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SUCCESSFUL WEIGHT LOSS MAINTENANCE

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■ **Abstract** Obesity is now recognized as a serious chronic disease, but there is pessimism about how successful treatment can be. A general perception is that almost no one succeeds in long-term maintenance of weight loss. To define long-term weight loss success, we need an accepted definition. We propose defining successful long-term weight loss maintenance as intentionally losing at least 10% of initial body weight and keeping it off for at least 1 year. According to this definition, the picture is much more optimistic, with perhaps greater than 20% of overweight/obese persons able to achieve success. We found that in the National Weight Control Registry, successful long-term weight loss maintainers (average weight loss of 30 kg for an average of 5.5 years) share common behavioral strategies, including eating a diet low in fat, frequent self-monitoring of body weight and food intake, and high levels of regular physical activity. Weight loss maintenance may get easier over time. Once these successful maintainers have maintained a weight loss for 2–5 years, the chances of longer-term success greatly increase.

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INTRODUCTION

Obesity is a major health problem in the United States, with over 50% of Americans classified as overweight or obese. Many of these individuals are attempting to lose weight (39). However, the perception of the general public is that long-term reduction in body weight is difficult to achieve. The goal of this chapter is to summarize the information available on successful weight loss maintenance. How many achieve this goal? How do they do it? What are the consequences? In describing successful weight loss maintainers, we draw heavily on findings from the National Weight Control Registry (NWCR), a registry of individuals who have been extremely successful at long-term weight loss maintenance.

PREVALENCE OF WEIGHT LOSS MAINTENANCE

Currently, few data are available on the prevalence of successful weight loss maintenance. One limit is the lack of a consistent criterion to define "success" and another is the difficulty of distinguishing intentional from unintentional weight loss. We therefore propose to define success in weight loss maintenance as achieving an intentional weight loss of at least 10% of initial body weight and maintaining this weight loss for at least one year. We could not find sufficient data, collected in a systematic fashion, to provide reliable information on predictors of weight loss for longer periods.

Overall there is a feeling of pessimism regarding long-term weight loss success (18). This pessimism started with a study by Stunkard & McLaren-Hume (42), who followed 100 obese individuals referred to a nutritional weight loss program and found that 2 years after treatment, only 2% maintained a weight loss of at least 20 lb. This finding was instrumental in creating the perception, perpetuated in the popular media, that hardly anyone succeeds in long-term maintenance of weight loss.

Recent studies of clinical programs are more positive. Every year for 4 years, Kramer et al (24) followed up on 114 men and 38 women who had participated in a behavioral weight loss program. Using a strict criterion of maintaining 100% of one's weight loss, they found that only 0.9% of men and 5.3% of women were consistently successful (i.e. maintaining this criterion all of the 4 years). However, looking only at year 4, cross-sectional data showed that 2.6% of men and 28.9% of women had maintained 100% of their weight loss. Several studies have used 5 kg or greater weight loss as a criterion of success. With this criterion, 13% (51) to 22% (41) of participants are successful 5 years after treatment.

These studies may underestimate the true prevalence of weight loss maintenance because they are based on only one episode of weight loss and may not be

representative of the general population. Most people who lose weight do so on their own, without participation in formal programs (5, 6); thus, data from clinical research programs may reflect "hard core" dieters, who may be most resistant to successful weight loss maintenance. Bartlett et al (4) reviewed eight studies that examined the prevalence of successful weight loss in community samples; they were unable to reach conclusions regarding prevalence because these studies lacked consistent definitions of successful weight loss and many failed to use nationally representative samples. Moreover, most of the studies assessed weight loss, not weight loss maintenance.

McGuire et al (27) recently reported results of a random-digit-dial telephone survey in a nationally representative sample of 500 adults in the United States. Weight loss maintainers were defined as those who at the time of the survey had maintained a weight loss of ≥10% of their maximum weight for at least 1 year. Of particular interest are those who reported being overweight [body mass index (BMI) $\geq$ 27 kg/m^2] at their maximum weight ($N = 228$). Of these, 62% indicated that at some point in their life they had lost 10% of their maximum weight, and 38% reported that they were currently 10% below their maximum weight. Of the 228 reporting having been overweight, 69 (30.3%) had maintained this 10% weight loss for at least 1 year. These 69 individuals had on average maintained a weight loss of 42 lb for 7 years.

This survey included a question about whether the weight loss was intentional. Of the 228 overweight individuals in the survey, 47 (20.6%) reported that they had intentionally lost weight and had maintained a weight loss of 10% for at least 1 year. Of these individuals, 28 had reduced to normal weight (BMI $<$ 27).

HOW TO DEFINE SUCCESS IN WEIGHT LOSS MAINTENANCE?

It is important to adopt a consistent definition of successful weight loss maintenance. The definition must include criterion for magnitude of weight loss and duration of maintenance. Weight losses of 5%–10% of initial body weight can lead to substantial improvement in risk factors for diabetes and heart disease and can lead to reductions in or discontinuations of medications for these conditions (31). Thus, if the focus is on overall health, achieving and maintaining a 10% weight loss should be considered successful, even though for many obese individuals this weight loss may not return them to a nonobese state. Successful weight loss maintenance may involve some weight regain. For example, an individual who lost 20% of initial body weight but regained half of the lost weight would still be 10% below initial body weight, would presumably still have overall improved health, and thus should be considered "successful."

In defining successful weight loss, it is important that the loss be intentional. Several recent studies suggest that unintentional weight loss occurs frequently in the population. Because the causes and consequences of unintentional weight loss

are likely to differ from those associated with intentional weight loss, it is important to distinguish between the two.

Finally, we propose that 1 year of maintenance be the minimum criterion, in keeping with the Institute of Medicine (IOM) definition. A 5-year duration might be a stricter criterion, but we believe research would be stimulated by first adopting the 1-year criterion and then studying the factors that help those individuals who have succeeded for 1 year sustain their success through 5 years.

Thus, we propose that individuals who have intentionally lost at least 10% of their body weight and have kept it off at least 1 year be considered "successful weight loss maintainers." By this definition, according to our data, 21% of overweight/obese persons may be successes.

THE NATIONAL WEIGHT CONTROL REGISTRY

Much of the information about successful weight loss maintenance comes from the National Weight Control Registry (NWCR), founded in 1994 to study weight loss and weight maintenance strategies of successful weight loss maintainers. To be eligible for the NWCR, individuals must have maintained at least a 30-lb weight loss for at least 1 year. On recruitment, all subjects sign an informed consent form and then are sent several questionnaires to complete. These questionnaires seek information about weight loss and weight maintenance behaviors, as well as weight history, quality of life, and demographic information. All participants are asked to complete additional follow-up questionnaires on an annual basis.

There are currently over 3000 subjects in the NWCR. They average 45 years of age and are 80% women, 97% Caucasian, and 67% married. The average weight loss reported by NWCR participants is 30 kg, and the average duration of weight maintenance is 5.5 years. These subjects maintain a body weight that is, on average, 10 BMI units lower than their pre–weight loss BMI (from 35–25 kg/m^2).

About half (46%) of NWCR subjects report having been overweight as children. Many report a strong family history of obesity, with 46% reporting one parent as overweight or obese and 27% reporting both parents as overweight or obese.

Almost all NWCR subjects (90%) have experienced previous unsuccessful attempts at weight loss. No obvious factor or factors distinguish this successful weight loss from previous failures other than registry participants noting a greater commitment, stricter dieting, and a greater role of exercise.

Clearly, a negative energy balance is needed to produce weight loss. A negative energy balance can be achieved by either decreasing intake or increasing expenditure. Research studies consistently show that successful weight loss maintainers change both their intake and their expenditure in order to lose weight and maintain their losses. In the NWCR, 89% of participants reported modifying both diet and exercise to achieve their successful weight loss (22). In subjects who reported modifying food intake to lose weight, the most commonly reported methods were restricting intake of certain types or classes of foods (88%), limiting quantity

(44%), and counting calories (44%). However, there was marked variability in how they made these changes. About half of the registry participants (45%), but 63% of the men, reported losing on their own whereas the remainder of the registrants (55%), and 60% of the women, used a formal (e.g. commercial) weight loss program (22).

Although most health professionals recommend changes in both diet and physical activity for weight loss, many popular weight loss plans emphasize diet more than physical activity. It is worth noting that very few of these successful weight loss maintainers used diet alone to lose weight.

STRATEGIES FOR MAINTENANCE OF WEIGHT LOSS

Although the approaches to weight loss differed widely among NWCR subjects, we found much more similarity in the strategies used for maintenance of weight loss. The three strategies that were common to a large proportion of NWCR participants include (*a*) eating a diet low in fat and high in carbohydrate, (*b*) frequent self-monitoring, and (*c*) regular physical activity.

Diet

To determine current dietary intake, registry members were asked on entry into the registry to complete the Block Food Frequency questionnaire. On average, participants reported consuming 1381 kcal/day (5778 $\pm$ 2200 kJ/day), with 24% of calories from fat, 19% from protein, and 56% from carbohydrates (22). There were no differences in the quality of the diet reported by participants who lost weight on their own compared with those who used weight loss programs (40). Both groups ate a diet that satisfied the Daily Reference Intakes for calcium, vitamin C, vitamin A, and vitamin E.

Recently, because some popular diets recommend restricting carbohydrates to lose weight, data from registry participants were analyzed to determine carbohydrate intake (57). Only 7.6% of registry members reported eating fewer than 90 g of carbohydrate/day; for many of these individuals, total daily energy intake appeared unreasonably low. Additional analyses were done to determine the proportion of subjects eating diets with $<$24% carbohydrates (1500 calories/$\leq$90 g of carbohydrate). Less than 1% of registry participants consumed such low-carbohydrate diets. Compared with registry members who had higher carbohydrate intake, those ingesting $<$24% carbohydrates maintained their weight loss for less time and were less physically active. Thus, the low-fat, high-carbohydrate, low-calorie–eating pattern appears to be what characterizes the majority of registry participants.

Registry members reported eating on average 4.87 meals or snacks/day, with few eating less often than twice a day (22). On average, they ate at fast food restaurants approximately once a week (0.74 times/week) and had 2.5 meals/week in other types of restaurants. Thus, although the majority of meals were eaten

at home, these individuals maintained their weight loss while enjoying meals at restaurants.

As part of the random-digit-dialing survey described above, successful weight loss maintainers (those who intentionally lost ≥10% of their maximum weight and maintained it for at least 1 year) were compared with regainers (those who lost at least 10% of their body weight but gained it back) and controls (those whose weight had never been ≥10% above their current level and who were weight stable) (29). These individuals were all asked to complete the Food Habits Questionnaire. This questionnaire examines strategies used to restrict fat intake and has been shown to relate to fat intake. Weight loss maintainers reported greater avoidance of fried foods and more substitution of low-fat for high-fat foods than either regainers or controls. Again, these findings suggest the importance of low-fat eating in the maintenance of weight loss.

Other studies have shown that successful weight loss maintenance is associated with changes in both the quantity and quality of foods consumed. Clinic-based studies have examined the association between self-reported dietary intake and weight loss after either 12 or 18 months of treatment. These studies indicate that individuals who are most successful at weight loss maintenance report lower caloric intake (19), reduced portion sizes (17), reduced frequency of snacks, and, perhaps most consistently, reduction in the percentage of calories from fat (11, 55).

Several studies have identified decreased consumption of specific foods as being associated with weight loss maintenance. French et al (8) found that decreased consumption of french fries, dairy products, sweets, and meat was positively associated with weight loss maintenance. Holden et al (15) present data on 118 patients who were followed for 3 years after ending a very-low-calorie diet. Those who reported that they consumed cheese, butter, high-fat snacks, fried foods, and desserts less than once a week were more successful at long-term weight control. Eating "healthy" foods at least once/week was unrelated to weight loss.

Self-Monitoring Weight and Behaviors Related to Weight

Registry members were asked how frequently they monitored their weight. Over 44% reported weighing themselves at least once a day, and 31% reported weighing themselves at least once a week (22). Few other studies have examined weighing as a component of long-term weight loss maintenance. However, monitoring dietary intake is frequently associated with weight loss success. Guare et al (10) completed a 1-year follow-up on 106 participants in behavioral weight loss programs. Those participants who at 1 year most frequently monitored their intake maintained a weight loss of 18 kg compared with the approximately 5-kg weight loss maintained by those who monitored their intake less often. Other studies have likewise found that consistent self-monitoring is related to weight loss (3). This is not surprising. Frequent monitoring of weight allows one to detect weight regain in its early stages and to initiate strategies to reverse the trend and avoid a major relapse.

Self-monitoring may be viewed as one component of the more general construct of cognitive restraint (i.e. the degree of conscious control one exerts over eating behaviors). On the Three Factor Eating Scale, registry members report high levels of dietary restraint (mean = 7.1), similar to the levels reported by patients who have recently completed treatment for obesity, though not nearly as high as the levels seen in eating-disordered patients (23). These data suggest that successful maintainers continue long-term to use behavior-change strategies taught in weight loss programs. However, why some individuals can persist in conscious control of intake whereas others revert back to old habits is unclear.

Physical Activity

Regular physical activity has been found in many studies to be associated with long-term weight loss maintenance (20, 37). Most subjects in the NWCR report engaging in regular physical activity to lose weight as well as to maintain the weight loss. Only 9% of registry subjects report maintaining weight loss without regular physical activity. Using the Paffenbarger Physical Activity Questionnaire (33), we determined current levels of physical activity. Women in the registry report expending an average of 2545 kcal on physical activity per week and men report an average of 3293 kcal/week. This amount of physical activity is comparable to about 1 h of moderate intensity physical activity, such as brisk walking, per day. This is much higher than physical activity recommendations for the general public. The Surgeon General recommends that adults engage in 30 min of moderate intensity physical activity at least 3 days/week (46). Among registry subjects, 52% expend more than 1000 kcal and 72% more than 2000 kcal on physical activity per week.

Physical activity experts now recommend that rather than only planned exercise, people increase "lifestyle physical activity," which involves being more active in daily life (e.g. increase walking, taking stairs, etc) (46). Most registry subjects report efforts to increase both lifestyle activity and regular planned exercise. As noted above, only 9% report that they do no physical activity for weight loss maintenance. Among registry members, 49% report using a combination of walking and another form of regular exercise, 28% report only walking, and 14% report only another form of regular exercise. Thus, the combination of lifestyle and programmed exercise is used by almost half the participants, and walking is an important aspect of the exercise for over 75%.

Table 1 shows the six most frequently reported physical activities of subjects in the registry (45). It is interesting that a high proportion of subjects report weight lifting. In the registry, 24% of men and 20% of women regularly engage in weight lifting. A representative national population, the National Health Interview Survey, conducted in 1991, reported that 20% of men but only 9% of women regularly engage in weight lifting. Thus, women in the registry engage in weight lifting to a much greater extent than do women in the general population. The extent to which this contributes to their success in weight loss maintenance is not clear.

TABLE 1 The six most common activities reported by National Weight Control Registry subjects

Activity	% Reporting engaging in activity
Walking	76.6
Cycling	20.6
Weight lifting	20.3
Aerobics	17.8
Running	10.5
Stair climbing	9.3

METABOLIC AND BEHAVIORAL FACTORS IN WEIGHT LOSS MAINTENANCE

It is not clear to what extent metabolic versus behavioral factors contribute to the low success rate in long-term weight loss maintenance. It could be that there is a physiological set-point for weight and that reducing weight below this level leads to physiological compensation. Alternatively, the difficulty in maintaining a weight loss could be due to the difficulty in making permanent changes in diet and physical activity behaviors.

The Metabolic State of the Reduced-Obese

The difficulty in long-term weight maintenance could have metabolic causes. It is possible that weight loss creates a metabolic state favoring weight regain in order to return body weight to some optimal or regulated level. This metabolic state could be due to one or more of the following causes: (*a*) a resting metabolic rate lower than expected for the new, lower body weight; (*b*) a reduced ability to oxidize fat, thus favoring positive fat balance and fat gain; (*c*) increased insulin sensitivity; and/or (*d*) relatively low leptin levels.

Low Resting Metabolic Rate in the Reduced-Obese State Resting metabolic rate (RMR) declines with weight loss, but the question is whether this decline leaves the reduced-obese with an inappropriately low RMR or whether the decline in RMR is appropriate for the new, lower body mass. During the acute phase of weight loss, RMR appears to decline because of both food restriction and loss of body mass (35, 50). This is why is it important to measure RMR after a period of weight stabilization following weight loss. In the long-term, the decline in RMR would be expected to be proportional to the decline in fat-free mass (FFM) because fat loss produces only very small declines in RMR (35).

Some reports indicate that RMR declines with weight loss to a much greater extent than the decline in FFM, whereas other reports indicate that the decline

in RMR with weight loss is appropriate for the reduction of FFM. In favor of a greater-than-expected drop in RMR with weight loss, Leibel et al (26) reported a reduction in resting metabolic rate of 12.6–16.7 kJ/kg of FFM lost in obese subjects maintaining a 10% reduction in body weight. Others (9, 38, 50) have found that the reduction in RMR with weight loss, over the long-term, is appropriate for the reduction in body mass. Astrup et al (2) recently published a meta-analysis of RMR in reduced-obese subjects. They reviewed 12 published studies and obtained individual data on 124 reduced-obese subjects and 121 control subjects from 15 different published studies. Using traditional meta-analysis, they found that RMR was about 5% lower in reduced-obese subjects than in control subjects. However, the more interesting analysis was a comparison of the 124 reduced-obese with the 121 control subjects. In this comparison, RMR was not significantly lower in the reduced-obese ($P < 0.09$). Furthermore, the 3%–5% reduction in RMR seen in the reduced-obese group was explained entirely by 15% of the reduced-obese subjects. They suggested that although a low RMR might characterize some reduced-obese subjects, this is not the norm.

We examined RMR in relation to FFM in 50 NWCR subjects and in 50 matched control subjects (56). In both groups, RMR was appropriate for body composition and there was no evidence of a lower-than-expected RMR in NWCR subjects. The regression line relating FFM and RMR was not different for the two groups, which suggests that RMR in our reduced-obese subjects was not inappropriately low.

It is possible that the extremely high levels of physical activity seen in NWCR subjects may be masking a low RMR. Van Dale et al (48) found that subjects who engaged in regular exercise during and following weight loss had a "normal" RMR relative to body mass, whereas those who did not exercise had a lower-than-predicted RMR relative to body mass. It should be noted, however, that in our study (56), the matched control subjects were reporting high levels of physical activity, similar to those reported by NWCR subjects.

The controversy in this area continues. In NWCR subjects, we failed to find any evidence of a greater "metabolic efficiency" or a "metabolic impairment." Although increased metabolic efficiency might occur in some subjects, it does not seem to be an obligatory consequence of weight loss. It is possible that some of the differences between studies may reflect heterogeneity between reduced-obese subjects. It is also likely that other methodological issues contribute to different results. We know little, for example, about how the method of weight reduction (large versus small deficit, exercise versus no exercise), the amount of weight loss, or the duration of weight loss maintenance affect the metabolic state of the reduced-obese individual. Part of the problem has been getting access to enough long-term successes to study how these factors impact metabolism after weight loss.

Fat Oxidation in the Reduced-Obese State Because achieving body weight maintenance requires achieving fat balance, an alteration in the ability to use fat as a fuel could be a factor in predisposing reduced-obese subjects to regain weight. Given that it is affected by many dietary factors and by physical activity,

assessment of substrate oxidation is not easy. Several investigators have reported that reduced-obese subjects may have a higher respiratory quotient (RQ), indicative of a lower rate of fat oxidation, than do control subjects. Larson et al (25) reported a higher adjusted 24-h RQ in formerly obese subjects than in matched control subjects who had not lost weight. Astrup et al (1) found lower rates of fat oxidation in formerly obese subjects compared with controls while both groups were consuming high-fat diets.

In the NWCR we found registry members had a slightly higher (0.807 versus 0.791, $P = 0.05$) fasting RQ than a control group of nonreduced individuals (56). However, the usual diet NWCR subjects reported consuming was lower in fat than that of the control subjects. Because usual fat oxidation is positively correlated with usual fat intake, it is not clear whether the lower fat oxidation seen in NWCR subjects reflects an altered metabolic state or simply an altered diet.

Thus, although there are consistent reports of a higher RQ (i.e. lower fat oxidation) in reduced-obese subjects, the question remains as to whether this indicates an impairment in or a reduced capacity for fat oxidation. It remains a distinct possibility, however, that a low rate of fat oxidation in reduced-obese subjects could predispose them to weight gain, especially when they consume high-fat diets.

Insulin Resistance as a Contributor to Weight Regain The role of insulin resistance in weight gain is also controversial. Several studies have shown that within a population, those who are most insulin sensitive at baseline will gain the most weight (13, 43, 47), although this finding is not consistent across all populations (14). Similarly, there are inconsistent findings related to whether insulin sensitivity predicts weight regain. Yost et al (59) reported that in 10 moderately obese women, changes in insulin sensitivity (determined using a euglycemic clamp) following a 3-month period of weight loss and a 3-month period of weight maintenance were positively correlated with subsequent weight gain at 12 and 18 months. The authors hypothesized that the increased insulin sensitivity produced a decrease in skeletal muscle lipid oxidation, directing lipid toward storage in adipose tissue. In contrast, Wing (53) examined this relationship in two groups of subjects who participated in a 3- to 6-month weight loss program. In 125 nondiabetic subjects, changes in neither fasting insulin nor insulin levels in response to a glucose load were significantly related to subsequent weight regain. Similarly, insulin sensitivity measured using Bergman's minimal model was not related to subsequent weight regain in 33 diabetic subjects. The inconsistency across studies may relate to differences in study population, methods of assessing insulin sensitivity, and/or duration of the weight maintenance phase. Furthermore, all the studies reported changes in body weight (rather than fat mass), and none reported changes in physical activity levels, an important determinant of insulin sensitivity. Thus, whether insulin sensitivity plays a role in weight regain following a period of weight loss remains to be determined. Studies of rats provided with an obesity-producing diet have not, in general, found insulin sensitivity to predict weight gain (34). Currently we have no data on insulin sensitivity among NWCR subjects.

Low Leptin as a Factor in Weight Regain It has recently been suggested that low leptin levels may exist in reduced-obese subjects and may be a factor in propensity to regain weight (7). In this study, leptin levels were positively correlated with body fat mass in a group of eight reduced-obese and eight control subjects. However, leptin levels were lower in the reduced-obese subjects. Reduced-obese subjects also had a lower rate of fat oxidation than did the control subjects. Nagy et al (30), however, found the leptin levels were not related to weight regain over a 4-year period in 14 postmenopausal women. Furthermore, Wing et al (55) reported that leptin levels decreased along with body weight during obesity treatment and that neither baseline levels nor changes in serum leptin predicted weight regain. Leptin levels drop with weight loss, and the initial drop may be greater than the drop in fat mass (36). The important question for weight loss maintenance is whether the relationship between circulating leptin levels and body fat mass is altered significantly from baseline after weight loss and weight stabilization. It is important to point out that the question can only be answered if a period of weight stabilization precedes measurements. We are currently collecting data on circulating leptin levels in NWCR subjects.

The Metabolic State of NWCR Subjects

In summary, we have not been able to document a clear metabolic state consistent with the notion of increased "metabolic efficiency" in reduced-obese subjects. It is certainly possible that the high levels of physical activity seen in NWCR subjects may be "masking" this metabolic predisposition to regain weight. Alternatively, it is possible that NWCR subjects do not exhibit such a metabolic predisposition and that their success is due to permanent behavior changes of the kind generally recommended in weight loss programs.

Behavioral Factors in Long-Term Weight Loss Maintenance

Although we have not clearly identified metabolic factors important for long-term weight loss maintenance, we have identified behavioral factors that seem to predict success. These include eating a diet low in fat, self-monitoring body weight and food intake, and engaging in high levels of physical activity. We believe that the current population recommendations to reduce dietary fat are consistent with success in weight loss maintenance. Our subjects report 24% of total energy from fat, and many recommendations to the public are to reduce dietary fat below 30%. It is possible that a recommendation of 25% of energy from fat would be a better recommendation for persons maintaining a weight loss, but insufficient data exist to support such a public health recommendation. Our data would, however, argue strongly against any increases in the amount of dietary fat recommended to the public.

Self-monitoring has been recognized as a useful behavior during weight loss, and data obtained from the NWCR suggests that this is a useful behavior to continue during weight maintenance.

Finally, high levels of physical activity seem to be associated with long-term weight maintenance. Although the exact way in which physical activity helps with successful weight loss maintenance is not fully understood, it does seem that a high degree of regular physical activity is a key to the success of the subjects in the registry. Data from the NWCR suggest that the optimal amount of physical activity to maintain weight loss may be about 1 h/day, or an expenditure of approximately 2500–3000 kcal/week. Others have reported results similar to these. Schoeller et al (37) found that the relationship between the amount of physical activity and the prevention of weight regain was not linear. They found that a threshold value of 11 kcal/kg of body weight was necessary to prevent weight regain. This value roughly translates into the addition of 1.3 h of such moderate activity as brisk walking per day, or 0.6 h of vigorous activity per day. More recently, Jakicic et al (16) found that after weight loss, 200 min or more of physical activity per week was associated with continued weight maintenance, whereas less physical activity was associated with weight gain in a dose-dependent fashion.

Taken together, this body of literature in obese-reduced subjects suggests that our physical activity goals for weight management programs may need to be substantially higher than the physical activity recommendations to the general population. It is important to realize that the current physical activity guidelines for the population were developed to optimize cardiovascular health and were not based on prevention of weight gain. Although we have substantial data to suggest that regular physical activity protects against weight gain in nonobese individuals (12), we do not have a good database on which to develop specific physical activity guidelines to prevent weight gain. Developing such a database should be a high priority.

PSYCHOLOGICAL CONSEQUENCES OF SUCCESSFUL WEIGHT LOSS MAINTENANCE

Concern has been raised that weight loss, and the vigilance required to maintain weight loss long-term, may be associated with increased risk of eating disorders or depression symptomatology. This concern stems in large part from the study by Keys et al (21) of semistarvation in normal-weight young men. In their study, weight losses of approximately 25% of initial weight were achieved in these normal-weight individuals. Such weight losses were associated with extreme negative psychological reactions and, in a subgroup, short periods of binge eating. The important question is whether the more-modest weight losses (10% of body weight) that typically occur in overweight persons produce such negative effects. This literature was recently reviewed by the National Task Force on the Prevention and Treatment of Obesity (32). They concluded that participants in behavioral weight loss programs typically experience improvements in symptoms of depression or anxiety with weight loss, regardless of whether the weight loss is produced by moderate diets, very-low-calorie diets, or weight loss medications.

Before weight loss programs, participants typically report levels of dysphoria in the nondepressed range; these levels are further reduced with weight loss. Binge eaters, who enter treatment with higher levels of depressive symptomatology, experience greater improvements with weight loss. Likewise, both binge eaters and nonbinge eaters who participate in weight loss programs that utilize a balanced diet with moderate caloric restriction experience reduction in binge eating episodes. Rather than precipitating binge eating (a common concern), such programs appear to ameliorate this problem. Three studies (44, 49, 58) have evaluated the effect of very-low-calorie diets and subsequent refeeding on binge eating. In two of the three (49, 58), there was no adverse effect of the very-low-calorie diet on binge eating, but the third study did suggest a temporary increase in binge eating in those who were nonbingers at baseline (44). Methodological issues related to the assessment of binge eating in this study make it difficult to interpret the results.

Likewise, no adverse psychological effects of weight loss have been observed in the NWCR (23). At entry into the registry, members are asked to complete the Center for Epidemiologic Studies Depression Scale (CES-D), the Symptom-Checklist-90-R, and selected questions from the Eating Disorders Examination related to binge eating and purging. Scores on these assessments were compared with findings in the literature for relevant comparison groups (including those with psychiatric disorders, obese patients, nondieting control subjects, and random samples of the US population).

Registry participants reported an average CES-D score of 9.2 (range 0–52); 18% of registry participants scored >16, the cutoff used to distinguish "cases" for nondepressed individuals. These findings are similar to nondepressed community control subjects (who have mean CES-D scores of 4.1–10.4, with 21% of individuals reporting scores >16). In contrast, studies of clinically depressed patients have mean scores of 13–38 on the CES-D, with over 70% of individuals scoring >16. Registry participants also appear similar to obese and nonobese community samples on the Global Symptoms Index of the SCL-90-R.

Rates of binge eating and vomiting were also very low in registry members; 8% reported four or more binges/month, and only 1.8% reported any episodes in the preceding month of vomiting for weight loss purposes. These results are strikingly lower than what is observed in eating-disordered populations.

In addition, participants in the registry are asked to indicate whether weight loss has resulted in improvement, worsening, or no change in various aspects of their life (22). As shown in Table 2, the vast majority of individuals report positive changes in all aspects. Over 90% of the sample reported improvement in their overall quality of life, level of energy, mobility, general mood, and self-confidence.

There are only two areas where any substantial worsening due to weight loss was noted. Fourteen percent of registry members reported worsening in time spent thinking about food (49% reported improvement in this regard) and 20% reported worsening in time spent thinking about their weight (51% reported improvement in this regard). Thus overall weight loss maintenance appears to produce marked improvements in quality of life for the majority of individuals.

TABLE 2 Effect of weight loss on other areas of life[a]

Determinant	Improved	No difference	Worse
Quality of life	95.3	4.3	0.4
Level of energy	92.4	6.7	0.9
Mobility	92.3	7.1	0.6
General mood	91.4	6.9	1.6
Self-confidence	90.9	9.0	0.1
Physical health	85.8	12.9	1.3
Interactions with			
opposite sex	65.2	32.9	0.9
same sex	50.2	46.8	0.4
strangers	69.5	30.4	0.1
Time spent interacting with others	59.1	39.6	1.3
Job performance	54.5	45.0	0.6
Other hobbies	49.1	36.7	0.4
Interactions with parents	32.8	65.0	2.2
Interactions with spouse	56.3	37.3	5.9
Time spent thinking about			
food	49.1	36.7	14.2
weight	51.0	28.6	20.4

[a]$N = 784$. Results indicate percentage.

FACTORS ASSOCIATED WITH WEIGHT REGAIN

Registry members are followed over time to try to identify variables related to continued success (28). Over 1 year of follow-up, 35% of registry participants regained 5 lbs or more, 59% maintained their weight loss, and 6% lost additional weight. Baseline characteristics that increased the risk of regain included more recent weight loss (fewer than 2 years versus more than 2 years), larger weight losses (>30% of maximum weight versus <30%), and higher levels of depression, disinhibition, and binge eating at entry into the registry. These findings are of interest, particularly the duration effect. It appears that the first few years after weight loss are the most vulnerable period for weight regain. Maintaining ones weight loss for 2–5 years decreased the risk of subsequent regain by 50%. Thus, individuals who succeed in maintaining their weight loss for

more than 2 years have a markedly improved chance of continuing to maintain it long-term.

Regainers were also characterized by several key behavior changes that occurred over the year of follow-up and distinguished them from maintainers. Gainers increased their fat intake, whereas maintainers kept theirs consistent. Both groups reported decreases in physical activity, but the regainers had greater decreases: expending approximately 800 fewer kcal/week compared with 400 kcal/week in the maintainers. Gainers also reported decreases in their level of dietary restraint and increases in disinhibition (i.e. loss of control while eating). These findings confirm the importance of the behavior changes described in earlier sections of this chapter for the long-term maintenance of weight loss.

SUMMARY

It is important that a consensus be reached on a definition for successful weight loss maintenance. Our recommendation is that an intentional weight loss of greater than or equal to 10% of initial body weight that is maintained at least 1 year be considered success. According to this definition, approximately 20% or more of individuals who attempt weight loss would be "successful." Although the NWCR does not provide information about how many people achieve long-term weight loss success, it does provide information about strategies used to achieve and maintain a weight loss. With regard to weight loss, the most obvious conclusion from the NWCR is that weight loss should include both changing diet and increasing physical activity. We do not, however, see any particular type of diet modification to achieve the weight loss that is common to these successful weight loss maintainers.

We believe that strategies for weight loss maintenance may be the key to long-term weight management success. We find three behaviors in a vast majority of NWCR subjects. First, these subjects engage in high levels of physical activity. The amount of physical activity that facilitates successful weight loss maintenance may be closer to 1 h/day rather than the 30 min three times per week suggested in recommendations to the general public. Consequently, we may need to increase our physical activity goals in obesity treatment programs. Second, these subjects report eating a diet low in fat and high in carbohydrate. We believe this is important information given the oscillating nature of popular diet books regarding optimum macronutrient composition for weight loss. Third, these subjects report regular self-monitoring of weight. Maintaining a substantial weight loss may be a long-term challenge, and it may be important to have access to information about success. This may be particularly important in terms of initiating early strategies to stop weight regain. Currently, the data seem to suggest that differences in behavior are stronger predictors of weight regain than the differences in physiology or metabolism. Further research with frequent assessments of behavior and metabolic parameters may be helpful in determining which set of factors is most strongly related to long-term maintenance of weight loss.

Part of the reasons for developing the NWCR was to counter the belief that "no one succeeds long-term at weight loss." We believe the subjects in the NWCR show that you can achieve and maintain substantial amounts of weight loss. Furthermore, we have found that these subjects live "normal" lives after weight loss and consistently report that life is better after weight loss. Our subjects tell us that their success requires substantial effort but that it is worth it. Finally, our data suggest that over time, it does get easier to maintain weight loss. It may be a lifelong struggle, but once you have maintained a weight loss for 2–5 years, the chances of longer-term success greatly increase.

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