Decreased caloric intake in normal-weight patients with bulimia: comparison with female volunteers\(^1,2\)

Harry E Gwirtsman, Walter H Kaye, Eva Obarzanek, David T George, David C Jimerson, and Michael H Ebert

ABSTRACT Patients with bulimia (binge-purge syndrome) frequently complain that they consume a very restrictive diet to avoid gaining weight. To investigate this claim, 23 hospitalized bulimic patients were assessed daily for body weight, caloric intake, macronutrient diet content, activity measures, and body composition estimates during weight-stable periods. Bulimic patients ate fewer kilocalories per kilogram body weight (22.1 ± 4.6 kcal/kg) than did age-matched normal women (29.7 ± 6.5 kcal/kg) but had similar activity levels and body composition. Clinical variables, such as history of laxative abuse, anorexia, or obesity, and physiological characteristics, such as body weight, activity level, or dietary content, could not account for this difference in caloric consumption. Bulimic patients tended to eat a diet lower in fat and higher in protein than did control subjects. These results agree with observations of increased efficiency of caloric utilization in obese patients and support patient complaints of a tendency to gain weight easily. *Am J Clin Nutr* 1989;49:86-92.

KEY WORDS Bulimia, obesity, caloric requirements, caloric efficiency, diet, macronutrients, body composition

Introduction

Bulimic disorder is a psychiatric illness in which patients binge eat enormous quantities of food. When bulimic disorder occurs in normal-weight individuals, the binge-eating behavior is often accompanied by immediate purging, either by vomiting or by the use of laxatives (1). Frequently, bulimic individuals claim that the vomiting preceded the binge-eating and that vomiting was utilized early as a means of weight control. Such patients complain that they are unable to maintain a so-called normal weight merely by restricting their intake and that they tend to gain weight on a diet that other individuals of their age consider to be normal. It was previously thought that such statements were distortions of reality and were merely another manifestation of the illness. This study was undertaken to ascertain objectively whether hospitalized patients with bulimic disorder demonstrate a higher degree of metabolic efficiency than do normal control subjects.

It has been debated in recent years whether alterations can occur in the efficiency with which animals metabolize the energy contained in their food (2, 3). In human adults, studies of metabolic efficiency have mostly investigated obese subjects or subjects who were formerly obese; a number of the studies found that such individuals have more efficient caloric utilization than control subjects have. For example, obese or formerly obese subjects have a smaller metabolic response to such thermogenic stimuli as glucose (4), mixed meals (5), postprandial exercise (6), or a thermogenic drug (7). Kaye et al (8) reported that anorexic patients studied during a weight-stable period after refeeding have greater levels of caloric consumption than do healthy control women. This finding did not persist in a population of previously low-weight patients studied \( \geq 6 \) mo after weight recovery. The former group also had increased activity levels compared with control subjects (8). Furthermore, bulimic anorexic subjects consumed significantly fewer calories corrected for body surface area (BSA) than did nonbulimic anorexic subjects (9). This data, coupled with other uncontrolled investigations reporting greater premorbid body weight among bulimic anorexic subjects than nonbulimic anorexic subjects (10, 11), suggests that bulimic subjects are highly efficient at utilizing ingested calories.

Methods

Subjects

All patients were hospitalized on a clinical research unit of the National Institutes of Mental Health. All subjects gave writ-

\(^1\) From the Section on Biomedical Psychiatry, Laboratory of Clinical Science, National Institutes of Mental Health, Bethesda, MD.

\(^2\) Address reprint requests to HE Gwirtsman, UCLA School of Medicine, NPI 760 Westwood Plaza, Los Angeles, CA 90024.

Received August 13, 1987.

Accepted for publication January 5, 1988.

DECREASED CALORIC INTAKE IN BULIMIA

Caloric data from a subset of long-term weight-restored bulimic anorectic patients whose first-degree relatives were free of psychiatric illness. Concomitant with anorexic symptoms, including distorted body image, binge eating and purging up to the time of their hospital stay. All long-term weight-restored patients had some degree of continuing anorexic symptoms, including distorted body image, peculiar eating habits, and obsessions concerning dietary intake or food. Caloric data from a subset of these long-term weight-restored patients were previously presented (8).

Control subjects consisted of 15 healthy women who were free of medical, psychiatric, and neurological conditions and whose first-degree relatives were free of psychiatric illness. Control subjects were determined to be free of mental disorders on the basis of a structured psychiatric interview by one of the investigators (HEG). All subjects were medication free during the study.

Procedure

Caloric intake and activity measurements were quantified in the hospital during a period of stable weight. Bulimic subjects were instructed to maintain a stable body weight (±1.0 kg) during their hospitalization. This weight-stable phase of hospitalization lasted from 2 to 6 wk while studies were performed. During this phase of hospitalization, patients could only leave the ward if accompanied by staff. Normal control subjects and long-term weight-restored anorexic subjects were also instructed to maintain a stable body weight (±1.0 kg) during the weight-stable study period of 6–10 d. Every morning before breakfast and after voiding, subjects were weighed in a hospital gown on the same metabolic scale. During activity measurements all subjects remained restricted to the inpatient unit to ensure a consistent range of movement.

All food was ordered from the hospital kitchen and caloric content was documented before the food was given to the patients. The uneaten food was returned to the kitchen and weighed and an estimate of daily caloric intake was made. In an independent study (13) we calibrated the accuracy of the method of caloric estimation used in this report by methods previously reported (23, 24). The monitors were used continuously, attached to a belt around the waist of each subject. Two monitors were used to be equal to each other and throughout the study maintained a variance of <7%.

Activity monitors were automatically and continuously recorded for 24 h/day for 3–5 d by methods previously reported (23, 24). Activity counts were recorded for consecutive 15-min periods (8). The monitors were worn continuously, attached to a belt around the waist of each subject. Two monitors were used throughout the study. These monitors were initially calibrated to be equal to each other and throughout the study maintained a variance of <7%.

The activity monitor noted trunk movement but did not quantify energy expenditure. Our rationale for locating the monitor on the waist was the observation that patients and volunteers most often exercised by pacing or doing calisthenics. The continuous variables were evaluated with a one-way ANOVA and Student’s t test (two-tailed) (22). Differences found on the one-way ANOVA were evaluated by the Scheffe Test (22).

Results

Data for bulimic patients and control subjects are presented in Table 1. Bulimic patients did not differ from control subjects in age or height. Activity levels in controls were slightly and nonsignificantly lower than those seen in patients. Bulimic patients weighed significantly less than did control subjects and also had significantly lower BMIs, a trend towards lower BSAs, and a trend toward a lower TBKs. Bulimic patients also ate significantly fewer calories per day and ate fewer kilocalories per kilogram body weight as well as fewer kilocalories per
## TABLE 1
Clinical and dietary variables for bulimic patients and control subjects

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bulimic patients</th>
<th>Control subjects</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (y)</td>
<td>23.7 ± 4.6</td>
<td>22.9 ± 3.8</td>
<td></td>
</tr>
<tr>
<td>Height (mm)</td>
<td>1642 ± 57</td>
<td>1654 ± 59</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>53.3 ± 6.0</td>
<td>58.0 ± 7.5</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Percent IBW</td>
<td>91.8 ± 10.9</td>
<td>100.3 ± 11.9</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>Laxative abuse (n)</td>
<td>6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Previously anorectic (n)</td>
<td>10</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Previously overweight (n)</td>
<td>6</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>19.7 ± 2.1</td>
<td>21.2 ± 2.4</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>BSA (m²)</td>
<td>1.6 ± 0.1</td>
<td>1.6 ± 0.1</td>
<td></td>
</tr>
<tr>
<td>Energy (kcal/d)</td>
<td>1172.6 ± 260.3</td>
<td>1693.7 ± 299.2</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>TBK†</td>
<td>86.1 ± 10.9</td>
<td>93.7 ± 10.6</td>
<td>0.08</td>
</tr>
<tr>
<td>Percent body fat</td>
<td>25.7 ± 7.2</td>
<td>23.0 ± 6.9</td>
<td></td>
</tr>
<tr>
<td>LBM (kg)</td>
<td>39.1 ± 5.0</td>
<td>42.6 ± 4.8</td>
<td></td>
</tr>
<tr>
<td>Energy per wt (kcal/kg)</td>
<td>22.1 ± 4.6</td>
<td>29.7 ± 6.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Energy per BMI (kcal/BMI)</td>
<td>59.7 ± 13.7</td>
<td>81.5 ± 19.5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Energy per BSA (kcal/BSA)</td>
<td>745.6 ± 152.9</td>
<td>1038.7 ± 185.0</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Energy per kg LBM (kcal/kg LBM)</td>
<td>29.1 ± 5.9</td>
<td>39.0 ± 6.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Activity count†</td>
<td>1646 ± 484</td>
<td>1400 ± 445</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Fat intake (%)</td>
<td>29 ± 6</td>
<td>35 ± 5</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Carbohydrate intake (%)</td>
<td>52 ± 5</td>
<td>50 ± 5</td>
<td></td>
</tr>
<tr>
<td>Protein intake (%)</td>
<td>19 ± 3</td>
<td>15 ± 3</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

* x ± SD. Unless otherwise noted, for bulimic patients n = 23 and for control subjects n = 15.
† Bulimic patients, n = 16; control subjects, n = 8.
‡ Bulimic patients, n = 17; control subjects, n = 10.

unit of BMI or BSA (Fig 1). The lower caloric intake per kilogram body weight in bulimic patients could not be accounted for by differences in activity because control subjects had lower activity levels than bulimic patients.

There was also no statistically significant correlation between kilocalories ingested and activity levels when the group as a whole was considered or when control or bulimic groups were considered separately. Additionally, the difference in ingested kilocalories per kilogram between bulimic patients and control subjects could not be accounted for by altered differences in body composition because both percent body fat and LBM did not differ either clinically or statistically in the two groups. Furthermore, when caloric intake was expressed in terms of kilograms LBM to adjust for the small difference in LBM in those subjects whose TBK levels were measured, energy per kilogram (kcal/kg) LBM was still significantly lower in bulimic patients than control subjects.

Bulimic patients with no history of anorexia (n = 13) were compared with bulimic patients with a history of anorexia (n = 10). The data on a proportion of this latter group were presented previously (8). The former group had a higher frequency of binge-vomit episodes (38.2 ± 3.5 vs 6.3 ± 8.6 per week, p < 0.01) and a higher body weight (97.5 ± 8.8 vs 89.7 ± 7.2% IBW, p < 0.05). However, the two groups of bulimic subjects did not differ in age, height, duration of illness, activity, or kilocalories per kilogram ingested (Table 2, Fig 2). Previously anorexic bulimic patients had slightly lower BMIs than did nonanorexic bulimic patients (18.7 ± 2.0; p < 0.05) but did not differ on kilocalories ingested per BMI.

An analysis dividing bulimic patients who did or did not have associated laxative abuse found that 6 of 23 (26%) of the bulimic patients studied had associated laxative abuse. There was no difference found between laxative abusers and nonabusers in age, duration of illness,
TABLE 2
Previously anorexic and nonanorexic bulimic subjects compared with control subjects

<table>
<thead>
<tr>
<th>Subject ID</th>
<th>Age</th>
<th>Ht</th>
<th>Avg wt</th>
<th>% IBW</th>
<th>Days at stable wt</th>
<th>Energy/wt</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>kcal/kg</td>
</tr>
</tbody>
</table>

**Nonanorexic bulimic subjects**

(n = 13)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>49</td>
<td>20</td>
<td>1.625</td>
<td>54.6</td>
<td>98</td>
<td>33</td>
</tr>
<tr>
<td>23</td>
<td>22</td>
<td>1.520</td>
<td>47.3</td>
<td>96</td>
<td>10</td>
</tr>
<tr>
<td>59</td>
<td>25</td>
<td>1.590</td>
<td>54.5</td>
<td>102</td>
<td>25</td>
</tr>
<tr>
<td>22</td>
<td>26</td>
<td>1.620</td>
<td>55.2</td>
<td>99</td>
<td>17</td>
</tr>
<tr>
<td>26</td>
<td>19</td>
<td>1.650</td>
<td>68.5</td>
<td>118</td>
<td>17</td>
</tr>
<tr>
<td>29</td>
<td>21</td>
<td>1.650</td>
<td>53.0</td>
<td>92</td>
<td>9</td>
</tr>
<tr>
<td>20</td>
<td>19</td>
<td>1.655</td>
<td>53.7</td>
<td>92</td>
<td>25</td>
</tr>
<tr>
<td>18</td>
<td>24</td>
<td>1.730</td>
<td>59.8</td>
<td>94</td>
<td>13</td>
</tr>
<tr>
<td>21</td>
<td>21</td>
<td>1.590</td>
<td>59.4</td>
<td>111</td>
<td>13</td>
</tr>
<tr>
<td>56</td>
<td>29</td>
<td>1.650</td>
<td>52.6</td>
<td>91</td>
<td>8</td>
</tr>
<tr>
<td>58</td>
<td>25</td>
<td>1.676</td>
<td>49.6</td>
<td>89</td>
<td>9</td>
</tr>
<tr>
<td>60</td>
<td>24</td>
<td>1.645</td>
<td>54.2</td>
<td>94</td>
<td>18</td>
</tr>
<tr>
<td>65</td>
<td>34</td>
<td>1.630</td>
<td>50.1</td>
<td>89</td>
<td>26</td>
</tr>
</tbody>
</table>

| x̄ | 23.8 | 1.633 | 54.8 | 96.6 | 17.2 | 21.9 |
| SD | 4.3  | 0.050 | 5.4  | 7.3  | 7.9  | 4.5  |

**Previously anorexic bulimic subjects**

(n = 10)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>21</td>
<td>1.610</td>
<td>52.8</td>
<td>97</td>
<td>8</td>
</tr>
<tr>
<td>51</td>
<td>23</td>
<td>1.730</td>
<td>51.6</td>
<td>86</td>
<td>28</td>
</tr>
<tr>
<td>19</td>
<td>22</td>
<td>1.670</td>
<td>50.4</td>
<td>91</td>
<td>20</td>
</tr>
<tr>
<td>68</td>
<td>20</td>
<td>1.680</td>
<td>50.0</td>
<td>84</td>
<td>3</td>
</tr>
<tr>
<td>28</td>
<td>31</td>
<td>1.570</td>
<td>39.6</td>
<td>81</td>
<td>4</td>
</tr>
<tr>
<td>74</td>
<td>28</td>
<td>1.525</td>
<td>41.8</td>
<td>85</td>
<td>8</td>
</tr>
<tr>
<td>62</td>
<td>16</td>
<td>1.689</td>
<td>59.4</td>
<td>98</td>
<td>6</td>
</tr>
<tr>
<td>52</td>
<td>32</td>
<td>1.701</td>
<td>49.8</td>
<td>81</td>
<td>4</td>
</tr>
<tr>
<td>24</td>
<td>24</td>
<td>1.720</td>
<td>60.1</td>
<td>96</td>
<td>5</td>
</tr>
<tr>
<td>71</td>
<td>19</td>
<td>1.630</td>
<td>55.9</td>
<td>99</td>
<td>14</td>
</tr>
</tbody>
</table>

| x̄ | 23.6 | 1.653 | 51.4 | 87.9 | 10.0 | 51.2 |
| SD | 5.2  | 0.067 | 6.2  | 9.9  | 8.2  | 6.6  |

**Control subjects**

(n = 15)

<p>| | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>43</td>
<td>35</td>
<td>1.720</td>
<td>59.3</td>
<td>94</td>
<td>3</td>
</tr>
<tr>
<td>41</td>
<td>21</td>
<td>1.640</td>
<td>61.0</td>
<td>107</td>
<td>7</td>
</tr>
<tr>
<td>42</td>
<td>23</td>
<td>1.625</td>
<td>49.9</td>
<td>89</td>
<td>7</td>
</tr>
<tr>
<td>47</td>
<td>26</td>
<td>1.700</td>
<td>59.9</td>
<td>98</td>
<td>7</td>
</tr>
<tr>
<td>44</td>
<td>22</td>
<td>1.750</td>
<td>70.2</td>
<td>108</td>
<td>4</td>
</tr>
<tr>
<td>40</td>
<td>21</td>
<td>1.530</td>
<td>54.4</td>
<td>110</td>
<td>5</td>
</tr>
<tr>
<td>48</td>
<td>22</td>
<td>1.615</td>
<td>53.2</td>
<td>96</td>
<td>5</td>
</tr>
<tr>
<td>39</td>
<td>20</td>
<td>1.660</td>
<td>65.2</td>
<td>112</td>
<td>8</td>
</tr>
<tr>
<td>37</td>
<td>25</td>
<td>1.610</td>
<td>49.5</td>
<td>90</td>
<td>8</td>
</tr>
<tr>
<td>70</td>
<td>20</td>
<td>1.645</td>
<td>46.1</td>
<td>86</td>
<td>2</td>
</tr>
<tr>
<td>45</td>
<td>21</td>
<td>1.710</td>
<td>60.2</td>
<td>97</td>
<td>3</td>
</tr>
<tr>
<td>63</td>
<td>21</td>
<td>1.670</td>
<td>51.2</td>
<td>93</td>
<td>6</td>
</tr>
<tr>
<td>64</td>
<td>23</td>
<td>1.680</td>
<td>59.0</td>
<td>99</td>
<td>3</td>
</tr>
<tr>
<td>80</td>
<td>23</td>
<td>1.575</td>
<td>58.8</td>
<td>112</td>
<td>4</td>
</tr>
<tr>
<td>81</td>
<td>21</td>
<td>1.690</td>
<td>71.8</td>
<td>115</td>
<td>6</td>
</tr>
</tbody>
</table>

| x̄ | 22.9 | 1.654 | 58.0 | 99.6 | 5.7  | 29.7 |
| SD | 3.8  | 0.054 | 7.4  | 9.8  | 3.0  | 6.5  |

Frequency of binging and purging, body type, percent IBW, or caloric consumption, either in absolute terms or per unit of body mass. Additionally, bulimic subjects who were previously obese were compared with those who had never been > 110% of IBW. The former group weighed significantly more than the latter group (57.5 ± 6.7 kg vs 51.9 ± 5.2 kg, p < 0.05) but the two groups did not differ on any other variable.
All the bulimic patients were studied only during a weight-stable period when no significant trend in weight change could be elicited by regression analysis. Weight-stable periods were defined as a string of consecutive days in which no linear trend in weight could be detected. In addition, we double-checked these weight-stable periods by comparing the average weight of the last 2d of the weight-stable period with the average weight of the first 2d of the weight-stable period. This revealed individual weight changes that ranged from −0.6 kg to +0.6 kg for bulimic patients and from −0.7 kg to +0.7 kg for normal subjects. Results from paired *t* tests indicated the mean weight differences of −0.07 ± 0.30 kg and −0.16 ± 0.34 kg for bulimic patients and control subjects, respectively, were both nonsignificant. Furthermore, there was no correlation between individual weight changes and caloric intake. Thus, subjects whose weight change during the weight-stable period was slightly negative did not tend to have a lower caloric intake than those whose weight change was slightly positive. Finally, recalculating the mean caloric intake of each individual to account for weight changes that occurred did not significantly alter the relationship between the caloric intakes of the groups. On the contrary, adjusting caloric intake for weight differences widened the gap in caloric intake between bulimic patients and control subjects (1162 kcal vs 1709 kcal, respectively). Thus four lines of statistical analyses, linear regression of daily weights, paired *t* test of weight changes, noncorrelation between caloric intake and weight change, and average caloric intake adjusted for weight changes, support the contention that the weight-stable periods reflect caloric requirements for weight maintenance in the hospital setting.

Bulimic patients (*n* = 13) were studied for a prolonged period so that determinations could be made of weight and caloric intake during the first and fourth weeks of hospitalization. There were no significant differences found in caloric intake or weight between these two periods. Therefore, merely being hospitalized on an inpatient unit did not change the caloric requirements of the patients studied.

As previously mentioned, weight did not correlate with caloric requirements in any group. However because bulimic patients did weigh slightly less than the control subjects weighed, we felt that it was important to rule out weight as a confounding variable in this study. Consequently we divided the bulimic sample into those who were <95% IBW (*n* = 12; 83.9% IBW) and those who were >95% IBW (*n* = 11; 100.5% IBW) at the time of the study. It was found that higher-weight bulimic patients were younger than lower-weight bulimic patients (21.5 ± 1.2 y vs 25.7 ± 1.2 y) but did not differ on any other variable. Higher-weight bulimic patients were not different in weight from control subjects. Furthermore, when each subgroup of bulimic patients was compared with control subjects, it was found that the caloric intake of lower-weight bulimic patients (1139 ± 80 kcal/d) and higher-weight bulimic patients (1209 ± 84 kcal/d) were both less than that of control subjects (1694 ± kcal/d). This relationship held even when caloric intake was expressed as kcal/BMI.

There was a significant correlation between caloric intake and LBM among the 22 patients whose TBK levels and caloric intakes were measured. When caloric intake was covaried with LBM, the above results were not altered. Thus, when adjusted for differences in LBM, caloric intake (1158 vs 1649 kcal/d for bulimic patients and control subjects, respectively) and intake per kilogram LBM (29.1 vs 41.4 kcal/kg LBM for bulimic patients and control subjects, respectively) were significantly lower for the bulimic patients (*p* < 0.0004).

The macronutrient content of the diet was examined in the study population. It was found that the whole group of bulimic patients ate a diet that was higher in percent protein (19.0 ± 3.1 vs 15.4 ± 2.7%) and lower in percent fat (29.7 ± 5.9 vs 35.2 ± 5.0%) than the diet of control subjects (Fig 3). This relationship also held up in previously anorexic bulimic patients, bulimic patients without past anorexia, low- and high-weight bulimic patients, bulimic patients with or without laxative abuse, and bulimic patients with or without past obesity. Carbohydrate intake was similar in all the groups. Thus eating-disordered patients achieved a lower caloric content in their diets by choosing a low-fat, high-protein diet. Despite this low-fat diet bulimic patients had lower caloric requirements than did the control subjects.

**Discussion**

The major finding in this study is that patients with bulimia require a lower caloric intake per unit of body mass than do age-matched and sex-matched normal control subjects. This finding could not be accounted for by differences in activity levels, clinical variables (such as history of anorexia or obesity, or coexisting laxative abuse), or by differences in body composition in the pa-
patients studied. Additionally, when the patient sample was
divided into lower- and higher-weight classes, the energy
efficiency of each weight class of bulimic patients was
higher than those of the normal control subjects. One
month of hospitalization did not alter these findings be-
cause the caloric requirements of the patients studied for
1 mo remained elevated. It is unlikely that any portion
of the caloric intake was achieved through surreptitious
eating because patients were observed 24 h/d by trained
nursing staff, even when patients were in the bathroom
and the showers. Moreover, patients would have had to
consistently binge and vomit for a number of days to
achieve a significant impact on mean caloric intake or
body weight. Considering the extent of behavioral con-
trol and observation, it is highly unlikely that this could
have occurred without being discovered. Although bu-
ilic patients sometimes show signs of edema or altered
fluid and electrolyte balance, data were included in this
study only when fluid and electrolyte balance was com-
pletely stabilized.

The validity of this study relies upon the accuracy of
the estimate of caloric requirements and upon the activity
data. The accuracy of the caloric intakes was con-
firmed by an independent study (13) during which ali-
quots of food were analyzed by complete proximate
analysis. Estimates of caloric requirements for weight
maintenance were based upon periods of \( \pm 17.2 \pm 7.9 \text{ d} \)
during which no gain or loss in body weight > 1 kg nor
any trend in weight gain or loss was demonstrated by the
more sensitive method of linear regression. Therefore,
the mean caloric intake during the period under investi-
gation is a reasonably accurate estimate of energy re-
quirements for weight maintenance. Unfortunately, we
were only able to measure caloric intake in our normal
control subjects and in some of our bulimic patients \( n = 6 \) for a mean of only 6 and 8 d, respectively. Although
this brief evaluation provides only limited data, the find-
ings in these bulimic patients are consistent with those \( n = 17 \) for whom we were able to measure caloric intake
for a mean of 29 d. Moreover, the caloric intake in the
early part of hospitalization did not vary from the caloric
intake in the later part of hospitalization in the bulimic
patients for whom we had extended data. Note that de-
spite differences in body weight among the groups, when
caloric intake was expressed in terms of various indica-
tors of body mass, ie body weight, BSA, and BMI, all
yielded similar relationships to the caloric cost of weight
maintenance among the groups of subjects. Thus caloric
intake was relatively stable during the course of inpatient
stay.

An associated finding in this study was that bulimic
patients tended to consume less fat and more protein
than did normal control subjects. This was surprising be-
cause we had expected the bulimic patients to continue
to crave carbohydrates in the hospital. However, under
conditions where subjects were prevented from binging
and purging, they ate a low-fat, high-protein diet. Despite
the thermogenic effect of a high-protein diet (26), this
did not appear to increase the caloric requirement of the
bulimic patients. Thus bulimic patients still tended to
use food with greater efficiency than did control subjects
even though differences in the macronutrient composi-
tion of the diets of bulimic patients and control subjects
would favor increased caloric utilization for the bulimic
patients.

What might account for these differences in energy re-
quirement? One possible explanation is that chronic
binging and purging behavior may alter energy effi-
ciency. In this study this behavior appeared to be the crit-
ical clinical variable that differentiated patients from
control subjects with respect to caloric efficiency. In a
related study restrictor anorexic subjects were compared
with bulimic anorexic subjects and always demonstrated
significant differences in caloric efficiency (9). A spec-
trum of energy efficiency may exist in human beings,
with nonbulimic anorexic individuals at one extreme,
normal individuals in the middle, and bulimic and obese
individuals at the other extreme. There is some recent
data indicating that obese individuals have enhanced ca-
loric efficiency compared with lean control subjects (6). It
also was found that previously obese anorexic subjects
(perhaps a bulimic subgroup) gained weight more rap-
idly on the same food intake than did anorexics who
were previously of normal weight (27). Finally it is also
possible that repeated bouts of weight loss, as seen in bu-
ilic subjects, alter energy efficiency (K Brownell, per-
sonal communication, 1986).

Other investigators suggested that the mechanism un-
derlying regulation of energy efficiency may in part in-
volve adrenergic and thyroid systems. Although bulimic
subjects did not show abnormalities in thyroxine levels,
they appeared to have lowered triiodothyronine levels
(28) and an abnormality in the thyroid stimulating hor-
mones (TSH) response to thyrotropin releasing hormone
(TRH) (29, 30). Our group has been involved in the in-
tensive investigation of the noradrenergic system in bu-
limia. We found a significant reduction in sympathetic

FIG 3. Normal-weight bulimic patients \( n = 23 \) ate significantly
more protein \( p < 0.001 \) and significantly less fat \( p \sim 0.001 \) than did
volunteers \( n = 15 \). Carbohydrate content of the diet did not differ
between bulimic patients and volunteers.
activity associated with reduced caloric intake (WH Kaye et al, unpublished observation, 1986) (9) similar to preclinical observations in laboratory rodents (31). Whether reduced thyroid or sympathetic nervous system activity is secondary to reduced caloric intake or is the cause of reduced caloric intake has not been determined.

These findings have important clinical implications. When bulimic patients are induced to cease their binging and vomiting behavior, we suggest that physicians and dietitians prescribe a diet in which the caloric level is lower than might be expected. Our experience suggests that some patients will tend to gain weight if this is not done, especially when hospitalized. Because patients are often averse to any gain in body weight, this may lead to grave mistrust between patient and physician or dietician. It is not possible to determine at this point whether the abnormality in energy utilization is a trait-related phenomenon or is caused by the binging and vomiting or by cycles of weight loss. However, it is well known that vomiting is an effective means of weight control. Unless bulimic patients are counselled about dietary intake with the above considerations in mind, they will return to vomiting as a means of weight control. Although there are no known chemical means of altering energy efficiency, we suggest that physicians and dietitians prescribe regular aerobic exercise as an integral part of the treatment program for a proportion of their normal-weight bulimic patients provided there are no contraindications to such exercise. Perhaps this will allow bulimic patients in the abstinent phase to attain a relatively normal caloric intake for weight and height. Furthermore, if obese individuals have increased caloric efficiency, such clinical considerations may be all the more compelling for this group.

We gratefully acknowledge the assistance of Ruth Timmons in data organization.

References