied the nutritional intake of women in the most severe stages of AN and living in a hospital ward while on a refeeding diet. A control group was compiled, which consisted of healthy-weight women who self-reported their dietary intake. They found that the AN patients consumed higher amounts of protein and lower amounts of fats as compared to controls. No difference between groups was found with respect to consumption of carbohydrates. This differs from earlier studies indicating that patients with AN avoided carbohydrates and thus suffered from “carbohydrate starvation” (Crisp; Crisp and Hurst). Beumont et al. (1981) also discovered that the diets of the AN patients were not meeting the Recommended Dietary Allowances (RDAs) for protein, calcium, iron, ascorbic acid, and retinol. This finding was also novel, because evidence for deficiencies in vitamins had not been found in previous studies (Berkman; Bliss and Russell), although hypercarotenemia had been documented in one study (Robboy, Sato, & Schwabe, 1974). More recent research indicates that women with AN can accurately report their nutritional intake and over half of these patients in this study failed to meet the RDA for vitamin D, B12, calcium, folate, zinc, magnesium, and copper (Hadigan et al., 2000).

Despite the cited research on the nutritional intake of women with AN in hospitalized settings, there have been no published studies comparing the nutritional intake of women suffering from AN who are not being held in an inpatient treatment setting. Thus,

use of nutritional data from hospitalized individuals with AN may yield distorted findings since their dietary intake is often increased/controlled to insure rehabilitation. Furthermore, when control groups were used, normal-weight females rather than women with similar body masses were employed in these studies. This omission is substantial because “normal” or larger females would likely have greater nutritional intake simply because their bodies require it. The present study improved upon past investigations by examining women with subclinical AN in their natural environment and by recruiting naturally thin females who did not exhibit symptoms of AN to serve as comparable-mass control participants.

1.2. Exercise studies

In many case studies, clinicians have reported generalized hyperactivity or excessive exercising in those with AN (Bruch and Yates). Rates for women with AN who exhibit high levels of exercise have ranged from 38% (Crisp, Hsu, Harding, & Hartshorn, 1980) to 80% (Davis, Kennedy, Ralevski, & Dionne, 1994). Furthermore, patients with AN who abuse exercise, compared to those who just engage in self-starvation, have more severe psychopathology (Davis and Davis). Similar to the nutrition research, there has been no research examining energy expenditure in females with AN who were not in an inpatient setting.

In conclusion, the DSM-IV (APA, 1994) and clinical lore implies that individuals with AN eat less and exercise more compared to normal healthy women. However, previous research lends only indirect support to this notion. Existing studies succumb to methodological flaws including lack of comparable-mass controls and/or examination of these variables only in a controlled hospitalized environment. The purpose of this study was to rectify weaknesses of past literature by investigating the nutritional intake and expenditure of energy of nonhospitalized, college females suffering from subclinical AN and to compare them to similar-sized college women.

2. Method

2.1. Participants

Female participants at a midsized southeastern public university were recruited spring of 1999 using fliers and email for an interdisciplinary study. Of the 550 women who responded to the initial email, 75 females returned requested information about their health and eating habits and their height and weight via email. These 75 females then

participated in a telephone interview for a small financial incentive utilizing the Structured Clinical Interview for the DSM-III-R (APA, 1987) for AN (restrictive type; SCID; Spitzer, Williams, & Gibbon, 1987), a reliable method for providing a differential diagnosis of the eating disorders. The criteria on the SCID were altered slightly to bring it up-to-date with the DSM-IV (APA, 1994).

Screened participants who met both DSM-IV criteria for AN-restrictive type (APA, 1994) and the relaxed body mass index (BMI) cut-off were recruited as participants in the experimental group. Only women who met the criteria for AN-restrictive type were chosen due to evidence suggesting there are significant clinical, and possibly biological differences between the different types of AN (DaCosta & Halmi, 1992). To meet the criteria for the comparable-mass control group, participants could not meet any of the criteria for AN, must have denied any bingeing or purging behaviors, and met the BMI cut-off. In sum, 31 females were invited to attend one of two in-person clinic days in the Exercise Science Department Laboratory. Five of these females either failed to attend the clinic days or produced incomplete data sets. The groups that resulted were 11 AN participants and 15 comparable-mass control participants. These women were mostly Caucasian females (i.e., one Hispanic) ranging in age from 18 to 24 years (mean=20, S.D.=1.6). Each was given a financial incentive for participating.

2.2. Materials

2.2.1. Symptom Check List-90 (SCL-90)

The SCL-90 (Derogatis, 1994) is a 90-item self-report inventory of symptoms whereby participants rate symptoms on a Likert scale ranging from 0 (not at all) to 4 (extremely). Internal consistency coefficients are adequate and range from .77 to .90 and test–retest reliability correlations over 1-week range from .78 to .90 across the nine subscales (Derogatis, Rickels, & Rock, 1976). The SCL-90 has shown adequate construct validity as measure of general psychopathology and its General Symptom Index, which can range from 0 to 4, was used as such in the present study (Derogatis, 1994).

2.2.2. Eating Disorder Inventory-II (EDI-II)

The EDI-II is a 64-item inventory measuring the cognitive and behavioral characteristics of AN and bulimia nervosa (Garner & Olmstead, 1984). Participants rate their behavior and beliefs on a six-item Likert scale ranging from 0 to 3 with multiple responses resulting in zero. Using a sample of normal participants and those with AN, internal

consistency for each of the eight subscales has been found to be above .80 and strong support has been found for the convergent and discriminant validity. The EDI-II (Garner & Olmstead, 1991) was adapted to meet criteria for AN for the DSM-IV (APA, 1994). The EDI-II subscales were summed for a total score, with possible ranges between 0 and 192, and used as a clinical measure of AN symptoms in this study.

2.2.3. Cognitive Behavioral Dieting Scale (CBDS)

The CBDS (Martz, Sturgis, & Gustafson, 1996) is a 14-item Likert-type scale ranging from 1 to 5 that assesses dieting behaviors and cognition over the “past 2 weeks.” Internal consistency has been found to be high with an α=.95 and an adequate 2-day test–retest reliability of r=.92 for females. In a study using hierarchical regression, the CBDS predicted caloric intake and caloric balance above and beyond relevant physical variables such as BMI and exercise (Martz et al., 1996). The CBDS is summed for a total score and the possibilities range from 14 to 70. This measure was used to assess dieting in this study.

2.2.4. Commitment to Exercise Scale (CES)

The CES measures attitudes towards exercising using an eight-item Likert-type scale ranging from 1 to 15 (Davis, Brewer, & Ratusny, 1993). The CES was designed to assess “obligatory” and “pathological” aspects of exercise. Internal consistency of the measure is .96; the test–retest reliability is .96 (Davis, Kennedy, & Ralevski, 1995). Scores in this study were obtained by summing the total scale with a possible range between 8 and 120.

2.2.5. Seven-Day Physical Activity Recall (PAR)

The Seven-Day PAR Measure (Blair et al., 1985) estimates total expenditure of energy by asking participants to recall the amount of time spent in “moderate,” “hard,” and “very hard” activities during the previous 7 days. Dishman and Steinhardt (1988) found support for this measure for use in the college population with correlations of r=.87 between the PAR and a 7-day diary. Responses reported on this measure were converted into caloric expenditures per day by blind, trained research assistants using the Exercise Logging System, (E-Log), version 2.17, (The Cooper Institute for Aerobics Research, 1994), a computer program for evaluation of exercise that translates total expenditure of energy into kilocalories (kcal). Although the data presented in this study came from the first rater, all exercise logs were converted a second time by a different

research assistant, blind to the first analysis, for interrater reliability. Interrater reliability for energy expenditure was, r=.55, P<.05.

2.2.6. 24-h Dietary recall and 72-h dietary log

A 24-h dietary recall was obtained during the clinic day and a 72-h dietary log subsequent to the clinic day was obtained to examine differences in participants' self-report of caloric and other nutrient intake. Both methods of nutritional assessment were used to help compensate for weaknesses inherent in each. Reported type and quantity of foods and beverages in the 24-h dietary recalls and 72-h dietary logs were analyzed by two blind, trained research assistants and converted into an extensive nutrient list by using the computer program, Food Processor II, version 3.11 enhanced (ESHA Research, 1990). Food Processor II includes 2400 foods and may be used to analyze 30 different food components. Due to the large nutrient database of the United States Dietary Association (USDA), few data were missing. Results included caloric content and macronutrients (% protein, % carbohydrates, and % fat). Although the data presented in this study came from the first rater, interrater reliability was obtained by correlating the two raters' output on caloric intake. For the 24-h recall, r=.56, P<.05. Interrater reliability for the 72-h dietary log was, r=.76, P<.001, both indicating adequate but not exceptional agreement.

2.2.7. Brief Dietary Screen for High Fat (BDSHF)

The BDSHF (Block, Clifford, Naughton, Henderson, & McAdams, 1989) is a 13-item questionnaire that identifies the amount of dietary fat based on the categories of foods from which Americans commonly consume their fat. The BDSHF served as an assessment of high or low intake of fat by asking participants for a recall of the amount of food eaten in 13 different categories during the previous year. In its development, the BDSHF was tested on 101 women and correlated with 4-day dietary logs, with r=.58 resulting between the BDSHF's mean grams of fat and mean grams of fat reported by 4-day dietary logs (Block et al., 1989). Scoring of the BDSHF is complicated and produces results whereby higher numbers indicate more intake of dietary fat. All BDSHFs were scored twice by different research assistants, blind to the other's analysis, for interrater reliability. Interrater reliability was, r=.86, P<.01. The BDSHF was used in this study as an additional self-reported measure of dietary fat.

2.3. Additional assessments

Participants had height and weight assessed to obtain an accurate assessment of BMI. Additional physiological measures (i.e., serum fats and cytokines), were assessed during the clinic days, but were not used in this study.

2.4. Design and procedure

This was a two-group, comparable-mass control, quasi-experimental design with the following dependent variables: the SCL-90, EDI-II, CBDS, CES, 24- and 72-h dietary intake and log, BDSHF, PAR, and height and weight. Participants were asked to report for their 1.5-h testing session in the Exercise Science Laboratory of the university. Two clinic days, separated by 4 weeks in time (to allow for adequate recruitment time and to provide the clinic with a group of participants for blood draws and serum lab tests which had to be conducted on the same day) were conducted. Participants first read and signed a consent form explaining the study and documenting the university Institutional Review Board's approval. Participants were scheduled, two at a time, every 15 min beginning at 6:30 a.m. and continuing until 10:00 a.m. For physiological measures, which were part of the interdisciplinary study, all participants were asked to refrain from intake of food or caloric beverages after midnight the night before. Trained research assistants from the Psychology Department interviewed participants and administered the psychological, behavioral, and nutritional assessments. Exercise Science research assistants obtained physical assessments. All research assistants were blind to participants' group assignment. Participants left the testing session with their 72-h dietary logs and were instructed that reimbursement for their participation was contingent upon completion and return of this data. After this was accomplished, participants were sent information about how to obtain their reimbursement. This mailing also contained feedback concerning their serum cholesterol and other blood fats and whether or not we recommended they consult a physician. Likewise, those in the AN group were sent a letter containing a recommendation that they consult a psychotherapist about their struggles with food, exercise, and body image and campus resources were listed.

3. Results

Comparisons between groups for BMI were conducted to verify AN and control groups yielded equivalent groups on body mass. An analysis of variance (ANOVA) yielded results that were not significant, $F(1,24)=0.01$, $P>.05$, with a mean of 19.0 for AN and a mean of 18.5 for control participants, establishing comparable mass.

A two-group multivariate ANOVA revealed significant differences between the AN and control groups on the four psychological assessments (SCL-90-GSI, EDI-II-total, CBDS, and CES), Wilks' F(1,1,9.5)=11.03, P<.001. Participants in the AN group evidenced greater psychopathology as assessed by the SCL-90, Wilks' F(1,24)=18.18, P<.001, greater eating disorder symptoms as assessed by the EDI-II-total, Wilks' F(1,24)=19.61, P<.001, more cognition and behavior related to dieting as assessed by the CBDS, Wilks' F(1,24)=40.31, P<.001, and more compulsive attitudes toward exercising as assessed by the CES, Wilks' F(1,24)=5.99, P<.05 than participants in the control group. See Table 1 for means, standard deviations, and comparison norms.

Table 1. Means and standard deviations for dependent variables between groups. Values in parentheses represent standard deviations.

Variable	Anorexics, *n*=11	Percentile score normative comparison of college females	Controls, *n*=15	Percentile score normative comparison of college females	One-way ANOVA *P* value
BMI	19.0 (1.2)		18.5 (1.1)		>.05
Cognitive–Behavioral Dieting Scale	48.8 (11.1)	Mean of 34.0 reported in Martz, Graves, and Sturgis (1997) for college females	23.3 (9.4)	Mean of 34.0 reported in Martz et al. (1997) for college females	<.001
Commitment to Exercise Scale	68.6 (26.5)	Mean of 61.5 reported in Davis et al. (1993) for normal females	45.6 (21.4)	Mean of 61.5 reported in Davis et al. (1993) for normal females	<.05
Eating Disorders Inventory-II Total	71.3 (33.4)		26.7 (17.6)		<.001
EDI-II Drive for Thinness subscale	9.2 (5.1)	81st Percentile (Garner, 1991)	1.4 (2.4)	36th Percentile (Garner, 1991)	
EDI-II Body Dissatisfaction subscale	13.6 (7.4)	72nd Percentile (Garner, 1991)	4.1 (5.0)	31st Percentile (Garner, 1991)	<.001
SCL-90	1.3 (0.68)	97th Percentile (Derogatis, 1994)	0.5 (0.25)	73rd Percentile (Derogatis, 1994)	<.001
24-h Dietary recall	1805.9 (1001.4)		2757.2 (792.6)		<.05
72-h Dietary log	1773.1 (812.42)		2432.4 (925.1)		<.10
BDSHF	154.5 (89.39)		210.9 (113.9)		>.05
Expenditure of energy	954.3 (990.6)		845 (807.4)		>.05

Reports for the 24-h dietary recall and 72-h dietary log were converted into kilocalories. AN participants reported consuming significantly fewer kilocalories on the 24-h recall, Wilks' F(1,23)=7.01, P<.05 than control participants. An ANOVA revealed a trend for experimental participants reporting fewer kilocalories than control participants on the 72-h dietary log, Wilks' F(1,23)=3.35, P<.10. Contrary to previous research, a MANOVA did not yield significant differences between groups with regard to differences in intake of carbohydrates, protein, and fat, Wilks' F(1,0.5,9.5)=1.5, P>.05 as reported on the 24-h recall. A significant difference between groups was not found on the BDSHF, Wilks' F(1,24)=1.86, P>.05. To assess for any reactance to the different methods used to collect this nutritional data, a repeated-measures ANOVA was run between groups over

time between the 24-h recall and 72-h log establishing no time effect for time, $F(1,23)=0.67$, $P>.05$.

An ANOVA assessing differences between groups on self-reports of formal exercise energy expenditure converted into kilocalories was not significant, Wilks' $F(1,24)=0.09$, $P>.05$. Fig. 1 and Fig. 2 illustrate group means on these behavioral variables.

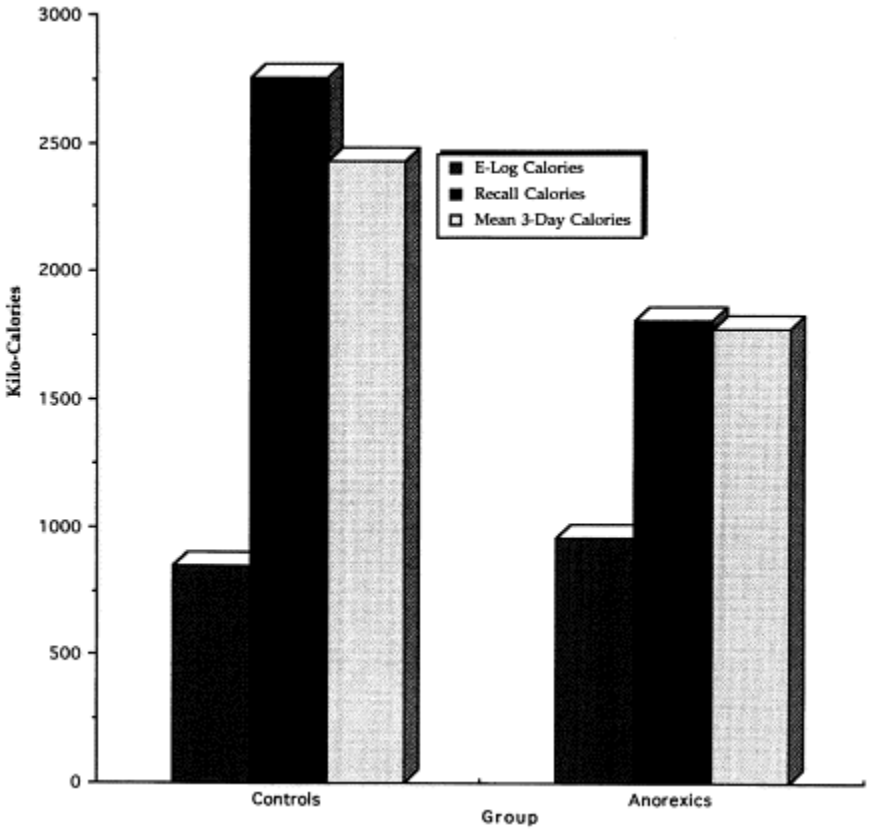

Fig. 1. Group differences in E-Log exercise energy expenditure, 24-h dietary recall of kilocalories and 72-h logged kilocalories. The AN group did not differ for E-Log expenditure ($P>.05$), but did differ significantly ($P<.05$) from the control group for the 24-h recall, and there was a trend for a difference ($P<.10$) for the 72-h log.

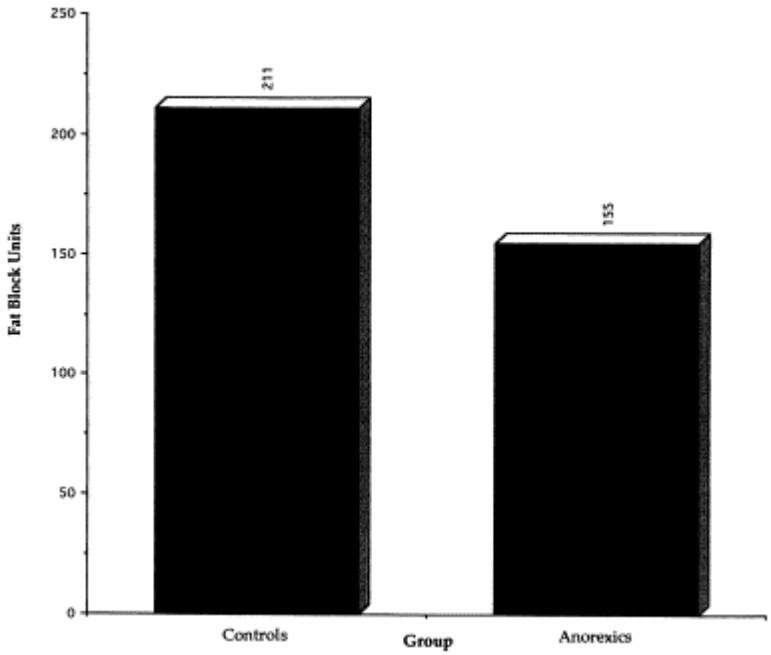

Fig. 2. Group differences in fat block units as measured by the BDSHF (Block et al., 1989). Results did not yield a significant difference between groups (P>.05).

4. Discussion

The present research improved upon past designs by examining nutrition and energy expenditure in nonhospitalized subclinical AN individuals and a comparable-mass control group. AN individuals in their natural environment reported consuming fewer kilocalories, although similar intake of macronutrients than control participants, despite comparable body mass. Although AN participants reported more compulsive attitudes toward exercise than control participants, the two groups did not differ in self-reported expenditure of exercise. In addition to meeting DSM-IV criteria (with relaxed BMI criterion; APA, 1994) for AN based on interview data, AN participants reported experiencing greater general psychopathology and endorsed more eating disordered specific psychopathology compared to comparable mass controls. Furthermore, as indicated in Table 1, the psychological data produced by the AN group were clearly in a pathological range compared to the established norms on these measures.

Our AN sample was not self-identified as anorexics, and this label was not shared with participants. Although none of the AN participants reported being involved in psychotherapy, 55% of these women reported use of antidepressant medications (vs. 7% of control participants). This provides further indirect support that this was a fairly

distressed sample. Given high comorbidity between AN and depression (Kennedy, Kaplan, Garfinkel, & Rockert, 1994) and the use of antidepressant medication in the treatment of AN (Peterson & Mitchell, 1999), it appears that many participants were receiving some form of treatment. It is unclear whether participants were prescribed such medication for AN, depression, or other presenting problems however. We did not assess length of time on the medications, thus it is questionable how successful this form of treatment was in targeting symptoms of AN. We did, however, recommend in a debriefing letter that was mailed to AN participants that they should consider use of campus psychotherapy services for their struggles with food, exercise, and body image.

Nutritionally, AN participants reported significantly less caloric intake than controls on both the 24-h dietary recall (34% less) and through a trend on the 72-h dietary log (27% less). There are several possible explanations for this finding. It is possible that individuals with AN self-present themselves as eating less than controls even though their true food consumption is comparable. Second, since history of weight change was not assessed in this study, it is possible that those with AN were in the process of weight reduction as compared to the stable weight of controls. Finally, it is possible that chronic caloric restriction lowers the resting metabolic rate (RMR) in individuals with AN so they maintain a stable weight on less food compared to controls. However, research examining RMR found that those with AN have decreased RMR only if they have lower lean body mass as compared to healthy controls (Melkchoir et al., 1989).

We must also consider other potential biases in the way the nutritional data was gathered in this study. Could the disorder of AN alter self-reported food intake systematically compared to controls? Hadigan et al. (2000) have suggested individuals with AN can accurately report their nutritional intake, but it is possible that those with AN may be more reliable in reporting food intakes due to their rigid focus on food (Russell, 1978). Or to the contrary, individuals with AN may lie deliberately about their food intake to avoid criticism (Beumont et al., 1981). This research failed to include direct behavioral data regarding food intake and therefore, possible biases of either nature could not be determined. We must comment, however, on the low interrater reliability obtained between the two blind raters examining these food logs (i.e., r=.56 for 24-h food recall; r=.76 for 3-day logs). The research assistants who entered this data had been adequately trained for this duty, but were novices and this likely created some disagreement in their ability to match the myriad of choices in linking foods and quantities on the participants logs to the food list in the computer program. Likewise, lack of detail in the logs on the part of participants (e.g., iced tea rather than iced tea sweetened with 1 tablespoon of sugar) will lower the ability of raters to be accurate.

Although the caloric consumption was significantly lower, there were no differences found between groups with respect to the intake of macronutrients (i.e., carbohydrates, protein, and fat) on the 24-h dietary recall. Therefore, the composition, or relative food choices, between the two groups seemed to be equivalent. AN participants appeared merely to be consuming less of the same foods compared to participants without anorexia. This negligible finding coincides with Beumont et al.'s (1981) finding that the AN participants were not avoiding carbohydrates as suspected by earlier investigators (Crisp; Crisp and Hurst). This similarity in food choices was further supported by the lack of differences in dietary fat intake between groups on the BDSHF.

Absence of a significant difference between groups on the expenditure of energy does not support previous research (Crisp et al., 1988; Davis and Davis, in press). Whereas the AN participants reported more compulsive exercising attitudes as indicated by their reports on the CES, their reports of the actual amount of the exercise behavior per typical week did not differ from the control participants. It is possible that the effect observed by Davis et al. surfaces more in AN who have more severe decreases in BMI (those meeting full DSM criteria). This discrepancy deserves more attention in future research.

Although all of the women who participated in this study were observably lean, a predominant limitation of this study was the relatively high BMI used diagnostically to meet the criterion for AN. Hence, the females in this study were diagnosable with subclinical AN. The DSM-IV suggests a weight requirement of less than or equal to 85% of the weight expected as normal for an individual's height and weight (APA, 1994). The ICD-10 translates this into a stricter criterion requiring a BMI of 17.5 kg/m2 (World Health Organization (WHO). Combining both groups, the mean BMI for this study was 18.79 kg/m2, therefore, not quite low enough to make the stricter ICD-10 criterion. However, the results from the initial screening interviews, the EDI-II, the 24-h dietary recall, and the CBDS consistently conclude that AN participants evidenced more of the cognition and behaviors characterizing individuals with AN than did the controls. This BMI limitation may be due to the sampling of individuals from a nonhospital setting, who were enrolled in college and seemingly maintaining normal lifestyles. Yet, as indicated by the psychological results or use of antidepressant medication, these individuals were clearly distressed. Keep in mind that the participants' academic and interpersonal functioning was not assessed in this research and therefore their level of collegiate functioning could not be determined. Additionally, clinicians and researchers have

questioned the DSM-IV (APA, 1994) criterion for the weight requirement of AN (Beumont and Walsh). AN is the only psychological diagnosis in the DSM-IV that includes physiological criteria (APA, 1994). Likewise, this criterion does not take into account one's genetic predisposition for body mass. It is possible that a woman who is genetically meant to be 140 lb at 5 ft 5 in. (i.e., BMI=23 kg/m2), could be weight suppressed and anorexic at 110 lb (i.e., BMI=19 kg/m2), but still not meet the rigid BMI criteria of 17.5 kg/m2. Clinicians know this weight criteria should not be held as a strict requirement for diagnosis, since weight-suppressed patients have varied in their weights in the past while still meeting the behavioral criteria for anorexia (Beumont et al., 1994). The DSM-IV further acknowledges 17.5 kg/m2 as a strict guideline that should be used as an estimate rather than the rule (APA, 1994). This suggests that, although the participants in the current study did not meet the “strict” DSM-IV criterion for expected weight, they were indeed exhibiting the critical behaviors of subclinical AN.

In addition to these findings and beyond the scope of this study, we must take note of the unique control group recruited specifically for this study. These women did not exhibit symptoms of AN and appeared to be naturally lean and healthy women. They were not, however, representative of the typical female on this university campus. Thus, it is possible that these are nondistressed women who unintentionally set unrealistic norms that become impossible for the average woman to achieve. Because of their existence on college campuses, they may become the ideal that others would like to achieve despite their differing body types.

To conclude, this was the first study to examine the psychological, nutritional, and energy expenditure in individuals with AN who were not hospitalized by comparing them to individuals without anorexia but who were comparable in body mass. The findings from this study attempted to rectify weaknesses in the previous research. Future research should focus on individuals suffering from AN at the subthreshold level in nonhospital settings to gain a better understanding of these individuals in their natural environments to further the understanding of this biopsychosocial disorder.

5. Uncited references

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