



# Update on Behavioral Weight Loss Treatments to Reduce Obesity and Lower Cardiometabolic Risks

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## Abstract

**Purpose of Review** Obesity is an intractable clinical and public health problem that is associated with morbidity and mortality. This review provides an update on current and emerging behavioral weight loss interventions (BWLIs).

**Recent Findings** Because lifestyle behaviors are primary determinants of weight loss success, BWLIs are front-line treatments in the clinical management of obesity. BWLIs provide guidance in dietary restriction, increased physical activity, and decreased sedentary behavior to achieve reductions in body weight. Intensive in-person comprehensive BWLIs providing 14 or more sessions over 6 months are effective in producing weight losses of 5–10% and are recommended by clinical guidelines. High-intensity BWLIs providing frequent contacts during the first 2 years have been shown to be more effective in preventing weight regain than lower intensity programs. The Medicare Diabetes Prevention Program (MDPP) is an evidence-based, federally supported translational community-based BWLI program that is being made available to communities across the US. Mindfulness-based interventions, acceptance-based interventions, and motivational interviewing are evidence-based modalities that have been recently translated into BWLIs. Current evidence suggests they can provide short-term weight loss similar to established BWLIs, but further research is needed to evaluate their effectiveness for long-term weight loss maintenance. Internet-based delivery of BWLIs offers the potential advantages of greater accessibility and reach, user anonymity, and cost-effectiveness for long-term weight loss maintenance.

**Summary** Comprehensive, intensive BWLIs are effective, but long-term weight maintenance is challenging and requires ongoing participant engagement. Newer translational BWLIs and Internet-based BWLIs are being developed to improve weight loss outcomes.

**Keywords** Obesity · Weight loss · Cardiometabolic · Lifestyle · Behavioral · Novel interventions

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## Introduction

Obesity is one of the greatest public health challenges, and its adverse health effects are linked to morbidity, disability, and death [1–4]. In the USA, the prevalence of obesity was 38.0% for men and 41.5% for women in 2015–2016 [5]. Obesity increases the risk of heart disease, hypertension, hyperlipidemia, pulmonary disease, stroke, type 2 diabetes mellitus, hepatobiliary disease, osteoarthritis, and cancer [6–12]. Additional cardiovascular sequelae include increased risk of atrial fibrillation, heart failure, and increased systemic inflammation and prothrombotic state [13–16]. Genetic, hormonal, and metabolic factors predispose some individuals to obesity [17, 18].

Patients with obesity may have difficulty achieving an ideal weight; however, they are often capable of achieving a healthier weight [19]. Modest weight losses of 5–10% have been

associated with significant improvements in cardiovascular risk factors, and more substantial weight losses lead to even greater health benefits [20].

Obesity treatment is aimed at balancing energy intake and expenditure [21] and includes behavioral interventions, medications, hormonal treatments, and bariatric surgery. Although the causes of obesity are multifactorial, lifestyle behaviors are significant predictors of energy balance and patients' weight status. Behavioral treatments are important in the modification of these behaviors and in the clinical management of obesity.

A search of published reports on behavioral weight loss interventions (BWLIs) for years 2013–2019 consistently identified several emerging treatments that have been evaluated alone and in combination with more established BWLIs. This article provides a brief review of established BWLIs and highlights emerging treatments in the field.

## Behavioral Weight Loss Interventions

Behavioral treatments are widely recommended as first-line interventions for overweight and obese individuals [22]. They can lead to significant improvements in weight and reduced risks of diabetes and other obesity-associated morbidity, and BWLIs are associated with less weight gain compared with controls and present little to no risk of harm [23]. The US Preventive Services Task Force (USPSTF) recommends that physicians offer or refer BWLIs to adults with a body mass index of 30 or higher [24].

BWLIs provide support in making lifestyle changes including caloric restriction, increased physical activity, and decreased sedentary behavior in order to correct energy imbalances and achieve and maintain reductions in body weight [23]. They also support patient adherence to weight loss programs, which is an important predictor of success [21, 25–27]. Table 1 provides descriptions of these techniques which have their underpinnings in classical and operant conditioning, cognitive behavioral therapy, and social cognitive theory which posits that individual self-efficacy, behavioral reinforcement, and environmental supports are keys to behavior change [28]. BWLIs are provided by professionals with degrees in nutrition, psychology, social work, health education, exercise physiology, and related fields. Lay interventionists may also be effective [29].

Intensive in-person, comprehensive BWLIs that provide 14 or more sessions over 6 months have been effective in producing weight losses of 5–10% and are strongly recommended by the American College of Cardiology/American Heart Association Task Force on Practice Guidelines [30]. Systematic reviews have found that participants in intensive BWLIs experienced significantly greater weight loss and reduced waist circumference compared with controls at up to 24 months of follow-up and were more likely to achieve 5%

weight loss from baseline [23, 31]. The USPSTF has expressed limited confidence, however, in the evidence for BWLIs to improve long-term health outcomes, including all-cause mortality, cardiovascular events, and quality of life, rating the strength of evidence as low [23].

Individual BWLIs are typically provided several times monthly for the first 4–6 months, after which weight loss maintenance continues through individual or group sessions at reduced frequency of contact [22]. More effective weight loss maintenance has been associated with higher treatment intensity (approximately weekly contacts) during the first 2 years [32]. Group treatment usually comprises 8 to 15 participants, and evidence suggests that group treatment can be more effective for weight loss than individual treatment even among participants who initially express a preference for individual treatment [33]. Group-based weight loss interventions may be more effective than individual interventions because they provide peer support [34, 35].

## Exemplar Behavioral Weight Loss Program

The Diabetes Prevention Program (DPP) is a well-studied BWLI designed to prevent or delay the development of type 2 diabetes for adults at increased risk for the development of diabetes and microvascular complications. It is an intensive, comprehensive BWLI program that is widely regarded as model for community-based programs to which cardiologists and other clinicians may refer patients [36]. It often serves as the standard for BWLIs against which newly developed weight loss interventions are compared, such as those described in the section of this article entitled, “[Emerging Modalities in Behavioral Weight Loss Treatment](#).”

The DPP trial randomized more than 3200 adults into three groups: the 16-session DPP intensive lifestyle intervention, standard lifestyle recommendations plus metformin (850 mg twice daily), or standard lifestyle recommendations plus placebo twice daily [36]. The intensive lifestyle intervention included a 16-session core curriculum, frequent face-to-face meetings with lifestyle coaches, supervised physical activity sessions, motivational campaigns, and a maintenance component that combined individual and group approaches [37]. By the end of a 24-week lifestyle curriculum, average weight loss was 5.6 kg in the lifestyle intervention group, 2.1 kg in the metformin group, and 0.1 kg in the placebo group [36]. After an average follow-up period of 34 months, the lifestyle intervention reduced diabetes incidence by 58% while metformin decreased diabetes by 31% compared with placebo [36].

The intensive behavioral intervention provided by the DPP resulted in substantial weight loss during the first 2 years with significant reductions in the incidence of diabetes, and comparable findings have been reported from similar interventions

**Table 1** Behavioral weight loss techniques

Goal setting	Setting agreed upon goals for weight loss, often 1–2 lb/week or 5–10% loss of initial body weight within the first 6 months
Positive reinforcement	Self-reward for goal attainment using an immediate, desirable reward, e.g., calling a friend, reading a good book
Stimulus control	Identifying and managing environmental factors that trigger undesired eating
Problem-solving	Defining problems or barriers to weight loss, identifying and evaluating alternatives, and choosing a course of action
Behavior chain mapping	Outlining a chain of thoughts, feelings, and events, including precipitating events and vulnerability factors that lead to undesired eating
Relapse prevention	Identifying and preventing high-risk situations for undesired eating or reduction of physical activities that promote weight loss
Self-monitoring	Monitoring behaviors and outcomes using food diaries, physical activity records, and self-weighing
Eliciting motivation	Helping the patient identify their reasons for wanting to lose weight and the benefits they will realize through weight loss
Social support	Emotional and instrumental support from others that facilitates weight loss
Social learning	Acquisition of weight loss skills and behaviors from others via observation, imitation, and modeling
Nutrition and physical activity education	Dietary counseling and education, education about physical activities that facilitate weight loss and recommended frequency, intensity, and duration
Meal planning	Planning and preparing meals to achieve weight loss while accounting for the patient's nutritional needs, financial resources, and time available for shopping and food preparation
Modifying eating style	Changing eating behaviors, e.g., chewing more slowly, monitoring feelings of satiety, drinking water immediately before a meal or between bites, taking a break during a meal
Cognitive restructuring	Guiding the patient in understanding how dysfunctional thought patterns can undermine weight loss efforts and how those patterns can be changed. Examples of unhelpful patterns are all-or-nothing thinking, negative self-evaluations, unrealistic goals, and justifications for overeating
Stress management techniques	Methods include progressive muscle relaxation, diaphragmatic breathing, and meditation

[38–41]. Based on these findings, intensive BWLs have been developed for translation into community settings [42].

## Medicare Diabetes Prevention Program (MDPP)

The Medicare Diabetes Prevention Program (MDPP) is a translational community-based weight loss program based on the DPP that was launched in 2012 as a pilot program in partnership with the YMCA-USA, Centers for Disease Control and Prevention, and other partners [43]. The MDPP is now being offered to Medicare beneficiaries by community organizations across the USA. It consists of 12 months of group sessions for individuals with an indication of prediabetes, and an additional 12 months of ongoing maintenance sessions for those who meet weight loss and attendance goals to help ensure that they maintain healthy behaviors [44]. Organizations providing MDPP services are compensated by performance-based payments through the Centers for Medicare and Medicaid (CMS) [45].

A physician referral is not required for Medicare beneficiaries to participate in the MDPP program. Clinicians, however, have a key role to play in helping patients understand their diabetes risk and recommending the program [44]. This is important because although 48% of adults aged 65 and older have prediabetes, only 14% are aware of their condition [46].

## Emerging Modalities in Behavioral Weight Loss Treatment

Although standard BWLI programs are often successful for achieving 5–10% weight loss in the short term, greater initial weight losses would be beneficial. In addition, most of the initial weight that is lost is typically regained within 5 years [47]. New methods are emerging that seek to improve adherence through the acquisition of skills for changing thought patterns and behaviors to support both immediate and long-term weight loss. They may be used alone or as an adjunct to established BWLs. Three such approaches are discussed in the following section.

Each approach discussed in this section includes an evaluation of its translation via Internet technologies. Delivering weight loss interventions via the Internet has many advantages: 24/7 accessibility, user anonymity, greater reach to those who would otherwise not receive the intervention, and the capacity to quickly update interventions [48, 49]. These technologies have the potential for lower costs per unit due to increased economies of scale compared with traditional in-person behavioral weight loss services [50]. Conversely, high rates of attrition could result from providing online content rather than live face-to-face interactions to facilitate the difficult challenge of weight loss [51].

### Mindfulness-Based Weight Loss Programs

Mindfulness has been defined as “the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment.” [52]. It is said to be “simple to practice, but not necessarily easy” because it requires effort and persistence to overcome habitual patterns of thinking [53]. Mindfulness training has been evaluated as a BWLI due to its potential to increase levels of self-awareness necessary for weight loss, such as monitoring of food intake and noticing thoughts and feelings that trigger overeating [54]. Mindfulness trains individuals to allow distressing thoughts and sensations to come into awareness but to regard them without judgment. By so doing, distress tolerance is increased and emotional reactivity is reduced, which have the potential to make mindfulness self-reinforcing [55]. Mindfulness can be practiced formally through meditation practice, as taught in programs such as mindfulness-based stress reduction (MBSR) [56], or informally, by practicing present moment awareness during routine activities such as eating or exercise.

A recent meta-analysis of 19 studies found mindfulness-based interventions for weight loss to be moderately effective for reducing weight and largely effective for improving eating behaviors [54]. Across the studies, mean weight loss was 3.3% of initial body weight at post-treatment, and continued weight loss at follow-up was observed [54]. In comparison, traditional diet and exercise interventions resulted in mean weight loss of 4.7% at post-treatment (a non-significant effect size difference) but with increasing weight at follow-up, whereas weight continued to decrease at follow-up in the mindfulness intervention groups [54]. This suggests that skills developed through mindfulness training may be particularly useful for long-term weight loss. Weight loss effect sizes were greater for interventions that combined formal meditation practice with informal mindfulness exercises, compared with formal meditation alone. Mindfulness training had large effects on reducing obesity-related eating behaviors [54].

Two additional meta-analyses and reviews of empirical studies assessing the effects of mindfulness on weight loss

and related behaviors have been published in recent years, although some reservations have been expressed about the heterogeneity of the mindfulness interventions included in these reviews [54]. Ruffault and colleagues [57] did not detect a significant relationship between mindfulness training and weight loss in a systematic review and meta-analysis of 12 studies, but found that mindfulness reduced both impulsive eating and binge eating and increased levels of physical activity. Rogers and colleagues [58] conducted a meta-analysis of 15 studies and found mindfulness training to have large effects on improvement in eating behaviors, medium effects for eating attitudes, and small effects on body mass index.

### Using Technology to Deliver Mindfulness Interventions

There are few published technology-based mindfulness interventions for weight loss [59]. In an 11-week RCT, 90 college students were randomized to either a mindfulness mobile phone app group or a group that engaged in behavioral self-monitoring using an electronic diary to track diet and exercise. There were no significant between-group differences in weight loss at 11 weeks; however, the mindfulness app group reported significantly fewer episodes of emotional eating, fewer episodes of uncontrolled eating, lower stress levels, and higher levels of both mindfulness and mindful eating [60].

A workplace-based RCT randomized 89 participants to either receive a combined live and online mindfulness training program based on the mindfulness-based stress reduction (MBSR) or a wait list control group [61]. A range of behaviors were measured including dietary intake, eating behaviors, and physical activity. After 8 weeks, the mindfulness group participants had significantly increased fruit and vegetable intake and healthy eating behaviors and reduced fast food consumption [61].

### Summary of the Evidence for Mindfulness-Based Treatments

Mindfulness training can be effectively applied to weight loss and eating behaviors. Although disparate methods were used to assess outcomes in several studies, multiple trials reported mindfulness to be highly effective in reducing obesity-related eating behaviors. Mindfulness appears to have modest effects on short-term weight loss; however, evidence suggests that it may be more effective than traditional treatments for increasing weight loss over time. Mindfulness may be a useful adjunctive skill set for enhancing the effectiveness of traditional diet and exercise programs on reducing obesity-related eating behaviors and increasing long-term weight loss. Mindfulness programs are available through healthcare systems, community centers, and online.

## Acceptance-Based Interventions

The high prevalence of obesity may in part be due to a mismatch between humans' inherited drives to consume highly palatable food and conserve physical energy within the modern environment in which high-calorie foods are readily available and offsetting expenditures of physical energy are seldom required [62]. Accordingly, investigators are seeking ways to help overweight individuals to become less reactive to thoughts and feelings that give rise to unnecessary eating and lead to the avoidance of physical activity. Acceptance and Commitment Therapy (ACT) "increases the attention paid to internal states by using acceptance and mindfulness techniques, and commitment and behavioral activation techniques, to produce psychological flexibility." [63]. Psychological flexibility is the awareness of one's thoughts and feelings in the present moment without activating needless psychological defenses and the ability to respond to internal states and environmental cues in ways that are consistent with chosen values [63]. It promotes acceptance of hunger cravings and tolerance of the discomforts of physical exercise in order to uphold personal values [64].

### Acceptance-Based Weight Loss Interventions

Often referred to as acceptance-based treatment (ABT) in obesity research, the ACT model has been applied to weight loss in several recent clinical trials. A trial comparing standard behavioral treatment (SBT) to a combination of both SBT and ABT (SBT/ABT) for 190 overweight and obese individuals found that 25 sessions of SBT/ABT resulted in significantly greater weight loss at 12 months than those who received SBT alone (13.3% vs. 9.8%) [65]. Compared with the results of a prior investigation [66], greater weight loss success with ABT was attributed to using more experienced intervention clinicians and focusing ABT on willingness and acceptance of reduced eating pleasure rather than on coping skills [65]. A long-term follow-up study found that both groups regained most of the lost weight over 3 years, with weight losses at 36 months diminished to 4.7% for SBT/ABT and 3.3% for SBT alone, which were not significantly different [67]. However, the ABT group reported significantly higher quality of life at 24 and 36 months and was more likely to have achieved 10% weight loss at 36 months than the SBT group [67].

Based on prior evidence suggesting that ABT may be effective for individuals with high levels of emotional eating [66], a trial comparing ABT to SBT was conducted with a group of 162 overweight or obese adults reporting high levels of internally disinhibited eating. Internally disinhibited eating is the tendency to impulsively or opportunistically overeat in response to thoughts, feelings, and other stimuli [68], and it has been shown to be strongly associated with weight gain and

obesity [69]. Mean weight losses at 24 months were not significantly different (4.1% for ABT vs. 2.4% for SBT). However, the ABT group regained significantly less weight at 24 months than the SBT group, and more ABT participants lost 5% of their initial body weight [70].

### Acceptance-Based Interventions to Increase Physical Activity

Physical exercise is often inconvenient and uncomfortable and requires internal regulation of adverse thoughts and feelings that can lead to avoidance or discontinuation, which ABT interventions are designed to address.

Physical activity levels have been increased by ABT interventions in samples not specifically selected for overweight or obesity. In a 12-week study of 59 adults with low levels of physical activity, a greater proportion of those who underwent a DVD-based ABT intervention met or exceeded 3000 steps in 30 min on 5 days each week compared with a control group (30.4% vs. 4.3%) [71]. An 8-week study of 54 young women found that 4 h of training in ABT resulted in increased minutes of exercise at 5 weeks but not at 8 weeks post-intervention [72].

A trial of 189 overweight and obese participants randomized to receive either twenty-five ABT or SBT group sessions over 1 year reported non-statistically significant increases in minutes of moderate-to-vigorous exercise between groups at 12 months [73]. Six months after the start of the intervention period, exercise increased by approximately 44 min/week in the ABT group and 34 min/week in the SBT group but declined from those apices by approximately 24% in the ABT group and 14% in the SBT group by the end of 1 year [73]. It is important to note, however, that the baseline mean minutes of exercise for both groups were more than 90 min per week. In a small 12-week group-based pilot study of 16 overweight and obese adults who had recently lost at least 5% of their body weight, ABT participants increased moderate-to-vigorous physical activity by 69% to nearly 200 min/week, and improved exercise levels were significantly associated with experiential acceptance [74]. Experiential acceptance is a primary goal of ABT and is defined as "the adoption of an intentionally open, receptive, flexible, and nonjudgmental posture with respect to moment-to-moment experience" through a "voluntary and values-based choice to enable or sustain contact with private experiences or events." [75].

Two additional trials designed to increase both weight loss physical activities did not detect statistically significant increases in moderate-to-vigorous physical activity levels for ABT vs. SBT at 1 year [76] and ABT vs. untreated controls at 16 weeks [77].

## Using Technology to Deliver Acceptance-Based Interventions

Little evidence was found to support using telephone or Internet-based ABT interventions to increase weight loss or physical activity; however, there was evidence for the use of these modalities to effectively deliver ABT for other behavioral problems and conditions including smoking cessation [78] and symptom interference for patients with metastatic breast cancer [79].

### Summary of the Evidence for Acceptance-Based Treatment

Based on the evidence, ABT and combined ABT/SBT weight loss interventions were similar in effectiveness to SBT in facilitating weight loss during the first 12 months. ABT and ABT/SBT, however, sustained long-term weight loss more effectively than SBT in some trials and were shown to significantly improve reported quality of life for weight loss participants over the long term. With respect to increasing physical activity, the effects of ABT were not significantly different from those of SBT in the largest trial.

## Motivational Interviewing

Motivational interviewing (MI) is a collaborative, goal-oriented style of communication designed to address ambivalence and strengthen motivation and commitment to change [80]. It involves engaging the individual, helping them focus their goals, evoking their reasons for change, and guiding them in taking steps toward change by helping them resolve ambivalence [81]. It has been used to address a wide range of problems including substance use, gambling, parenting practices, HIV prevention, and health behaviors.

MI-based interventions for weight loss and physical activity have most often been compared with standardized dietary advice or usual care, which are comparatively weak interventions. A meta-analysis of 11 MI-based weight loss and physical activity trials reported a medium mean effect size ( $d = 0.51$ ) for reducing body mass compared with control interventions. [82] A large meta-analysis evaluating the effects of MI on several health behaviors reported medium mean effects in a separate analysis of 4 MI diet and exercise interventions ( $d = 0.53$ ) [83]. A meta-analysis of primary care interventions reported a medium mean effect size for weight loss ( $d = 0.47$ ) and a negligible mean effect size for physical activity ( $d = 0.07$ ), but both outcomes failed to reach statistical significance, possibly because the analyses were statistically underpowered [84]. A systematic review of 24 MI randomized controlled trials (RCT) for weight loss among adults in primary care reported that 13 studies reported weight losses of 5% or greater for MI compared with controls, and nine studies (37.5%) found significant weight loss at post-treatment [85].

## Using Technology to Deliver Motivational Interviewing Interventions

A multi-component RCT randomized 100 participants to either a website intervention group designed to increase healthy eating or an attention control group [86]. Through the website, the following five behavioral interventions were delivered in succession to participants over 6 months including MI to elucidate the relationships between values, actions, and consequences [86]. Fruit and vegetable intake increased significantly over the control group at 6 months and was primarily attributed the MI and maintenance components of the intervention [86]. Intake of saturated fat and added sugar decreased in the website intervention group but were not significantly different than the control condition.

Increasing daily intake of fruits and vegetables is an evidence-based strategy for weight loss [87]. In an RCT designed to increase fruit and vegetable consumption, 2540 participants were randomized to one of three conditions: a website that provided general information about fruits and vegetables (control group), a tailored web site matched the individual's dietary preferences, or the tailored web site plus MI counseling provided via e-mail [88]. Compared with baseline, intake of 5 or more fruits and vegetables per day at 12 month follow-up increased from 22 to 78% for the group assigned to the tailored web site plus MI counseling via e-mail, from 20 to 78% for the tailored website group, and from 21 to 75% for the control group [88]. The website was instrumental for increasing intake, while the additions of tailoring and MI appeared to have added marginal value.

Because MI is usually delivered through face-to-face interactions, an RCT tested whether integrating an avatar into a website designed to deliver MI would increase physical activity in comparison with a text-based website that provided identical MI content [89]. The avatar was an animated figure that communicated content through text balloons rather than voice and provided simple non-verbal expressions. At 1 month, self-reported physical activity significantly increased in both MI-based intervention groups compared with no treatment, although the addition of the avatar did not increase physical activity over the text-based MI website [89].

### Summary of the Evidence for Motivational Interviewing

The evidence suggests that MI interventions can result in significant weight loss and increased physical activity, with medium effect sizes. Although MI is a highly relational skill set, it can be effectively delivered through websites to significantly increase intake of fruits and vegetables and levels of physical activity.

## Conclusions

Comprehensive, intensive BWLIs can result in an average weight loss of up to 8 kg or 5–10% of initial weight within 6 months and are associated with improvements in cardiometabolic health [22, 36]. Frequent contacts between weight loss interventionists and participants are important for achieving and maintaining initial levels of weight loss over the long term [90]. In the absence of frequent program contacts, participants typically regain one third of lost weight in the first follow-up year and continue to regain over the ensuing years [91].

Given that obesity is considered by many to be a chronic relapsing condition [92], it may not be realistic to expect any behavioral intervention to be sustained without long-term reinforcement and accountability, which were not consistently provided in many of the reviewed studies. It may be helpful to integrate approaches used in chronic disease management [93] into BWLI programs including post-intervention telephone support, coaching, and ongoing delivery of the intervention via the Internet for as long as needed [67].

New behavioral interventions are being developed to increase the degree of initial weight loss and support weight loss maintenance either alone or in combination with standard behavioral weight loss treatments. Initial weight loss successes for the emerging interventions were generally similar to losses with standard behavioral weight loss treatments and were often followed by weight regain in the absence of sustained interventions. Internet-based technologies have the potential to sustain weight loss interventions cost-effectively while extending reach and improving access, but more research is needed to determine how best to use these technologies.

## Compliance with Ethical Standards

**Conflict of Interest** James J. Werner declares that he has no conflict of interest.

**Human and Animal Rights and Informed Consent** This article does not contain any studies with human or animal subjects performed by any of the authors.

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