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Maintenance of lost weight and long-term management of obesity

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Synopsis

Weight loss can be achieved through a variety of modalities, but long-term maintenance of lost weight is much more challenging. Obesity interventions typically result in early rapid weight loss followed by a weight plateau and progressive regain. This review describes our current understanding of the biological, behavioral, and environmental factors driving this near-ubiquitous body weight trajectory and the implications for long-term weight management. Treatment of obesity requires ongoing clinical attention and weight maintenance-specific counseling to support sustainable healthful behaviors and positive weight regulation.

Keywords

obesity treatment; weight loss; weight maintenance; behavioral counseling; appetite; physiology

Introduction

Robert is a 47 year old patient who initially weighed 270 pounds. He lost 85 pounds three years ago by carefully following your guidance to decrease his caloric intake to 1500 calories per day and exercise six days weekly. Today he comes in for his annual physical examination. You were excited to hear about his continued progress and see how much more he's lost, but you felt immediately dejected to see that he had regained almost 60 pounds. "I don't know what to do...the weight keeps coming back on. I keep trying, but there must be something wrong. I'm sure my metabolism is in the dumps. It feels like every moment of the day I can't help but think about food – it was never like this before I lost the weight. And no matter how hard I try to stop eating after one serving, I just can't seem to do it anymore."

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Feeling defeated, he says “I don’t even know what’s the point of doing this anymore!”

Frustrated, you remind him that he was able to do it just fine when he was losing weight initially, and he just needs to keep working hard at it. “I know it’s not easy, but I can’t help you unless you’re willing to help yourself. You just need to work harder and take control of this again.” You feel for him, but you know that you need to be stern to get him past this backsliding. Hoping to motivate him, you remind him how bad he will feel if he regains more weight, and you tell him to make a follow-up appointment for six months and warn him that if he doesn’t turn things around quickly he will have to restart his blood pressure medications.

Substantial weight loss is possible across a range of treatment modalities, but long-term sustenance of lost weight is much more challenging, and weight regain is typical^{1–3}. In a meta-analysis of 29 long-term weight loss studies, more than half of the lost weight was regained within two years, and by five years more than 80% of lost weight was regained (Figure 1)⁴. Indeed, previous failed attempts at achieving durable weight loss may have contributed to the recent decrease in the percentage of people with obesity who are trying to lose weight⁵ and many now believe that weight loss is a futile endeavor⁶.

Here, we describe our current understanding of the factors contributing to weight gain, physiological responses that resist weight loss, behavioral correlates of successful maintenance of lost weight, as well as the implications and recommendations for long-term clinical management of patients with obesity.

Why is it so difficult to lose weight and keep it off?

The obesogenic environment

Long term weight management is extremely challenging due to interactions between our biology, behavior, and the obesogenic environment. The rise in obesity prevalence over the past several decades has been mirrored by industrialization of the food system⁷ involving increased production and marketing of inexpensive, highly-processed foods^{8–10} with supernormal appetitive properties^{11,12}. Ultraprocessed foods¹³ now contribute the majority of calories consumed in America¹⁴ and their overconsumption has been implicated as a causative factor in weight gain¹⁵. Such foods are typically more calorically dense and far less healthy than unprocessed foods such as fruits, vegetables, and fish¹⁶. Food has progressively become cheaper¹⁷, fewer people prepare meals at home^{18,19}, and more food is consumed in restaurants¹⁸. In addition, changes in the physical activity environment have made it more challenging to be active throughout the day. Occupations have become more sedentary²⁰ and suburban sprawl necessitates vehicular transportation rather than walking to work or school as had been common in the past. Taken together, changes in the food and physical activity environments tend to drive individuals towards increased intake, decreased activity, and ultimately weight gain.

Physiological responses to weight loss

Outdated guidance to physicians and their patients gives the mistaken impression that relatively modest diet changes will consistently and progressively result in substantial weight loss at rate of one pound for every 3500 kcal of accumulated dietary calorie deficit^{21–24}. For example, cutting just a couple of cans of soda (~300 kcal) from one's daily diet was thought to lead to about 30 pounds of weight loss in a year, 60 pounds in 2 years, etc. Failure to achieve and maintain substantial weight loss over the long term is then simply attributed to poor adherence to the prescribed lifestyle changes, thereby potentially further stigmatizing the patient as lacking in willpower, motivation, or fortitude to lose weight²⁵.

We now know that the simple calculations underlying the old weight loss guidelines are fatally flawed because they fail to consider declining energy expenditure with weight loss²⁶. More realistic calculations of expected weight loss for a given change in energy intake or physical activity are provided by a web-based tool called NIH Body Weight Planner (<http://BWplanner.niddk.nih.gov>) that uses a mathematical model to account for dynamic changes in human energy balance²⁷.

In addition to adaptations in energy expenditure with weight loss, body weight is regulated by negative feedback circuits that influence food intake^{28,29}. Weight loss is accompanied by persistent endocrine adaptations³⁰ that increase appetite and decrease satiety³¹ thereby resisting continued weight loss and conspiring against long-term weight maintenance.

Explaining the weight plateau

The overlapping physiological changes that occur with weight loss help explain the near-ubiquitous weight loss time course: early rapid weight loss that stalls after several months, followed by progressive weight regain³². Different interventions result in varying degrees of weight loss and regain, but the overall time courses are similar. As people progressively lose more and more weight, they fight an increasing battle against the biological responses that oppose further weight loss.

Appetite changes likely play a more important role than slowing metabolism in explaining the weight loss plateau since the feedback circuit controlling long-term calorie intake has greater overall strength than the feedback circuit controlling calorie expenditure. Specifically, it has been estimated that for each kilogram of lost weight, calorie expenditure decreases by about 20–30 kcal/d whereas appetite increases by about 100 kcal/d above the baseline level prior to weight loss³¹. Despite these predictable physiologic phenomena, the typical response of the patient is to blame themselves as lazy or lacking in willpower, sentiments that are often reinforced by healthcare providers, as in the example of Robert, above.

Using a validated mathematical model of human energy balance dynamics^{27,31}, Figure 2 illustrates the energy balance dynamics underlying the weight loss time courses of two example 90 kg women who either regain (blue curves) or maintain (orange curves) much of their lost weight after reaching a plateau within the first year of a diet intervention. In both women, large decreases in calorie intake at the start of the intervention result in rapid loss of

weight and body fat leading to a modest decrease in calorie expenditure that contributes to slowing weight loss. However, the exponential rise in calorie intake from its initially reduced value is the primary factor that halts weight loss within the first year. In contrast to the modest drop in calorie expenditure of less than 200 kcal/d at the weight plateau, appetite has risen by 400–600 kcal/d and energy intake has increased by 600–700 kcal/d since the start of the intervention.

These mathematical model results contrast with patients' reports of eating approximately the same diet after the weight plateau that was previously successful during the initial phases of weight loss³³. While self-reported diet measurements are notoriously inaccurate and imprecise^{34–36}, it may be possible to reconcile such data with objectively quantified increases in calorie intake. It is entirely possible that patients truly believe they are sticking with their diet despite not losing any more weight or even regaining weight.

The patient's perception of ongoing diet maintenance despite no further weight loss may arise because the physiological regulation of appetite occurs in brain regions that operate below the patient's conscious awareness³⁷. Thus, signals to the brain that increase appetite with weight loss could introduce subconscious biases such as portion sizes creeping upwards over time. Such a slow drift upwards in energy intake would be difficult to detect given the large 20–30% fluctuations in energy intake from day to day^{38,39}. Furthermore, a relatively persistent effort is required to avoid overeating to match the increased appetite that grows in proportion to the weight lost³¹. For example, the model-calculated intervention effort for the simulated patient who experiences the weight plateau at six months followed by weight regain (Figure 2, blue curves) maintains more than ~70% of their initial intervention effort until the plateau. Perhaps self-reported diet maintenance before and after the weight plateau is more representative of the patients' relatively persistent effort to avoid overeating in response to their increased appetite³¹. New technologies using repeated weight monitoring can be used calculate changes in calorie intake and effort over time⁴⁰ and help guide individuals participating in a weight loss intervention^{41–44}.

Weight regain versus maintenance

From a purely calorie balance perspective, a patient who maintains lost weight after the first year of an intervention (Figure 2, orange curves) may be eating only about 100 kcal/d fewer than a patient who experiences long-term weight regain (Figure 2, blue curves). However, such a small difference in food intake behavior is somewhat misleading considering that prevention of weight regain requires about 300–500 kcal/d of increased persistent effort to counter the ongoing slowing of metabolism and increased appetite associated with the lost weight. The more typical pattern of long-term weight regain is characterized by a waning effort to sustain the intervention.

There are likely many factors that account for the ability of some patients to achieve and maintain large weight losses over the long term whereas others experience substantial weight regain. Unravelling the biological, psychosocial, educational, and environmental determinants of such individual variability will be an active area of obesity research for the foreseeable future⁴⁵.

The role of diet composition

The laws of thermodynamics dictate that the energy derived from macronutrients being oxidized via the intricate biochemical pathways of oxidative phosphorylation inside cells can be equated to the values measured by combusting these fuels in a bomb calorimeter. However, this equivalence does not necessarily imply that “a calorie is a calorie” when it comes to diets with different macronutrient proportions differentially impacting weight loss.

Altering dietary macronutrient composition could theoretically influence overall calorie intake or expenditure resulting in a corresponding change in body weight. Alternatively, manipulation of diet composition can result in differences in the endocrine status in a way that could theoretically influence the propensity to accumulate body fat or affect subjective hunger or satiety. These possibilities do not necessarily violate the laws of thermodynamics since any change in the body’s overall energy stores (i.e. fat mass) must be accompanied by changes in calorie intake or expenditure. Therefore, it is theoretically possible that a particular diet could result in an advantageous endocrine or metabolic state that promotes weight loss. This promise provides fodder for the diet industry and false hope to the patient with obesity since it implies that if they simply choose the right diet then weight loss can be easily achieved.

In recent years, there has been a reemergence of low-carbohydrate, high-fat diets as popular weight loss interventions. Such diets have been claimed to reverse the metabolic and endocrine derangements resulting from following advice to consume low-fat, high-carbohydrate diets that allegedly caused the obesity epidemic. Specifically, the so-called “carbohydrate-insulin model of obesity” posits that diets high in carbohydrates are particularly fattening because they increase the secretion insulin and thereby drive fat accumulation in adipose tissue and away from oxidation by metabolically active tissues, and this altered fat partitioning results in a state of “cellular starvation” leading to adaptive increases in hunger, and suppression of energy expenditure⁴⁶. Therefore, the carbohydrate-insulin model implies that reversing these processes by eating a low-carbohydrate, high-fat diet should result in effortless weight loss⁴⁷. Unfortunately, important aspects of the carbohydrate-insulin model have failed experimental interrogation⁴⁸ and, for all practical purposes, “a calorie is a calorie” when it comes to body fat and energy expenditure differences between controlled isocaloric diets varying in the ratio of carbohydrate to fat⁴⁹. Nevertheless, low-carbohydrate, high-fat diets may lead to spontaneous reduction in calorie reduction and increased weight loss, especially over the short term^{50–52}. Meta-analyses of long-term weight loss have suggested that low-fat weight loss diets are slightly, if statistically, inferior to low-carbohydrate diets⁵³, but the average differences between diets is too small to be clinically significant⁵⁴. Furthermore, the similarity of the mean weight loss patterns between diet groups in randomized weight loss trials strongly suggests that there is no generalizable advantage of one diet over another when it comes to long-term calorie intake or expenditure³³.

In contrast to the near equivalency of dietary carbohydrate and fat, dietary protein is known to positively influence body composition during weight loss^{55,56} and has a small positive effect on resting metabolism⁵⁷. Diets with higher protein may also offer benefits for

maintaining weight loss⁵⁸, particularly when the overall diet has a low glycemic index⁵⁹. This might be partially mediated by dietary protein's greater effect on satiety compared to carbohydrate and fat^{55,56} along with the possibility of increased overall energy expenditure⁶⁰. More research is needed to better understand whether these potentially positive attributes of higher protein diets outweigh concerns that such diets mitigate improvements in insulin sensitivity that are typically achieved with weight loss using lower protein diets⁶¹.

Whereas long-term diet trials have not resulted in clear superiority of one diet over another with respect to average weight loss, within each diet group there is a high degree of individual variability and anecdotal success stories abound for a wide range of weight loss diets³³. Some of this variability may be due to interactions between diet type and patient genetics^{62,63} or baseline physiology such as insulin sensitivity⁶⁴⁻⁶⁷. Such interactions offer the promise of personalized diets that optimize the patient's chances for long-term weight loss success^{45,63}. Unfortunately, diet-biology interactions for weight loss have not always been reproducible^{68,69} and likely explain only a fraction of the individual variability.

It is certainly possible that the patients who successfully lost weight on one diet would have been equally successful had they been assigned to an alternative diet. In other words, long-term success with a weight loss diet may have less to do with biology than factors such as the patient's food environment, socioeconomic, medical comorbidities, and social support, as well as practical factors, such as developing cooking skills and managing job requirements. Such non-biological factors likely play a strong role in determining whether diet adherence is sustainable.

Clinical recommendations for long term weight management counseling

Given the physiologic and environmental obstacles to long-term maintenance of lost weight described above, we offer the following recommendations for clinical practice and then present an alternative preferable depiction of the opening case example.

Long term benefits require long term attention

Long term behavioral changes and obesity management require ongoing attention. Even the highest quality short-term interventions are unlikely to yield continued positive outcomes without persisting intervention and support. Several studies show that ongoing interaction with healthcare providers or in group settings significantly improves weight maintenance and long-term outcomes, compared with treatments that end after a short period of time (Figure 3)^{70,71}. The importance of long-term intervention has been codified in the obesity treatment guidelines, which state that weight loss interventions should include long term comprehensive weight loss maintenance programs that continue for at least 1 year⁷².

With respect to the case study at the start of this paper, the physician should not expect ongoing weight loss without ongoing support and interaction. Rather than asking Robert to turn things around on his own, the physician has an opportunity to reengage with Robert to offer guidance and support in a more intensive and regular manner than sending him off on his own for six months, or if this is not realistic in a busy primary care practice, he could

refer Robert to an obesity medicine specialist, registered dietitian, comprehensive weight management clinic, or recommend that he engage in a community weight management group, such as the Diabetes Prevention Program (now covered by Medicare for patients with prediabetes), or a commercial program, such as Weight Watchers.

Use weight maintenance-specific counseling/strategies

Behavioral strategies for initiation of weight loss are described elsewhere in this volume []. Weight-loss specific behaviors associated with long term success include: frequent self-monitoring and self-weighing, reduced calorie intake, smaller and more frequent meals/snacks throughout the day, increased physical activity, consistently eating breakfast, more frequent at-home meals compared with restaurant and fast-food meals, reducing screen time, and use of portion-controlled meals or meal substitutes^{2,73-75}. Weight maintenance-specific behavioral skills and strategies help patients to build insight for long-term management, anticipate struggles and prepare contingency plans, moderate behavioral fatigue, and put into perspective the inevitable lapses and relapses of any long-term engagement.

Although the research is mixed, several studies show improved weight loss outcomes in patients receiving weight maintenance-specific training, compared with those who only receive traditional weight loss training⁷⁶⁻⁷⁹. Strategies are discussed below for weight maintenance-specific counseling.

Strengthen satisfaction with outcomes

People tend to focus on what they haven't achieved, rather than what they've already accomplished. Unlike with weight loss, during which the external reward of watching the scale decrease and clinical measures (e.g., lipid levels) improve can increase motivation, the extended period of weight maintenance has fewer of these explicit rewards. To support motivation and make salient satisfaction with outcomes, call attention to patients' progress, which often becomes overlooked. Providers can point to the magnitude of weight that has been kept off, putting it into context in terms of average expected weight loss (described below), as well as clinical improvements in risk factors, such as blood pressure and glycemic control. Additionally, showing patients "before and after" photographs of themselves and other tangible evidence of progress helps them to build awareness of and appreciate the benefits they have already achieved, which may improve long-term persistence with weight maintenance efforts.

Relapse prevention training

Anticipating and managing high-risk situations for "slips" and lapses helps patients minimize lapses, get back on track, and avoid giving up. This counseling often includes self-weighing and identifying weight thresholds that signal the need for reengaging with a support team or initiating contingency strategies; proactively developing plans and practicing strategies for managing and coping with lapses; problem solving to identify challenges, formulate solutions, and evaluate options; and building strategies for non-food activities and coping mechanisms, such as engaging in hobbies or mindfulness activities, to minimize counterproductive coping mechanisms, such as emotional eating.

Cognitive restructuring

Cycles of negative and maladaptive thoughts (e.g., “What’s the point...I failed again and I’ll never lose weight!”) and coping patterns (e.g., binge eating in response to gaining a few pounds) are counterproductive and demotivating. Helping patients to recognize and restructure the core beliefs and thought processes that underlie these patterns helps minimize behavioral fatigue and prevent or productively manage slips and lapses.

Developing cognitive flexibility

Many tendencies that promote initial weight loss are unrealistic over the long term. For example, many patients aim to make large, absolute changes in an “all-or-none” fashion via rigid rules, such as aiming for “no carbs” or very restrictive intake. Much as a sprinter can run all-out for a short race, but not for the entirety of a marathon, expecting strict, all-out efforts and clear-cut, black-and-white outcomes over the lifelong management of obesity is a recipe for frustration and failure. Instead, learning to accept that rigid expectations and “perfect” adherence to behavioral goals is unrealistic and building cognitive flexibility to take in stride when one’s plans do not go according to plan is a core competency for long term sustainable behavioral changes and weight management.

Appeal to patients’ deeper motivations

External, superficial rewards are unlikely to support the long term endurance needed for weight maintenance. For example, studies of financial rewards to incentivize behavioral changes, such as weight loss or tobacco cessation, yield initial benefits that invariably wane precipitously over time^{80,81}. Whereas “white knuckling” and external, controlled motivations, such as directives from a spouse or healthcare provider, may lead to short-term weight loss, longer term sustained motivation is more likely when patients take ownership of their behavioral changes and goals, and engage in them because they are deeply meaningful or enjoyable^{80,81}. As an example, compared with difficulty of sticking to a strict low-fat or low-carb diet, which are often arbitrarily prescribed and of little personal significance to the patient, and therefore difficult to maintain, countless millions throughout the world rigorously stick to comparably strict kosher, halal, or vegan eating patterns, which are aligned with their religious, ethical, or other deeply held beliefs and values. Similarly, prescribing daily gym visits to someone who hates the gym environment or gym activities is unlikely to be fruitful, whereas supporting patients to find more enjoyable physical activities, such as sports or group dance-exercise classes, increases the likelihood of continuing over time.

Manage expectations – both for patients and providers

Both patients and healthcare providers have wildly unrealistic expectations for weight loss outcomes. In one study, patients entering a diet and exercise program expected to lose 20–40% of their starting body weight - amounts that can only realistically be achieved by bariatric surgery⁸². Physician expectations are similarly inflated: in a survey of primary care physicians, acceptable behavioral weight loss was considered to be a loss of 21% of initial body weight⁸³. In contrast, numerous studies show that diet, exercise, and behavioral counseling, in the best of cases, only leads to 5–10% average weight loss, and few patients

with significantly elevated initial weights achieve and maintain an “ideal” body weight. From a cognitive psychology perspective, a waning intervention effort may be due to disappointment in the degree of weight loss actually achieved⁸² leading the patient to conclude that the effort is not worth the achieved benefits⁸⁴.

Although the published data is mixed on whether unrealistic outcomes will deter weight loss success, it stands to reason that excessive discrepancies between expectations and actual outcomes would be demoralizing and increase negative thoughts and self-blame (which itself is associated with numerous negative health outcomes⁸⁵), and may diminish long term persistence for continued behavioral change and weight loss maintenance. We recommend advising patients about the physiologic challenges of long term weight loss and the degree of weight loss that can be realistically expected from behavioral interventions. At minimum, there’s no known harm of offering this insight and being frank with patients about expectations, and it may help them navigate the minefield of unscrupulous diet programs and promises that promise miraculous outcomes.

Nonetheless, positive outcomes of behavioral counseling extend beyond weight loss. Despite the modest weight losses associated with behavioral interventions, small weight losses can lead to impressive health improvements and risk factor reductions. In the Diabetes Prevention Program, 7% weight loss over six months led to 58% reduction in development of diabetes, despite half the weight being regained over three years⁸⁶. In the Look Ahead trial, 6% weight loss over eight years yielded improvements in a range of cardiovascular risk factors, including glycemic control and lipids, as well as less medication usage, and reduced hospitalizations and healthcare costs^{87,88}.

While losing weight is important for improved health, people’s motivations for seeing the scale go down is all-too-often driven by cultural norms for thinness and healthcare provider-imposed weight loss directives. These external motivations can move the weight loss needle in the short-run, but they rarely lead to long-lasting determination. As described in the section above, long term management is improved when motivations are aligned with personal values and preferences. Helping patients shift their locus of motivation from weight loss alone to intrinsically meaningful areas, such as health improvement, can improve long term weight and behavioral outcomes⁸⁹.

Escalate treatment as needed

For patients that do not achieve sufficient weight loss or health improvements with basic counseling in primary care settings, there are several opportunities to intensify therapy. Consider referral to a registered dietitian, obesity medicine physician, or comprehensive weight management clinic, as well as targeted specialists (such as a behavioral psychologist for patients with binge eating disorder or body dysmorphia). For patients with BMI greater than 30 kg/m² (or 27–30 kg/m² with obesity-related comorbid conditions), obesity pharmacotherapy leads to as much as 15% weight loss in responders, with weight loss being maintained in several studies for several years^{90–92}. For patients with BMI greater than 40 kg/m² (or 35–40 kg/m² with comorbidities), bariatric surgery is a well-studied and valuable option that leads to large, sustainable weight losses in most patients⁹³.

Using the principles discussed above, a more productive encounter in response to Robert's presentation might go like this:

Physician: "I understand, and I know it's challenging. It sounds like you're feeling frustrated because you've worked so hard and you feel like you've got nothing to show for it."

He nods and says, "Exactly. What's the point of doing this anymore?"

Physician: "From my view, the evidence we have shows something different: You're actually doing quite well in the scheme of things. I actually see quite a lot of progress for your efforts. You're down 25 lbs, right? That's almost 10% down from where you started...that's impressive. Few people lose that much weight and keep it off for three years. Studies show that even under the best of circumstances with aggressive counseling, average weight loss is between 5–10% of starting body weight – so you're doing better than most! You've been able to get off several blood pressure medications and you no longer take the pain medicine for your back and knees. And, we know from studies that losing just 7%, even if part of it is regained over the years, lowers the risk of diabetes by 60%!" His eyes widen. "Weight goes up and down, and our bodies fight back against weight loss, so this is never easy. Some regain and relapse is inevitable – just like in other areas of life." He takes a deep breath and clearly seems more engaged and hopeful. "So let's figure out how we can move forward and keep getting the benefits, and I'll be here with you to help along the way. Let's agree on a couple of next steps, and we'll meet again in a few weeks to see how it's going. If we need, we can also consider additional strategies or treatments."

Conclusion

The degree of weight loss and its maintenance should not be the sole metric of obesity treatment success. Rather, physicians should support and encourage patients to make sustainable improvements in their diet quality and physical activities if these behaviors fail to meet national guidelines^{94,95}. Such lifestyle changes over the long-term will likely improve the health of patients even in the absence of major weight loss⁹⁶.

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Key points

- Long-term maintenance of lost weight is the primary challenge of obesity treatment.
- Biological, behavioral, and environmental factors conspire to resist weight loss and promote regain.
- Treatment of obesity requires ongoing attention and support, and weight maintenance-specific counseling, to improve long-term weight management.
- Realistic long-term weight loss magnitude is significantly lower than patient and healthcare provider expectations. However, even small amounts of sustained weight loss lead to clinical health improvements and risk factor reductions.

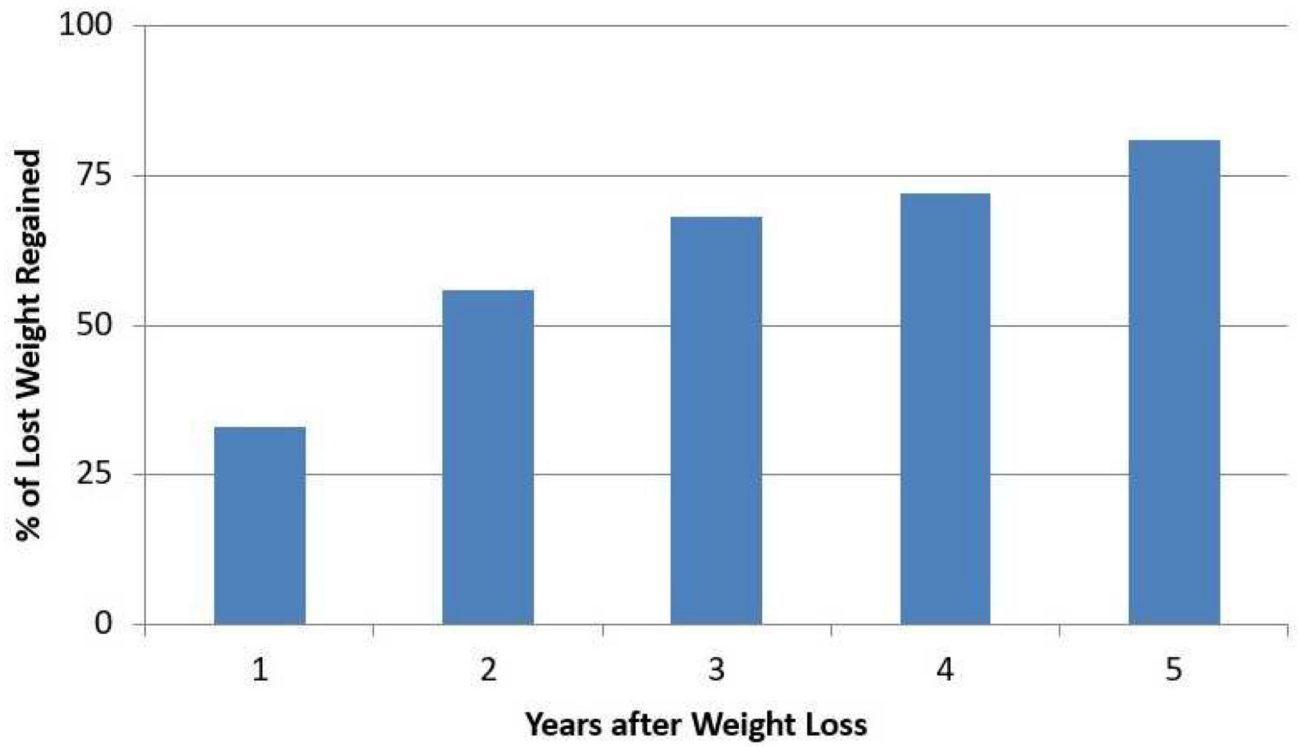


Figure 1.

Average time course of weight regain after a weight loss intervention.

Data from Anderson JW, Konz EC, Frederich RC, et al. Long-term weight-loss maintenance: a meta-analysis of US studies. *Am J Clin Nutr* 2001;74(5):579–584.

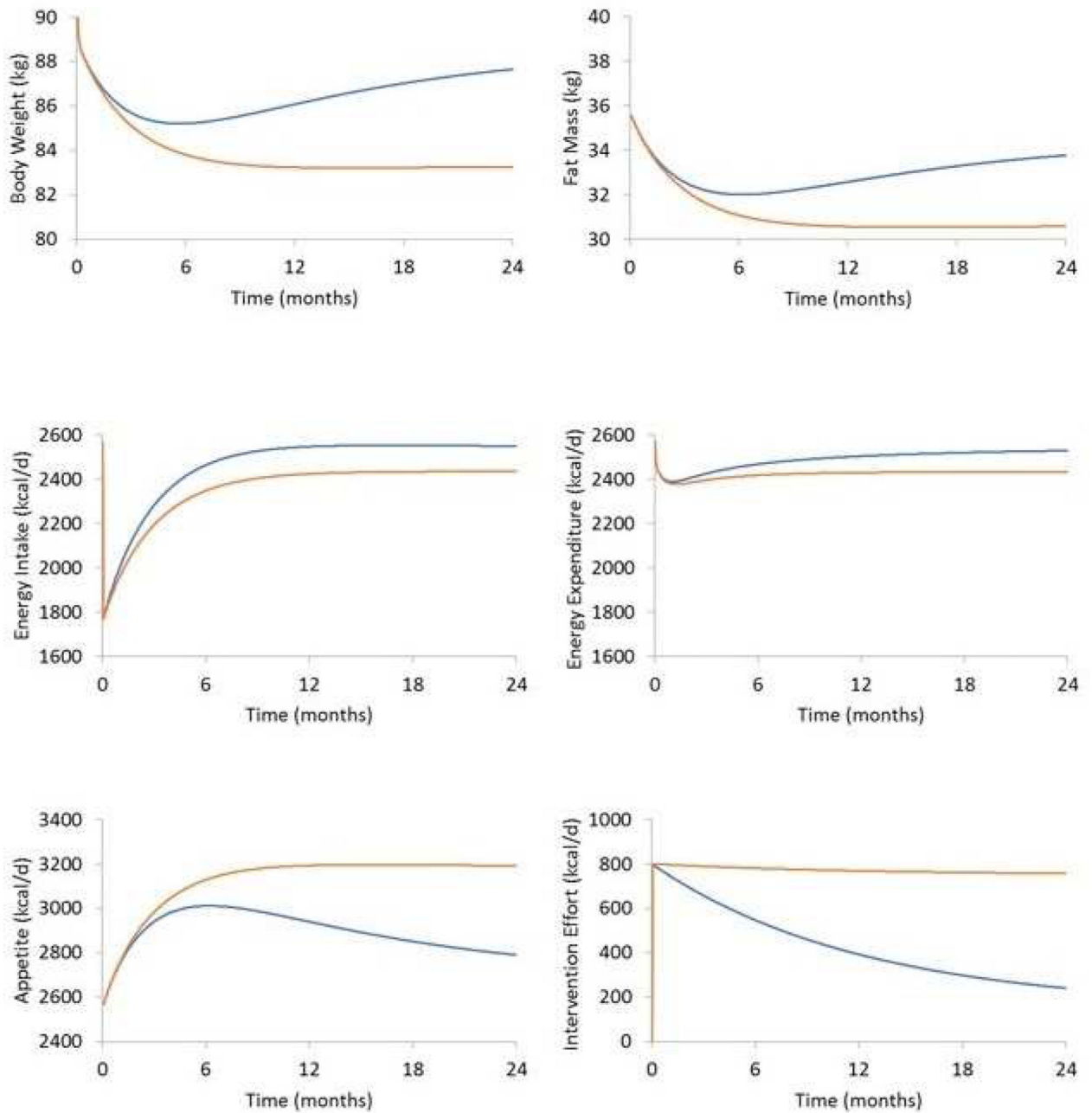


Figure 2. Mathematical model simulations of body weight, fat mass, energy intake, energy expenditure, appetite, and effort for two hypothetical women participating in a weight loss program. The curves in blue depict the typical weight loss, plateau and regain trajectory whereas the orange curves show successful weight loss maintenance.

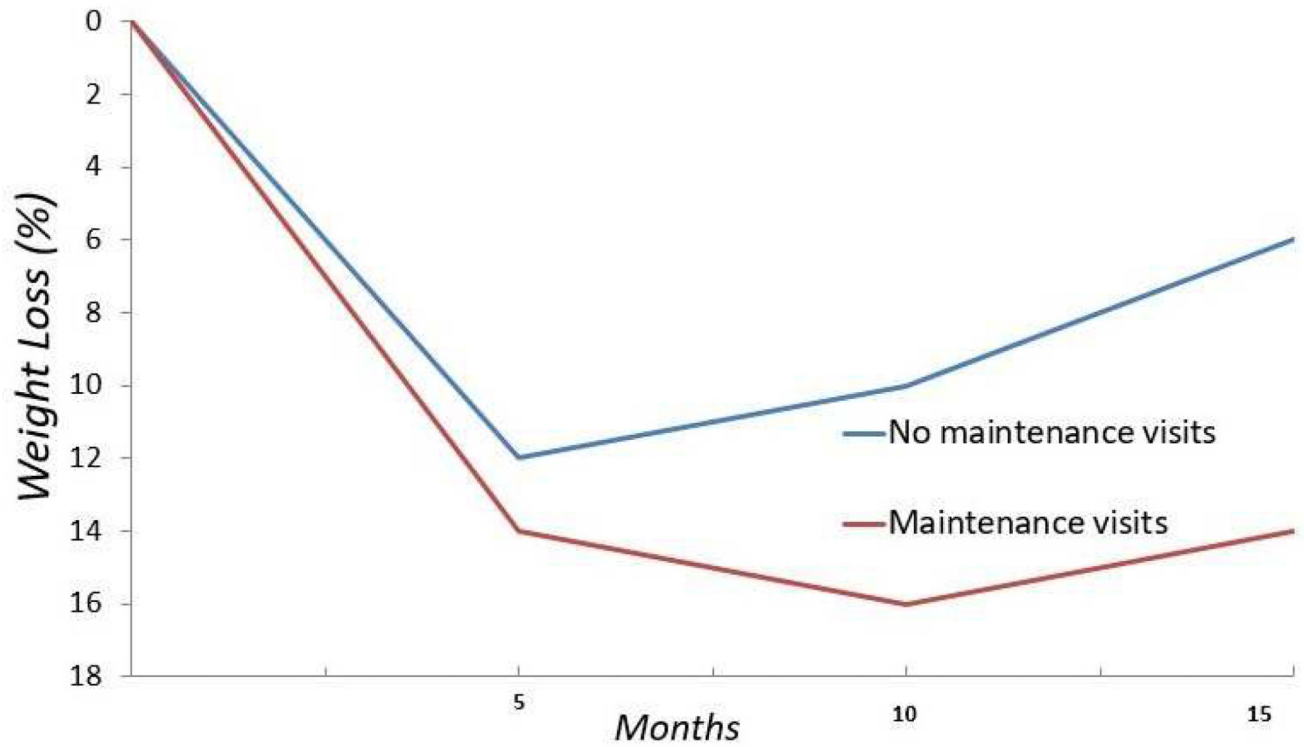


Figure 3.

Weight management programs with a focus on maintenance of lost weight demonstrate improved long-term weight loss (red curve) compared to programs without maintenance visits (blue curve).

Adapted from Perri MG, McAllister DA, Gange JJ, et al. Effects of four maintenance programs on the long-term management of obesity. *J Consult Clin Psychol* 1988;56(4):529–534; with permission.