BEHAVIORAL APPROACHES TO OBESITY MANAGEMENT

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ABSTRACT

Obesity is extremely prevalent, affecting 42.5% 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 risk of developing 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 as a stand-alone intervention for inducing a clinically meaningful mean weight loss, it is very important for facilitating weight maintenance and improving health outcomes. Principles of behavioral treatment include self-monitoring, stimulus control, and goal setting. Weight regain is common after an initial treatment period of 6-12 months, but frequent follow-up with an interventionist, which includes at least monthly counseling, can mitigate it. Treatments delivered by telephone, internet, or smartphone can be more easily disseminated to larger populations and can produce clinically meaningful mean weight losses if they include content similar to that of in-person lifestyle interventions and provide personalized feedback.

INTRODUCTION

Obesity, defined by a body mass index (BMI) ≥ 30 kg/m², is the most common nutritional disease in the United States, affecting 42.5% of adults (1) and 19% of children and adolescents (2). An additional 31% of American adults have a BMI in the overweight range of 25.0-29.9 kg/m². Obesity is associated with an increased risk of developing cardiovascular disease

(3), 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 lifestyle modification or behavioral weight loss treatment), 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 interventions include three key components: diet, physical activity, and behavior therapy. This chapter describes each intervention component and reviews the short-term and long-term effectiveness of this approach. Lifestyle interventions have traditionally been delivered in 30-90 minute, in-person, group or individual sessions by a trained interventionist (usually a registered dietitian, psychologist, exercise physiologist, or other health-care professional). Although this is by far the best-researched treatment modality, the past two decades have seen an exponential growth in digital and other remote treatment approaches, which are reviewed in the final section.

EFFICACY OF HIGH-INTENSITY, IN-PERSON LIFESTYLE INTERVENTION PROGRAMS

Interventions categorized as “high-intensity” by the Obesity Guidelines provide a minimum of 14 treatment sessions during the first 6 months (10). Maintenance sessions may be delivered at a reduced frequency thereafter. 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 behavior modification, lose an average of 5-8% of initial weight in 6 months (9-11), and approximately 60-65% of patients lose ≥5% of their 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 participants with obesity or overweight and 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 initial 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 individuals with overweight/obesity and 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 and one individual visit per month and replaced two meals per day with a liquid supplement (i.e., shake). They were instructed to consume 1200-1800 kcal/day (with calories adjusted based on initial weight). During months 7 to 12, ILI participants had two group sessions and one individual visit each month, and used meal replacements for one meal per day. For the next 3 years, participants were offered one individual on-site visit and one 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 HbA_{1C}, 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).

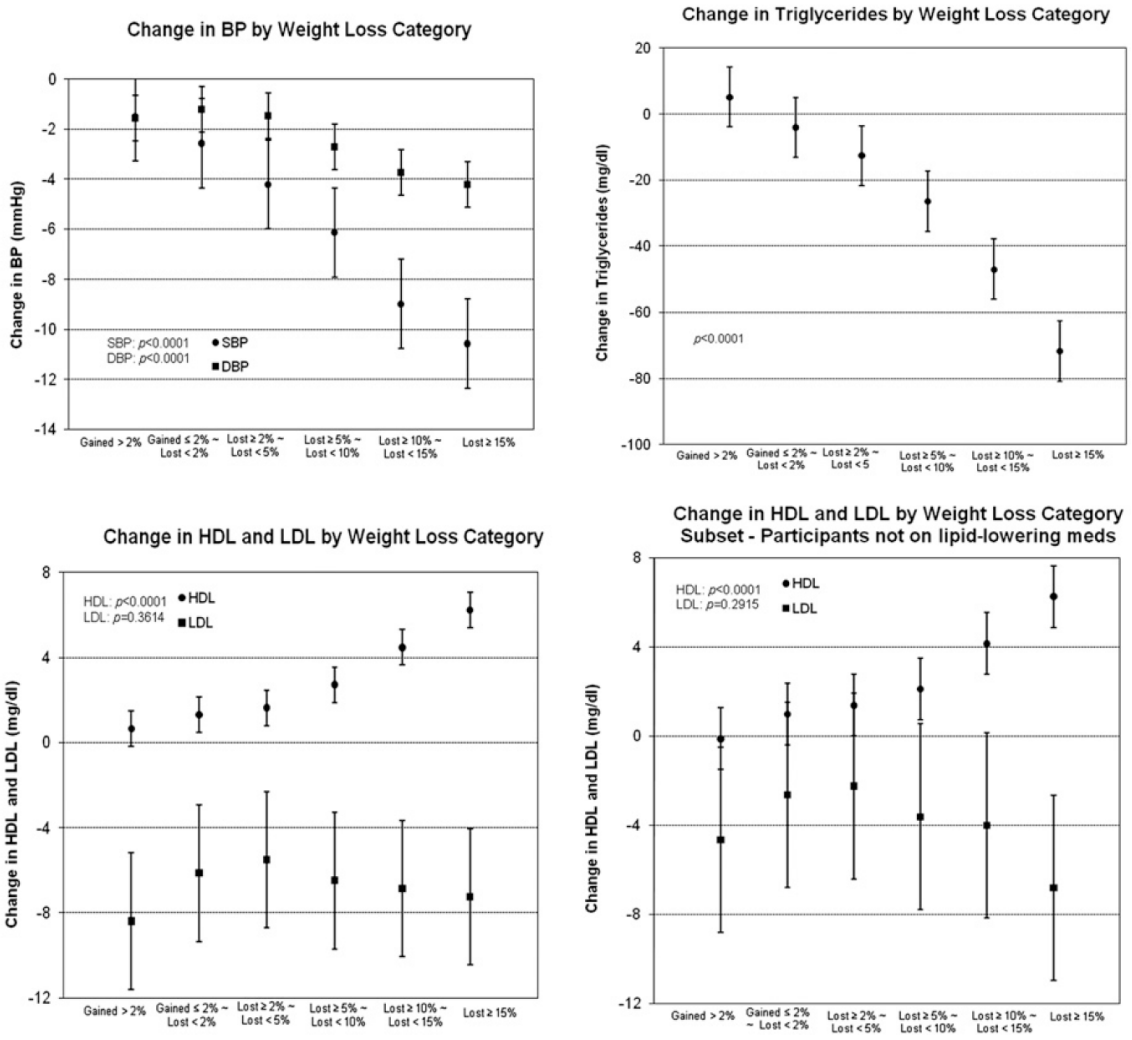

Figure 1. Change in risk factors by weight loss categories for the Look AHEAD cohort. Data in all figures are presented as least square means and 95% CIs adjusted for clinical sites, age, sex, race/ethnicity, baseline weight, baseline measurement of the outcome variable, and treatment group assignment. 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. However, a follow-up assessment of ILI and DSE

participants 16 years post-randomization continued to reveal no significant differences in CVD morbidity and mortality between the two groups (16).

LIFESTYLE INTERVENTION COMPONENTS

Dietary Recommendations

The primary goal of the dietary prescription in a behavioral weight loss program is to induce a 500-750 kcal/day deficit (10,11). For women, this involves consuming about 1200-1500 kcal/day, while for men the goal is about 1500-1800 kcal/day. Calorie targets also can be based on body weight, with 1200-1500 kcal/day recommended for people who weigh less than 250 lbs. at baseline and 1500-1800 kcal/day for those ≥250 lbs. (10,11). 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 (17). 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 (19,20). 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 (21). Low-fat diets provide 10% to 20% of calories from fat and recommend plant-based foods including whole-grains, fruits, and vegetables (22). 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 (23).

The outcomes of comparative studies of these different types of diets have consistently concluded that adequate weight loss depends less on the macronutrient content of the diet and more on the caloric deficit (17). 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) (24). The study showed no difference in the amount of weight lost among the diet groups, all of which were designed to produce 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 (25,26) (Figure 2). 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 (27).

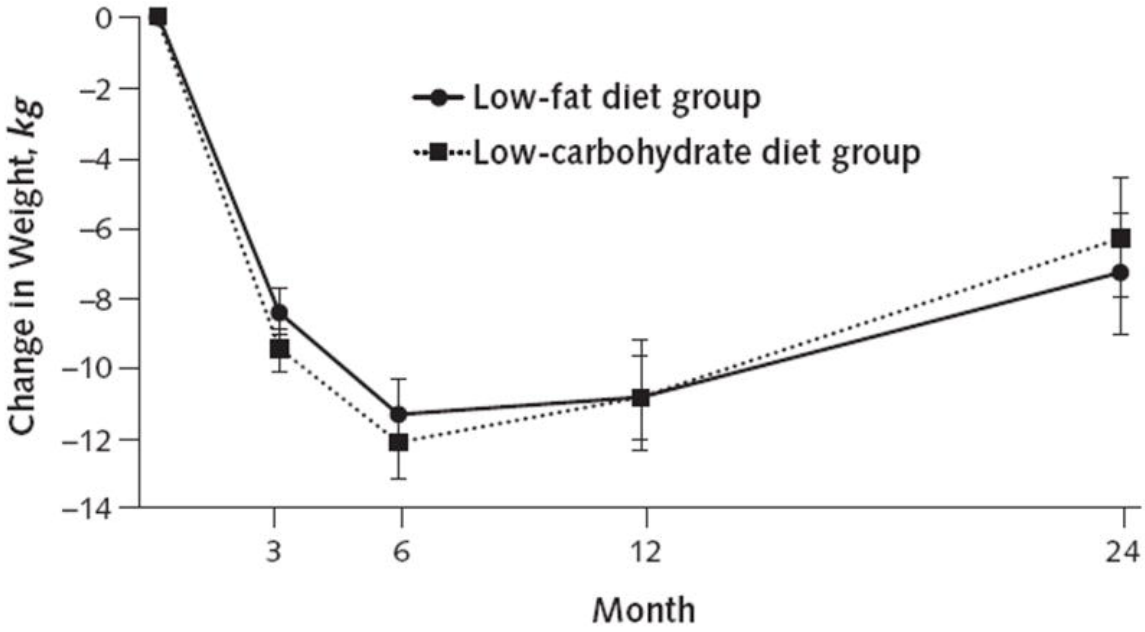

Figure 2. Change in body weight for participants in low-fat and low-carbohydrate diet groups after 24 months, based on random-effects linear model. Figure is reprinted with permission from reference (25).

Because it appears that caloric restriction contributes to weight loss more 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. (28) demonstrated that a low-glycemic index diet produced greater improvements in HbA_{1c} in patients with overweight and 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 (24,25,29), compared to low-carbohydrate diets. The latter diets, by contrast, are associated with greater reductions in triglycerides (26,29-33), increases in high-density lipoprotein cholesterol (25,26,29-33), and improvements in HbA_{1C} in patients with type 2 diabetes (33). 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	Dietary	Weight	Month	Comment/ Other Results

		Provided	Intervention	Change		
Dansinger et al[26]	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. No significant changes in blood pressure or blood glucose at 12 months in either group.
Das et al[34]*	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[28]	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 HbA_{1c} in the low-glycemic load group.
Foster et al[29]	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 [25]	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.
Gardner et al[30]	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[24]	811 (64% F) 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[32]	322 (14% F) 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[33]	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[35]	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 (18).
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; HbA_{1c}, hemoglobin A_{1c}; 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 Recommendations

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 lifestyle activity into individuals' 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 (36).

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 (36). 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 (37). The exercise performed in this study consisted of 30 min/day of moderate activity on 5 days per week. Similarly, Wing et al (38) 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 (39,40). Jakicic et al (40), in a secondary analysis of a randomized controlled trial, 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 long-term, sustained weight loss (41). 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 1 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 (42). 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 (36).

PHYSICAL ACTIVVITY AND CARDIOVASCULAR HEALTH

Physical activity also is crucial for improving cardiovascular health for both individuals with obesity and those of average-weight. Even in the absence of significant weight loss, regular bouts of aerobic activity have been found to reduce blood pressure (43), lipids (44), and visceral fat (45), the latter of which is associated with improved glucose tolerance and insulin sensitivity in non-diabetic individuals and glycemic control in patients with type 2 diabetes (46,47). 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 individuals with overweight and obesity, regardless of adiposity. Barry et al (48) performed a meta-analysis of 10 studies and concluded that, compared to individuals who were fit and had normal weight, unfit individuals had twice the risk of all-cause mortality regardless of their BMI, whereas individuals who were fit and had obesity had similar mortality risks as normal-weight, fit individuals. Similarly, in a longitudinal study of 25,000 men, Lee et al (49) found that those who were lean but unfit had double the mortality rate of those who were fit and lean. These findings indicate that all individuals should increase their physical activity to improve their health, regardless of its impact on body 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 dietary and activity recommendations. Behavioral principles were first applied to the treatment of obesity in the 1960's and early 1970's and, since then, have been developed into a program of behavioral and cognitive strategies (11). 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 (50, 51). 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 (or other dietary goals), 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 loss of 5-10 percent of initial body weight at the end of the weight loss phase (at about 6 months). These goals should be trackable and should specify when and how the goal will be accomplished. During a typical treatment session, the lifestyle interventionist reviews each patient's progress in achieving goals from the previous session and helps the patient set new goals. If the goals from a previous session are not met, the interventionist assists individuals with identifying and reducing barriers to goal achievement or with modifying their goals accordingly. In group programs, this information is often shared with the entire group to further increase accountability and support problem-solving.

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 behavior change efforts. It can answer the most important question about behaviors: are they getting better, staying the same, or getting worse? Daily records also function to increase patients' awareness of target behaviors and their effect on weight change. Self-monitoring is strongly linked to success in weight loss. Individuals who regularly monitor their weight, activity levels, and eating patterns usually achieve the largest weight losses (52,53).

Patients are encouraged to record all foods and beverages consumed and their calorie content (or an alternative dietary target) to determine if they have met their dietary goals. A thorough self-monitoring report might also include the individual's feelings that day, particularly those that were associated with excess or unplanned eating, or other individually-identified triggers for overeating. Tracking the minutes and type of physical activity or pedometer step counts can be used to monitor improvements in the patient's activity level. Patients also should be instructed to weigh themselves regularly at home, at least once per week, and to keep a record of their weekly weights.

Although some patients prefer traditional paper records, the majority now track these targets using smartphone applications (apps) and other digital devices such as wearable physical activity trackers and "smart" scales that automatically record body weight. Although these digital tools increase self-monitoring consistency and are preferred by most patients (54), they have not been found to enhance weight loss when compared to traditional tracking methods (52, 55, 56). Novel tracking tools such as digital food photography and bite counting devices may further reduce the burden of active recording, but some studies have suggested that these methods are less strongly correlated with weight loss and may produce smaller mean losses than active recording methods (57).

In lifestyle intervention programs, patients review their self-monitoring records with an interventionist who helps them to assess their progress, set goals, and problem solve barriers to goal adherence.

Individuals often underestimate calorie intake and overestimate physical activity (58), 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 underestimates of portion sizes or hidden sources of fat and/or sugar intake. Interventionists also can 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 external and internal cues that influence eating and exercise behaviors (11, 50, 51). 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, such as watching television. Internal food cues include both physical sensations and 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 reduce negative food and activity cues -- either by avoiding problem cues or by creating new habits in response to those cues -- and to enhance cues for desired behaviors. Examples of cue reduction include avoiding places that sell or serve high-calorie foods, staying away from all-you-can-eat buffets, and keeping any high-calorie foods that are associated with overeating out of the house. The patient can instead be encouraged to buy single portions of these foods on planned occasions. For cues that cannot be avoided, the patient may be encouraged to identify an appropriate alternative behavior, such as taking a 5-minute break instead of snacking when bored at work. To increase cues for healthy eating, patients can be taught to improve the visibility and availability of healthy, low-calorie foods in their home or workplace, such as by storing these foods at eye-level. 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. By making these changes, patients can ensure that their work and home environments facilitate (rather than interfere with) weight loss.

COGNITIVE STRATEGIES

Strategies from cognitive-behavioral therapy (CBT) have been incorporated into many lifestyle interventions. CBT focuses on identifying, testing, and correcting maladaptive thoughts in order to change emotions or behavior. For example, thoughts like “I’ll never reach my weight loss goal; I might as well eat whatever I want.”) can reduce the likelihood that a patient will adhere to their dietary goals. Patients are taught to create a rational response to these negative thoughts, such as by noting that “My weight loss may be slower than I would like, but continuing to make healthy choices gives me the best chance of long-term success,” or by highlighting some of the benefits that they experience when they make healthier eating choices (50, 51).

Some lifestyle programs also have incorporated strategies from motivational interviewing that are

designed to help patients resolve ambivalence about the costs and benefits of behavior change, identify reasons for change, and improve self-efficacy. More recently, alternative cognitive strategies derived from mindfulness and acceptance-based psychological treatments have been incorporated into weight loss interventions. These treatments promote non-judgmental, present-moment awareness and willingness to experience discomfort in order to pursue long-term goals rather than cognitive change. Thus far, programs that place a significant emphasis on any of these cognitive techniques have not consistently enhanced weight loss when compared to standard lifestyle interventions, and those shown to be superior have only increased weight loss by 1-2 kg (59). However, because fewer studies have incorporated these techniques into comprehensive, high-intensity lifestyle interventions, they remain promising targets for future research.

STRUCTURE OF IN-PERSON BEHAVIORAL TREATMENT: SHORT- AND LONG-TERM

The lifestyle interventions provided in studies like the DPP and Look AHEAD followed a structured curriculum that gradually introduced different behavior change skills. Detailed treatment descriptions can be obtained from the intervention manuals for these two studies (50, 51) or an adaptation of the DPP protocol provided by Wadden, Tsai, and Tronieri for in-person delivery in primary care settings (60). Behavioral weight loss interventions are most commonly delivered in group sessions, which have been found to be as effective as individual counseling for weight loss in several studies (61,62). It may be that any weight loss benefit of receiving personalized support with individual counseling is roughly equivalent to the benefits of a greater degree of social support, empathic understanding, and healthy competition among group members. However, group treatment is more cost effective than individual counseling.

Frequency and duration of contact during the weight loss period are additional predictors of weight loss success (10,61). This benefit is apparent in trials comparing high-intensity lifestyle intervention programs to programs that provided identical dietary and physical activity recommendations with a lower session frequency, as well as in systematic reviews and meta-analyses of the efficacy of lifestyle interventions. For example, in a study by Perri and colleagues (63) that compared three different visit schedules to a control condition, the group that received 8 treatment sessions in the first 6 months had a weight loss of 3.5 kg at month 24 that did not differ significantly from the 2.9 kg loss of the control group, whereas patients who received 16 sessions had a loss of 6.7 kg that was superior to both groups. Of note, the group that received 24 sessions in the first 6 month did not differ in weight loss from the 16-session group at any time, suggesting that there may not be a benefit of further increasing visit intensity (while increasing costs). In 2012, the United States Preventative Services Task Force recommended that weight loss programs include at least 12-26 intervention sessions per year for optimal weight loss (64). This recommendation was based on their systematic review, which reported weight losses of 4 to 7 kg for programs with that level of intensity compared to 1.5 to 4 kg in programs offering fewer than 12 sessions (61). These findings were consistent with the Obesity Guideline's conclusion that programs that provided at least 14 sessions in the first 6 months produce a weight loss of 5 to 8 kg, those that provide 6-13 sessions (1-2 sessions per month) produce a 2 to 4 kg loss, and those that provide less than monthly sessions induce minimal weight loss (10).

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 (65) 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. 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;	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

	regular feedback and support from a trained interventionist	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 (66)

REMOTELY-DELIVERED LIFESTYLE MODIFICATION INTERVENTIONS

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. Travel time also can represent a cost and inconvenience for patients, and many individuals, particularly those in rural and economically disadvantaged urban areas, do not have adequate access to evidence-based care. Over the past two decades, a growing body of research has investigated the use of telephone, computer, and smartphone-based methods for delivering lifestyle interventions to patients. Larger numbers of individuals can be reached with these methods at a cost that is significantly less than that of in-person interventions, particularly if little to no provider input is required. The COVID-19 pandemic further highlighted the need to identify effective ways of delivering lifestyle interventions remotely, as in-person treatment programs were either suspended or quickly migrated to phone calls or videoconferencing platforms due to stay-at-home orders and social distancing policies.

Telehealth Delivery

Remote interventions delivered live by a provider via telephone or videoconferencing, often referred to as telehealth, produce weight loss outcomes that are most consistent with those of in-person interventions. This delivery method improves treatment access and reduces travel time and cost for participants, but it has minimal impact on provider time and training costs. Several large trials have compared individual or group telephone calls to in-person treatment delivery. For example, Donnelly et al (67) achieved median 26-week weight losses of 13.0% with group conference calls which did not differ from the 12.7% loss of patients who attended on-site groups (both also received a 12-week 1200-1500 kcal/day portion-controlled diet). Similarly, Appel et al (68) showed comparable weight losses at 24 months for participants who received telephone-delivered sessions compared to those that received in-person visits (4.6 kg and 5.1 kg, respectively). Telephone-based interventions also have shown to be effective for weight maintenance and appear to attenuate weight regain to a similar degree as ongoing in-person sessions (62,65,69).

In the past several years, videoconferencing platforms have become more widely accessible. These platforms provide the capability for remotely

delivered face-to-face interactions, which allow for visual demonstrations and may enhance feelings of connection with the interventionist and/or group (70). This delivery format has yet to be compared to in-person intervention in a randomized trial; however, pilot and short-term studies report weight losses that are 3 to 8 kg larger than control or minimal intervention conditions (71-73), which suggests that videoconferencing also may produce weight losses that are similar in magnitude to those of in-person interventions.

Digital Delivery via the Internet or Smartphone

Digitally-delivered programs in which standardized intervention content is delivered via digitally-accessible articles, messages (e.g., e-mail or SMS), or pre-recorded videos further reduce costs and interventionist burden when compared to live interventionist delivery either in person or through telehealth. Some of the earliest interventions with digital session content were developed for delivery via the internet. In an early study, Tate el al. (74) demonstrated that an Internet-based behavioral approach consisting of email-based lessons, online self-monitoring of diet and physical activity, and e-mail feedback from an interventionist produced greater 6-month weight losses of 4.1 kg compared to the 1.6 kg loss achieved by participants who received an educational program (i.e., Internet resources with no specific instruction in changing eating and activity habits). As technology has evolved, digital programs have more typically been developed for mobile delivery via smartphone apps or in formats accessible via either the computer or smartphone. Intervention delivery via text message also has been evaluated, but typically produces small mean weight losses (1-2 kg) when used as a stand-alone intervention format (75).

Relatively few studies have directly compared the efficacy of digitally-delivered to in-person treatment. Harvey-Berino and colleagues (76) compared the same 24-session group lifestyle intervention delivered weekly: 1) in-person; 2) by internet (including online content, self-monitoring tools, and weekly chat groups); or 3) in a hybrid format (the internet program with monthly in-person meetings). Weight losses were 8.0, 5.5, and 6.0 kg, respectively, with in-person treatment superior to the other two groups. These findings, along with the results of multiple systematic reviews, suggest that the strongest digitally-delivered interventions produce short-term losses that are at least 20-35% smaller than those achieved with in-person counseling (77, 78). Such interventions are valuable given their wide reach and low cost, and the difference between the results of these digital interventions and in-person programs is likely to wane over time with regain. However, the average effect of digitally-delivered interventions is small (1-3 kg), highlighting the importance of identifying features associated with effective interventions (77, 78).

The provision of tailored feedback is by far the most commonly identified characteristic that differentiates effective from less effective digital interventions (77, 78). In earlier digital trials, feedback was provided directly by an interventionist. Increasingly, digital programs provide fully-automated, personalized feedback, generated from algorithms that analyze participants' self-monitoring data. This tailored automated feedback appears to produce weight losses that are similar in magnitude to programs with interventionist-delivered feedback (e.g., 79, 80). A 2015 study by Martin and colleagues (81) evaluated a combined approach providing participants with highly personalized automated and weekly interventionist-initiated feedback (by phone, email, or app), in addition to app-based lesson materials, in an

effort to maximize weight loss. Participants were given activity monitors and smart scales, and the app delivered automated graphic feedback comparing their physical activity and weight loss to expected targets (calculated based on their starting weight and calorie prescription). If participants' weight losses fell outside of the expected range, they were prompted to select a behavioral strategy (e.g., use portion-controlled foods) to get back on track. In this 12-week pilot study, intervention participants lost 9.4 kg compared to 0.6 kg in the control group (81). Additional research is investigating the potential for just-in-time adaptive interventions (JITAIs) that use machine learning to identify individual risk factors for behavioral lapses and provide tailored feedback and intervention strategies at the times when an individual is most at risk. An initial evaluation of a JITAI intervention that was designed to promote dietary adherence by predicting dietary lapses produced a 10-week weight loss of 4.7% when combined with an app-based commercial weight loss program (82).

User engagement has been found to correlate with weight loss in several digital trials, making it another potential target for improving the efficacy of digital interventions. One approach for enhancing engagement is to increase the interactive quality of the digital program. Thomas, Leahey, and Wing (83) tested the efficacy of a 12-week online program that provided interactive lessons that incorporated videos, quizzes, and practical exercises. The program also provided self-monitoring tools and fully automated weekly feedback based on participants' recorded data. At 6 months, intervention participants lost 5.4 kg, compared to 1.3 kg for control participants who received static lessons about the benefits of weight loss (without behavioral strategies). Other efforts to increase interactive engagement have incorporated lifestyle programs into social media platforms, virtual reality, or online games, and several of these interventions also have produced mean weight losses of 4-5 kg (84). A recent study by Vaz and colleagues (85) combined several of these techniques into a smartphone app that provided automated feedback on weight and physical activity recorded via smart scale and activity tracker, respectively; text- and app-initiated engagement prompts from an interventionist; social networking and sharing of food and exercise data; and peer competitions based on dietary and physical activity adherence. The app produced a mean weight loss of 7.2 kg at 6 months, which was 4.2 kg larger than a control group that received two weight management visits.

Unfortunately, the efficacy of most commercially-available weight loss apps has not been systematically evaluated. A majority of these apps include only a small percentage of the behavioral strategies typically featured in intensive lifestyle programs (86), and most do not provide tailored feedback. Such programs are not likely to induce a clinically meaningful weight loss for most individuals. For example, the highly popular app, MyFitnessPal, which helps users set a calorie goal and track food intake, produced a mean loss of only 0.03 kg in 6 months in primary care patients, compared with a gain of 0.3 kg in controls (87). The frequency of logins declined sharply after the first month (to close to 0), which again underscores the problem of maintaining user engagement with digitally-delivered interventions that do not provide interactive content. Results have been more promising for online and app-based commercial programs that do provide comprehensive intervention content. Weight losses of 4-5 kg were achieved at 3-6 months in a randomized trial evaluating an online commercial program that provided nine weekly e-mail delivered video lessons, online content (e.g., recipes), self-monitoring tools,

personalized summaries of self-monitoring data, and the option to chat with an interventionist online (88). Overall, these findings suggest that providers can support their patients' weight loss by helping them to identify digital programs that offer comprehensive session content and personalized feedback.

CONCLUSION

There is clear evidence that intensive lifestyle interventions are effective in helping patients with obesity to lose 5-10% of initial body weight, a loss that is associated with improvements in CVD risk factors and other obesity-related comorbidities. Lifestyle approaches emphasize prescriptions for dietary intake, increased physical activity, and behavioral skills such as self-monitoring. Traditionally, these interventions have been delivered in-person by a trained interventionist, which limits their potential dissemination. It is also possible to achieve a clinically meaningful weight loss with digitally-delivered programs that include little to no contact from an interventionist, provided the intervention provides comprehensive session content, tailored feedback, and features that promote user engagement.

One of the most challenging aspects of behavioral weight control is keeping off lost weight. Several strategies can facilitate this goal, including maintaining patient-provider contact beyond the initial weight loss intervention, either in-person or remotely, 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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