

# Abnormal Caloric Requirements for Weight Maintenance in Patients With Anorexia and Bulimia Nervosa

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**Objective:** This study tested previous findings that patients with eating disorders who attain normal weight have abnormal caloric requirements for maintaining weight. **Method:** Fifty-three female patients meeting the DSM-III-R criteria for anorexia nervosa and/or bulimia nervosa were divided into four subgroups, and their daily caloric intake was measured over a weight-stable period. Patients with anorexia nervosa (restricting and bulimic subtypes) were studied 4 weeks after refeeding and weight gain, when they had attained 95% of average body weight. Patients with normal-weight bulimia (previously anorexic or never previously anorexic) were studied 1–4 weeks after admission to an inpatient unit. **Results:** After weight restoration, restricting anorexic patients required significantly more calories per day to maintain weight than did bulimic anorexic patients, as measured with corrections for weight, body surface area, and fat-free mass. Previously anorexic normal-weight bulimic patients required significantly more calories per day to maintain weight than never-anorexic normal-weight bulimic patients, as measured with correction for weight but not with the other factors used to correct caloric intake. **Conclusions:** To maintain stable weight after weight restoration, restricting anorexic patients require a significantly higher caloric intake than do bulimic anorexic patients. Differences in caloric needs between normal-weight bulimic patients with and without histories of anorexia may depend on the methods used to correct caloric requirements. Body surface area may be the most precise correction factor across different subgroups of eating disorder patients. Elevated caloric requirements, when coupled with reduced food intake, may particularly contribute to relapse in anorexic patients.

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The eating disorders anorexia nervosa and bulimia nervosa are associated with considerable morbidity and mortality, partly because a substantial number of patients with these disorders relapse after treatment (1–3). The psychophysiological processes contributing to poor treatment outcome are not well understood. Recent studies at several institutions (4–6) suggest that alterations in caloric utilization, and perhaps energy balance, may tend to perpetuate these disorders and make recovery more difficult.

It is important, first, to recognize that there are several distinct subgroups of patients with eating disorders. Boundaries between subgroups and the terminology used to differentiate these subgroups have been in flux. Nevertheless, a considerable body of literature (7–12) suggests

that certain factors distinguish subgroups of patients with eating disorders. These factors include the amount of weight lost, the type of pathological eating behavior, and certain psychopathological characteristics (13).

The most common eating disorder is bulimia nervosa (DSM-III-R). This disorder is at least 10 times more prevalent than anorexia nervosa (14–16). Bulimic patients periodically binge and purge, usually by vomiting. The majority of patients with bulimia nervosa remain at normal weight (normal-weight bulimia), i.e., they maintain a body weight above 85% of average body weight and have never been emaciated (12, 17, 18). A second subgroup of patients with bulimia nervosa are those who have met criteria for anorexia nervosa either before or after the onset of their bulimic behavior.

Perhaps the best-known eating disorder is anorexia nervosa, of which the most distinguishing characteristic is severe emaciation. Two types of food consumption are seen in anorexia nervosa. Patients who fulfill only the DSM-III-R criteria for anorexia nervosa lose weight exclusively by fasting or restricting food intake. Patients with anorexia nervosa who also binge and/or purge

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(bulimic anorexic patients) qualify for *DSM-III-R* diagnoses of both anorexia nervosa and bulimia nervosa. Compared to restricting anorexic patients, bulimic anorexic patients exhibit more evidence of premorbid behavioral instability, a higher incidence of premorbid and familial obesity, a greater susceptibility to depression, and a higher incidence of behavior suggestive of impulse disorder (7–9, 11). In fact, bulimic anorexic patients appear to share many features in common with normal-weight bulimic patients, for example, impulsive behavior and a predisposition to obesity (12).

Outcome studies have suggested that a considerable number of patients with eating disorders relapse after treatment (1–3). Although this poor outcome has been attributed to psychological and psychosocial factors (19–21), physiological factors (such as abnormalities in caloric requirements for weight maintenance) may also play a role. Anorexic patients, after weight restoration, have required excessive caloric intake to maintain their weight (4, 5). Thus, rapid weight loss in anorexic patients after discharge from the hospital could be due to increased metabolic needs as well as refusal of food. Conversely, bulimic patients studied at a normal body weight have been found to have decreased caloric needs to maintain weight (5, 6). In these patients, a synergism between hyperphagia and hypometabolism (which could promote quick weight gain) may contribute to resumption of binge eating and purging in order to satisfy appetite but avoid weight gain.

There is no consensus about the best method of correcting the caloric requirements of patients with eating disorders for height, weight, and body composition. Clinically, caloric requirements may be expressed as total calories (kcal/day) and total calories corrected for body weight (kcal/kg/day), body surface area (kcal/body surface area/day), body mass index (kcal/body mass index/day), and fat-free mass (kcal/fat-free mass/day).

This study was conducted to confirm and extend previous findings of abnormal caloric utilization in a new and larger group of subjects. In addition, we wanted to explore three disputed issues: 1) whether restricting and bulimic anorexic patients require different caloric intakes to maintain weight after weight restoration (4, 5), 2) whether normal-weight bulimic patients require the same number of calories to maintain stable weight as do previously anorexic bulimic patients (5, 6), and 3) the best method of correcting for body height and weight when determining caloric needs of patients with eating disorders.

## METHOD

The subjects were female patients who met the *DSM-III-R* criteria for anorexia nervosa and/or bulimia nervosa and gave written informed consent before participating in the study. All caloric measurements took place while patients were undergoing nutritional monitoring on an inpatient eating disorder unit as part of their treatment. All subjects had been free of medication for

at least 3 weeks prior to the study. It is important to emphasize that all patients were studied when their body weight was within the normal range.

We separated these eating disorder patients into four groups according to their subtype of eating behavior and the length of time they had been at a normal and stable weight. Two groups of anorexic patients, 13 who had anorexia nervosa (anorexia, short-term weight stable) and nine who had both anorexia and bulimia nervosa (anorexia-bulimia, short-term weight stable), had been admitted to the hospital while underweight. The total mean $\pm$ SD length of hospitalization was 111 $\pm$ 31 days for the restricting anorexic patients and 72 $\pm$ 19 days for the bulimic anorexic patients. Daily caloric intake was measured 4 weeks after the patients had reached their target weight (95% of average body weight as determined by the 1959 Metropolitan Life Tables) (22), approximately 2 weeks prior to discharge from our inpatient weight restoration program. Two groups of patients with bulimia, 11 who had previous histories of anorexia nervosa (anorexia-bulimia, long-term weight stable) and 20 who had never had anorexia nervosa (bulimia, long-term weight stable), had been admitted to the hospital while their weight was in a normal range (between 85% and 115% of average body weight). They were studied 1–4 weeks after admission. Bulimic patients with histories of anorexia were hospitalized 50 $\pm$ 24 days, and normal-weight bulimic patients, 46 $\pm$ 17 days. We defined "long-term weight stable" as no anorexic episode (weight <85% of average body weight) within the last 6 months.

All food was supplied by the clinic's metabolic research kitchen. Each food item was weighed before and after meals to determine the number of calories consumed. Anorexic subjects ate three meals, at 8:00 a.m., noon, and 5:00 p.m., and two snacks, at 3:00 and 9:00 p.m. Bulimic subjects ate three meals, at 8:00 a.m., noon, and 5:00 p.m., and one snack at 9:00 p.m. Patients were required to eat all meals within 45 minutes and snacks within 30 minutes; they could not have food at other times or store food in their rooms. Subjects were observed for 1 hour after meals and in the bathroom at all times to prevent vomiting.

Maintenance calories were started at 25 kcal/kg/day for long-term weight-stable patients and 50 kcal/kg/day for short-term weight-stable patients. Over the study period, caloric intake was monitored by a registered dietitian, and meals were adjusted so that patients would maintain a stable weight ( $\pm$ 1.0 kg). Short-term weight-stable patients were required to eat sufficient food to maintain their weight at 95% of average body weight. Long-term weight-stable subjects were not studied during the first 6 days of treatment so that abnormalities of fluid status and inconsistent eating behavior, which are frequently seen during the first days of hospitalization, would not influence study results. Long-term weight-stable patients were required to maintain the weight that had become stabilized after fluid balance had been restored.

Maintenance calories were determined by averaging

**TABLE 1. Demographic and Body Composition Characteristics of 53 Patients With Eating Disorders**

Variable	Group A: Anorexia, Short-Term Weight Stable (N=13)		Group B: Anorexia- Bulimia, Short-Term Weight Stable (N=9)		Group C: Anorexia- Bulimia, Long-Term Weight Stable (N=11)		Group D: Bulimia, Long-Term Weight Stable (N=20)		F	df	p	Significant (p<0.05) Group Differences
	Mean	SD	Mean	SD	Mean	SD	Mean	SD				
Age (years)	17.3	4.6	22.1	5.2	23.3	5.3	20.7	4.1	3.73	3, 49	0.02	A<C
Duration of illness (years)	2.1	2.4	8.5	4.6	6.9	4.2	5.9	3.4	6.62	3, 49	0.0008	A<B, C, D
Weight (kg)	49.3	4.5	53.7	3.9	54.3	3.4	56.5	4.6	7.63	3, 49	0.0003	A<B, C, D
Height (cm)	158.3	8.3	166.1	5.6	165.8	5.7	163.2	6.1	3.59	3, 49	0.02	A<B, C
Percent of average body weight	94.2	1.8	93.6	2.9	95.1	4.4	101.8	7.3	8.82	3, 49	0.0001	A, B, C<D
Low percent of av- erage body weight	66.5	7.5	76.4	5.0	77.1	5.7	93.6	5.6	56.88	3, 49	0.0000	A<B, C<D
High percent of av- erage body weight	97.1	13.3	117.4	17.9	112.4	19.9	117.6	17.1	4.30	3, 48	0.009	A<D
Current percent of highest weight	98.6	12.1	81.4	13.5	86.4	11.2	87.8	10.8	4.30	3, 47	0.009	A>B
Body mass index	19.7	0.7	19.4	0.6	19.7	0.9	21.2	1.8	6.66	3, 49	0.0007	A, B, C<D
Body surface area	1.5	0.1	1.6	0.1	1.6	0.1	1.6	0.1	5.55	3, 49	0.002	A<B, C, D
Fat-free mass	38.9 <sup>a</sup>	4.8	42.4 <sup>b</sup>	3.0	43.1 <sup>c</sup>	3.3	44.5 <sup>d</sup>	3.2	5.02	3, 36	0.005	A<D

<sup>a</sup>N=11.<sup>b</sup>N=5.<sup>c</sup>N=10.<sup>d</sup>N=14.

the calories the patients consumed per day over at least a 7-day weight-stable period. Patients were weighed daily on the same scale. Methods for determining a stable weight have been reported elsewhere (4–6); they involve performing a regression analysis with days as the independent variable and weight as the dependent variable (23, 24). Subjects were considered to have a stable weight if the correlation coefficient was not significant at the  $p=0.05$  level for the given time period. Weight data reported in this article represent the mean daily weight for all days of the study period.

Because different methods of correcting for height and weight have been reported (4–6), we corrected caloric intake for weight (kg), for body surface area (body surface area =  $0.007184 \times [\text{height (cm)}]^{0.725} \times [\text{weight (kg)}]^{0.425}$ ) (25), for height and weight, using body mass index (body mass index =  $\text{weight [kg]} / \text{height [m]}^2$ ) (26), and for fat-free mass as determined by skin fold measurements (27, 28).

In the data analysis, tests for normality and equality of variances were performed before parametric analysis. Variables not meeting these criteria were transformed before parametric analysis. Frequencies of binge eating and vomiting were compared by using nonparametric methods. Linear and hierarchical regression analyses were used to assess the relation between patient variables and caloric needs. Multivariate analysis of variance (MANOVA) was used to compare multiple variables between groups. Univariate analysis of variance (ANOVA) and analysis of covariance were conducted, with post hoc two-tailed  $t$  tests with the Bonferroni correction for multiple group comparisons. For all significant (by  $t$  test) group differences in caloric requirements there was a power of  $\geq 0.80$ . All statistical

analyses were done using BMDP statistical software (BMDP Statistical Software, Inc., Los Angeles, 1988). Units are expressed as mean  $\pm$  SD.

## RESULTS

### *Demographic and Body Composition Characteristics*

The demographic and body composition characteristics of the four groups of eating disorder subjects ( $N=53$ ) were compared by ANOVA (table 1). The anorexia, short-term weight-stable group was younger, had a shorter duration of illness, weighed less, and had a lower body surface area than all other groups. They were also shorter in stature than the anorexia-bulimia, short-term weight-stable and long-term weight-stable groups. The bulimia, long-term weight-stable group had a higher percentage of body fat than any other group when this was measured as body mass index; however, the only two groups that differed significantly in terms of fat-free mass were the anorexia, short-term weight-stable and the bulimia, long-term weight-stable groups. The anorexia, short-term weight-stable group had a previous low weight that was lower than that of all other groups, and the bulimia, long-term weight-stable group had a greater previous low weight than that of all other groups. The anorexia, short-term weight-stable group had a lower previous high weight and a higher current weight as a percentage of previous high weight than the bulimia, long-term weight-stable group.

The anorexia, short-term weight-stable group did not have histories of binge eating or vomiting. Weekly

**TABLE 2. Caloric Requirements of 53 Patients With Eating Disorders for Stable Weight ( $\pm 1.0$  kg) Maintenance Corrected for Body Weight, Body Mass Index, Body Surface Area, and Fat-Free Mass**

Variable	Group A: Anorexia, Short-Term Weight Stable (N=13)		Group B: Anorexia- Bulimia, Short-Term Weight Stable (N=9)		Group C: Anorexia- Bulimia, Long-Term Weight Stable (N=11)		Group D: Bulimia, Long-Term Weight Stable (N=20)		F	df	p	Significant ( $p < 0.05$ ) Group Differences
	Mean	SD	Mean	SD	Mean	SD	Mean	SD				
Study days	9.0	1.2	8.0	0.9	10.2	2.4	10.4	2.6	3.38	3, 49	0.03	B<D
kcal/day	2419	250	2392	308	1520	124	1456	163	83.63	3, 49	0.0000	A, B>C, D
kcal/kg/day	49.1	2.9	44.4	3.4	28.0	2.0	25.9	3.0	222.97	3, 49	0.0000	A>B>C>D
kcal/body mass index/day	123.4	14.6	122.8	14.0	77.2	8.2	69.1	10.1	83.04	3, 49	0.0000	A, B>C, D
kcal/body sur- face area/day	1633.0	96.7	1501.1	139.0	952.9	59.7	909.9	92.9	196.28	3, 49	0.0000	A>B>C, D
kcal/fat-free mass/day	62.3 <sup>a</sup>	5.2	56.4 <sup>b</sup>	3.9	35.0 <sup>c</sup>	2.7	34.0 <sup>d</sup>	3.3	160.20	3, 36	0.0000	A>B>C, D

<sup>a</sup>N=11.  
<sup>b</sup>N=5.  
<sup>c</sup>N=10.  
<sup>d</sup>N=14.

mean $\pm$ SD binge frequencies for the other groups were as follows: anorexia-bulimia, short-term weight stable, 19.3 $\pm$ 18.4 (range=0–42); anorexia-bulimia, long-term weight stable, 16.4 $\pm$ 11.1 (range=5–35); bulimia, long-term weight stable, 13.3 $\pm$ 8.5 (range=3–30). One anorexia-bulimia, short-term weight-stable subject denied binge eating. However, her parents reported that she indulged in multiple binges per week, so she was classified as bulimic, but her binge frequency was listed as zero. Weekly vomiting frequencies were as follows: anorexia-bulimia, short-term weight stable, 19.0 $\pm$ 18.8 (range=0–42); anorexia-bulimia, long-term weight stable, 16.1 $\pm$ 11.1 (range=5–35); bulimia, long-term weight stable, 12.3 $\pm$ 9.2 (range=3–30). There was no difference in terms of binge or vomiting frequency between these three groups.

There was a significant difference in the frequency of amenorrhea or oligomenorrhea between groups (Fisher's exact test,  $p=0.001$ ). At the time of the study, all of the anorexia, short-term weight-stable group were amenorrheic. Seven of nine subjects in the anorexia-bulimia, short-term weight-stable group, nine of 11 in the anorexia-bulimia, long-term weight-stable group, and eight of 20 in the bulimia, long-term weight-stable group had amenorrhea or oligomenorrhea.

A MANOVA was conducted to compare all four groups on age, height, weight, previous low weight as a percentage of average body weight, previous high weight as a percentage of average body weight, current weight as a percentage of previous high weight, duration of illness, number of calories consumed per day, body surface area, and body mass index. The results of this analysis were significant (Wilks's lambda=0.01;  $F=15.39$ ,  $df=27$ , 120.33,  $p<0.0001$ ).

*Comparisons of Subgroups*

*Anorexia, short-term weight stable versus anorexia-bulimia, short-term weight stable.* For the patients studied

within 4 weeks after the completion of in-hospital weight restoration, the calories necessary to maintain a stable body weight were significantly different for the restricting anorexic patients and the bulimic anorexic patients in terms of kcal/kg/day ( $t=3.74$ ,  $df=49$ ,  $p<0.01$ ), kcal/fat-free mass/day ( $t=3.29$ ,  $df=36$ ,  $p<0.01$ ), and kcal/body surface area/day ( $t=2.79$ ,  $df=49$ ,  $p<0.05$ ) (table 2 and figure 1). In contrast, there was no difference between these groups in terms of kcal/body mass index/day. Using age and low weight as a percentage of average body weight as covariates did not affect group differences, except that when age was used as a covariate in the comparisons of kcal/body surface area/day, the significance of the difference was reduced to a trend.

*Anorexia-bulimia, long-term weight stable versus bulimia, long-term weight stable.* The two groups of long-term weight-stable patients were of similar weight (table 1) and consumed similar amounts of calories per day. These groups were similar when their daily caloric requirements were corrected for body mass index, body surface area, and fat-free mass (table 2 and figure 1). However, bulimic patients with histories of anorexia nervosa consumed more calories corrected for body weight (kcal/kg/day, table 2) than did those without histories of anorexia nervosa ( $t=3.10$ ,  $df=48$ ,  $p<0.05$ ). This difference continued to be significant when age was used as a covariate, but it was not significant when low weight as a percentage of average body weight was used as a covariate.

*Anorexia-bulimia, short-term weight stable versus anorexia-bulimia, long-term weight stable.* We studied two groups of bulimic patients with coexisting histories of anorexia nervosa. These two groups were studied at a similar weight. Those studied after short-term weight recovery (within 4 weeks) required significantly more calories (in terms of absolute daily caloric intake or calories adjusted for any correction factor, table 2) to maintain their weight than did those who were long-term (i.e., 3.8 $\pm$ 2.5 years; range=0.9–8.8 years) weight

stable. These two groups were similar in age, duration of illness, and previous low and high body weights (table 1). For the long-term weight-stable bulimic anorexic patients, there was no relation between current caloric requirements and the time since their last underweight episode. These findings continued to be significant when age and low weight as a percentage of average body weight were used as covariates.

#### *Relation Between Body Height and Weight and Demographic Variables and Caloric Needs*

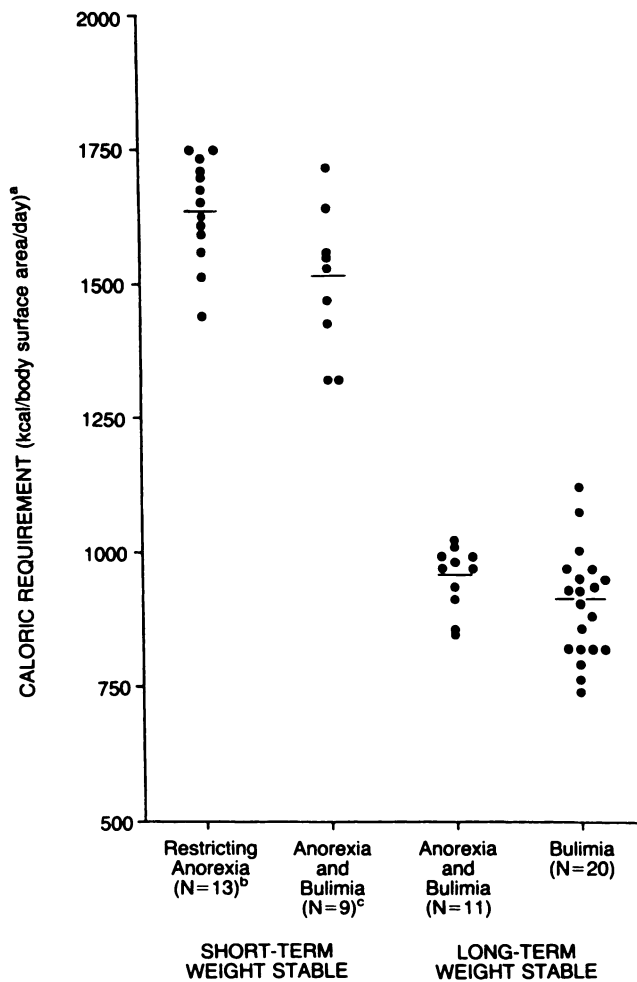
Total caloric intake per day was correlated with body weight, body surface area, body mass index, and fat-free mass (table 3). An analysis was performed with subjects divided into two groups on the basis of whether they were short- or long-term weight stable, and a second analysis was performed with the patients divided into the four groups used to compare caloric requirements. All correlations between body surface area and caloric intake showed significance or a trend toward significance. Weight and fat-free mass were less precisely correlated with caloric intake, whereas body mass index showed no relation to caloric intake. Scatterplots of caloric intake and body correction factors were consistent with a linear relation between caloric intake and body weight correction factors. However, future studies with larger sample sizes are needed to confirm this finding.

For the anorexia-bulimia, short-term weight-stable group, age and duration of illness were significantly ( $N=9$ ,  $p \leq 0.05$ ) correlated with kcal/body surface area/day (age,  $r=-0.67$ ; duration of illness,  $r=-0.67$ ) and kcal/kg/day (age,  $r=-0.69$ ; duration of illness,  $r=-0.73$ ). For the bulimia, long-term weight-stable group, age was correlated with kcal/body mass index/day ( $r=-0.45$ ,  $N=20$ ,  $p < 0.05$ ).

#### DISCUSSION

This study confirms and extends previous findings of abnormalities in caloric intake among patients with eating disorders. First, we found that in the weeks after weight restoration, restricting anorexic patients had greater caloric requirements than bulimic anorexic patients for all methods of correction of caloric intake except body mass index. Second, when two groups of bulimic patients, those with and those without histories of anorexia nervosa, were studied after being at a stable and normal weight for an extended period of time, a significant difference in caloric requirements between the groups was observed only when the data were expressed as kcal/kg/day. Third, recent weight gain appeared to have a substantial influence on the calories necessary for patients with bulimia and anorexia nervosa to maintain weight. That is, bulimic anorexic patients who were studied within 4 weeks of weight recovery appeared to need about 150% more calories (800 kcal/day) than did an otherwise similar group of bulimic patients with histories of anorexia whose weight

**FIGURE 1. Caloric Requirements Corrected for Body Surface Area of 53 Patients in Four Subgroups of Eating Disorders**



<sup>a</sup>Body surface area =  $0.007184 \times [\text{height (cm)}]^{0.725} \times [\text{weight (kg)}]^{0.425}$ .

<sup>b</sup>Anorexia, short-term weight stable greater than anorexia-bulimia, short-term weight stable ( $p < 0.05$ ) and greater than anorexia-bulimia, long-term weight stable and bulimia, long-term weight stable ( $p < 0.01$ ).

<sup>c</sup>Anorexia-bulimia, short-term weight stable greater than anorexia-bulimia, long-term weight stable and bulimia, long-term weight stable ( $p < 0.01$ ).

had been restored for a mean of  $3.8 \pm 2.5$  years. Finally, this study suggests that body surface area may be the best correction factor for caloric intake.

#### *Differences in Caloric Requirements Between Subgroups of Anorexic Patients*

Previous studies of short-term weight-restored anorexic patients have conflicting findings. Kaye et al. (4) reported that restricting anorexic subjects needed more calories than bulimic anorexic subjects in terms of kcal/kg/day, kcal/body mass index/day, and kcal/body surface area/day. However, Newman et al. (5) found these groups to be similar in terms of kcal/body mass

**TABLE 3. Relation Between Calories per Day Required by 53 Patients With Eating Disorders for Weight Maintenance and Height and Weight Correction Factors**

Group	Weight			Body Surface Area			Body Mass Index			Fat-Free Mass		
	N	r	p	N	r	p	N	r	p	N	r	p
Anorexia and anorexia-bulimia, short-term weight stable	22	0.70	<0.01	22	0.67	<0.01	22	0.06	0.79	16	0.65	<0.01
Anorexia-bulimia and bulimia, long-term weight stable	31	0.31	0.09	31	0.44	0.01	31	-0.12	0.53	24	0.40	0.05
Anorexia, short-term weight stable	13	0.82	<0.01	13	0.83	<0.01	13	-0.32	0.29	11	0.75	<0.01
Anorexia-bulimia, short-term weight stable	9	0.84	<0.01	9	0.78	0.01	9	0.60	0.09	5	0.63	0.25
Anorexia-bulimia, long-term weight stable	11	0.49	0.12	11	0.62	0.04	11	-0.29	0.38	10	0.47	0.17
Bulimia, long-term weight stable	20	0.34	0.14	20	0.41	0.08	20	0.01	0.95	14	0.37	0.19

index/day. We found that restricting anorexic patients had significantly greater caloric needs than bulimic anorexic patients when caloric intake was corrected for body weight, body surface area, and fat-free mass. However, we found no difference between groups when caloric intake was corrected for body mass index. It is possible that discrepancies among the findings of different groups of investigators are related to the methods used to correct for daily caloric intake.

In this study the restricting anorexic patients were younger than the bulimic anorexic patients. Since caloric requirements decrease with age (29), it is possible that the differences between these two groups were related to differences in age. Age was not significantly correlated with caloric requirements within any of the four subgroups; however, when age was used as a covariate in the analysis of caloric requirements, the significance of the difference between restricting and bulimic anorexic patients was less substantial. Future studies using either larger sample sizes or restricting and bulimic anorexic subjects matched for age would be necessary to investigate this finding.

We did not study healthy volunteer women. Nevertheless, the magnitude of the caloric intake necessary for weight maintenance in patients with anorexia nervosa, whatever the correction factor, was well in excess of caloric requirements for healthy control women (4).

*Differences in Caloric Requirements Between Subgroups of Bulimic Patients*

Gwirtsman et al. (6), using kcal/kg/day and kg/body mass index/day, found that long-term weight-stable anorexic bulimic patients were similar in caloric requirements to bulimic patients with no previous history of anorexia. In contrast, Newman et al. (5), using kcal/body mass index/day, found that previously anorexic bulimic patients needed significantly more calories than nonanorexic bulimic patients. We found that the possibility of differences between these bulimic subgroups, matched for age and weight, depended on the methods used to correct daily caloric intake. Previously anorexic bulimic patients needed more calories than nonanorexic bulimic patients when kcal/kg/day was used, but these groups were similar in terms of total kcal/day and total kcal/day corrected for body surface area, body mass index, and fat-free mass.

Newman et al. (5) found that the daily caloric intake of bulimic patients was positively related to age and negatively related to previous high body weight. In contrast, we found no relation between age and caloric needs and, like Gwirtsman et al. (6), we did not find that previous high weight influenced caloric requirements.

Gwirtsman et al. (6) compared their patients to matched healthy control volunteers studied under similar conditions. They found that both anorexic bulimic and bulimic patients needed significantly fewer calories than volunteers to maintain a stable weight. We were not able to study healthy volunteer women and thus cannot determine whether caloric intake for the bulimic women in this study was less than for healthy matched control subjects.

*Relation of Recent Weight Gain to Caloric Needs in Anorexic Bulimic Patients*

An important question raised by this study is whether abnormalities of caloric intake represent a state-related (presence or absence of recent weight gain) or a trait-related phenomenon. We compared two groups of anorexic bulimic patients who were at similar weight and lean body mass. The short-term weight-stable group (who were studied within 4 weeks after weight restoration) needed a significantly greater daily caloric intake than did the long-term weight-stable group (studied an average of 3.8±2.5 years after recovery from an anorexic episode). These findings agree with previous reports (4, 5) suggesting that inflated caloric needs in the short-term period are likely to be state related.

*Most Useful Body Size Correction Factor for Determining Caloric Needs*

It is not certain which method of correcting for different body heights and weights among patients is most useful for patients with eating disorders (4-6). If it is assumed that the subgroups of eating disorder patients are similar in terms of their metabolic needs, then energy utilization (daily caloric intake) should be proportional to body mass. Our data suggest that, when controlling for the presence or absence of recent weight gain, body surface area may be the best correction factor for determining the caloric needs of eating disorder patients. We found that absolute body weight and fat-

free mass were correlated relatively less well with caloric needs and that body mass index was poorly correlated with caloric needs.

The finding that body surface area was positively related to caloric intake makes sense, since body surface area is a physiologically derived factor that has been shown to be related to resting metabolic rate and lean body mass (30). Body mass index appears to be a less precise approximation of the relative relation of height and weight to caloric needs (31).

Several points about our data should be noted. First, physical activity, which has been shown to contribute to energy needs in patients with eating disorders (32) and other subjects (33), may alter the relation between caloric intake and body mass. Second, we began feeding patients a prescribed amount of kcal/kg/day and then adjusted caloric intake depending on changes in daily body weight. While kcal/kg/day was not the most precise correction factor, it is possible that our method of prescribing caloric intake biased relationships to other correction factors. Finally, it is possible that skin fold measurements may be somewhat inaccurate in measuring fat-free mass and thus invalidate the use of this correction factor.

#### *Significance of Altered Caloric Needs in Patients With Eating Disorders*

These findings are of clinical importance in the treatment of patients with anorexia nervosa. These patients have a high relapse rate (1). Presumably, a high rate of relapse occurs because anorexic patients frequently remain resistant to consuming sufficient calories after recovery. Our findings suggest that another factor, abnormally high caloric requirements for weight maintenance, also plays a significant role in rapid weight loss and relapse after discharge from inpatient treatment. Restricting and bulimic anorexic patients require 45–50 kcal/kg/day, compared to approximately 30 kcal/kg/day reported for healthy control subjects (6). Thus, before discharge, patients with anorexia nervosa should learn about and practice consuming the large amount of calories they appear to need to maintain their weight in the short term. Such treatment has the potential of reducing the high rate of relapse in this illness.

This study could not determine whether normal-weight bulimic patients have lower caloric needs, because we did not have a normal comparison group. However, studies of caloric utilization (6) and of metabolic rate (34, 35) suggest that normal-weight bulimic women may have reduced energy needs. The difference in caloric requirements for weight maintenance between normal-weight bulimic women and healthy volunteers is less extreme than that seen in anorexic patients. For a normal-weight bulimic woman without a history of anorexia who weighs 50 kg, the difference in caloric needs may translate into several hundred calories per day less than for a peer without an eating disorder. It remains uncertain whether normal-weight bulimic women are not adequately satiated when consuming

reduced calories (which may be necessary to maintain a stable weight), but this may contribute to an increased urge to binge eat. Conversely, prescribing a normal caloric intake may cause weight gain and contribute to bulimic patients' resuming purging as a means of weight control.

#### REFERENCES

1. Hsu LKG: Outcome of anorexia nervosa. *Arch Gen Psychiatry* 1980; 37:1041–1046
2. Keller MB, Herzog DB, Lavori PW, Ott IL, Bradburn IS, Mahoney EM: High rates of chronicity and rapidity of relapse in patients with bulimia nervosa and depression (letter). *Arch Gen Psychiatry* 1989; 46:480–481
3. Hsu LKG, Sobkiewicz TA: Bulimia nervosa: a four-to-six-year follow-up study. *Psychol Med* 1989; 19:1035–1038
4. Kaye WH, Gwirtsman HE, Obarzanek E, George T, Jimerson DC, Ebert MH: Caloric intake necessary for weight maintenance in anorexia nervosa: nonbulimics require greater caloric intake than bulimics. *Am J Clin Nutr* 1986; 44:435–443
5. Newman MM, Halmi KA, Marchi P: Relationship of clinical factors to caloric requirements in subtypes of eating disorders. *Biol Psychiatry* 1987; 22:1253–1263
6. Gwirtsman HE, Kaye WH, Obarzanek E, George DT, Jimerson DC, Ebert MH: Decreased caloric intake in normal-weight patients with bulimia: comparison with female volunteers. *Am J Clin Nutr* 1989; 49:86–92
7. Beaumont PJV, George GCW, Smart DE: "Dieters" and "vomitters" in anorexia nervosa. *Psychol Med* 1976; 6:617–622
8. Garfinkel PE, Moldofsky H, Garner DM: The heterogeneity of anorexia nervosa. *Arch Gen Psychiatry* 1980; 37:1036–1040
9. Casper RC, Eckert ED, Halmi KA, Goldberg SC, Davis JM: Bulimia: its incidence and clinical importance in patients with anorexia nervosa. *Arch Gen Psychiatry* 1980; 37:1030–1035
10. Halmi KA, Falk JR: Anorexia nervosa: a study of outcome discrimination in exclusive dieters and bulimics. *J Am Acad Child Psychiatry* 1982; 21:369–375
11. Strober M, Salkin B, Burroughs J, Morrell W: Validity of the bulimia-restrictor distinction in anorexia nervosa: parental personality characteristics and family psychiatric morbidity. *J Nerv Ment Dis* 1982; 170:345–351
12. Garner DM, Garfinkel PE, O'Shaughnessy M: The validity of the distinction between bulimia with and without anorexia nervosa. *Am J Psychiatry* 1985; 142:581–587
13. Herzog DB, Copeland PM: Eating disorders. *N Engl J Med* 1985; 313:295–303
14. Stangler RS, Printz AM: *DSM-III* psychiatric diagnosis in a university population. *Am J Psychiatry* 1980; 137:937–940
15. Halmi KA, Falk JR, Schwartz E: Binge-eating and vomiting: a survey of a college population. *Psychol Med* 1981; 11:697–706
16. Pope HG Jr, Hudson JL, Yurgelun-Todd D: Anorexia nervosa and bulimia among 300 suburban women shoppers. *Am J Psychiatry* 1984; 141:292–294
17. Pyle RL, Mitchell JE, Eckert ED, Halvorson PA, Neuman PA, Goff GM: The incidence of bulimia in freshman college students. *Int J Eating Disorders* 1983; 2:75–85
18. Fairburn CG, Cooper JP: Self-induced vomiting and bulimia nervosa: an undetected problem. *Br Med J (Clin Res)* 1982; 284: 1153–1155
19. Hsu LKG, Crisp AH, Harding B: Outcome of anorexia nervosa. *Lancet* 1979; 1:62–65
20. Pope HG, Hudson JL: Antidepressant drug therapy for bulimia: current status. *J Clin Psychiatry* 1986; 47:339–345
21. Garner DM, Fairburn C, Davis R: Cognitive-behavioral treatment of bulimia nervosa: a critical appraisal. *Behav Modif* 1987; 4:398–431
22. Metropolitan Life Insurance Company: New weight standards for men and women. *Stat Bull Metropol Life Insur Co* 1959; 40:1–11
23. Khosla T, Billewicz WZ: Measurement of change in body weight. *Br J Nutr* 1965; 18:227–239

## CALORIC REQUIREMENTS FOR WEIGHT MAINTENANCE

24. Robinson MF, Watson PE: Day-to-day variations in body weight. *Br J Nutr* 1965; 19:225-235
25. DuBois D, DuBois E: A formula to estimate the approximate surface area if height and weight be known. *Arch Intern Med* 1916; 17:23-44
26. Webb P: Energy expenditure and fat-free mass in men and women. *Am J Clin Nutr* 1981; 34:1816-1826
27. Durnin JVGA, Womersley J: Body fat assessed from total body density and its estimation from skin fold thickness: measurements of 481 men and women from 16 to 72 years. *Br J Nutr* 1974; 32:77-97
28. Brozek J, Grande F, Anderson JT, Keys A: Densitometric analysis of body composition: revision of some quantitative assumptions. *Ann NY Acad Sci* 1963; 110:113-140
29. Garrow JS: *Energy Balance and Obesity in Man*. Amsterdam, Elsevier-North Holland, 1978
30. Cunningham JJ: Body composition and resting metabolic rate: the myth of feminine metabolism. *Am J Clin Nutr* 1982; 36:721-726
31. Garrow JS, Webster J: Quetelet's index ( $W/H^2$ ) as a measure of fatness. *Int J Obesity* 1985;9:147-153
32. Kaye WH, Gwirtsman HE, Obarzanek E, George DT: Relative importance of caloric intake needed to gain weight and level of physical activity in anorexia nervosa. *Am J Clin Nutr* 1988; 47: 987-994
33. Ravussin E, Lillioja S, Anderson TE, Christin L, Bogardus C: Determinants of 24-hour energy expenditure in man: methods and results using a respiratory chamber. *J Clin Invest* 1986; 78: 1568-1578
34. Bennett SM, Williamson DA, Powers SK: Bulimia nervosa and resting metabolic rate. *Int J Eating Disorders* 1989; 8:417-424
35. Devlin MJ, Walsh T, Kral JG, Heymsfield SB, Pi Sunyer FX, Dantzig S: Metabolic abnormalities in bulimia nervosa. *Arch Gen Psychiatry* 1990; 47:144-148