

# Weight Regain Prevention

Christina Garcia Ulen; Mary Margaret Huizinga, MD, MPH; Bettina Beech, DrPH; and Tom A. Elasy, MD, MPH

Obesity has reached epidemic proportions in the United States. In 2005–2006, > 72 million adults, or 34% of the population > 20 years of age, were obese (BMI  $\geq$  30 kg/m<sup>2</sup>).<sup>1</sup> Obesity is significantly correlated with hypertension, hyperlipidemia, diabetes, and infertility; yet, a 5% reduction in weight can translate into clinically significant improvements in health.<sup>2,3</sup> Lifestyle and pharmacological interventions are effective at inducing clinically significant levels of weight loss.<sup>4–6</sup> However, maintaining weight loss over a period of years has proved more challenging and has led to the classification of obesity as a chronic, relapsing disease.<sup>7</sup> Respective systematic reviews of pharmacological-, behavioral-, and diet-based weight loss treatments conclude, however, that continued therapy is essential for minimizing weight regain after weight loss.<sup>8–12</sup>

This conceptual review of the weight regain phenomenon analyzes the efficacy and clinical utility of formal weight loss and weight loss maintenance programs and highlights factors underlying weight regain and weight loss maintenance. Although weight regain prevention remains a challenge, there is room for optimism; a nationally representative survey estimates that 20% of individuals attempting weight loss are able to achieve and maintain 5% weight reductions for at least 1 year.<sup>13</sup> Among successful weight losers, various studies indicate that more than 60, 35, and 19% of individuals are able to maintain

10% weight reductions for 1, 3, and 5 years, respectively.<sup>14–16</sup>

## Methods

The first section presents the scope of the weight regain phenomenon by analyzing the long-term efficacy of weight loss programs. Data have been gathered from systematic and meta-analytical reviews of randomized controlled trials of nonsurgical weight loss therapy programs. Weight loss surgery is an option for some patients with obesity; a discussion of the risks and benefits of surgery is beyond the scope of this article and will not be considered here.

## IN BRIEF

Long-term maintenance of weight loss is an important, but often elusive, goal. Diet and pharmacological treatments for obesity are generally effective at inducing 8–10% weight reductions by 6 months. Thereafter, weight regain is a common phenomenon. Maintenance-phase medication and individual and group follow-up slow weight regain such that weight reductions at program completion average 2–6, 2–7, and 2–7% greater, respectively, than those in control groups receiving no maintenance contact. Consistent and structured eating, frequent self-weighing, and high levels of physical activity acquired through short bouts of brisk walking are pragmatic recommendations to support weight regain prevention.

The second section presents the efficacy of weight loss maintenance programs to support weight reduction and prevent weight regain. The goal is to identify best practices for weight regain prevention. Data are from randomized controlled trials in which program duration was longer than 6 months and the efficacy of a maintenance program was assessed relative to no follow-up support, placebo, or a comparative maintenance intervention group. Trials were identified through a keyMesh search on PubMed for “weight loss maintenance” and “weight regain prevention” and bibliography reviews of identified articles. The outcomes reported are statistically significant group differences in weight reduction, percentage of initial weight loss maintained, and net effect of the intervention on percentage of weight reduction. If not reported, percentage of weight reduction was calculated from baseline weight and the amount of weight lost; the percentage of weight loss maintained was calculated from initial weight lost and amount of weight loss maintained; and the intervention effect was calculated as the arithmetic mean difference in percentage of weight reduction. Baseline weight was not reported in three studies, and weight loss in kilograms was presented instead.

The third section identifies risk factors for weight regain and strategies used by successful weight loss maintainers. Data are from reports based on population surveys including the National Health and Nutrition

Examination Survey (NHANES) for 1999-2002,<sup>14,17</sup> *Consumer Reports*,<sup>18</sup> and *Consumer and Health Styles 2004*;<sup>19,20</sup> the National Control Registry for Weight Control (NWCR), a longitudinal database containing information on > 4,000 self-selected individuals who have maintained a weight loss ≥ 13.6 kg for at least 1 year;<sup>21</sup> and post-hoc analyses of randomized controlled trials.

**Long-Term Efficacy of Weight Loss Programs**

The mainstays of weight loss therapy include diet, exercise, behavioral therapy, and pharmacological therapy. Although the duration of programs varies, maximal weight loss occurs in the first 6 months of therapy.<sup>22,23</sup> The short- and long-term efficacy of weight loss programs is presented in Table 1. With the exception of continuous pharma-

cological therapy, the pattern of weight regain is evident from 6 months on.

**Diet restriction**

Calorie restriction programs restrict caloric intake by 300–500 kcal/day and fat calories to < 30% of daily caloric consumption. The expected rate of weight loss is 0.5–1.0 lb/week. In a review of 51 diet restriction programs, weight reductions at 6 months averaged 5% of baseline weight.<sup>22</sup> By 2 and 3

**Table 1. Long-Term Outcomes of Randomized Controlled Trials for Nonsurgical Weight Loss: Results From Meta-analyses and Systematic Reviews**

Program	Description	Weight loss at 6 months (kg)	Average weight reduction (%)				
			6 months	1 year	18 months	2 years	3 years <sup>c</sup>
Exercise <sup>22</sup>	Physical activity: 150 minutes/week	2.4	2.7	-	-	1.0	*
<b>Diet</b>							
Calorie restriction <sup>22</sup>	Reduce intake by 500 kcal/day	4.9	5.0	4.6	-	4.4	3.0
Low-calorie diet <sup>26,30</sup>	Intake: 800–1600 kcal/day	8.8	9.7	5.0 <sup>a</sup>	-	5.0 <sup>b</sup>	*
Meal replacement <sup>22,30</sup>	Replace 2 meals/day Intake: 800–1600 kcal/day	8.6	9.6	7.5 <sup>a</sup>	*	*	*
Very-low-calorie diet <sup>22,26</sup>	Intake < 800 kcal/day; liquid diet	17.9	16.0	10.0	-	6.3 <sup>b</sup>	*
Diet and Exercise <sup>22</sup>	Low-calorie diet and exercise	7.9	8.5	-	-	-	4.0
Standard Behavioral Therapy <sup>12,23</sup>	Group therapy led by dietitian; stimulus control and self-monitoring; diet and exercise	9–10	10.0	-	7.8	3.8	1.8
Commercial Programs <sup>34,d</sup>	Weight Watchers	6	6.4	5.3	-	3.2	*
<b>Medication</b>							
Orlistat <sup>22</sup>	Continuous medication use ± adjunct lifestyle program	8.3	8.0	7.0	-	7.0	5.3
Sibutramine <sup>22</sup>	Continuous medication use, ± adjunct lifestyle program	8.2	8.4	8.4	-	11.0	*

<sup>a</sup>Statistically significant group differences  
<sup>b</sup>Nonstatistically significant group differences  
<sup>c</sup>Behavioral therapy value is based on an average of 4.3 years follow-up  
<sup>d</sup>Based on the results from one randomized controlled trial  
<sup>e</sup>Follow-up data not available

Downloaded from http://diabetesjournals.org/clinical/article-pdf/26/3/100/498993/100.pdf by guest on 29 September 2022

years, weight reductions averaged 4.4 and 3%, respectively.

### Diet and exercise

Diet-only programs have proven more effective than exercise-only programs for inducing clinically significant levels of weight loss.<sup>22</sup> Yet, exercise can enhance the amount of weight loss achieved from dieting.<sup>22,24</sup> A meta-analysis of 17 trials demonstrates that average weight reductions for combined programs are 8.5% at 6 months and 4% at 4 years.<sup>22</sup> Nonetheless, reversion to baseline weight is predicted by 5.5 years; a steady rate of regain is observed from 6 months on.<sup>25</sup> The pattern of weight regain is slower in patients without diabetes and in those participating in induction programs that recommend fewer calories per day.

### Low-calorie diets

Low-calorie diets (LCDs) restrict caloric intake to 800–1600 kcal/day. A meta-analysis of formalized LCD programs estimates average weight loss at 6 months to be 9.7% of baseline weight.<sup>26</sup> By 1 and 2 years, weight reductions average 5%. Altering the macronutrient composition of LCDs to be very-low-fat or low-carbohydrate diets has not enhanced long-term weight loss outcomes.<sup>27,28</sup>

### Meal replacements

Meal replacement (MR) programs are often prescribed by physicians, but trials examining their efficacy have only emerged in the past 10 years.<sup>29</sup> During weight loss, all or the majority of meals are replaced. In the maintenance phase of care, meal replacements are gradually titrated down and replaced with a sensible diet. Although calories are restricted within the range of LCD programs, MRs are thought to improve diet adherence by removing calorie counting and portion control from the patient's control. In a review of MR programs with a duration of 3 months or longer, weight losses at 6 months and 1 year averaged 9.6 and

7.5% of baseline weight, respectively.<sup>30</sup> Two meta-analyses have demonstrated that MR programs are more effective than LCDs for maintaining weight loss at 1 year;<sup>22,30</sup> the net difference in weight loss maintained at 1 year was 2.6 kg in favor of MR.<sup>30</sup>

### Very-low-calorie diets

Very-low-calorie diets (VLCDs) are intensive diet programs that must be supervised by a physician.<sup>31</sup> Daily caloric intake is restricted to 400–800 kcal/day, often via a liquid diet for up to 4 months. VLCDs are associated with rapid weight loss—16% weight reductions are commonly observed at 6 months—followed by rapid weight regain.<sup>22,26,32</sup> Six trials have directly compared the efficacy of VLCD to LCD programs for weight loss. In these programs, continuous use of an LCD was compared to a sequential regimen of a VLCD followed by an LCD. A meta-analysis of these studies demonstrates that the initial net benefit derived from a VLCD diminishes over time such that group differences were not statistically significant at 2 years.<sup>26</sup>

### Behavioral therapy

Behavioral therapy, in combination with diet and exercise, is highly effective at inducing weight loss.<sup>6</sup> The goal of behavioral therapy is to promote weight loss through changes in diet and activity level. Standard behavioral therapy (SBT) programs are generally provided in a group setting, led by a dietitian or health psychologist, and focused on stimulus control, self-monitoring of diet, physical activity and weight, and nutrition counseling, among other topics.<sup>23</sup> Average duration of SBT programs is 4–6 months. In a review of nine programs, weight reductions averaged 10% at 6 months and 8% at 18 months.<sup>23</sup> Follow-up data are sparse. A separate study found that at 2 and 4 years, weight reductions approached 3.8 and 1.8 kg, respectively.<sup>12</sup>

### Commercial weight loss programs

Weight Watchers is the only commercial program to report data from randomized controlled trials.<sup>33</sup> In a multicenter trial, participants randomly assigned to a Weight Watchers program lost significantly more weight than a self-help control group.<sup>34</sup> For the Weight Watchers group, weight reductions of 4.6% were maintained at 1 year, and reductions of 3% were maintained at 2 years. Between-group differences in percentage of weight reduction averaged 3% at both time points. In a second study, individualized support from a dietitian greatly enhanced weight outcomes among Weight Watchers participants; 60% of those receiving dietitian support achieved 10% weight reductions at 1 year.<sup>35</sup> Follow-up data are not available.

### Weight loss medication

Orlistat and sibutramine are the only two drugs approved by the Food and Drug Administration (FDA) for long-term treatment of obesity.<sup>36</sup> A recent trial demonstrated that the efficacy of pharmacological treatment for obesity is enhanced when medication use is combined with a lifestyle program focused on diet, exercise, and behavioral therapy.<sup>37</sup> Published meta-analyses, however, pool data from trials that provided adjunctive lifestyle programs and those that did not. In a meta-analysis of 20 trials, pharmacological therapy ± adjunctive support induced an 8% body weight reduction by 6 months.<sup>22</sup> Weight loss hit a plateau at 6 months. With continued medication use, however, 7–11% body weight reductions were maintained for up to 3 years. A second meta-analysis demonstrated that pharmacologically treated patients were three times as likely as those solely relying on lifestyle programs to maintain clinically significant weight losses for 1–2 years.<sup>24</sup> Weight regain, however, often occurs after medication discontinuation.<sup>36</sup>

## Weight Loss Maintenance Programs

The goal of weight loss maintenance programs is to prevent weight regain after weight loss. Programs can be classified by approach: sequential medication use, sequential dieting, individualized follow-up support, or group-based follow-up support. This section provides an overview of the long-term outcomes of randomized controlled trials of weight regain prevention programs (Table 2).

### Sequential medication

Sequential medication use appears to be an effective strategy for delaying rapid weight regain. In each of the eight trials identified, maintenance-phase medication use improved end-of-program weight loss maintenance outcomes over placebo.<sup>29,38–44</sup> Weight reductions averaged 2–6% greater among those receiving maintenance-phase medication compared to placebo. Sequential medication use induced additional weight loss in three trials.<sup>39,40,44</sup> and slowed the pattern of weight regain in the other five trials.<sup>29,38,41–43</sup> Neither the type of induction therapy nor the amount of weight initially lost appears to explain this differential effect. Most troubling, however, is that intervention effects appear to diminish rapidly after medication discontinuation,<sup>40</sup> and dose reduction does not appear to be an effective alternative.<sup>29</sup> Incidentally, addition of a second weight loss medication during the maintenance phase does not appear to produce a synergistic effect.<sup>45</sup>

### Sequential dieting

Although sequential dieting is common in the literature—low-calorie diets often follow very-low-calorie diets; partial meal replacements often follow meal replacement diets—few trials have assessed the efficacy of sequential dieting for prevention of weight regain. Findings from one trial suggest that optional food provision is not an effective weight regain prevention strategy.<sup>12</sup> Three other trials have assessed the

relative efficacy of sequential dieting approaches for preventing weight regain. Within the context of group follow-up support, sequential dieting with a low-carbohydrate diet was equally as effective as a low-fat diet;<sup>46</sup> an MR was equally effective as orlistat;<sup>47</sup> and an MR was equally effective as an LCD<sup>48</sup> for supporting weight regain prevention at program completion. In all of these trials, 90–100% of initial weight losses were maintained at program completion.

Given the multi-component design of these trials, it is difficult to assess the relative contribution of sequential dieting to weight regain prevention. Moreover, follow-up data are only available from one trial, and significant weight regain was evident after discontinuation of maintenance support.<sup>48</sup>

### Individual follow-up support

In terms of individual follow-up support, telephone contact has received the most attention in the literature and appears to be effective, especially after group induction therapy and when provided by a therapist. In all identified trials, the trend was for telephone support to improve weight loss maintenance outcomes over no maintenance contact. Group differences only reached statistical significance in three of the seven study groups identified.<sup>49,50</sup> In these programs, end-of-program weight reductions averaged 2–7% greater for those receiving telephone support compared to no maintenance care. Telephone maintenance support after relapse prevention training produced the largest benefit over usual maintenance care, and benefits were sustained 6 months after discontinuation of maintenance contact.<sup>49</sup>

In contrast to traditional behavioral therapy, relapse prevention training (RPT) acknowledges that lapses in self-care behavior are inevitable.<sup>51</sup> The focus of RPT is thus to teach anticipatory planning and coping techniques.<sup>52</sup> It is hypothesized that individualized follow-up support enhances outcomes

by enabling new skill assimilation.<sup>49</sup> Telephone support after group-based induction, including behavioral therapy and nonbehavioral therapy, have also enhanced weight loss maintenance outcomes.<sup>49,50</sup> Notably, nontherapist contact<sup>12</sup> and telephone contact after a telephone-based induction program<sup>53,54</sup> or individualized cognitive behavioral therapy<sup>55</sup> have not proven effective for supporting weight regain prevention.

In addition to the telephone, other routes of delivery of individualized follow-up support have been explored in the weight regain prevention literature. One trial assessed the efficacy of an onsite stepped-care approach; after a group-based induction program, participants were eligible to receive individualized problem solving training during the maintenance phase of care if they regained > 1% of baseline weight.<sup>56</sup> Although the stepped-care program did prevent weight regain *per se*, among those who regained > 1%, those who received individualized problem-solving training greatly benefited from the stepped-care approach. Other trials found that an interactive website<sup>50</sup> and mail-based maintenance support<sup>53,54</sup> were no more effective than a self-directed maintenance program or usual care for supporting weight regain prevention.

### Group follow-up support

Group follow-up support has been explored after weight loss induction via medication, group behavioral therapy, and very-low-calorie diets. It has additionally been provided to support weight regain prevention among successful weight loss maintainers, that is, individuals that had lost and successfully maintained > 10% weight reductions for at least 1 year. Compared to induction only or usual maintenance care, the trend in all trials was for group follow-up support to enhance weight loss maintenance outcomes at both program completion and thereafter.<sup>12,57–65</sup> Group differences reached statistical

**Table 2. Efficacy of weight loss maintenance programs by maintenance strategy, results from randomized controlled trials**

Ref.	Induction		Maintenance	Study end points		% Initial WL main- tained			% Weight reduction §			Net effect on % weight reduction §§		
	Sequential medication	Induction		Post-Maintenance	Follow-up	Post-Maintenance	Follow-up	Post-Maintenance	Follow-up	Post-Maintenance	Follow-up	Post-Maintenance	Follow-up	Post-Maintenance
38	Diet + BC†	18 m	Orlistat + eucaloric diet + BC	-	73%	-	8% <sup>a</sup>	-	2% <sup>c</sup>	-	Maintenance placebo			
39	Diet ††	25 m	Orlistat + eucaloric diet	-	117%	-	7% <sup>a</sup>	-	3% <sup>c</sup>	-	Maintenance placebo			
40	VLCD + DC†	13 m	Sib + DC	16 m	163%	113%	13% <sup>a</sup>	9%	6% <sup>c</sup>	4%	Maintenance placebo			
41	VLCD + DC†	21 m	Sib + DC	-	67%	-	10% <sup>a</sup>	-	3%	-	Maintenance placebo			
42	VLCD + BC†	38 m	Sib + BC	-	62%	-	8% <sup>a</sup>	-	2%	-	Maintenance placebo			
43	Sib + Diet†	24 m	Sib	-	75%	-	9% <sup>a</sup>	-	4% <sup>c</sup>	-	Maintenance placebo			
44	Sib + MR + BC†	12 m	Sib + LCD/1 MR/day + BC	-	138%	-	11% <sup>a</sup>	-	6% <sup>c</sup>	-	Maintenance placebo			
29	Orlistat + Diet + BC ††	25 m	Orlistat + BC	-	89%	-	8% <sup>a,b</sup>	-	3%; 3%	-	Maintenance placebo & half dose			
29	Orlistat + Diet + BC ††	25 m	Orlistat (half dose) + BC	-	56%	-	5%	-	0%	-	Maintenance placebo			
45	Sib + LCD + SBT	16 m	Sib + Orlistat + BC	-	100%	-	13%	-	1%	-	Maintenance orlistat placebo			
12	SBT	18 m	Optional food provision	-	68%	-	9.0 kg	-	-0.2 kg	-	Induction only			

**Table 2. Efficacy of weight loss maintenance programs by maintenance strategy, results from randomized controlled trials**

46	VLCD + SBT	LC + BT boosters	9 m	-	100%	-	19%	-	0%	-	LF instead of LC maintenance
47	VLCD + SBT <sup>††</sup>	MR + BT boosters	12 m	-	90%	-	19%	-	1%	-	Orlistat instead of MR maintenance
48	VLCD + SBT <sup>†</sup>	MR, scheduled refeeding + BT Boosters	12 m	21 m	100%	40%	15%	6%	0	2%	LCD instead of MR maintenance
48	VLCD + SBT <sup>†</sup>	MR, scheduled refeeding + BT Boosters	12 m	21 m	87%	20%	13%	3%	-2%	-3%	Refeeding based on weight
55	CBT	Telephone support	21 m	-	114%	-	8%	-	5%	-	Induction only
53, 54	BC: telephone	Telephone support available	24 m	-	42%	-	1 kg	-	0.4 kg	-	Usual care
49	Non-BT (group diet counseling)	Telephone & mail support	10 m	16 m	80%	70%	8% <sup>a</sup>	7%	3%	3%	Induction only
12	SBT	Telephone support, non-therapist	18 m	-	73%	-	9.3 kg	-	0.7 kg	-	Induction only
49	SBT	Telephone & mail support	10 m	16 m	100%	70%	10%	7%	1%	-1%	Induction only
49	SBT & RPT	Telephone & mail support	10 m	16 m	92%	92%	12% <sup>a</sup>	12% <sup>a</sup>	7%	8%	Induction only
50	SBT <sup>†</sup>	Telephone support	36 m	-	44%	-	4% <sup>a,b</sup>	-	2% <sup>c</sup> ; 2%	-	Self-directed; interactive website
56	SBT + PST, stepped care	PST stepped care, onsite	12 m	18 m	100%	50%	8%	4%	2%	0%	SBT induction only

Table 2. Efficacy of weight loss maintenance programs by maintenance strategy, results from randomized controlled trials

		Mail support available	24 m	-	37%	-	0.7 kg	-	0.1 kg	-	Usual care
53,54	BC: mail										
	Group follow-up support										
58	-	Internet maintenance support <sup>†††</sup>	18 m	-	-	-6%	-	0%	-	-	Newsletter
58	-	On-site maintenance support <sup>†††</sup>	18 m	-	-	-3% <sup>a</sup>	-	3%	-	-	Newsletter
12	SBT <sup>d</sup>	BT boosters	12 m	24 m	100%	11%	7%	4%	4%	4%	Induction only
59	SBT	Peer group mtgs	12 m	25 m	83%	10% <sup>b</sup>	7% <sup>a</sup>	1%; -3%	3%	3%	Induction only; SBT + Boosters
60	SBT	Peer group mtgs + Telephone	18 m	27 m	100%	10% <sup>a</sup>	5% <sup>a</sup>	2%	5%	5%	Induction only
61	SBT	Peer group mtgs + Telephone	17 m	23 m	78%	7% <sup>a</sup>	6% <sup>a</sup>	7%	5%	5%	Induction only
61	SBT + EX	Peer group mtgs + Telephone	17 m	23 m	83%	10% <sup>a</sup>	8% <sup>a</sup>	4%	4%	4%	Induction only
62	SBT	RPT sessions	12 m	18 m	140%	7%	4% <sup>a</sup>	2%	3%	3%	Induction only
63	SBT	RPT sessions	17 m	-	67%	6%	-	2%	-	-	Induction only
63	SBT	PST sessions	17 m	-	122%	11% <sup>a</sup>	-	7%	-	-	Induction only
64	SBT: ITV <sup>††</sup>	BT boosters: internet	18 m	-	80%	8%	-	2%; 2%	-	-	Minimal contact; onsite boosters
66	SBT <sup>††</sup>	Weight focused boosters	12 m	18 m	89%	8%	6% <sup>b</sup>	1%	2%	2%	Exercise focused boosters
57	SBT	BT boosters + SI	18 m	24 m	117%	14%	9%	1%	-3%	-3%	SBT + Boosters

**Table 2. Efficacy of weight loss maintenance programs by maintenance strategy, results from randomized controlled trials**

57	SBT	BT boosters + EX	18 m	24 m	100%	71%	14%	10%	0%	-2%	SBT + Boosters
57	SBT	BT boosters + EX + SI	18 m	24 m	114%	100%	16%	14%	3%	2%	SBT + Boosters
67	VLCD + DC ††	Walking 2-3 hrs/wk + DC	12 m	36 m	107%	60%	16%	9%	3%; 0%	4%	DC maintenance; walking 4-6hrs/wk
68	VLCD + DC ††	Weights + DC	8 m	31 m	100%	43%	14%	6%	1%; 2%	1%	DC maintenance; walking 90min/wk
65	Orlistat ††	BT + euca- loric diet	12 m	-	100%	-	4% <sup>a</sup>	-	3%	-	Maintenance usual care

Abbreviations: LCD, low-calorie diet; MR, meal replacement diet; DC, regular dietitian contact; BC, individual, regularly scheduled behavioral counseling by a therapist; VLCD, very-low-calorie diet; Sib, sibutramine; SBT, standard behavioral therapy; RPT, relapse prevention training; PST, problem solving training; Ex, exercise; SI, social influence; ITV, interactive television; CBT, cognitive behavioral therapy.  
 †: Average weight change from pre-induction weight; calculated as necessary from baseline weight and reported weight lost (kg).  
 ††: Group difference in % weight reduction  
 †††: Non-randomized lead-in induction program. Participants required to have lost set amount of weight to be eligible for randomization to maintenance therapy.  
 ††††: Non-randomized lead-in induction program. No weight loss requirements for randomization to maintenance therapy.  
 †††††: Randomization of successful weight loss maintainers who had lost more than 10% body weight and already maintained weight loss for > 1 year.  
 a: Statistically significant group differences in weight change (kg or %) from the point of randomization between intervention and placebo, induction only or minimal maintenance contact control group.  
 b: Statistically significant group differences in weight change (kg or %) from the point of randomization between intervention groups.  
 c: Statistically significant net effect (kg or %) between intervention and control group.  
 d: Based on a review of 18 study groups.

significance in six of the 11 study groups identified ( $P > 0.05$  for group differences in weight change). In these studies, end-of-program weight reductions averaged 2–7% greater for those receiving group-based maintenance support compared to no support. Peer group meetings with individualized therapist contact<sup>60,61</sup> and problem-solving training<sup>63</sup> produced the greatest benefit over usual care, although behavioral therapy booster meetings were also effective.<sup>12</sup> Programs of comparable duration have yet to determine the relative efficacy of these programs for supporting weight regain prevention.

Maintenance programs based on relapse prevention training and peer group meetings produced a delayed benefit.<sup>59,62</sup> Although no effect was demonstrated at program completion, 6–12 months later, weight reductions were significantly greater among those who previously received maintenance support than among those who had not. A weight-focused maintenance program similarly produced a delayed benefit over an exercise-focused maintenance program.<sup>66</sup>

Internet delivery of group follow-up support has yet to be validated in the literature. In one trial, Internet-based booster meetings delivered via Internet chatrooms appeared to enhance weight loss maintenance outcomes compared to a minimal contact and an onsite booster group.<sup>64</sup> Group differences did not reach statistical significance, however. In another trial, group-based Internet support offered to successful weight losers effectively decreased the proportion of participants who regained weight; however, only onsite support proved effective for minimizing the amount of weight regained compared to a newsletter control group ( $P < 0.05$ ).<sup>58</sup>

The utility of supplemental exercise programming during group-based maintenance support has been assessed in three trials.<sup>57,67,68</sup> In each of these trials, induction therapy did not include a specific focus on exercise; rather,

exercise was introduced as a key strategy for weight loss maintenance. In addition to group-based maintenance support, participants in these programs were encouraged to meet energy expenditure goals via participation in supervised and independent exercise programs. Exercise expenditure goals were moderate in nature (1,000 kcal/week) and focused on walking, cycling, and/or weight resistance training. Although the trend was for supplemental exercise programming to enhance weight loss maintenance outcomes compared to nonsupplemented maintenance support, group differences did not reach statistical significance in any study.

Given the likelihood of rapid weight regain after medication discontinuation and the desire of many patients to not use weight loss medications indefinitely, there is a need to identify maintenance programs to be used after medication discontinuation. One trial has addressed this question.<sup>65</sup> Compared to usual maintenance care, group follow-up support after pharmacological treatment of obesity enhanced weight loss maintenance outcomes at program completion ( $P < 0.05$ ); weight reductions averaged 3% greater for those who received group follow-up support compared to usual maintenance care.<sup>65</sup> Moreover, 100% of initial weight losses were maintained by those receiving group-based follow-up support.

The trials identified in this review appear to support the assertion that continued therapy, be it based on maintenance-phase medication, sequential dieting with group follow-up support, individualized telephone support, or group-based follow-up support, is effective for slowing or delaying weight regain. Only one program identified—telephone support after relapse prevention training—supported weight regain prevention during the life of the maintenance program and new weight stabilization thereafter.

The long-term efficacy of other seemingly effective weight regain prevention programs, such as group-based problem solving training or sequential medication, is uncertain, because follow-up data have not been reported. Preliminary evidence, however, suggests that rapid regain occurs after discontinuation of maintenance medication.

In terms of relative efficacy of maintenance approaches, research is limited. One trial demonstrated that within the context of a multi-component program, sequential dieting with an MR was as effective as sequential medication for supporting weight regain prevention. Further research on the relative efficacy of maintenance approaches for supporting weight regain prevention and new weight stabilization are needed.

#### Factors Underlying Weight Regain and Weight Loss Maintenance

Some individuals are better able than others to maintain weight losses. Factors underlying weight regain and weight loss maintenance have been identified, and the former can be classified along a time axis (Table 3). Factors are clinical, psychological, and behavioral in nature.

#### Weight regain

Pre-treatment indicators of future weight regain include older age;<sup>69</sup> Mexican-American ethnicity;<sup>70</sup> frequent previous diet attempts;<sup>71,72</sup> high baseline or maximum weight;<sup>73–75</sup> nonmedical triggers for weight loss induction;<sup>76</sup> binge eating;<sup>77</sup> dietary disinhibition (loss of control while eating);<sup>77,78</sup> “all or nothing” thinking;<sup>79</sup> perceived barriers to exercise, including “too tired,” “too hard,” “not enough time,” and “no companion”; perceived barriers to diet, including “high cost of healthy foods” and “eating away from home too often”;<sup>19,20</sup> and lacking self-efficacy, motivation, realistic weight loss goals, and a strong body image.<sup>80</sup>

Post-weight loss indicators of weight regain include weight loss

> 15–30% of baseline weight;<sup>14,81</sup> early regain;<sup>82</sup> not responding to early regain;<sup>78</sup> perceptions of hunger;<sup>83</sup> dissatisfaction with achieved weight loss;<sup>80</sup> dietary disinhibition;<sup>81</sup> emotional eating;<sup>78</sup> binge eating; consuming a diet high in calories, fats, and sugars;<sup>14</sup> frequent consumption of fast food (> 2–3 times per week);<sup>20</sup> a sedentary lifestyle or decreased frequency and level of physical activity;<sup>14</sup> and viewing more than 2–4 hours of television a day.<sup>14</sup> Although somewhat counterintuitive, continuation of weight loss efforts is also associated with weight regain.<sup>16,73</sup>

#### Weight loss maintenance

Studies of the NWCR of successful weight loss maintainers provide insight into the transient course of successful weight loss maintenance. Among successful weight loss maintainers, modest weight regain and weight fluctuations are common, and recovery from regain > 2.6 kg is difficult.<sup>81,84</sup> During the first years of weight loss maintenance, continued effort and attention to weight control is essential. By 2 years, however, maintainers report less reliance on weight loss strategies and reduced attention and effort to weight control, perhaps reflecting new habit assimilation.<sup>85</sup> Furthermore, maintenance of weight loss for  $\geq 2$  years is protective against subsequent regain; by 2 years the likelihood of regaining 2.6 kg in the coming year is only 50%; by 5 years the likelihood drops to 27%.<sup>81</sup> Evidence from the NHANES survey similarly supported the contention that among successful weight loss maintainers, years from maximal weight loss is protective against weight regain.<sup>14</sup>

Studies of the NWCR identify eight behavioral strategies important for weight loss maintenance.<sup>21,77,86</sup> These included maintaining high levels of physical activity and limiting television viewing to less than a few hours a day; eating a diet low in calories and fat; regularly consuming breakfast;

**Table 3. Factors Underlying Weight Regain After Weight Loss**

Weight Regain		Weight Loss Maintenance
Pre-treatment	Post-treatment	Strategies used by successful maintainers
Older age	Weight reduction > 15–30%	High levels of physical activity
Mexican-American	Early regain	Diet low in calories, fats, and sugars
High number of previous diets	Not responding to early regain	Frequent self-monitoring
High maximum or baseline weight	Continuation of weight loss efforts	Consistent eating habits throughout the week and year
Frequent binge eating	High levels of perceived hunger	Regular consumption of breakfast
“All or nothing” thinking	Dissatisfaction with weight loss	Catching of slips before they turn into large gains
Dietary disinhibition	Dietary disinhibition	Limited TV viewing
Low exercise and diet self-efficacy	Frequent emotional eating	Regulated emotional eating
Low motivation	Frequent binge eating	Help-seeking behavior
Unrealistic weight loss goals	Diet high in calories, fats, sugars	Direct coping with stress and behavioral lapses
Negative body image	Decreased frequency and level of exercise	
	TV viewing > 2–4 hours/day	

maintaining a consistent eating pattern throughout the week and year; reigning in emotional eating; frequently monitoring weight; and catching slips before they turn into large-scale weight gains. A Consumer Reports survey additionally identified direct coping, (i.e. with stress and lapses in behavior) as opposed to avoidance or emotional eating and help-seeking as important behaviors for successful weight loss maintenance.<sup>18</sup>

**Clinical Implications**

The obesity literature has identified numerous weight loss induction programs that are effective at inducing clinically significant levels of weight loss. Diet and exercise, low-calorie diets, meal replacement, behavioral therapy, and pharmacological agents are generally effective at inducing 8–10% weight reductions by 6 months. VLCDs have demonstrated the capacity to induce even larger weight losses. For all programs, maximal weight loss occurs in the first 6 months of therapy. For all nonpharmacological programs, weight

regain begins shortly thereafter. On average, weight losses at 2 years range between 3 and 6% for nonpharmacological therapies and between 7 and 8% for pharmacological therapies. For individuals at risk, these outcomes are within the range known to induce improvements in cardiovascular risk factors and prevent type 2 diabetes.<sup>2,3</sup>

Weight loss maintenance programs identified in this review demonstrate that sequential medication use and individual and group follow-up support are effective for improving weight loss maintenance outcomes, predominantly by slowing the pattern of weight regain. Only one program, telephone contact after relapse prevention training, produced clinically significant benefits that were sustained well after discontinuation of maintenance contact. Although the ideal outcome of weight loss maintenance programs would be new weight stabilization, delayed onset of weight regain is a second-best outcome. The cardiovascular and metabolic health benefits associated with weight reduction

accrue in a dose-dependent fashion. Noncurative therapies are streamlined into the treatment of hypertension and dyslipidemia; acceptance of continuous models of care for obesity may also be necessary.<sup>12</sup>

Potential points of care to support weight regain prevention are highlighted in Table 4. Patients often expect to lose 20–30% of body weight.<sup>87–89</sup> On average, patients are only achieving half of this goal and are not sustaining it for much longer than 6 months. The impact of unrealistic weight loss goals on weight loss maintenance is uncertain.<sup>80,87,89–92</sup> Satisfaction with weight loss attained, however, predicts weight loss maintenance success.<sup>79,92,93</sup> Patient education on the health benefits from modest weight reductions may serve to promote patient satisfaction with weight loss achieved, and in turn, support weight loss maintenance.

Presenting the phenomenon of weight regain as a likely event in the course of weight loss maintenance may also support weight loss maintenance. Those at greater risk of weight

Downloaded from <http://diabetesjournals.org/clinical/article-pdf/26/3/100/498993/100.pdf> by guest on 29 September 2022

regain—those who lost a large amount of weight initially, have a history of dieting, are older, are not exercising, and tend to eat in response to their emotions—should be made aware of their risk profile and encouraged to seek help when behavior reversion or early regains occur. It may be necessary to emphasize that, although they are no longer dieting per se, continued attention to weight, diet, and exercise is essential for successful weight loss maintenance. Given that the risk of regain declines with time, 2–5 years should be presented as a benchmark for successful weight loss maintenance.

In support of patient efforts, physicians should emphasize the importance of weight control, diet, and exercise. The NWCR and the Stop Regain program demonstrate that frequent self-weighing is associated with weight

loss maintenance.<sup>21,58</sup> Moreover, a decline in the frequency of self-weighing is independently associated with weight regain.<sup>94</sup> Self-weighing whether daily or weekly enables pattern recognition, provides an opportunity for positive reinforcement, and is thought to promote self-regulation of behavior. Although some have expressed concerns that self-weighing may negatively affect the psyche, a follow-up study to the Stop Regain program found that frequency of self-weighing was actually associated with a decline in depressive symptoms, increased dietary restraint, and decreased dietary disinhibition.<sup>95</sup>

A balanced and consistent diet is essential for weight loss maintenance. In support of good habit formation, diets should obtain limited calories from fat and sugar,<sup>17,21</sup> and be consis-

tent throughout the day, week, and year.<sup>21</sup> Often, successful weight losers report consuming less variety in all food groups with the exception of fruits.<sup>96</sup> However, flexible control, as opposed to rigid diet restriction of certain food groups, is recommended as a means to support weight loss maintenance.<sup>97</sup> Other dietary strategies used by successful weight loss maintainers include self-recording of intake, planning meals, regulating portion size, consuming more than five servings of fruits and vegetables a day, and limiting intake of fast food.<sup>19,20,28</sup>

Exercise is central to weight loss maintenance. Correlational studies demonstrate that frequent exercisers are more likely to maintain weight losses. Randomized control trials support this finding as well.<sup>98–100</sup> Although the Centers for Disease Control and

**Table 4. Recommended Points of Care to Support Long-Term Weight Loss Maintenance**

Research Area	Findings	Recommendation
Weight loss programs	Long-term efficacy of formal weight loss reduction programs is limited. Only 3–7% of weight reductions are maintained at 3 years. These weight losses are not aligned with patient expectations of 20–30% weight reductions.	Satisfaction with weight loss goals is associated with weight loss maintenance. Discuss the health benefits from modest weight reductions; namely, 5–7% weight reductions are associated with cardiovascular disease risk reduction and prevention of type 2 diabetes.
Weight loss maintenance programs	Continued therapy delays or slows the pattern of weight regain.	Maintain therapeutic contact with recent weight losers. Best practices include prescription of pharmacological agents, meal replacements, telephone support from a health professional, or group therapy focused on problem solving training, relapse prevention training, or behavioral therapy. Concepts of the latter can also be incorporated into individual care.
Factors underlying weight change after weight loss	Weight regain is common. Pre-treatment and post-treatment factors associated with weight regain are clinical, psychological, and behavioral in nature. Successful weight loss maintenance is attainable. Continued attention to weight control, diet, and exercise is essential for weight loss maintenance. Between 2 and 5 years after weight loss, efforts become less burdensome and the likelihood of regaining weight is greatly reduced.	Treat modest weight regain as a likely event. Make patients aware of their risk profile and help plan for potential lapses in behavior and/or modest regain. Emphasize the importance of self-weighing for weight control; consumption of a diet low in calories from fat and sugar, eating a regular breakfast, and consistent eating patterns throughout the year for diet control; and short bouts of brisk walking as a means to maintain high levels of physical activity. Identify 2 years as an important benchmark in weight loss maintenance efforts.

Downloaded from <http://diabetesjournals.org/clinical/article-pdf/26/3/100/498993/100.pdf> by guest on 29 September 2022

Prevention recommends 150 minutes/week for weight control.<sup>101</sup> studies of successful weight loss maintainers suggest that higher levels of physical activity are necessary for weight regain prevention. The American College of Sports Medicine recommends 60–90 minutes of moderate activity per day.<sup>102</sup>

Exercise prescriptions do not have to be daunting. The relationship between activity levels and weight loss maintenance appears to be dose-dependent.<sup>99,103,104</sup> Randomized trials suggest that total energy expenditure and not intensity or duration of physical activity is most important for weight loss maintenance.<sup>104,105</sup> Home-based exercise programs with or without the provision of home exercise equipment and/or focusing on short bouts of exercise are more effective for improving exercise adherence than is supervised group exercise, providing personal trainers, or emphasizing long bouts of exercise.<sup>12,106</sup> Moreover, brisk walking is the most common form of exercise reported by successful weight loss maintainers in the NWCR,<sup>21,107</sup> and research shows that an increase in leisure activity and steps per day are associated with weight loss maintenance.<sup>19,108,109</sup> Moderate physical activity achieved through lifestyle activity, intermittent bouts of exercise, and increased steps taken per day are easy recommendations for exercise adherence and weight loss maintenance.<sup>105</sup>

Much attention in the literature has been given to identifying effective treatments for obesity. The strength of the present review is its focus on weight regain prevention and analysis of data from randomized controlled trials. It is limited by the fact that the review was nonexhaustive and based on reported and calculated data, including the use of arithmetic mean group differences to define net effect. Nonetheless, the review provides an important overview of the weight regain phenomenon and identifies

translatable points of care for primary care physicians.

### Conclusion

Long-term maintenance of weight loss is an important, but often elusive, goal.

Evidence from this review and others cited in the literature find that continued therapy from a health professional is essential for weight loss maintenance success. In support of weight loss maintenance, physician-patient interactions should include a discussion of patient goals, the weight regain phenomenon, decision points in self-care and help-seeking behavior, and conclude with advice about self-monitoring, diet, and exercise.

### REFERENCES

- <sup>1</sup>Ogden CL, Yanovski SZ, Carroll MD, Flegal KM: The epidemiology of obesity. *Gastroenterol* 132:2087–2102, 2007
- <sup>2</sup>Knowler WC, Barrett-Connor E, Fowler SE, et al.: Reduction in the incidence of type 2 diabetes with lifestyle intervention or metformin. *N Engl J Med* 346:393–403, 2002
- <sup>3</sup>Pi-Sunyer FX: A review of long-term studies evaluating the efficacy of weight loss in ameliorating disorders associated with obesity. *Clin Ther* 18:1006–1035; discussion 1005, 1996
- <sup>4</sup>Shepherd TM: Effective management of obesity. *J Fam Pract* 52:34–42, 2003
- <sup>5</sup>Shaw K, Gennat H, O'Rourke P, Del Mar C: Exercise for overweight or obesity. *Cochrane Database Syst Rev* CD003817, 2006
- <sup>6</sup>Shaw K, O'Rourke P, Del Mar C, Kenardy J.: Psychological interventions for overweight or obesity. *Cochrane Database Syst Rev* CD003818, 2005
- <sup>7</sup>Orzano AJ, Scott JG: Diagnosis and treatment of obesity in adults: an applied evidence-based review. *J Am Board Fam Pract* 17:359–369, 2004
- <sup>8</sup>O'Meara S, Riemsma R, Shirran L, Mather L, ter Riet G: A systematic review of the clinical effectiveness of orlistat used for the management of obesity. *Obes Rev* 5:51–68, 2004
- <sup>9</sup>Rucker D, Padwal R, Li SK, Curioni C, Lau DC: Long-term pharmacotherapy for obesity and overweight: updated meta-analysis. *BMJ* 335:1194–1199, 2007
- <sup>10</sup>Ayyad C, Andersen T: Long-term efficacy of dietary treatment of obesity: a systematic review of studies published between 1931 and 1999. *Obes Rev* 1:113–119, 2000
- <sup>11</sup>Saris WH: Very-low-calorie diets and sustained weight loss. *Obes Res* 9 (Suppl. 4):295S–301S, 2001
- <sup>12</sup>Perri MG: Improving the maintenance of weight lost in behavioral treatment of obesity. In *Handbook of Obesity Treatment*. Wadden TA, ed. New York, Guilford Press, 2002, p. 357–379
- <sup>13</sup>McGuire MT, Wing RR, Hill JO: The prevalence of weight loss maintenance among American adults. *Int J Obes Relat Metab Disord* 23:1314–1319, 1999
- <sup>14</sup>Weiss EC, Galuska DA, Kettel Khan L, Gillespie C, Serdula MK: Weight regain in U.S. adults who experienced substantial weight loss, 1999–2002. *Am J Prev Med* 33:34–40, 2007
- <sup>15</sup>Lowe MR, Miller-Kovach K, Phelan S: Weight-loss maintenance in overweight individuals one to five years following successful completion of a commercial weight loss program. *Int J Obes Relat Metab Disord* 25:325–331, 2001
- <sup>16</sup>Wadden TA, Frey DL: A multicenter evaluation of a proprietary weight loss program for the treatment of marked obesity: a five-year follow-up. *Int J Eat Disord* 22:203–212, 1997
- <sup>17</sup>Weiss EC, Galuska DA, Khan LK, Serdula MK: Weight-control practices among U.S. adults, 2001–2002. *Am J Prev Med* 31:18–24, 2006
- <sup>18</sup>Dohm FA, Beattie JA, Aibel C, Striegel-Moore RH: Factors differentiating women and men who successfully maintain weight loss from women and men who do not. *J Clin Psychol* 57:105–117, 2001
- <sup>19</sup>Kruger J, Blanck HM, Gillespie C: Dietary and physical activity behaviors among adults successful at weight loss maintenance. *Int J Behav Nutr Phys Act* 3:17, 2006.
- <sup>20</sup>Kruger J, Blanck HM, Gillespie C: Dietary practices, dining out behavior, and physical activity correlates of weight loss maintenance [Abstract]. *Prev Chronic Dis* 5:A11, 2008
- <sup>21</sup>Wing RR, Phelan S: Long-term weight loss maintenance. *Am J Clin Nutr* 82 (1 Suppl.):225S–225S, 2005
- <sup>22</sup>Franz MJ, VanWormer JJ, Crain AL, Boucher JL, Histon T, Caplan W, Bowman JD, Pronk NP: Weight-loss outcomes: a systematic review and meta-analysis of weight-loss clinical trials with a minimum 1-year follow-up. *J Am Diet Assoc* 107:1755–1767, 2007
- <sup>23</sup>Wadden TA, Crerand CE, Brock J: Behavioral treatment of obesity. *Psychiatr Clin North Am* 28:151–170, ix, 2005
- <sup>24</sup>Douketis JD, Macie C, Thabane L, Williamson DF: Systematic review of long-term weight loss studies in obese adults: clinical significance and applicability to clinical practice. *Int J Obes (Lond)* 29:1153–1167, 2005
- <sup>25</sup>Dansinger ML, Tatsioni A, Wong JB, Chung M, Balk EM: Meta-analysis: the effect of dietary counseling for weight loss. *Ann Intern Med* 147:41–50, 2007
- <sup>26</sup>Gilden Tsai A, Wadden TA: The evolution of very-low-calorie diets: an update and meta-analysis. *Obesity (Silver Spring)* 14:1283–1293, 2006
- <sup>27</sup>Strychar I: Diet in the management of weight loss. *CMAJ* 174:56–63, 2006
- <sup>28</sup>Tangney CC, Gustashaw KA, Stefan TM, et al. A review: which dietary plan is best for your patients seeking weight loss and sustained weight management? *Dis Man* 51:284–316, 2005

- <sup>29</sup>Davidson MH, Hauptman J, DiGirolamo M, Foreyt JP, Halsted CH, Heber D. Weight control and risk factor reduction in obese subjects treated for 2 years with orlistat: a randomized controlled trial. *JAMA* 281:235–242, 1999
- <sup>30</sup>Heysfield SB, van Mierlo CA, van der Knaap HC, Heo M, Frier HI: Weight management using a meal replacement strategy: meta and pooling analysis from six studies. *Int J Obes Relat Metab Disord* 27:537–549, 2003
- <sup>31</sup>National Institutes of Health: Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: the evidence report. *Obes Res* 6 (Suppl. 2):S1S–209S, 1998
- <sup>32</sup>Anderson JW, Konz EC, Frederich RC, Wood CL: Long-term weight-loss maintenance: a meta-analysis of US studies. *Am J Clin Nutr* 74:579–584, 2001
- <sup>33</sup>Tsai AG, Wadden TA, Womble LG, Byrne KJ: Commercial and self-help programs for weight control. *Psychiatr Clin North Am* 28:171–192, ix, 2005
- <sup>34</sup>Heshka S, Anderson JW, Atkinson RL, et al. Weight loss with self-help compared with a structured commercial program: a randomized trial. *JAMA* 289:1792–1798, 2003
- <sup>35</sup>Djuric Z, DiLaura NM, Jenkins I, Darga L, Jen CK, Mood D, Bradley E, Hryniuk WM. Combining weight-loss counseling with the weight watchers plan for obese breast cancer survivors. *Obes Res* 10:657–665, 2002
- <sup>36</sup>Bray GA: Drug treatment of obesity. *Psychiatr Clin North Am* 28:193–217, ix–x, 2005
- <sup>37</sup>Wadden TA, Berkowitz RI, Sarwer DB, Prus-Wisniewski R, Steinberg C: Benefits of lifestyle modification in the pharmacologic treatment of obesity: a randomized trial. *Arch Intern Med* 161:218–227, 2001
- <sup>38</sup>Hill JO, Hauptman J, Anderson JW, et al. Orlistat, a lipase inhibitor, for weight maintenance after conventional dieting: a 1-y study. *Am J Clin Nutr* 69:1108–1116, 1999
- <sup>39</sup>Sjostrom L, Rissanen A, Andersen T, Boldin M, Golley A, Koppeschaar H, Krempf M. Randomized placebo-controlled trial of orlistat for weight loss and prevention of weight regain in obese patients. *Ter Arch* 72:50–54, 2000
- <sup>40</sup>Apfelbaum M, Vague P, Ziegler O, Hanotin C, Thomas F, Leutenegger E: Long-term maintenance of weight loss after a very-low-calorie diet: a randomized blinded trial of the efficacy and tolerability of sibutramine. *Am J Med* 106:179–184, 1999
- <sup>41</sup>Mathus-Vliegen EM: Long-term maintenance of weight loss with sibutramine in a GP setting following a specialist guided very-low-calorie diet: a double-blind, placebo-controlled, parallel group study. *Eur J Clin Nutr* 59 (Suppl. 1):S31–S38; discussion S39, 2005
- <sup>42</sup>Richelsen B, Tonstad S, Rossner S, et al. Effect of orlistat on weight regain and cardiovascular risk factors following a very-low-energy diet in abdominally obese patients: a 3-year randomized, placebo-controlled study. *Diabetes Care* 30:27–32, 2007
- <sup>43</sup>James WP, Astrup A, Finer N, Hilsted J, Kopelman P, Rossner S., Sarris WH, Van Gaal LF. Effect of sibutramine on weight maintenance after weight loss: a randomised trial. *Lancet* 356:2119–2125, 2000
- <sup>44</sup>Early JL, Apovian CM, Aronne LJ, Fenstrom MH, Frank A. Sibutramine plus meal replacement therapy for body weight loss and maintenance in obese patients. *Obesity (Silver Spring)* 15:1464–1472, 2007
- <sup>45</sup>Wadden TA, Berkowitz RI, Womble LG, Sarwer DB, Arnold ME, Steinberg CM: Effects of sibutramine plus orlistat in obese women following 1 year of treatment by sibutramine alone: a placebo-controlled trial. *Obes Res* 8:431–437, 2000
- <sup>46</sup>LeCheminant JD, Gibson CA, Sullivan DK, et al. Comparison of a low carbohydrate and low fat diet for weight maintenance in overweight or obese adults enrolled in a clinical weight management program. *Nutr J* 6:36, 2007
- <sup>47</sup>LeCheminant JD, Jacobsen DJ, Hall MA, Donnelly JE: A comparison of meal replacements and medication in weight maintenance after weight loss. *J Am Coll Nutr* 24:347–353, 2005
- <sup>48</sup>Agras WS, Berkowitz RI, Arnow BA, Telch CF, Marnell M, Henderson J, Morris Y, Wilfley DE. Maintenance following a very-low-calorie diet. *J Consult Clin Psychol* 64:610–613, 1996
- <sup>49</sup>Perri MG, Shapiro RM, Ludwig WW, Twentyman CT, McAdoo WG: Maintenance strategies for the treatment of obesity: an evaluation of relapse prevention training and posttreatment contact by mail and telephone. *J Consult Clin Psychol*. 52:404–413, 1984
- <sup>50</sup>Svetkey LP, Stevens VJ, Brantley PJ, Appel LJ, Hollis JF, Loria CM. Comparison of strategies for sustaining weight loss: the weight loss maintenance randomized controlled trial. *JAMA* 299:1139–1148, 2008
- <sup>51</sup>Marlatt GA, George WH: Relapse prevention: introduction and overview of the model. *Br J Addict* 79:261–273, 1984
- <sup>52</sup>Larimer ME, Palmer RS, Marlatt GA: Relapse prevention: an overview of Marlatt's cognitive-behavioral model. *Alcohol Res Health* 23:151–160, 1999
- <sup>53</sup>Jeffery RW, Sherwood NE, Brelje K, Pronk NP, Boyle R, Boucher JL, Hase K. Mail and phone interventions for weight loss in a managed-care setting: Weigh-To-Be one-year outcomes. *Int J Obes Relat Metab Disord* 27:1584–1592, 2003
- <sup>54</sup>Sherwood NE, Jeffery RW, Pronk NP, Boucher JL, Hansen A, Boyle R. Mail and phone interventions for weight loss in a managed-care setting: weigh-to-be 2-year outcomes. *Int J Obes (Lond)* 30:1565–1573, 2006
- <sup>55</sup>Leibbrand R, Fichter MM: Maintenance of weight loss after obesity treatment: is continuous support necessary? *Behav Res Ther* 40:1275–1289, 2002
- <sup>56</sup>Carels RA, Darby L, Cacciapaglia HM, et al. Applying a stepped-care approach to the treatment of obesity. *J Psychosom Res* 59:375–383, 2005
- <sup>57</sup>Perri MG, McAllister DA, Gange JJ, Jordan RC, McAdoo G, Nezu AM: Effects of four maintenance programs on the long-term management of obesity. *J Consult Clin Psychol* 56:529–534, 1988
- <sup>58</sup>Wing RR, Tate DF, Gorin AA, Raynor HA, Fava JL: A self-regulation program for maintenance of weight loss. *N Engl J Med* 355:1563–1571, 2006
- <sup>59</sup>Perri MG, McAdoo WG, McAllister DA, Lauer JB, Jordan RC, Yancey DZ, Nezu AM. Effects of peer support and therapist contact on long-term weight loss. *J Consult Clin Psychol* 55:615–617, 1987
- <sup>60</sup>Perri MG, McAdoo WG, Spevak PA, Newlin DB: Effect of a multicomponent maintenance program on long-term weight loss. *J Consult Clin Psychol* 52:480–481, 1984
- <sup>61</sup>Perri MG, McAdoo WG, McAllister DA, Lauer JB, Yancey DZ: Enhancing the efficacy of behavior therapy for obesity: effects of aerobic exercise and a multicomponent maintenance program. *J Consult Clin Psychol* 54:670–675, 1986
- <sup>62</sup>Baum JG, Clark HB, Sandler J: Preventing relapse in obesity through posttreatment maintenance systems: comparing the relative efficacy of two levels of therapist support. *J Behav Med* 14:287–302, 1991
- <sup>63</sup>Perri MG, Nezu AM, McKelvey WF, Shermer RL, Renjilian DA, Viegner BJ: Relapse prevention training and problem-solving therapy in the long-term management of obesity. *J Consult Clin Psychol* 69:722–726, 2001
- <sup>64</sup>Harvey-Berino J, Pintauro S, Buzzell P, Gold EC: Effect of internet support on the long-term maintenance of weight loss. *Obes Res* 12:320–329, 2004
- <sup>65</sup>Woo J, Sea MM, Tong P, Ko GT, Lee Z, Chan J, Chow FC. Effectiveness of a lifestyle modification programme in weight maintenance in obese subjects after cessation of treatment with Orlistat. *J Eval Clin Pract* 13:853–859, 2007
- <sup>66</sup>Leermakers EA, Perri MG, Shigaki CL, Fuller PR: Effects of exercise-focused versus weight-focused maintenance programs on the management of obesity. *Addict Behav* 24:219–227, 1999
- <sup>67</sup>Fogelholm M, Kukkonen-Harjula K, Nenonen A, Pasanen M: Effects of walking training on weight maintenance after a very-low-energy diet in premenopausal obese women: a randomized controlled trial. *Arch Intern Med* 160:2177–2184, 2000
- <sup>68</sup>Borg P, Kukkonen-Harjula K, Fogelholm M, Pasanen M: Effects of walking or resistance training on weight loss maintenance in obese, middle-aged men: a randomized trial. *Int J Obes Relat Metab Disord* 26:676–683, 2002
- <sup>69</sup>Hansen D, Astrup A, Toubro S, et al. Predictors of weight loss and maintenance during 2 years of treatment by sibutramine in obesity. Results from the European multi-centre STORM trial. *Int J Obes Relat Metab Disord* 25:496–501, 2001
- <sup>70</sup>Weiss EC GD, Khan LK, Gillespie C, Serdula MK: Weight regain in U.S. adults who experienced substantial weight loss, 1999–2002. *Am J Prev Med* 33:34–40, 2007

- <sup>71</sup>Passman WJ SW, Westerterp-Plantenga MS: Predictors of weight maintenance. *Obes Res* 7:43–50, 1999
- <sup>72</sup>Texiera PJ GS, Houtkooper LB, Cussler EC, et al.: Pretreatment predictors of attrition and successful weight management in women. *Int J Obes* 28:1124–1133, 2004
- <sup>73</sup>Lavery MA Identifying predictive variables for long-term weight change after participation in a weight loss program. *J Am Diet Assoc* 93:1017–1018, 1993
- <sup>74</sup>Hansen D AA, Tourbro S, Finer N, et al, for the Storm Study Group: Predictors of weight loss and maintenance during 2 years of treatment by sibutramine in obesity. Results from the European multi-centre STORM trial. *Int J Obes Relat Metab Disord* 25:496–501, 2001
- <sup>75</sup>Byrne SM CZ, Fairburn CG: Psychological predictors of weight regain in obesity. *Behav Res Ther* 42:1341–1356, 2004
- <sup>76</sup>Gorin AA, Phelan S, Hill JO, Wing RR: Medical triggers are associated with better short- and long-term weight loss outcomes. *Prev Med* 39:612–616, 2004
- <sup>77</sup>Niemeier HM, Phelan S, Fava JL, Wing RR: Internal disinhibition predicts weight regain following weight loss and weight loss maintenance. *Obesity (Silver Spring)* 15:2485–2494, 2007
- <sup>78</sup>Lavery MA, Loewy JW: Identifying predictive variables for long-term weight change after participation in a weight loss program. *J Am Diet Assoc* 93:1017–1024, 1993
- <sup>79</sup>Byrne SM, Cooper Z, Fairburn CG: Psychological predictors of weight regain in obesity. *Behav Res Ther* 42:1341–1356, 2004
- <sup>80</sup>Teixeira PJ, Going SB, Houtkooper LB, Cussler EC, Metcalfe LL, Blew RM. Pretreatment predictors of attrition and successful weight management in women. *Int J Obes Relat Metab Disord* 28:1124–1133, 2004
- <sup>81</sup>McGuire MT, Wing RR, Klem ML, Lang W, Hill JO: What predicts weight regain in a group of successful weight losers? *J Consult Clin Psychol* 67:177–185, 1999
- <sup>82</sup>Poston WS 2nd, Ericsson M, Linder J, Nilsson T, Goodrick GK, Foreyt JP: Personality and the prediction of weight loss and relapse in the treatment of obesity. *Int J Eat Disord* 25:301–309, 1999
- <sup>83</sup>Passman WJ, Saris WH, Westerterp-Plantenga MS: Predictors of weight maintenance. *Obes Res* 7:43–50, 1999
- <sup>84</sup>Phelan S, Hill JO, Lang W, Dibello JR, Wing RR: Recovery from relapse among successful weight maintainers. *Am J Clin Nutr* 78:1079–1084, 2003
- <sup>85</sup>Klem ML, Wing RR, Lang W, McGuire MT, Hill JO: Does weight loss maintenance become easier over time? *Obes Res* 8:438–444, 2000
- <sup>86</sup>Raynor DA, Phelan S, Hill JO, Wing RR: Television viewing and long-term weight maintenance: results from the National Weight Control Registry. *Obesity (Silver Spring)* 14:1816–1824, 2006
- <sup>87</sup>Foster GD, Wadden TA, Vogt RA, Brewer G: What is a reasonable weight loss? Patients' expectations and evaluations of obesity treatment outcomes. *J Consult Clin Psychol* 65:79–85, 1997
- <sup>88</sup>Jeffery RW, Wing RR, Mayer RR: Are smaller weight losses or more achievable weight loss goals better in the long term for obese patients? *J Consult Clin Psychol* 66:641–645, 1998
- <sup>89</sup>Linde JA, Jeffery RW, Finch EA, Ng DM, Rothman AJ: Are unrealistic weight loss goals associated with outcomes for overweight women? *Obes Res* 12:569–576, 2004
- <sup>90</sup>Cooper Z, Fairburn CG: A new cognitive behavioural approach to the treatment of obesity. *Behav Res Ther* 39:499–511, 2001
- <sup>91</sup>Jeffery RW, Kelly KM, Rothman AJ, Sherwood NE, Boutelle KN: The weight loss experience: a descriptive analysis. *Ann Behav Med* 27:100–106, 2004
- <sup>92</sup>Finch EA, Linde JA, Jeffery RW, Rothman AJ, King CM, Levy RL: The effects of outcome expectations and satisfaction on weight loss and maintenance: correlational and experimental analyses: a randomized trial. *Health Psychol* 24:608–616, 2005
- <sup>93</sup>Foster GD, Phelan S, Wadden TA, Gill D, Ermold J, Didie E: Promoting more modest weight losses: a pilot study. *Obes Res* 12:1271–1277, 2004
- <sup>94</sup>Butryn ML, Phelan S, Hill JO, Wing RR: Consistent self-monitoring of weight: a key component of successful weight loss maintenance. *Obesity (Silver Spring)* 15:3091–3096, 2007
- <sup>95</sup>Wing RR, Tate DF, Gorin AA, Raynor HA, Fava JL, Machan J: STOP regain: are there negative effects of daily weighing? *J Consult Clin Psychol* 75:652–656, 2007
- <sup>96</sup>Raynor HA, Jeffery RW, Phelan S, Hill JO, Wing RR: Amount of food group variety consumed in the diet and long-term weight loss maintenance. *Obes Res* 13:883–890, 2005
- <sup>97</sup>Westenhoefer J, von Falck B, Stellfeldt A, Fintelmann S: Behavioural correlates of successful weight reduction over 3 y. Results from the Lean Habits Study. *Int J Obes Relat Metab Disord* 28:334–335, 2004
- <sup>98</sup>Wing RR: Physical activity in the treatment of the adulthood overweight and obesity: current evidence and research issues. *Med Sci Sports Exerc* 31(11 Suppl.):S547–S552, 1999
- <sup>99</sup>Hill JO, Wyatt HR: Role of physical activity in preventing and treating obesity. *J Appl Physiol* 99:765–770, 2005
- <sup>100</sup>Catenacci VA, Wyatt HR: The role of physical activity in producing and maintaining weight loss. *Nat Clin Pract Endocrinol Metab* 3:518–529, 2007
- <sup>101</sup>Pate RR, Pratt M, Blair SN, Haskewell WL, Macera CA, Bouchard C, Buchner D, Ettinger W, Heath GW, King AC: Physical activity and public health: a recommendation from the Centers for Disease Control and Prevention and the American College of Sports Medicine. *JAMA* 273:402–407, 1995
- <sup>102</sup>Jakicic JM, Clark K, Coleman E, et al., American College of Sports Medicine position stand: appropriate intervention strategies for weight loss and prevention of weight regain for adults. *Med Sci Sports Exerc* 33:2145–2156, 2001
- <sup>103</sup>Jakicic JM, Marcus BH, Gallagher KI, Napolitano M, Lang W: Effect of exercise duration and intensity on weight loss in overweight, sedentary women: a randomized trial. *JAMA* 290:1323–1330, 2003
- <sup>104</sup>Jeffery RW, Wing RR, Sherwood NE, Tate DF: Physical activity and weight loss: does prescribing higher physical activity goals improve outcome? *Am J Clin Nutr* 78:684–689, 2003
- <sup>105</sup>Jakicic JM, Otto AD: Physical activity recommendations in the treatment of obesity. *Psychiatr Clin North Am* 28:141–150, ix, 2005
- <sup>106</sup>Jakicic JM, Wing RR, Butler BA, Robertson RJ: Prescribing exercise in multiple short bouts versus one continuous bout: effects on adherence, cardiorespiratory fitness, and weight loss in overweight women. *Int J Obes Relat Metab Disord* 19:893–901, 1995
- <sup>107</sup>Catenacci VA, Ogden LG, Stult J, Phelan S, Wing RR, Hill JO, Wyatt HR: Physical activity patterns in the National Weight Control Registry. *Obesity (Silver Spring)* 16:153–161, 2008
- <sup>108</sup>Villanova N, Pasqui F, Burzacchini S, et al. A physical activity program to reinforce weight maintenance following a behavior program in overweight/obese subjects. *Int J Obes (Lond)* 30:697–703, 2006
- <sup>109</sup>van Baak MA, van Mil E, Astrup AV, Finer N, Van Gaal L, Hilsted J, Kopelman PG: Leisure-time activity is an important determinant of long-term weight maintenance after weight loss in the Sibutramine Trial on Obesity Reduction and Maintenance (STORM trial). *Am J Clin Nutr* 78:209–214, 2003

*Christina Garcia Ulen is third-year student at the University of Michigan School of Medicine. Mary Margaret Huizinga, MD, MPH, is an assistant professor at Johns Hopkins University School of Medicine. Bettina Beech, DrPH, is an associate professor at the Diabetes Research and Training Center at Vanderbilt University Medical Center. Tom A. Elasy, MD, MPH, is director of the Prevention and Control Core of the Vanderbilt Diabetes Research and Training Center at Vanderbilt University Medical Center and medical director of the Vanderbilt Eskind Diabetes Center. He is also editor-in-chief of Clinical Diabetes.*