**BEHAVIORAL APPROACHES TO OBESITY MANAGEMENT**

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**ABSTRACT**

Obesity is extremely prevalent in developed countries, affecting about 36 percent of people in the United States alone. Advisory panels recommend a 5-10% reduction in initial weight for adults with obesity, or for those who are overweight, with a weight-related comorbidity. This loss can significantly reduce the development of type 2 diabetes and improve other cardiovascular disease (CVD) risk factors, as seen in the Diabetes Prevention Program and Look AHEAD trials. Greater reductions in weight produce even greater improvements in CVD risk factors. Weight loss can be achieved with a comprehensive lifestyle program that consists of dietary change, increased physical activity, and behavior therapy, provided in individual or group sessions. Behavioral treatment can be combined with diets of varying macronutrient composition as long as they induce a caloric deficit. Physical activity should be gradually increased over a period of 6 months, and although it is not effective for inducing weight loss, it is very important for facilitating weight maintenance. Principles of behavioral treatment include self-monitoring, stimulus control, and goal setting. Weight regain is common, but frequent follow up with an interventionist, which includes at least monthly counseling, can mitigate it. Treatment delivered by telephone, internet, and smartphone offer promising approaches that can be disseminated to larger populations.

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**INTRODUCTION**

Obesity, defined by a body mass index (BMI) ≥ 30 kg/m², is the most common nutritional disease in the United States, affecting about 36% of adults (1) and 17% of children and adolescents (2). An additional 33% of American adults are overweight, as judged by a BMI of 25.0-29.9 kg/m². Obesity is associated with increased risk factors for cardiovascular disease (3), including hypertension, dyslipidemia, and type 2 diabetes mellitus (4), along with other clinical conditions including nonalcoholic fatty liver disease, gastroesophageal reflux, obstructive sleep apnea and osteoarthritis(5-7). A weight loss of 5-10% of initial body weight improves these complications and has been recommended by expert panels sponsored by the World Health Organization (8), the National Institutes of Health (9), and several professional societies. Losses of this magnitude can be achieved with a high intensity lifestyle intervention (also known as behavioral weight control), as described in the Guidelines for the Management of Overweight and Obesity in Adults (i.e., Obesity Guidelines), (10) developed by The American College of Cardiology, American Heart Association, and the Obesity Society. Comprehensive lifestyle intervention includes three key components: diet, physical activity, and behavior therapy. This chapter describes lifestyle interventions for obesity and reviews the short-term and long-term effectiveness of this approach.

**OVERVIEW OF LIFESTYLE INTERVENTION**

Lifestyle intervention (or modification) provides a structured treatment protocol, implemented by a trained interventionist (usually a registered dietitian, behavioral psychologist, exercise physiologist, or other health-care professional), in which participants meet weekly for 30-90 minute sessions for an initial period of 16-26 weeks (10), followed by every-other-week sessions for an additional 6-12 months designed to facilitate weight maintenance. Weight loss is achieved through counseling patients about nutrition, suitable physical activities, and long-term weight management strategies.

**EFFICACY OF HIGH-INTENSITY LIFESTYLE INTERVENTION PROGRAMS**

In trials conducted in academic medical centers, participants treated by a 1200-1500 kcal/day diet, combined with regular exercise and a comprehensive program of group or individual lifestyle modification, lose an average of 5-8% of initial weight in 6 months (9,11), and approximately 60-65% of patients lose ≥5% of initial weight. The lifestyle programs provided in the Diabetes Prevention Program and the Look AHEAD study provide excellent examples of high intensity interventions.

**Diabetes Prevention Program**

In the Diabetes Prevention Program (DPP), more than 3,200 obese or overweight participants with impaired glucose tolerance were randomly assigned to a placebo, metformin, or an intensive lifestyle intervention, with the goal of inducing a 7% weight loss in the latter group (12). Participants in the lifestyle intervention group were given 16 individual on-site counseling sessions with a registered dietitian in the first 24 weeks, followed by at least one contact every other month for the remainder of the study. They were prescribed a reduced calorie, low-fat diet (1200-2000 kcal/day, depending on body weight), and 150 min/week of physical activity. After an average of 2.8 years, participants in the lifestyle intervention group lost a mean of 5.6 kg, compared to 0.1 and 2.1 kg in the placebo and metformin groups, respectively. The 5.6 kg weight loss translated to a 58% relative reduction in the risk of developing type 2 diabetes. Ten years after randomization, the lifestyle intervention group had regained most of their lost weight, but their incidence of type 2 diabetes remained 34% below that in the placebo group (13).

**Look AHEAD (Action for Health in Diabetes) Study**

The Look AHEAD study enrolled more than 5,100 overweight/obese individuals with type 2 diabetes mellitus, and participants were randomly assigned to a diabetes support and education (DSE) group or an intensive lifestyle intervention (ILI) group, with the aim of examining the long-term effects of a 7% weight loss on cardiovascular morbidity and mortality (14). Participants randomized to the DSE group received three group-education sessions each year in the first 4 years, whereas participants in the ILI group received treatment similar to that in the DPP with some modification. During the first 6 months, ILI participants had 3 weekly group treatment sessions per month and 1 individual visit per month and replaced 2 meals per day with a liquid supplement. They were instructed to consume 1200-1800 kcal/day (with calories adjusted based on weight). During months 7 to 12, ILI participants had 2 group sessions and 1 individual visit each month, and used meal replacements for 1 meal per day. For the next 3 years, participants were offered 1 individual on-site visit and 1 phone (or e-mail) contact per month.

After 1 year, ILI participants lost 8.6% of baseline weight, compared with 0.6% for the DSE group, and at year 4, mean weight losses were 4.7% versus 1.1%, respectively. These latter losses were maintained at 8 years, at which time patients in the ILI group lost 4.7% of initial weight, compared with 2.1% for DSE participants. The study was ended at a mean of 9.6 years of post-randomization follow-up because there were no differences in cardiovascular morbidity and mortality between groups. However, patients in ILI, compared to DSE, had significantly greater reductions in HbA1C, lost more weight, had larger improvements in cardiovascular disease risk factors (i.e., reductions in systolic and diastolic blood pressure and levels of triglycerides), and used fewer diabetes, hypertension, and lipid-lowering medications. Analyses showed that the greater the weight loss, the greater the improvements in those risk factors (Figure 1) (15).

**Figure 1.** **Change in risk factors by weight loss categories for the Look AHEAD cohort**.



Data in all figures are presented as least square means and 95% CIs adjusted for clinical sites, age, sex, race/ethnicity, baseline weight, baseline measurement of the outcome variable, and treatment group assignment. Figure is reprinted with permission from reference (15).

Compared to DSE, additional benefits in the ILI group included greater reduction of depression symptoms and remission or reduced severity of obstructive sleep apnea. The Look AHEAD and DPP studies both demonstrate that weight loss and long-term benefits to health can be achieved through participation in a lifestyle modification program.

**DIETARY INTERVENTIONS FOR WEIGHT LOSS**

The primary goal of the dietary prescription in a behavioral weight loss program is to induce a 500-750 kcal/day deficit (16). For women, this involves consuming about 1200-1500 kcal/day, while for men the goal is about 1500-1800 kcal/day (17). Calorie targets can also be based on body weight, with 1200-1500 kcal/day recommended for people who weigh less than 250 lbs. and 1500-1800 kcal/day for those >250 lbs. (11). The ideal composition of dietary macronutrients for producing weight loss has been studied extensively, with options including low-glycemic index diets, Mediterranean-type diets, low-fat diets, and reduced-carbohydrate diets (11). A low glycemic index is based on eating a diet containing foods with a lower glycemic load, that are less likely to cause large increases in postprandial blood glucose levels (18,19). A Mediterranean diet focuses on consuming higher amounts of plant-based foods, including fruits, legumes, vegetables, monounsaturated fats such as olive oil, and fish; and reduced consumption of foods high in saturated fats, like red meat and butter (20). A low carbohydrate diet approach, like an Atkins or “ketogenic” diet, is characterized by consuming as few as 20 g/day of carbohydrates, and focusing on foods that are higher in protein and fat (21). Low-fat diets, provide 10% to 20% of calories from fat and recommend plant-based foods including whole-grains, fruits, and vegetables (22). The outcomes of comparative studies of these different types of diets have consistently pointed to the conclusion that adequate weight loss depends less on the macronutrient content of the diet and more on the caloric deficit. The POUNDS LOST trial supported this conclusion in a large 2-year study that randomized patients to one of four diets with different macronutrient compositions, varying in proportions of fat, protein, and carbohydrate content (fat/protein/carbohydrate content: 20/15/65%; 20/25/55%; 40/15/45%; and 40/25/35%, respectively) (23). The study showed no difference in the amount of weight lost as long as the participants adhered to an energy deficit of approximately 750 kcal per day. Several other studies have also found that different dietary approaches produce weight losses that are comparable, provided there is a sufficient reduction in calories (24,25). The use of portion-controlled diets have been shown to facilitate greater weight losses than diets of conventional foods, but this is primarily due to improved adherence to calorie goals and not to their macronutrient profile (26).

Although it appears that caloric restriction contributes to weight loss more so than the macronutrient composition of the diet, diets should be chosen based on patients’ personal preferences and by the presence of comorbid conditions. For example, Fabricatore et al (27) demonstrated that a low-glycemic index diet produced greater improvements in HbA1c in overweight patients with type 2 diabetes than did a traditional low-fat diet, even though the two diets produced comparable weight losses. Low-fat diets appear to be associated with greater reductions in low-density lipoprotein cholesterol (23,24,28), compared to low-carbohydrate diets. The latter diets, by contrast, are associated with great reductions in triglycerides (25,28-32), increases in high-density lipoprotein cholesterol (24,25,28-32), and improvements in HbA1C in patients with type 2 diabetes (32). **Table 1** summarizes the results of selected randomized trials that examined the effects of macronutrient composition on changes in weight and health outcomes.

**Table 1.** **Weight loss results from randomized trials that compared diets with varying macronutrient compositions.**

| Study | N | No. Lifestyle Sessions Provided | Dietary Intervention | Weight Change |  Month | Comment/ Other Results |
| --- | --- | --- | --- | --- | --- | --- |
| Dansingeret al(25) |  160 (51% F) 58% completed | 4 |  Atkins (low-carb) Zone (even distribution) Weight Watchers (points based) Ornish (low-fat) | -2.1 kg a-3.2 kg a-3.0 kg a-3.3 kg a | 12 |  All participants had hypertension, dyslipidemia, and/or fasting hyperglycemia. Weight loss was associated with level of adherence. Each diet decreased LDL/HDL ratio. N No significant changes in blood pressure or blood glucose at 12 months in either group. |
| Das et al(33)\* | 34 (% F unknown)85% completed | 52 |  Low-glycemic load High-glycemic load | -7.8% a-8.0% a | 12 |  Triglycerides, total, HDL, and LDL cholesterol decreased in both groups. |
| Fabricatore et al(27) |  79 (80% F)63% completed | 30 | Low-glycemic load Low-fat | -4.5% a-6.4% a | 9 | All participants had type 2 diabetes. Larger reductions in HbA1c in the low-glycemic load group. |
| Foster et al(28) | 63 (68% F)59% completed | 3 |  Low-carbohydrate (high protein, high fat) Conventional (high-carbohydrate, low-fat) | -4.4% a-2.5% a | 12 |  HDL cholesterol increased more and triglycerides decreased more in the low-carbohydrate group. Greater reductions in LDL and total cholesterol in the low-fat group at 3 months. |
| Foster et al (24) | 307 (68% F)63% completed | 38 |  Low-carbohydrate Low-fat | -6.3 kg a-7.4 kg a | 24 |  HDL cholesterol increased more and triglycerides were lower only in the low-carbohydrate group. Greater decrease in LDL at 3 and 6 months in the low-fat group.  |
| Gardneret al(29) | 311 (100% F)80% completed | 8 |  Atkins (low-carbohydrate) Zone (even distribution) LEARN (calorie-restricted) Ornish (low-fat) | -4.7 kg a-1.6 kg b-2.2 kg ab-2.6 kg ab | 12 |  HDL cholesterol increased more in Atkins than Ornish group. Triglyceride levels decreased more in Atkins than Zone group. No differences in insulin or blood glucose between groups. Systolic blood pressure decreased more in Atkins than in all other groups. Diastolic blood pressure decreased more in Atkins group than in Ornish group. |
| Sacks et al(23)  |  811 (64% F) 7 9.5% completed | 66 |  Low-fat, average protein (highest carbohydrate)  Low-fat, high-protein High-fat, average-protein High-fat, high-protein (lowest carbohydrate) | -3.0 kg a-3.8 kg a-3.2 kg a-3.4 kg a | 24 |  LDL cholesterol decreased more in lowest fat than in highest fat group. HDL cholesterol increased more with lowest carbohydrate than with the highest carbohydrate diet. All diets decreased triglyceride levels similarly. All diets, except the highest carbohydrate, decreased fasting insulin (greater decrease in the high protein vs average protein diets). |
| Shai et al(31) |  322 (14% F)8 4.6% completed | 24 |  Low-fat  Mediterranean (moderate fat, restricted calorie with fat predominantly from olive oil and nuts)  Low-carbohydrate  | -2.9 kg a-4.4 kg b-4.7 kg b | 24 |  No significant change in LDL cholesterol in any group. HDL cholesterol increased in all groups, significantly more in the low-carbohydrate than low-fat group. Triglyceride levels decreased more in the low-carbohydrate than in the low-fat group. In diabetic participants, only the Mediterranean diet group had a decrease in fasting glucose.  Insulin decreased in all groups, for both diabetic and non-diabetic participants. All groups had a significant decrease in blood pressure. Adiponectin levels increased, and leptin levels decreased, in all groups.  |
| Stern et al(32)  | 132 (17% F)66% completed | 15 |  Low-carbohydrate Conventional (low-fat) | -5.1 kg a-3.1 kg a | 12 |  Triglyceride levels decreased more in the low-carbohydrate group than in the low-fat group. HDL cholesterol decreased less in the low-carbohydrate group than in the low-fat group. Changes in total and LDL cholesterol were not significantly different between groups. |
| Yancy et al(34) | 120 (76% F)66% completed | 9 |  Low-fat diet Low-carbohydrate, ketogenic diet with nutritional supplements | -6.7% a-12.9% b | 6 |  All participants were hyperlipidemic. Triglycerides decreased more and HDL cholesterol increased more in low-carbohydrate group. |

Table is reprinted with permission from reference (11)

All studies were analyzed by use of an intention-to-treat population, with the exception as indicated by an asterisk (\*).

Different letters (in superscript) indicate statistically significant differences in weight loss between groups.

F indicates female; LDL, low-density lipoprotein; HDL, high-density lipoprotein; VLDL, very low density lipoprotein; HbA1c, hemoglobin A1c; MR, meal replacements; CVD, cardiovascular disease.

\*A completer’s population was examined. †Results reported as “greater,” “larger,” “increased more,” etc represent statistically significant differences between treatment conditions.

**PHYSICAL ACTIVITY**

Physical activity is an important component of a comprehensive lifestyle intervention, in which participants are typically instructed to increase their physical activity gradually to approximately 150-180 min/week over the first 6 months. This goal can be achieved by engaging in moderate physical activity (e.g., brisk walking) for 30 minutes on 5 days per week (10,11,13). Physical activity can be increased by incorporating short bouts of activity into individual’s daily routines, such as increasing the amount of daily walking or using the stairs when possible, or by longer bouts of structured physical activity (e.g., at the gym). Individuals should be encouraged to engage in physical activities that they enjoy rather than be prescribed a particular activity. The recommended physical activity levels for facilitating long-term weight management are higher (225-300 min/week) than those for losing weight (35). The effects of physical activity on weight loss, the maintenance of weight loss, and CVD risk factors have been investigated extensively.

**Physical Activity and Weight Loss**

Physical activity has a modest impact on weight loss when compared with the effect of caloric restriction (35). This was demonstrated in a 12-week study in which participants achieved losses of 0.3-0.6% (male vs female) of initial weight from physical activity alone, compared to 5.5-8.4% (female vs male) and 7.5-11.4% (female vs male) losses for participants who reduced their calorie intake and those who changed both diet and physical activity, respectively (36). The exercise performed in this study consisted of 30 min/day on 5 days per week. Similarly, Wing et al (37) reported weight losses of 2.1, 9.1, and 10.3 kg after 6 months in participants assigned to physical activity alone, diet alone, and diet plus physical activity groups, respectively, all of whom were provided behavioral intervention.

**Physical Activity and Weight Maintenance**

Although exercise has a limited impact on weight loss during the initial phase of treatment, it plays an important role in weight loss maintenance. Several studies have shown that the more physical activity the patient engages in, the better the maintenance of lost weight (38,39). Jakicic et al (39), in a secondary analysis of a randomized controlled trial (RCT), demonstrated that women who exercised more than 200 min/week maintained greater weight losses than those who exercised 150-199 min/week or <150 min/week. Data from the National Weight Control Registry have also provided evidence that high levels of physical activity are characteristic of individuals who report for long-term, sustained weight loss (40). The Registry follows patients who have lost a minimum of 13.6 kg (i.e., 30 lb) in six months and maintained this loss for at least one year. Of these successful weight loss maintainers, 91% reported that they were exercising consistently, with women expending 2,545 kcal/week and men 3,293 kcal/week (41). Based on these findings and other evidence, the current recommendation by the American College of Sports Medicine is that, for weight maintenance, individuals should exercise at a minimum level equivalent to an hour of brisk walking per day (35).

**Physical Activity and Cardiovascular Health**

Although physical activity is minimally effective for inducing weight loss, it is crucial for improving cardiovascular health for both average-weight and obese individuals. In the absence of significant weight loss, regular bouts of aerobic activity have been found to reduce blood pressure (42), lipids (43), and visceral fat (44), the latter which is associated with improved glucose tolerance and insulin sensitivity (in non-diabetic individuals) and glycemic control (in patients with type 2 diabetes) (45,46). Several authors have evaluated the independent effects of cardiorespiratory fitness and adiposity on subsequent CVD mortality, and have suggested that high levels of cardiorespiratory fitness significantly decrease the CVD mortality risk in overweight and obese individuals, regardless of adiposity. Barry et al (47) performed a meta-analysis of 10 studies and concluded that, compared to individuals who were normal weight and fit, unfit individuals had twice the risk of all-cause mortality regardless of their BMI, whereas individuals who were obese and fit had similar mortality risks as normal-weight, fit individuals. Similarly, in a longitudinal study of 25,000 men, Lee et al (48) found that those who were lean but unfit had double the mortality of fit, lean men. These findings indicate that obese individuals should increase their physical activity to improve their health, regardless of its impact on their weight.

**PRINCIPLES OF BEHAVIOR THERAPY**

The third component of lifestyle intervention is behavior therapy, which refers to a set of principles and techniques used to help patients adopt new dietary and activity recommendations. Behavioral principles were first applied to obesity in the 1960’s and early 1970’s and, since then, have been developed into a program that includes several cognitive components, in addition to diet and exercise (49). The core components of behavior therapy include goal setting, self-monitoring, stimulus control, and problem solving.

**Goal Setting**

In behavioral weight loss treatment, goal setting refers to setting specific targets for making changes to the patient’s calorie intake, physical activity, and eating and exercise habits. Goals need to be objective and easily measurable in order to facilitate patients’ assessment of their progress. Patients are encouraged to have a target range for their total daily caloric intake, a daily or weekly exercise goal in minutes, and short- and long-term weight loss goals. Other behavioral goals are introduced as treatment proceeds. Patients should set goals that facilitate their losing about 0.5-1.0 kg per week, for a total of 5-10 percent of initial body weight lost at the end of the weight loss phase (at about 6 months). The goals should be trackable and should specify when and how the goal will be accomplished (50). During a treatment session, the lifestyle interventionist reviews the patient’s progress in achieving goals from the previous session and helps the patient set new goals. In group treatment, this information is often shared with the group as a whole to further increase accountability. If the goals from a previous session are not met, the interventionist assists individuals to modify their goals accordingly.

**Self-Monitoring**

Monitoring target behaviors in a systematic way is a crucial aspect of the behavioral approach to weight loss. Self-monitoring provides instant feedback about the effectiveness of target behaviors and the trajectory of the behaviors. It can answer the most important question about behaviors: are they getting better, staying the same, or getting worse? Self-monitoring is highly linked to success in weight loss. Individuals who monitor their weight, activity levels, and eating patterns usually achieve the greatest weight losses (51,52). Patients are encouraged to record all foods and beverages consumed and their calorie content. Patients total their calories daily to determine if they have met their goals. The minutes of physical activity, the type of physical activity, or the pedometer count can also be recorded in the personal record. A thorough self-monitoring report might also include the individual’s feelings that day, particularly those that were associated with excess or unplanned eating. Patients should also be instructed to weigh themselves regularly at home, at least once a week, and to keep a record of their weekly weights. In the National Weight Control Registry, participants who weighed themselves regularly lost more weight. Patients can use smart-phone applications, activity counters, and cellular- connected scales to facilitate self-monitoring (53).

In lifestyle intervention programs, patients review their self-monitoring records with an interventionist who helps them assess their progress, set goals, and problem solve. Individuals often underestimate calorie intake and overestimate physical activity (54), and interventionists can help patients who report meeting their calorie and activity goals, but do not lose weight, to identify additional sources of caloric intake. These may come from large portion sizes or hidden sources of fat and/or sugar calories. Interventionists can also help patients address barriers to effective self-monitoring, or set more flexible self-monitoring goals (e.g., record on fewer days per week), as appropriate.

**Stimulus Control**

The goal of stimulus control is to alter the external and internal cues that regulate eating and exercise behaviors (11,16). In classical conditioning, cues develop when two stimuli (e.g., objects, activities) are repeatedly experienced together, which creates an association between the two. The appearance of one stimulus can invoke the other stimulus. Food cues are cues that cause an individual to think about eating or about specific foods. These may include external cues, such as the sight or smell of food, or an activity that is frequently engaged in while eating. Internal cues include thoughts or emotions that the person has come to associate with eating. Similarly, activity cues include internal and external experiences that the person has come to associate either with being active (e.g., the sight of sneakers by the door) or being inactive (e.g., the couch).

Patients learn to alter their food and activity cues either by avoiding problem cues or creating new habits in response to those cues. For example, individuals are taught early on to make changes in their work and home environments so that these places can facilitate (rather than interfere with) weight loss. Examples of stimulus control include avoiding places that sell or serve high-calorie foods, staying away from all-you-can-eat buffets, and keeping trigger foods (which are associated with overeating) out of the house altogether. The patient can instead be encouraged to buy single portions of high-calorie foods on special occasions. To increase cues for healthy eating, patients can be taught to improve the visibility and availability of low-calorie foods and healthy snacks in their home or workplace, such as by placing these foods at eye-level when stored. They can also add cues that promote physical activity, such as arranging to walk at a certain time every day with a partner or leaving their gym bag in their car so that it is the first thing that they see when they leave work.

**STRUCTURE OF BEHAVIORAL TREATMENT: SHORT- AND LONG-TERM**

High intensity lifestyle intervention sessions can be conducted individually or in groups. In principle, individual counseling could be expected to produce greater weight loss because of the individual and personalized support participants receive. However, group sessions have been found to be as effective as individual counseling for weight loss in several studies (55). One reason why group treatment may be as effective as individual therapy is because it is associated with a greater degree of social support, empathic understanding, and healthy competition among the group members. Participants are given a chance to report on their successes and ability to meet their behavioral and weight loss goals. While both individual and group treatment are effective modalities for weight loss, the latter is more cost effective than individual counseling.

Studies indicate that participants should have at least 14 counseling sessions in 6 months, the criterion for high-intensity lifestyle intervention (10). Frequency and duration of contact during the weight loss period are other predictors of success (55). Treatment intensity has been found to be so significant that the current recommendation by the 2012 United States Preventative Services Task Force regarding behavioral weight loss management is that weight loss programs include at least 12-26 intervention sessions per year for optimal weight loss (56). This recommendation is supported by comparing trials in which participants in high intensity lifestyle intervention programs lost weight, independent of the macronutrient composition of the diet, to trials in which similar diets were used with minimum lifestyle intervention, resulting in less weight loss. Foster et al (24), for example, demonstrated that patients who received high intensity lifestyle modification (consisting of group sessions of 8-12 individuals once per week for the first twenty weeks, once every two weeks for the next twenty weeks, and finally once every other month for a total of two years) lost ~11 kg at 1 year and maintained a loss of 6-7 kg at 2 years, regardless of whether patients were on a low fat or low carbohydrate diet (**Figure 2**). This is in contrast to a study by Iqbal et al (57) , in which participants were assigned to similar low-carbohydrate and low-fat diets but were provided low intensity lifestyle intervention (i.e., < 1 session/month). They lost only 1.5 and 0.2 kg, respectively, at 2 years.

**Figure 2.** Change in body weight for participants in low-fat and low-carbohydrate diet groups after 24 months, based on random-effects linear model.



Figure is reprinted with permission from reference (24).

For weight loss maintenance, frequent, long-term contact with an interventionist is the most successful method for preventing weight regain. Weight loss maintenance sessions are important for providing individuals with the support and motivation needed to continue with the behavior changes they have made, such as engaging in physical activity, eating a low calorie diet, and self-monitoring. Wing et al (52) demonstrated that monthly in-person sessions were more effective in preventing weight regain over 18 months of intervention than was an education-control group or an internet-based intervention. Participants in the three groups regained an average of 2.5, 4.9, and 4.7 kg, respectively, after an initial weight loss of 19 kg.

Table 2 summarizes what the authors believe are the key components of lifestyle modification for both inducing and maintaining a weight loss of 5% to 10% of initial body weight.

**Table 2. Recommended Components of a High-Intensity Comprehensive Lifestyle Intervention to Achieve and Maintain a 5-to-10% Reduction in Body Weight.\***

|  |  |  |
| --- | --- | --- |
| Component | Weight Loss | Weight-loss Maintenance |
| Counseling  | ≥14 in-person counseling sessions (individual or group) with a trained interventionist during a 6-mo period; recommendations for similarly structured, comprehensive Web-based interventions, as well as evidence-based commercial programs | Monthly or more frequent in-person or telephone sessions for ≥1 yr with a trained interventionist |
| Diet | Low-calorie diet (typically 1200–1500 kcal per day for women and 1500–1800 kcal per day for men), with macronutrient composition based on patient’s preferences and health status | Reduced-calorie diet, consistent with reduced body weight, with macronutrient composition based on patient’s preferences and health status |
| Physical activity | ≥150 min per week of aerobic activity (e.g., brisk walking) | 200–300 min per week of aerobic activity (e.g., brisk walking) |
| Behavioral therapy | Daily monitoring of food intake and physical activity, facilitated by paper diaries or smart-phone applications; weekly monitoring of weight; structured curriculum of behavioral change (e.g., DPP), including goal setting, problem solving, and stimulus control; regular feedback and support from a trained interventionist | Occasional or frequent monitoring of food intake and physical activity, as needed; weekly-to-daily monitoring of weight; curriculum of behavioral change, including problem solving, cognitive restructuring, and relapse prevention; regular feedback from a trained interventionist |

\*Data are from the Guidelines (2013) for the Management of Overweight and Obesity in Adults, reported by Jensen et al. (10) The guidelines concluded that a variety of dietary approaches that differ widely in macronutrient composition, including ad libitum approaches (in which a lower calorie intake is achieved by restriction or elimination of particular food groups or by the provision of prescribed foods), can lead to weight loss provided they induce an adequate energy deficit. The guidelines recommended that practitioners, in selecting a weight-loss diet, consider its potential contribution to the management of obesity-related coexisting disorders (e.g., type 2 diabetes and hypertension). The guidelines did not address the possible benefits of strength training, in addition to aerobic activity. DPP denotes Diabetes Prevention Program. Table is reprinted with permission from reference (58)

**TECHNOLOGY USE FOR LIFESTYLE MODIFICATION**

In-person interventions can be costly because they require adequate facilities for hosting the intervention, staff for checking in patients, and the time of trained providers to deliver the intervention in an individual or group format. Travel time can also represent a cost and inconvenience for patients. The use of the telephone and the Internet may provide cost-effective ways to deliver lifestyle interventions to patients. Larger numbers of individuals can be reached with these methods at a cost that is significantly less than in-person intervention and promotes similar weight loss and weight loss maintenance. Donnelly et al (59) achieved median weight losses of 13.0% for group conference calls compared to 12.7% for on-site groups in a 26-week program. Similarly, Appel et al (60) showed comparable weight losses at 24 months for participants who received a telephone-delivered (no face to face contact) compared to in-person intervention (4.6 kg and 5.1 kg, respectively).

Furthermore, telephone-based intervention can be helpful for weight maintenance. The Obesity Guidelines (10) recommend the use of either telephone-delivered or in-person counseling for weight-loss maintenance, based on positive results from several randomized controlled trials (52,61,62). For example, in a study by Perri et al (62), obese women who had lost an average of 10 kg during a 6-month run-in period were randomly assigned to receive a twice-monthly weight loss maintenance program that was delivered by telephone or on site. Women in a third group received newsletters only. Participants in the two weight loss maintenance interventions both regained only 1.2 kg in the year of treatment, compared with a significantly greater gain of 3.7 kg for those in the newsletter group.

Several randomized controlled trials have also tested the role that the internet can play in delivering interventions for weight loss and weight-loss maintenance. Tate el al (63) demonstrated that an Internet-based behavioral approach—consisting of email-based lessons, self-monitoring (food records and physical activity), and feedback from an interventionist -- produced greater weight loss than an educational program (i.e., Internet resources with no specific instruction in changing eating and activity habits) at 6 months (4.1 vs 1.6 kg, respectively). In a study that compared delivery of the same 24-session intervention content by the internet to an on-site program, obese participants in the Internet program lost 5.5 kg in 6 months compared with a significantly greater 8.0 kg weight loss for those who received on-site treatment (64). The results of these short-term research studies suggest that Internet-based interventions are superior to no treatment or minimal intervention but less effective than in-person treatment (11). Successful Internet-based programs for weight loss management should include a structured curriculum that provides information and behavioral strategies for losing weight, along with personal feedback from an interventionist, delivered via email, text, or phone (16).

Despite their popularity, little is known about the effectiveness of smart-phone applications (apps) for weight management. In a 24-month study in which obese adults were randomized to an interactive smartphone app alone, personal coaching with an interactive app, or a control group, the app alone arm did not lead to greater weight loss compared to controls (65). Another randomized control trial testing a popular app revealed no weight loss at the end of 6 months (66). Overweight/obese patients in a primary care setting were randomized to usual medical care (i.e., instructions to choose any approaches they wished to lose weight) or usual medical care combined with instructions to use MyFitnessPal app (Under Armour, Inc, Baltimore, MD). Patients in the usual care group gained 0.3 kg at month 6, while those assigned to MyFitnessPal had no weight change (0 kg) (66). The success of apps and similar weight loss tools may depend on the presence of a third party (e.g., a relationship with an interventionist) that fosters patient accountability in adhering to behavioral strategies (i.e., recording food intake daily, etc).

**CONCLUSION**

There is clear evidence that intensive lifestyle interventions are effective in helping patients with obesity lose 5-10% of initial body weight, a loss that is associated with improvements in CVD risk factors and other obesity-related comorbidities. Behavioral approaches emphasize prescriptions for dietary intake, increased physical activity, and self-monitoring. One of the most challenging aspects of behavioral weight control is keeping off lost weight. Several strategies can facilitate this goal. They include: maintaining patient-provider contact beyond the initial weight loss intervention; adding telephone- or Internet-based counseling, alone or as an adjunct to in-person intervention; and prescribing high levels of physical activity after weight is lost in the first 6 months. In addition, the more that patients practice the skills used by participants in the National Weight Control Registry, the more likely they will be to maintain their weight loss.

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