Pattern and cost of weight gain in previously obese women

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Votruba, S. B., S. Blanc, and D. A. Schoeller. Pattern and cost of weight gain in previously obese women. *Am J Physiol Endocrinol Metab* 282: E923–E930, 2002.—Weight gain is common among postobese individuals, providing an opportunity to address the cost of weight regain on energy expenditure. We investigated the energy cost of weight regain over 1 yr in 28 women [age 39.5 ± 1.3 (SE) yr; body mass index 24.2 ± 0.5 kg/m²] with recent weight loss (>12 kg). Body composition, total energy expenditure (TEE), and thermic effect of a meal (TEM) were assessed at 0 and 12 mo. Metabolizable energy intake (MEI) was calculated from TEE and change in body composition. Fourteen women had a weight gain of 13.2 ± 2.1 kg. Twelve-month cumulative excess MEI, calculated as the intake in excess of TEE at month 0, was 749 ± 149 MJ. Of this, 462 ± 83 MJ (62%) were stored as accrued tissue, and 287 ± 72 MJ (38%) was increased TEE. Expressed per kilogram of body weight gain, the energy cost of weight gain was calculated to be 54.8 ± 4.6 MJ/kg. Interestingly, weight regain time courses fell into three distinct patterns, possibly requiring varying countermeasures.

We have found that previously obese women, who expended sufficient energy in physical activity to raise their total energy expenditure (TEE) to 1.75 times resting metabolic rate (RMR), maintained weight better than those who were less active (8, 10). This prospective study enrolled 35 women (age 39.5 ± 1.3 yr) from the Chicago area with a recent weight loss of ≥12 kg. Entry criteria included weight stability within 1 kg for 1.3 yr; body mass index of between 20 and 30 kg/m². Of these, 142 women had a weight gain of 13.2 ± 2.1 kg. Twelve-month cumulative excess MEI, calculated as the intake in excess of TEE at month 0, was 749 ± 149 MJ. Of this, 462 ± 83 MJ (62%) were stored as accrued tissue, and 287 ± 72 MJ (38%) was increased TEE. Expressed per kilogram of body weight gain, the energy cost of weight gain was calculated to be 54.8 ± 4.6 MJ/kg. Interestingly, weight regain time courses fell into three distinct patterns, possibly requiring varying countermeasures.

**METHODS**

Subjects were selected from participants in a previous prospective study on the effects of physical activity on weight maintenance (8, 10). This prospective study enrolled 35 women (age 39.5 ± 1.3 yr) from the Chicago area with a recent weight loss of ≥12 kg. Entry criteria included weight stability within 1 kg for >1 mo but not >3 mo, as well as a body mass index of between 20 and 30 kg/m².

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were measured upon admission, and a dose of doubly labeled water (DLW) was administered at the research center after an evening meal. Spot urine samples were collected before subjects received the dose and after isotopic equilibration, as well as 14 days later for the measurement of TEE and total body water (TBW) (9). FFM was calculated from TBW by assuming a hydration coefficient of 0.732, and FM was calculated by difference with body weight. A measurement of RMR was made using a Delta-Trac respiratory gas analyzer (Sensor Medics, Anaheim, CA). On the evening before the measurement, subjects were not allowed to consume alcoholic and caffeinated beverages. When subjects woke up, a 45-min measurement of respiratory gas exchange was made for each one while she rested in a supine position. The RMR was measured twice in each subject, during both the luteal and follicular phases of the menstrual cycle, and averaged. These two measurements differed by 2% (P = 0.07). The thermic effect of a meal (TEM) was measured for 4 h after a meal with an energy content equal to 50% of each subject’s RMR (10). Weight was measured at months 3, 6, and 9, as reported elsewhere (10). At 12 mo, TEE, RMR, and TEM were measured again in all subjects. The energy expended in physical activity (AEE) was calculated as the difference between TEE and RMR plus TEM.

The current data analysis includes 28 of the 35 women who completed the previous 1-yr study. One subject was excluded because of missing energy expenditure data at 12 mo; the others were excluded to provide two distinct groups. For the current analysis, subjects were categorized as either postobese weight stable or weight gaining. Weight-stable individuals were defined as those women who gained \( \leq 2 \) kg in the 12 mo after weight loss, whereas weight gainers were those who gained \( \geq 5 \) kg during the study. Six subjects were excluded because their weight gain over 1 yr was between 2.5 and 5 kg. Weight gain and body composition changes between 2.5 and 5 kg may be due to the limits of precision of the body composition techniques. Therefore, the exclusion of six women with a slight weight gain was a means of ensuring that no incorrect placement of subjects into the weight gaining or weight-stable group occurred. Twelve women were considered weight stable, whereas 16 women were categorized as weight gainers. Two of the weight gainers, however, had a decrease in energy expended in physical activity and, as a result, TEE during the study, which was the opposite pattern of the remainder of the group. As a result, those two subjects were analyzed separately where appropriate (see Table 2).

Calculations. To estimate MEI and calculate the energy cost of weight gain, several assumptions were necessary. Because energy expenditure was measured only at the start and the end of the 12 mo, we had to assume that any changes were linear over the interval. Weight gain was measured at 3-mo intervals and was assumed to be linear between measurements. We also assumed that subjects were already in positive energy balance and gaining weight at month 0 on the basis of regression analysis of average weight gain vs. time. The regression line was linear, with an intercept equal to the initial weight (Fig. 1). This implies that both weight-stable and weight-gaining subjects were gaining at least some weight from the start of the measurement period and were in a positive energy balance.

In our analysis of the data, we assumed MEI to equal TEE plus energy stored (Es) at both months 0 and 12. To estimate MEI, we needed to calculate the value for Es, which we did separately for FFM and FM (12)

\[
E_s = E_s(FM) = \delta FM \times 38,900 \text{ (kJ/kg)}
\]

\[
E_s = E_s(FM) = \delta FFM \times 23,500 \text{ (kJ/kg)}
\]

Fig. 1. Body weight changes in the weight-gaining subjects (\( n = 16 \)) and the weight-stable subjects (\( n = 12 \)).

Statistical analysis. We used a repeated-measures analysis of variance (RM-ANOVA) to detect differences between the components of energy expenditure across time (month 12 vs. month 0), with the weight response (weight gainers vs. weight-stable individuals) entered as an independent variable. When differences across time were studied only in the weight-gaining subjects, a paired t-test using the subjects as their own control was utilized. Statistical analyses were performed using StatView 5.01 (SAS Institute), and reported values are means \( \pm SE \) with \( P < 0.05 \) considered significant.

RESULTS

The progression of body weight for both weight gainers and weight-stable subjects is shown in Fig. 1. The weight-stable group showed very little fluctuation in weight throughout the 12-mo period. As a group, the weight gainers had a linear increase in body weight over the course of the measurement period and gained a total of 13.2 \( \pm 2.1 \) kg by 12 mo. On the basis of inclusion criteria, minimal weight gain was 5 kg at 12 mo.

Body composition of both the weight-stable and weight-gaining subjects at month 0 and month 12 is presented in Table 1. At month 0, the weight gainers were already heavier and had more FFM and FM than the weight-stable group, but classical unpaired t-tests between the two groups showed no significant difference in weight (\( P = 0.12 \)), FFM (\( P = 0.71 \)), and percent FM (\( P = 0.12 \)). The obvious variability of the results may explain the lack of significance. However, the use of an RM-ANOVA for the analyses of time and group effects increases the power of our statistical analyses to a confident level by removing the preexisting individual differences. The weight gainers significantly increased their body weight (\( +19\% \)), body mass index (BMI) (\( +18\% \)), FFM (\( +4\% \)), FM (\( +50\% \)), and percent FM (\( +26\% \)) by month 12. By design, the increase in those parameters was significantly greater in the weight-gaining than in the weight-stable group by month 12.

The components of TEE of both groups at month 0 and month 12 are shown in Table 2. Data from the two
weight gainers with a decrease in AEE over the 12-mo period are provided separately. At baseline (month 0), the weight-gaining and weight-stable groups do not differ in any aspect of TEE. The MEI of the weight gainers is ~1,270 kJ/day greater than that of the weight-stable group, but this is not significant. Both the weight-gaining and weight-stable groups had a significant increase from baseline to month 12 in MEI, TEE, TEE adjusted for FFM, TEM, and AEE expressed as kJ/day and per body weight. At 12 mo, the weight gainers had a significantly greater increase in MEI, TEE, and AEE (kJ/day) than the weight-stable group.

Figure 2 represents the changing contributions of various components of TEE in kilojoules per day and as a percentage of TEE from baseline to 12 mo. In the weight gainers, there is a shift in relative contribution of RMR and AEE to TEE that is not seen in the weight-stable group. The kilojoules per day of unadjusted RMR do not change dramatically from baseline in weight gainers, yet the fractional contribution of RMR to TEE decreases (~7 percentage points). In contrast, AEE as a percentage of TEE increases at month 12 in weight gainers (+6 percentage points). In both the weight gainers and the weight-stable group, $E_a$ and TEM remain relatively constant in terms of percentage of TEE. The two individuals who gained weight but decreased energy intake saw an increase in RMR as a percentage of TEE by month 12 (+15%) and a decrease in AEE as a percentage of TEE (~14%). The $E_a$ of this group is expected to be zero at baseline and 12% of TEE at 12 mo.

From baseline to 12 mo, the weight-gaining group had a significant increase in TEE of 785 ± 199 kJ/day (Fig. 3). This increase was in large part a result of significant increases in AEE and TEM of 573 ± 121 and 86 ± 37 kJ/day, respectively ($P < 0.05$ for both). When expressed per gram of weight gain, the TEE cost of weight gain increased 20.3 ± 4.0 kJ/g of weight gain. The AEE was responsible for the greatest portion of the increase (15.6 ± 3.2 kJ/g gain). TEM accounted for 2.6 ± 1.4 kJ/g of gain. RMR in kJ/g of weight gain changed relatively little (2.1 ± 2.2 kJ/g gain) and no more than TEM, which is the smallest component of energy expenditure.

Figure 3 also depicts the absolute changes in energy balance seen in weight gainers at month 12 compared with entry. These values represent the area under the curve for MEI over the entire year. The cumulative 12-mo MEI in the weight gainers was 749 ± 149 MJ. The majority of this was 462 ± 83 MJ of $E_a$, and the remainder is accounted for by TEE (287 ± 72 MJ). When divided by kilogram of weight gained, the total cost of weight gain is 54.8 ± 4.6 MJ/kg gain.

The calculated TEE cost of weight gain obtained in Fig. 3 is confirmed by regression analysis, which is similar to that used in previous studies on growth to determine the cost of weight gain. With our data, the change in MEI (kJ/day) was plotted against the change in body weight (g/day) after 1 yr (Fig. 4). The slope of the resulting regression line implies that 22.6 kJ [95% confidence intervals (CI) of 17.3 and 28.0] are expended for each gram of weight gain. The regression line that we obtained, however, differs from the traditional methods, because $E_a$ at baseline is not 0 in our analysis. The slope of our regression line represents only the cost of weight gain on TEE, rather than the traditional $E_a$ plus the cost of tissue synthesis. Adding the $E_a$ traditional estimate to calculate the total cost of weight gain results in a value of 54.8 ± 4.6 kJ·g⁻¹·day⁻¹.

As noted in Fig. 4, the variability along the regression line was large, yet it is comparable to the variability previously reported in similar studies on the energy cost of growth and/or tissue deposition (3, 5). When the six subjects with a weight gain between 2.5 and 5 kg who were excluded from our analyses were included in the regression analysis of Fig. 4, the slope of the relationship is 21.9 ± 2.6 kJ/g gain, with an $R^2 = 0.79$ (95% CI of 16.5 and 27.3). Also, when the weight-stable individuals are added to the regression analysis, the slope of the relationship becomes 21.9 ± 2.7 kJ/g gain, with an $R^2 = 0.68$ (95% CI of 16.4 and 27.4). In both cases, the slope is similar to that seen in Fig. 4. Thus, whereas variability is present in our analysis, the slope of the relationship is not biased by our exclusion procedure and can be considered accurate.
Table 2. Components of the total daily energy expenditure

<table>
<thead>
<tr>
<th></th>
<th>0 Mo</th>
<th>12 Mo</th>
<th>Effect of (by ANOVA)</th>
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<tbody>
<tr>
<td></td>
<td>Time</td>
<td>Group</td>
<td>Interaction</td>
</tr>
<tr>
<td>MEI, kJ/day</td>
<td>9.24 ± 317</td>
<td>9.49 ± 355</td>
<td>F = 13.2, F = 7.9, F = 6.8</td>
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<tr>
<td>Weight-stable group</td>
<td>10.51 ± 441</td>
<td>10.83 ± 742</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Weight-gaining group</td>
<td>(11.02 ± 1.155)</td>
<td>(10.17 ± 501)</td>
<td></td>
</tr>
<tr>
<td>TEE, kJ/day</td>
<td>9.08 ± 330</td>
<td>9.34 ± 357</td>
<td>F = 13.2, F = 2.5, F = 6.8</td>
</tr>
<tr>
<td>Weight-stable group</td>
<td>9.24 ± 318</td>
<td>10.81 ± 552</td>
<td>P &lt; 0.01</td>
</tr>
<tr>
<td>Weight-gaining group</td>
<td>(11.02 ± 1.115)</td>
<td>(9.04 ± 215)</td>
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<tr>
<td>TEE, FFM-adjusted kJ/day</td>
<td>9.30 ± 290</td>
<td>10.06 ± 326</td>
<td>F = 21.4, F = 0.005, F = 1.0</td>
</tr>
<tr>
<td>Weight-stable group</td>
<td>5.86 ± 255</td>
<td>10.24 ± 278</td>
<td>P = 0.0001</td>
</tr>
<tr>
<td>Weight-gaining group</td>
<td>(11.00 ± 1.273)</td>
<td>(8.74 ± 723)</td>
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<tr>
<td>RMR, kJ/day</td>
<td>5.47 ± 152</td>
<td>5.47 ± 189</td>
<td>F = 1.4, F = 2.0, F = 1.4</td>
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<tr>
<td>Weight-stable group</td>
<td>5.39 ± 166</td>
<td>5.99 ± 283</td>
<td>P = NS, P = NS, P = NS</td>
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<tr>
<td>Weight-gaining group</td>
<td>(5.76 ± 188)</td>
<td>(6.07 ± 523)</td>
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<tr>
<td>RMR, FFM-adjusted kJ/day</td>
<td>5.64 ± 92</td>
<td>5.85 ± 122</td>
<td>F = 2.9, F = 0.8, F = 0.5</td>
</tr>
<tr>
<td>Weight-stable group</td>
<td>5.59 ± 85</td>
<td>5.68 ± 131</td>
<td>P = NS, P = NS, P = NS</td>
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<tr>
<td>Weight-gaining group</td>
<td>(5.73 ± 93)</td>
<td>(5.90 ± 248)</td>
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<tr>
<td>TEM, kJ/day</td>
<td>502 ± 54</td>
<td>573 ± 56</td>
<td>F = 7.8, F = 1.8, F = 1.3</td>
</tr>
<tr>
<td>Weight-stable group</td>
<td>556 ± 64</td>
<td>728 ± 71</td>
<td>P = 0.01</td>
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<tr>
<td>Weight-gaining group</td>
<td>(645 ± 73)</td>
<td>(484 ± 47)</td>
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<tr>
<td>AEE, kJ/day</td>
<td>3,110 ± 269</td>
<td>3,300 ± 326</td>
<td>F = 14.0, F = 0.9, F = 7.2</td>
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<td>Weight-stable group</td>
<td>2,951 ± 222</td>
<td>4,096 ± 264</td>
<td>P = 0.001</td>
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<tr>
<td>Weight-gaining group</td>
<td>(4,621 ± 1270)</td>
<td>(2,490 ± 786)</td>
<td></td>
</tr>
<tr>
<td>AEE, kJ·day⁻¹·kg wt⁻¹</td>
<td>48 ± 4</td>
<td>51 ± 5</td>
<td>F = 4.1, F = 0.6, F = 0.8</td>
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<tr>
<td>Weight-stable group</td>
<td>42 ± 3</td>
<td>45 ± 2</td>
<td>P = 0.054</td>
</tr>
<tr>
<td>Weight-gaining group</td>
<td>(68 ± 23)</td>
<td>(31 ± 11)</td>
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Values are means ± SE of 12 weight-stable and 14 weight-gaining postobese subjects. AEE, activity energy expenditure; RMR, resting metabolic rate; MEI, metabolized energy intake; PAL, physical activity level; TEE, total energy expenditure; TEM, thermogenic effect of the meal. Nos. in parentheses refer to 2 weight-gaining postobese subjects whose weight gain is not explained by an increased energy intake (not included in the statistical analysis).

Fig. 2. Contribution of the resting metabolic rate (RMR), the thermic effect of the meal (TEM), the activity energy expenditure (AEE), and the energy stores (E. stored) to the total energy expenditure (TEE) for the weight-stable subjects (n = 12), the weight-gainers with an increase in metabolic energy intake (MEI, n = 14), and the weight-gainers with a decrease in MEI (n = 2) at months 0 and 12.
DISCUSSION

Traditional studies of the cost of weight gain rely mainly on calculations of the cost of tissue deposition and storage. These approaches, however, neglect the cost of increased energy expenditure associated with increased body weight. In our data set of 14 postobese women with a weight gain of 13 kg over 1 yr, the cost of weight gain, including the cost of both storage and increased energy expenditure, was found to be 55 MJ/kg of body weight gain. A 12-mo cumulative excess MEI of 750 MJ was calculated, of which 38% was attributable to an increase in TEE. The remaining 62% of the excess MEI is energy stored as accrued tissue.

Our analysis differs from the classical reported studies (2, 3, 5) by assuming that MEI was equivalent to total daily EE (TDEE) plus Es at both baseline and month 12. Usually, models of growth assume energy stored at baseline to be zero and Es to represent the stores accumulated throughout the study (11). We could not assume this, however, because the weight gainers already were increasing body weights at 3 mo, and because the baseline body weight of both gainers and stable women fell on a regression line of body weight vs. time (Fig. 1). This indicates that weight gain of the group is linear and began at or around the time of the first measurement.

Energy cost of weight gain. The TEE is composed of RMR, AEE, and TEM, all of which have been reported to be altered by weight gain (2, 12). As mentioned previously, 38% of the excess cumulative MEI over the 1-yr period was due to an increase in TEE. The TEE cost of weight gain is 20.3 ± 4.0 kJ/g weight gain, and at least three-quarters of this was accounted for by AEE. This finding of a large increase in AEE is consistent with the small increase in FFM (4.6 ± 1.5 g/day) and relatively large increase in FM (31.9 ± 5.8 g/day). The proportionately larger gain of metabolically inactive tissue (FM) results in an increase in the amount of energy needed to carry the extra weight. The total increase from baseline in AEE in kilojoules per day is 39%; yet, when expressed as kilojoules per day per kilogram, the increase in AEE from baseline is only 16% and is not significant. This suggests that AEE increased mainly from the energy costs of moving a larger body mass and not from a more active lifestyle.

Fig. 3. Changes in the components of the TEE of the weight gainers (n = 14). Left: average changes between month 0 and 12 in the TEE as divided into its different components: AEE, TEM, and RMR, expressed both in kJ/day and in kJ/kg of weight gain. Right: absolute changes in the MEI between month 0 and month 12 as divided into TEE and energy stores (E stored) expressed both in MJ and in MJ/kg of weight gain. *P < 0.05 vs. month 0.

Fig. 4. Regression analysis of changes in MEI vs. the changes in body weight for the weight-gaining subjects (n = 14, F = 83.6, P < 0.0001). No intercept has been included in the model. The slope was 22.6 ± 0.8 (t-value = 9.1, P < 0.0001), with a 95% confidence interval of 17.3 and 28.0.

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Surprisingly, we did not find that RMR changed with an absolute weight gain or per gram of weight gained when unadjusted for body composition. These findings contrast with what has previously been reported in overfeeding studies that induce rapid weight gain (2, 12). It is likely, however, that our ability to detect a significant difference in RMR between 0 and 12 mo is the result of a small sample size rather than a physiologically relevant finding. The predicted increase in RMR due to increased FFM would be 144 kJ/day. The weight gainers in this study had an increase in RMR by month 12 of 250 kJ/day. Therefore, in these women, RMR did increase beyond expectations based on FFM gain; however, the difference was not statistically different from baseline.

Previous studies with sample sizes similar to ours, however, were able to detect a significant increase in RMR. Forbes et al. (2) overfed 15 subjects for 3 wk and reported a 4.4-kg weight increase with an 8.7% increase in RMR. In 23 males, Tremblay et al. (12) showed a weight gain of 8.1 kg in 14 wk that corresponded to a significant increase in RMR. A potential reason for the varying results between our data and these studies is the degree of the overfeeding. In our study, the daily increment in MEI above TEE averaged 1.3 MJ/day, and participants ate ad libitum throughout a 12-mo period. In contrast, Forbes et al. increased energy intake 5.0–7.5 MJ/day for 15–19 days, and Tremblay et al. used a 353-MJ increase in energy intake over 100 days. The increased energy intakes in those studies were clearly larger than the intake experienced in our subjects. Saltzman and Roberts (7) have reviewed this subject and reported that increases in RMR are proportional to the rate of weight gain and thus the rate of overfeeding. Furthermore, because the weight gainers in our study appeared to be gaining weight even at baseline, the small increment of change in RMR would not be observed in our study.

In weight-gaining women, TEM increased significantly by 86 kJ/day (2.6 kJ/g gain) at 12 mo. Although it is of interest that TEM increased, the physiological relevance of such a small change is questionable. TEM remained constant as a percentage of TEE in the weight gainers. Moreover, TEM in the weight gainers did not increase significantly above that in the weight-stable group.

Pattern of weight gain. It has been well documented in animal studies that weight regain after weight loss.

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**Fig. 5.** Left: individual evolution of body weights of weight-gaining subjects as segregated by their pattern of gain: constant weight gainers (n = 4; A), late weight gainers (n = 3; B), and early weight gainers (n = 9; C). Right: theoretical evolutions of body weight (BW; A), TEE (B), and MEI (C) as suggested by the 3 patterns of gain.
is mainly due to energy intake returning to levels similar to or greater than those of ad libitum-fed controls, combined with a reduced TEE. This typically results in a hyperbolic pattern of weight regain until body weight is equivalent to that of controls (1). As a group, the weight gainer in this study displayed a linear weight gain over time, yet their pattern of weight gain over the year varied greatly (Fig. 5).

The patterns of weight gain seen can be divided into three categories: constant (n = 4), early (n = 7), and late gain (n = 3). Theoretically, the relationship of energy intake to TDEE varies depending upon the pattern of weight regain. This relationship is illustrated in Fig. 5, although it should be noted that the smoothed curves depicted do not represent daily reality, because both energy intake and physical activity can be expected to vary from day to day. Simplistically, a constant weight gain over time suggests a constant positive energy balance leading to a linear weight gain. A rapid early weight gain implies that a large positive energy balance is initially present. If energy intake remains relatively constant and TDEE intake increases secondarily to body weight, then weight regain should eventually plateau. In our data, the early gainer was in a positive energy balance of 980 ± 230 kJ/day at the start of the study and close to energy balance by month 12. The third scenario (later weight gain) suggests that individuals start their postobese state in energy balance. Energy intake slowly increases over time: a positive energy balance results, and weight regain follows. The later gainer in our data presumably were near energy balance at month 0 but were in positive energy balance by 1,500 ± 170 kJ/day by month 12.

The different patterns of weight regain with respect to time potentially reflect various degrees of adaptation to a changed lifestyle. For example, the postobese women in the study were reverting back to preweight loss behaviors of eating and physical activity, or there may have been postweight loss metabolic differences that predisposed these women to weight regain. We did not have pre-weight-loss measures of energy expenditure, but when the energy expenditures of these women were compared with those of never obese or obese women, there was little evidence of altered changes in energy expenditure other than a small reduction (5%) of FFM-adjusted RMR (8), and then there was no increase in FFM-adjusted RMR with weight gain, which would be expected had this difference been an adaptation to weight loss. This is consistent with reports of an absence of a decreased adjusted RMR in postobese individuals after they return to eucaloric diets (14, 15).

It should be mentioned, however, that our representation of energy balance and weight gain is based on two imperfect assumptions. First, we assume that changes in TDEE and body weight are linear between measurements. Second, we assume that the proportion of FM and FFM gained are the same throughout the period of body weight increase. Weinsier et al. (13) clearly point out that these assumptions are likely to be incorrect. They estimate that the cost of weight gain differs between a lean and obese person (17.6 vs. 45.2 MJ/kg, respectively). As body weight increases, FFM increases at a slower rate than FM. Also, the more metabolically active nonmuscle organ mass that is part of FFM increases at a slower rate than muscle mass. In addition, an increase in body weight is associated with a gradual increase in maintenance energy requirements as well as a changing cost of depositing more FM and relatively less FFM. These are issues, however, that cannot be addressed with the small number of subjects we have in each category of weight gain pattern. Additionally, the model proposed spans a 5- to 10-yr period of weight gain.

Conclusion. We observed that the actual cost of weight gain is comprised of both the energy value of newly stored tissues and the additional energy required to maintain the larger mass after relapse. After 1-yr follow-up of postobese women with weight regain, we calculated that the energy cost of weight gain was 54.8 ± 4.6 MJ/kg of body weight gain. Of this, 34.5 ± 1.7 MJ/kg gain is attributed to energy stored as accrued tissue, and the remaining 20.3 ± 4.0 MJ/kg gain is attributed to the increase in energy demand. More interestingly, however, we noted that our subjects fell into three distinct patterns of weight regain, which warrants further study because these patterns may require different interventions to prevent regain. In all patterns, the TEE at 1 yr was still greater than the MEI at month 0.

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