Original Research Communications—general

Caloric intake necessary for weight maintenance in anorexia nervosa: nonbulimics require greater caloric intake than bulimics[1–3]

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ABSTRACT In the past decade, patients with anorexia nervosa have been subdivided by the presence or absence of bingeing-and-purging behavior. Psychologic, physiologic, and premorbid weight differences have also been discovered between these subgroups. We now report that nonbulimic anorectics required 30–50% more caloric intake than bulimic anorectics to maintain a stable weight. This difference in caloric intake was independent of phase of illness; it was present at low weight and at intervals after weight restoration. Subjects were closely supervised on an inpatient hospital ward so that they could not binge or purge. Motor activity did not appear to explain these alterations in caloric requirements. Such differences in caloric intake could be trait related or a consequence of many years of starving or bingeing behavior. These findings are clinically relevant for advising eating disorder patients of caloric requirements necessary to maintain a normal weight. *Am J Clin Nutr* 1986;44:435–443

KEY WORDS Anorexia nervosa, bulimia, caloric intake, energy metabolism

Introduction

Patients with anorexia nervosa can be subdivided into two groups by appetitive behavior: those that fast and those that binge (1–6). These subgroups of anorectics are also psychologically different. Bulimic anorectics have been found to be more outgoing, more impulsive, more mood labile, and more sexually active than nonbulimic or food-restricting anorectics. We have recently reported (7) that these two groups, after weight recovery, differ in turnover of CNS serotonin.

Several investigators (1, 3) have reported that bulimics have a greater premorbid body weight than do nonbulimic anorectics. One explanation is that there are differences in efficiency of energy metabolism between these two groups of patients such that bulimic anorectics gain weight more easily than nonbulimic anorectics. It has been suggested that animals can alter the efficiency with which they utilize energy contained in food (8), although such studies have been questioned (9).

Several investigators have provided evidence that some human adults, most notably obese or formerly obese individuals are more energetically efficient than lean controls in

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Received September 16, 1985.
Accepted for publication March 13, 1986.

terms of their metabolic response to thermogenic stimuli such as glucose (10), mixed meals (11), postprandial exercise (12), and a thermogenic drug (13). Thus, although controversial, the possibility remains that differences in efficiency of energy utilization exist among human adults.

This study was done to test whether caloric intake would differentiate between a population of anorectics that either fast or binge and whether this difference was independent of phase of the illness. Such a finding might have wider implications for understanding weight regulation in humans as well as the relation between appetite and energy-metabolism efficiency.

Methods

Subjects

All subjects were hospitalized in clinical research units of the National Institutes of Health Clinical Center, National Institute of Mental Health. Subjects gave informed consent for the study. Patients who met DSM-III criteria for anorexia nervosa (14) were studied during three phases of illness: *1*) 11 anorectics (**Table 1**) were studied after 6 mo or longer of being continuously at < 75% of average body weight (underweight anorexia nervosa); *2*) the same 11 underweight anorectics (**Table 2**) were restudied 3–4 wk after correction of weight loss (recently weight-restored); and *3*) a separate group of 9 women who had been underweight with anorexia nervosa (**Table 3**), but who at the time of the present study had been weight recovered for at least a year (long-term weight-restored). A tenth subject in the third group (number 11) was also studied at low weight and after short-term weight restoration. Long-term weight-restored women had been able to maintain weight recovery for a mean (±SD) of 32 ± 12 mo (with a range of 1 to 10 yr). Control subjects (**Table 4**) consisted of 11 healthy women who had no medical, neurologic, or psychiatric problems.

The anorectic patients were separated by style of appetitive behavior into groups based on history obtained from the patient and, when possible, from relatives. Nonbulimic anorectics had lost weight by restricting caloric intake; these subjects never binged. Bulimic-anorectic patients engaged in bingeing behavior and all vomited and/or used laxatives after bingeing. In this study, patients who used laxatives (n = 5) but binged only a few times a month (subjects number 4, 5, 12, 15, 17) were grouped with bulimic anorectics. It is unsettled as to whether those who engage in vomiting or laxative abuse without bingeing should be considered in the bulimic contingent (1) or should be considered fasters (3, 4).

Caloric data

Subjects were restricted to a locked ward for control of environmental temperature, motor activity, and food intake. Following admission, underweight anorectics were nutritionally stabilized at a stable low weight that did not vary more than ±1.0 kg for 4–6 wk until they began the weight-gaining phase of the program. Refeeding and weight gain were accomplished by a modified behavior-modification program: no medication was used. The target weight

TABLE 1
Anorexia nervosa patients at low weight

Subject	Number of days at stable weight	Mean weight (kg) Mean ± SD	Daily caloric intake Mean ± SD	Caloric intake per body surface area
				kcal/m²
		Bulimics		
1a	12	39.9 ± 0.22	925 ± 167	642
2a	9	36.6 ± 0.40	1168 ± 268	859
3a	7	32.6 ± 0.22	713 ± 207	575
4a	12	30.8 ± 0.28	963 ± 228	789
5a	11	32.5 ± 0.09	601 ± 99	459
Mean	10	34.5*	874	665*
SD	2	3.7	222	161
		Nonbulimics		
6a	9	31.7 ± 0.10	1150 ± 186	891
7a	6	25.5 ± 0.48	1163 ± 311	1038
8a	9	33.4 ± 0.24	939 ± 198	751
9a	8	29.9 ± 0.07	927 ± 171	792
10a	21	28.6 ± 0.13	1029 ± 189	887
11a	19	27.9 ± 0.21	1015 ± 248	868
Mean	12	29.5*	1037	871*
SD	6	2.8	101	99

* $p < 0.05$, bulimics vs nonbulimics.

TABLE 2
Anorexia nervosa after short-term weight restoration

Subject	Number of days at stable weight	Mean weight (kg) Mean ± SD	Daily caloric intake Mean ± SD	Caloric intake per body surface area
				kcal/m²
		Bulimics		
1b	15	49.5 ± 0.17	2130 ± 330	1357
2b	28	49.5 ± 0.42	2001 ± 651	1291
3b	11	47.4 ± 0.24	2068 ± 538	1407
4b	29	44.1 ± 0.45	1451 ± 336	1022
5b	9	47.6 ± 0.28	1807 ± 259	1181
Mean	18	47.6*	1891†	1251†
SD	9	2.2	274	154
		Nonbulimics		
6b	13	46.1 ± 0.17	2399 ± 268	1589
7b	22	43.5 ± 0.23	2645 ± 428	1876
8b	39	40.6 ± 0.20	2197 ± 324	1627
9b	41	41.6 ± 0.14	2592 ± 637	1920
10b	28	41.7 ± 0.24	2203 ± 364	1620
11b	20	46.5 ± 0.21	2214 ± 223	1527
Mean	27	43.3*	2375†	1693†
SD	11	2.5	204	163

* $p < 0.05$, † $p < 0.01$, bulimics vs nonbulimics.

that was defined as reaching short-term weight restoration was the weight where women with secondary amenorrhea might be expected to menstruate (15, 16). After weight restoration was completed, anorectics were again asked to maintain a stable target body weight (±1.0 kg) for 4–6 wk. Anorectic patients continued in the behavior-modification program during short-term weight restoration so that we could get them to eat enough food to maintain a stable weight. The long-term weight-restored and the control subjects were briefly hospitalized under similar conditions.

Subjects were allowed only three 45-min meals/day and three 15-min snacks. No patients on the ward were allowed

TABLE 3
Anorexia nervosa after long-term weight restoration

Subject	Number of days at stable weight	Mean weight (kg) Mean ± SD	Daily caloric intake Mean ± SD	Caloric intake per body surface area
				kcal/m²
		Bulimics		
12	5	42.5 ± 0.08	715 ± 231	534
13	3	39.6 ± 0.38	1055 ± 74	787
14	8	60.5 ± 0.49	1040 ± 343	605
15	2	49.9 ± 0.21	1125 ± 64	717
16	4	49.9 ± 0.32	1256 ± 191	815
17	4	59.1 ± 0.26	1373 ± 191	822
Mean	4	50.3	1094*	713*
SD	2	8.5	225	120
		Nonbulimics		
18	2	55.2 ± 0.18	1935 ± 599	1256
19	4	53.9 ± 0.14	1423 ± 333	901
11	3	45.6 ± 0.20	1595 ± 198	1108
20	3	42.0 ± 0.23	1407 ± 207	1027
Mean	3	49.2	1590*	1073*
SD	1	6.4	245	149

* $p < 0.01$.

TABLE 4
Healthy control women

Subject	Number of days at stable weight	Mean weight (kg) Mean ± SD	Daily caloric intake Mean ± SD	Caloric intake per body surface area
				kcal/m²
21	4	60.2 ± 0.08	1428 ± 485	840
22	5	70.2 ± 0.27	1572 ± 650	850
23	2	46.1 ± 0.21	1795 ± 233	1213
24	4	59.3 ± 0.04	2421 ± 401	1433
25	5	49.6 ± 0.14	1687 ± 150	1125
26	7	61.0 ± 0.37	1866 ± 308	1111
27	8	59.8 ± 0.42	1389 ± 172	822
28	6	50.0 ± 0.30	1860 ± 367	1224
29	5	53.2 ± 0.19	1767 ± 204	1125
30	6	54.1 ± 0.60	1334 ± 293	889
31	3	65.4 ± 0.15	1858 ± 285	1074
Mean	5	57.2	1725	1064
SD	2	7.3	304	194

to have food in their rooms. All subjects were observed 24 h/day on the ward, including mealtime and bathroom visits so they could not secretly binge or vomit. All food was ordered from the hospital kitchen and caloric content documented before being given to the patients. After the uneaten food was returned to the kitchen and reweighed, an estimate of daily caloric intake was made. In an independent study, the accuracy of the method of caloric estimation used in this report was checked (17). Clinical caloric estimates were 102.2 ± 2.2% of the values found by chemical laboratory calorimetry, a nonsignificant difference.

Low-weight anorectics were often dehydrated on admission. Thus weight and calorie data in the interval after admission (usually the first 7–14 days of hospitalization) were discarded. During this initial interval of time, the dietitian worked with the subjects to adjust caloric intake in order to establish the amount necessary to maintain a stable weight. For this study, we used the longest sequential number of days where weight remained within ±1.0 kg but where there was no overall weight gain or loss. To determine that there was no overall weight gain or loss during this period of time, a linear-regression coefficient was calculated (daily weight versus number of days) (18, 19). The period of days was adjusted until the regression coefficient was nonsignificant ($p > 0.05$), indicating that there was no positive or negative linear trend in weight over this time interval. After the patients attained their target weight, daily caloric consumption for the short-term weight-restoration phase was similarly calculated. Short-term weight-restored anorectics required an interval of about 4–14 days after target weight was achieved to adjust their caloric intake so that they were able to maintain a stable weight. Data from this adjustment phase was discarded.

Long-term weight-restored anorectics and normal controls were only willing to remain locked on the ward, under similar conditions, for relatively brief periods of time (fewer than 8 days). Thus much less data are available for these groups. Although 12 long-term weight-recovered subjects were studied, 2 lost weight during their inpatient stay and so are not included. All normal controls were able to remain within 1 kg of their admission weight during this study.

Motor activity

Motor activity was automatically and continuously recorded for 24 h/day for 3–5 days by methods previously reported (20, 21). Motor activity was measured by an acceleration-sensitive device with a solid-state memory that stores data on the number of motor movements (22). The monitors were attached to a belt around the waist of the subjects. Two monitors were used throughout the study. These monitors, initially calibrated to be equal to each other, maintained a variance of < 7% throughout the study. Motor activity was not obtained on one long-term weight-recovered anorectic and one control.

Caloric correction for weight

Because the subject groups differed in weight, some method of comparing caloric intake corrected for differences in weight was necessary. Several methods of correction are widely used (23–27) but there is no clear agreement on the best method. We expressed total daily caloric intake in terms of body weight, body mass index, (weight/height^2), and body-surface area (28).

Data analysis

Bulimic and nonbulimic anorectics were compared within each phase of study by an independent two-tailed *t* test. Daily caloric intake per square meter of surface area was covaried with daily counts of motor activity by one-way ANOVA (29).

Results

Bulimic anorectics (28 ± 3 yr) were significantly older ($p < 0.05$) than the nonbulimic anorectics (23 ± 3 yr) in the group studied when underweight and after short-term weight

recovery, although the difference in mean ages of these two groups was only 5 yr. Long-term bulimic and nonbulimic anorectics were of similar ages (26 ± 5 vs 26 ± 6 yr). The ages of the healthy control women (23 ± 4 yr) were similar to the anorectics. All groups of anorectics had a similar duration of illness prior to study. In the group studied at low weight and after short-term weight restoration, bulimic anorectics had been ill for 96 ± 48 mo and nonbulimic anorectics for 84 ± 28 mo. For the long-term weight-restored anorectics, bulimics had been diagnosed as having anorexia nervosa 112 ± 51 mo prior to study and nonbulimic anorectics for 95 ± 49 mo prior to study. Heights were similar between all subgroups of anorectics and controls.

Low-weight patients with anorexia nervosa maintained a stable weight for 6–21 days (Table 1). Bulimic anorectics were significantly heavier than nonbulimic anorectics but consumed a similar number of calories/day. When caloric intake was corrected for body surface area, bulimic anorectics consumed significantly fewer calories/day than nonbulimic anorectics (**Figure 1**). Bulimic anorectics were significantly more active than nonbulimic anorectics (**Figure 2**).

After short-term weight recovery (Table 2), bulimic anorectics were still significantly

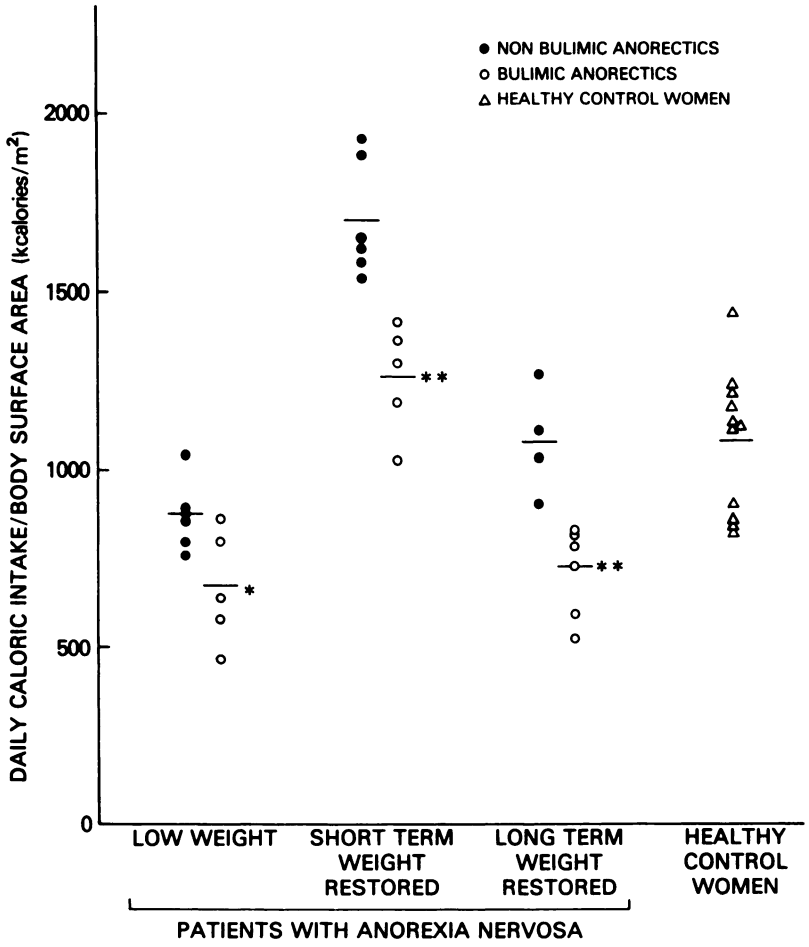

FIG 1. Daily caloric intake corrected for body surface area at phases of anorexia nervosa. Anorectics are separated by appetite-related behavior into nonbulimic (open circles) and bulimic (closed circles) subgroups in each phase. Healthy control women are indicated by triangles. All subjects maintained a stable weight (±1.0 kg) during caloric measurement. Subgroups are compared by two-tailed group *t* test, *$p < 0.05$, **$p < 0.01$.

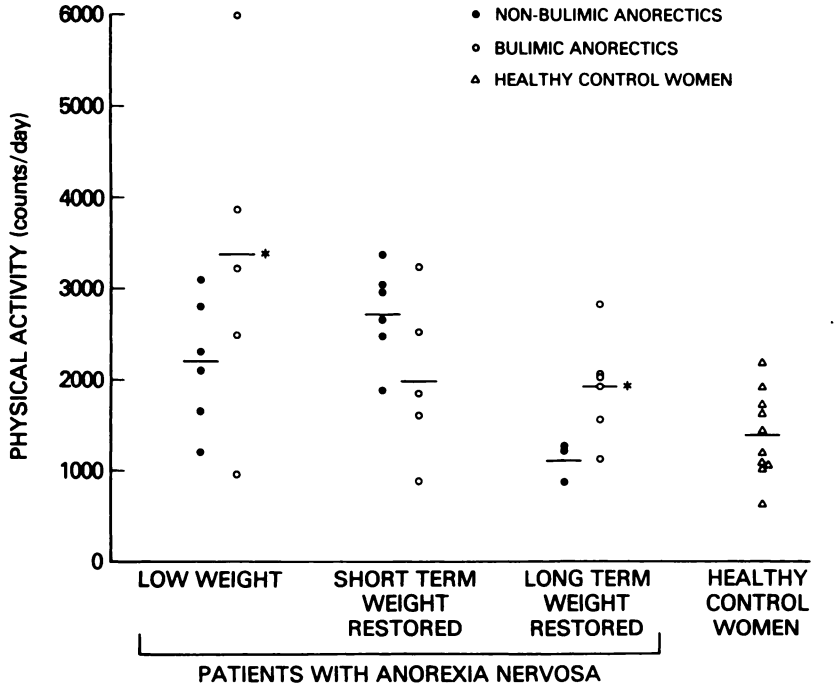

FIG 2. Daily activity counts during phases of anorexia nervosa. Nonbulimic (open circles) and bulimic (closed circles) anorectics are compared for each phase. Healthy control women are indicated by triangles. All subjects maintained a stable weight (±1.0 kg) during caloric measurement. Subgroups are compared by two-tailed group *t* test, *$p < 0.05$.

heavier than nonbulimic anorectics, yet nonbulimic anorectics consumed significantly more calories/day or per body surface area (Figure 1). Bulimic and nonbulimic anorectics had similar daily activity counts (Figure 2).

The bulimic and nonbulimic anorectics studied after long-term weight recovery (Table 3) were of similar weight. Although bulimics had significantly more activity counts/day than nonbulimic anorectics (Figure 2), bulimic anorectics at stable weight consumed fewer calories/day and per body surface area (Figure 1) than nonbulimic anorectics.

For each phase of the study, bulimic and nonbulimic anorectics were compared to controls by a one-way analysis of covariance, adjusting means of caloric intake/body surface area for motor activity. This analysis made no appreciable difference in terms of statistical conclusions that bulimic and nonbulimic anorectics had differences in energy-metabolism efficiency. Moreover, the same conclusions were reached when caloric intake was adjusted for body weight or for body mass index.

Previous investigators (1, 3) have noted significant differences in premorbid body weight between bulimic and nonbulimic anorectics. Thus we obtained data on premorbid weight from our subjects in order to determine whether bulimic anorectics had greater premorbid body weight than nonbulimic anorectics. The two separate groups of weight-restored (short-term and long-term) anorectics were combined and then separated by bulimic or nonbulimic behavior. Prior to weight loss, bulimic anorectics (n = 11) had been at a maximum of 104 ± 13% average weight (30). Nonbulimic anorectics (n = 9) had a trend (t = 1.96, p = 0.07, two-tailed t) towards a lower premorbid body weight, 94 ± 9% average body weight. The two groups had been at similar low body weight at some point in their illness, 58 ± 6 versus 53 ± 9% average body weight.

Discussion

This study has shown that at several stages of anorexia nervosa when weight remained

stable, nonbulimic anorectics needed to consume a greater number of calories than bulimic anorectics. Differences in activity did not account for these findings because bulimics had similar or greater activity counts than nonbulimics. Differences in body weight also did not account for these findings. Bulimic anorectics, in fact, weighed more than nonbulimic anorectics at several stages of study yet required a lower absolute caloric intake. Moreover, this difference in caloric intake between bulimics and nonbulimics persisted when total daily caloric intake was expressed in terms of body surface area or body mass index.

It is unlikely that malabsorption was responsible for increased caloric needs of the nonbulimics. Russell and Mezey (31) have demonstrated that, during refeeding with a high-calorie liquid diet, anorectics were able to absorb a normal proportion of ingested calories. In addition, no patient in this study had clinically observable edema. Thus, it is unlikely that weight gain from fluid accumulation could account for the observed differences in body weight or caloric intake.

The validity of this study relies upon the accuracy of the estimate of caloric intake. Investigators have generally agreed that caloric intake can be estimated accurately by the weighing of all food consumed (32–34). Our method of caloric estimation was similar and the accuracy of our caloric determinations was confirmed by laboratory analysis (17).

Furthermore, we used precautions to prevent food from being binged and vomited or hidden and thrown away by restricting subjects to a locked ward and by observing them at meals and in the bathrooms. No patient on the ward was allowed to have food other than at meals. While some loss of food occurred occasionally, it was rarely a significant problem.

We continuously measured caloric intake on underweight and short-term weight-restored anorectics for a mean of 11 and 23 days, respectively. During this period of time, no subject gained or lost > 1.0 kg nor demonstrated any trend in weight gain or loss. The mean caloric intake during this period of time should be a reasonably accurate estimate of energy requirements for weight maintenance. Unfortunately, we were only able to measure caloric intake in long-term weight-restored anorectics for a mean of 4 days. While this brief evaluation period after long-term weight restoration provided only limited data, the magnitude of the difference in caloric intake between bulimic and nonbulimic long-term weight-restored anorectics was similar to our findings in low-weight and short-term weight-restored anorectics.

Several investigators have observed that bulimic anorectics have greater premorbid weight than nonbulimic anorectics (1, 3). We have found a similar trend. These premorbid weight differences might indicate that alterations in efficiency of energy metabolism predated the onset of bulimic or nonbulimic anorectic behavior. However, it is also possible that years of chronic bingeing-and-purging behavior, or chronic starvation, might be responsible for this alteration in energy-metabolism efficiency.

Other investigators (35, 36) did not categorize anorectics into bulimic and nonbulimic subgroups, but did find that previously obese anorectics (presumably the bulimic subgroup) gained weight more rapidly, on the same food intake, than anorectics who had previously been of normal weight. Furthermore, Stordy et al (34) reported that previously obese anorectics, compared to those not previously obese, had a smaller increase in metabolic rate with rising weight and a tendency to exhibit a smaller thermic response to food. Thus, these data are also suggestive of differences in energy-metabolism efficiency between subgroups of anorectics.

We were surprised to find another difference in caloric intake. The short-term weight-restored anorectics needed more calories (to maintain a stable weight) than long-term weight-restored anorectics. [This finding is discussed at greater length elsewhere (37).] This was true for both bulimic and nonbulimic subgroups. The reduction in caloric intake between short- and long-term weight-restored anorectics cannot be attributed to changes in activity alone. It is not clear from this study whether a reduction in caloric intake in individual patients occurs in the months of transition from short- to long-term weight recovery because, with one exception, the short-term and long-term subjects were different people. One subject (number 11) was studied longitudinally and did show a reduction in ca-

loric intake between short-term and long-term weight restoration, but it is problematic to draw conclusions from one subject.

It is also possible that short-term and long-term weight-restored anorectics represent two different pools of subjects: those with poor outcome and those with good outcome, respectively. Increased caloric requirement might contribute to poor outcome in the short-term weight-restored anorectics because it would be difficult for these patients to eat sufficient calories to maintain weight. In contrast, the long-term weight-restored anorectics (the good-outcome cohort) might have needed fewer calories at the time they were short-term restored and thus have had an advantage in the fight to maintain weight. A longitudinal study will be necessary to answer these questions.

The findings reported in this paper are of clinical relevance in advising anorectics about the range of calories necessary to maintain weight after they finish a weight-restoration program. Nonbulimic anorectics would have greater difficulty in maintaining their weight, both because of their lack of motivation to eat sufficient food and because of a less efficient energy metabolism. Conversely, greater efficiency of energy metabolism in bulimic anorectics would tend to promote rapid weight gain and put bulimic anorectics at risk for becoming obese. At present, only a minority of anorectics are able to maintain a normal body weight permanently after weight restoration. A better understanding of caloric requirements for weight maintenance is necessary for the development of therapies that improve outcome in patients with anorexia nervosa.

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