

REVIEW

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## Behavioral Lifestyle Intervention in the Treatment of Obesity

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**Abstract:** This article provides an overview of research regarding adult behavioral lifestyle intervention for obesity treatment. We first describe two trials using a behavioral lifestyle intervention to induce weight loss in adults, the Diabetes Prevention Program (DPP) and the Look AHEAD (Action for Health in Diabetes) trial. We then review the three main components of a behavioral lifestyle intervention program: behavior therapy, an energy- and fat-restricted diet, and a moderate- to vigorous-intensity physical activity prescription. Research regarding the influence of dietary prescriptions focusing on macronutrient composition, meal replacements, and more novel dietary approaches (such as reducing dietary variety and energy density) on weight loss is examined. Methods to assist with meeting physical activity goals, such as shortening exercise bouts, using a pedometer, and having access to exercise equipment within the home, are reviewed. To assist with improving weight loss outcomes, broadening activity goals to include resistance training and a reduction in sedentary behavior are considered. To increase the accessibility of behavioral lifestyle interventions to treat obesity in the broader population, translation of efficacious interventions such as the DPP, must be undertaken. Translational studies have successfully altered the DPP to reduce treatment intensity and/or used alternative modalities to implement the DPP in primary care, worksite, and church settings; several examples are provided. The use of new methodologies or technologies that provide individualized treatment and real-time feedback, and which may further enhance weight loss in behavioral lifestyle interventions, is also discussed.

**Keywords:** obesity, lifestyle intervention, behavior modification, behavioral obesity treatment

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## Introduction

Over the past decade, obesity rates in the United States have remained fairly unchanged, with a prevalence of 35.9% in 2009–2010.<sup>1</sup> Obesity is associated with numerous chronic diseases, including type 2 diabetes mellitus, hypertension, high cholesterol, and heart disease.<sup>2</sup> A lower health-related quality of life is also associated with obesity.<sup>3</sup> Increasing health care costs are a major concern associated with the high prevalence of obesity and obesity-related diseases. In the United States, the total medical cost of adult obesity is estimated to be between \$147 billion and \$210 billion per year.<sup>4</sup> The medical costs associated with obesity also impact employers, as a study of 92,476 employees from seven organizations found obese individuals' total annual per capita employer and employee medical expenditures were 27.4% more costly than their overweight or healthy weight counterparts.<sup>5</sup> Thus, implementing effective behavioral approaches to treat obesity is necessary to reduce obesity-related morbidities and the costs associated with obesity.

Overweight and obesity result from positive energy balance; therefore, when energy intake exceeds energy expenditure, weight gain occurs. Foods and energy-containing beverages contribute to energy intake while energy expenditure consists of resting metabolic rate, thermic effect of food, and physical activity.<sup>6</sup> Of the three components that contribute to energy expenditure, physical activity is the only component under voluntary control that can be readily changed.<sup>6</sup> Thus, to alter energy balance for weight loss, energy intake can be reduced, physical activity can be increased, or both sides of energy balance can be changed. To improve health-related outcomes in adults, a weight loss of 10% of initial body weight, achieved via a comprehensive behavioral lifestyle modification approach, is recommended by the National Heart Lung and Blood Institute (NHLBI).<sup>7</sup> Key elements of a comprehensive behavioral lifestyle intervention for adults include behavior therapy, dietary goals, and physical activity goals.<sup>8–10</sup>

The purpose of this paper is to provide an overview of research regarding adult behavioral lifestyle intervention. The review focuses on intervention studies for weight loss that report on weight loss outcomes. Additionally, the review concentrates on research investigating dietary and physical activity approaches aimed at improving weight loss outcomes

that are supported within a behavioral intervention. As translation of efficacious programs into community-based settings is believed to be important in assisting with achieving the public health goal of improving adult weight status, issues related to translation are discussed and examples of translation, using the Diabetes Prevention Program (DPP), are provided. Areas of future research focusing on the use of new methodologies or technologies that provide individualized treatment and real-time feedback are also considered.

## Diabetes Prevention Program (DPP)

The DPP is considered to be the 'gold standard' for behavioral lifestyle intervention programs.<sup>11</sup> In the DPP, approximately 3,200 participants who were overweight or obese and with an elevated fasting glucose level were randomized to one of three groups: (1) standard recommendations plus metformin twice daily (metformin); (2) standard recommendations plus placebo twice daily (placebo); and (3) intensive behavioral lifestyle intervention (lifestyle). The two standard recommendation groups received written information at annual visits about the United States Department of Agriculture's (USDA) Food Guide Pyramid and National Cholesterol Education Program Step 1 diet. The lifestyle group received a core curriculum of 16 individual sessions over 24 weeks that introduced key behavioral strategies.<sup>12</sup> The DPP was a goal-based intervention, with a goal of losing 7% of initial body weight.<sup>11,12</sup> To achieve this weight loss goal, participants were recommended to engage in 150 minutes of moderate-intensity physical activity per week and consume between 1,200–1,500 kilocalories (kcal) per day, depending on their body weight.<sup>12</sup> Participants were followed for an average of 2.8 years, with the lifestyle group losing significantly more weight than the metformin and placebo groups (lifestyle = -5.6 kilograms [kg]; metformin = -2.1 kg; placebo = -0.01 kg,  $P < 0.001$  for all comparisons).<sup>11</sup> Additionally, the incidence of diabetes was 58% lower in the lifestyle group and 31% lower in the metformin group, as compared to the placebo group.<sup>11</sup>

## Look AHEAD (Action for Health in Diabetes)

The Look AHEAD (Action for Health in Diabetes) study was initiated in 2001 with the primary purpose to investigate the impact of a lifestyle



intervention, producing a minimum weight loss of 7%, on cardiovascular disease morbidity and mortality in individuals with diabetes.<sup>13</sup> Over 5,000, overweight (body mass index [BMI]  $\geq 25$  kg/m<sup>2</sup>) participants with type 2 diabetes were randomized to two groups, a diabetes support and education (DSE) group and an intensive lifestyle intervention (ILI) group.<sup>14</sup> The DSE group received three group education/social support sessions each year for the first 4 years. The ILI group was modeled after the DPP curriculum as described above.<sup>13</sup> One change in the dietary intervention component used in Look AHEAD as compared to DPP was the use of meal replacement products (eg, Slim-Fast® shakes). During the first 6 months, participants replaced two meals per day with meal replacement products, then one meal per day for months 7–12.<sup>13</sup> Additionally intervention contact time was different for the ILI group in Look AHEAD as compared to DPP. Look AHEAD had four contacts per month for months 1–6 (three group sessions, one individual session), three points of contact per month for months 7–12 (two group sessions, one individual session), two contacts per month during months 13–48 (one in-person; one mail, phone, or e-mail), plus optional 6-week refresher courses were offered (but not required), and two points of contact per year for the remainder of the intervention.<sup>13</sup> Participants were planned to be followed until 2014, but the trial was ended in 2012 due to a lack of difference in cardiovascular morbidity and mortality between groups, the primary outcome of the study.<sup>15</sup> However, 1-year and 4-year outcomes show the ILI group lost a greater percentage of initial weight than the DSE group (1-year: ILI =  $-8.6\% \pm 6.9\%$  versus DSE =  $0.7\% \pm 4.8\%$ ,  $P < 0.001$ ; 4-year: ILI =  $-6.2\%$  versus DSE =  $-0.9\%$ ,  $P < 0.001$ ).<sup>14,16</sup>

## Behavior Therapy

Strategies to change behavior come from behavior theory, which was founded by John B. Watson and behavior theory's theoretical perspective is that learning underlies human and animal behavior.<sup>17</sup> Behavior theory has three core components: antecedents, events that occur immediately before the behavior; the behavior; and consequences, events that immediately follow a behavior.<sup>18</sup> Behavior theory provides the basis for behavior therapy used in comprehensive behavioral lifestyle interventions. Behavior therapy

is used to provide participants with the strategies needed to modify eating and activity behaviors during obesity treatment.<sup>19</sup> Both DPP and Look AHEAD employed behavioral therapy strategies in the intensive behavioral lifestyle intervention study arms.<sup>12,13</sup>

A behavioral approach encourages self-monitoring of dietary and physical activity behaviors, stimulus control, goal setting, and pre-planning. Self-monitoring is considered the most important behavioral strategy in lifestyle interventions.<sup>20–22</sup> Self-monitoring increases awareness of the behavior and the increased awareness of the behavior is considered key for making a behavior change. Additionally, if a goal has been set for a behavior, self-monitoring allows progress towards achievement of the goal to be tracked. This feedback about behavior is essential to provide the opportunity for corrective action to take place so that the target goal can be achieved. Stimulus control involves altering the environment, such as adding or removing a stimulus to or from the environment, to assist with promoting healthy eating and activity behaviors. Goal setting involves establishing a specific, measurable, achievable goal that will promote change of the target behavior. For example, both DPP and Look AHEAD established a goal for daily caloric intake and a goal for weekly minutes of physical activity. To assist with shaping eating and physical activity behaviors, smaller goals that build to the larger goal or target behavior may be used. This strategy may be especially helpful when a large change in behavior is required. For example, this strategy is particularly helpful with physical activity, as many participants may be inactive upon entering a program.<sup>23</sup> As reaching a goal can be motivating and increases self-efficacy, small goals, or shaping, can be used to enhance an individual's success at achieving larger goals. Since barriers can prevent an individual from reaching a goal, pre-planning and problem-solving are behavior modification strategies that can be used to assist an individual with meeting the goals. Pre-planning involves the development of a specific plan to encourage a particular behavior, such as looking at a meal's calorie information prior to going to a restaurant in order to identify the best option that will meet a calorie goal. Problem-solving, on the other hand, is used to remove barriers. Problem-solving requires one to identify the problems or barriers, brainstorm solutions, and then select a solution to implement



and evaluate. Perri and colleagues<sup>24</sup> have demonstrated the benefit of implementing active problem-solving on long-term management of obesity. To change a behavior, behavioral therapy strategies are used all together to alter the target behavior.

In standard lifestyle interventions, behavioral techniques are taught to participants by trained interventionists in an individual or group format.<sup>25</sup> Each meeting typically begins with a weight measurement in a private location. During this weigh-in, the interventionist has the opportunity to guide the participant in understanding the relationship between the achievement of eating and physical activity goals and weight change over a specified time period. This assists with self-regulation, so that participants begin to understand how to alter eating and activity behaviors to influence weight. If progress has not been made toward the eating and activity goals, and weight has not decreased, problem solving is engaged in, and information from self-monitoring records may assist with this process.<sup>9,26,27</sup> The remainder of the session introduces a behavioral strategy.<sup>9,26,27</sup> To reinforce the behavioral strategy introduced during the session, participants will typically complete a related assignment at home to assist with implementation of the technique. As frequency of contact is considered to be an important component of comprehensive behavioral lifestyle interventions, weekly meetings occur during the first 6 months to facilitate weight loss, and pending the length of the intervention, meetings are then typically reduced to bi-monthly over the next 6–12 months to promote weight loss maintenance.<sup>10</sup>

Behavior therapy is the core component of lifestyle intervention. Within obesity treatment, behavior therapy is implemented to assist individuals in making dietary and physical activity changes; specifically, dietary and physical activity goals are prescribed during obesity treatment to alter energy balance that will produce weight loss.

## Dietary Goals in Behavioral Lifestyle Interventions

Within behavioral lifestyle interventions for obesity treatment various dietary goals can be targeted for change. Prescribed dietary interventions have traditionally focused on reducing energy and fat intake to assist with creating the energy deficit needed for weight loss.

## Energy-restricted, low-fat

The 2008 NHLBI clinical guidelines recommend an energy-restricted, low-fat diet for treatment of obesity.<sup>7</sup> The DPP<sup>11</sup> and Look AHEAD<sup>13</sup> trials both utilized an energy-restricted, low-fat diet, classically defined as 1,200–1,500 kcals per day with  $\leq 30\%$  kcals from fat. An energy-restricted diet is recommended to create an energy deficit of 500–1,000 kcals per day to incur a 1–2 pound per week weight loss.<sup>7</sup> While other dietary prescriptions exist, these dietary goals are the most commonly recommended dietary prescriptions during behavioral lifestyle interventions, and are thus considered the conventional diet for weight loss.<sup>28</sup>

## Macronutrients

Altering the macronutrient composition within the diet is another method used to promote weight loss. Several investigations have reduced the amount of carbohydrate within a diet to facilitate weight loss, while others have increased the amount of protein within an energy-restricted diet.

The low-carbohydrate diet was popularized by Dr. Atkins as a superior dietary method for weight loss, under the hypothesis that inducing ketosis would reduce hunger and ultimately assist in reducing intake.<sup>29</sup> No standard definition of low-carbohydrate exists; however, most interventions define a low-carbohydrate diet as 20 grams of carbohydrates per day.<sup>28,30,31</sup> In low-carbohydrate diets, energy is not restricted, yet research has found that energy intake does decrease when a low-carbohydrate diet is prescribed.<sup>32</sup> This reduction in energy intake, rather than ketosis, is the hypothesized mechanism by which a low-carbohydrate diet produces weight loss.<sup>33,34</sup> A systematic review of randomized controlled trials examining the effect of low-carbohydrate diets on weight loss found that low-carbohydrate diets reduced body weight over a  $\geq 3$  month time period when compared to corresponding baseline values.<sup>35</sup> Furthermore, two systematic reviews found that when compared to a low-fat and/or energy-restricted diet, the low-carbohydrate diet produced better weight loss at 6 months, but outcomes in weight loss were similar between the diets at 12 months.<sup>36,37</sup> To examine more long-term outcomes, Foster and colleagues<sup>38</sup> compared a low-carbohydrate diet to an energy-restricted, low-fat diet and examined weight loss outcomes at 2 years in approximately 300 obese



participants within a randomized controlled trial. While significant weight loss occurred, no difference in weight loss was found between the two diets (low-carbohydrate =  $-6.3$  kg [ $-8.1$  to  $-4.6$  kg, 95% confidence interval]; energy-restricted, low-fat =  $-7.4$  kg [ $-9.1$  to  $-5.6$  kg, 95% confidence interval]).

Alternatively, increasing the percent energy from protein is believed to enhance weight loss due to protein's satiating quality, which could assist with reducing overall energy intake.<sup>39-41</sup> A high protein diet is defined as 20%–30% energy from protein.<sup>40</sup> Findings from a study with 100 women randomized to either an energy-restricted, high-protein, low-fat diet (34% energy from protein, 20% energy from fat, 46% energy from carbohydrate) or an energy-restricted, high-carbohydrate, low-fat diet (17% energy from protein, 20% energy from fat, 64% energy from carbohydrate) for 12 weeks showed weight loss was not significantly different between conditions (high-protein:  $-7.6 \pm 0.4$  kg versus high-carbohydrate:  $-6.9 \pm 0.5$  kg).<sup>42</sup> Similarly, Brinkworth and colleagues<sup>43</sup> randomized 66 obese participants with type 2 diabetes to a low-protein (15% energy from protein, 55% energy from carbohydrate) or high-protein (30% energy from protein, 40% energy from carbohydrate), energy-restricted diet for 8 weeks, followed by 4 weeks of energy balance. At 12 weeks, mean weight loss was 5.7% of initial body weight, with no difference in weight loss between the diets.

To better understand the impact of differing macronutrient alternations on weight loss, Sacks and colleagues<sup>44</sup> conducted a 2-year randomized controlled trial with 811 overweight adults; participants were randomized to one of four energy-restricted diets: (1) low-fat, average-protein (20% energy from fat, 15% energy from protein, 65% energy from carbohydrate); (2) low-fat, high-protein (20% energy from fat, 25% energy from protein, 55% energy from carbohydrate); (3) high-fat, average-protein (40% energy from fat, 15% energy from protein, 45% energy from carbohydrate); or (4) high-fat, high-protein (40% energy from fat, 25% energy from protein, 35% energy from carbohydrate). Weight loss at 2 years was not significantly different between participants assigned to a 25% energy from protein diet or 15% energy from protein diet (25% protein:  $-3.6$  kg versus 15% protein:  $-3.0$  kg) or participants assigned to a 40% energy from fat diet or 20% energy from fat diet (40% fat:  $-3.3$  kg

versus 20% fat:  $-3.3$  kg). Additionally, percent energy from carbohydrate was found to have no effect on weight loss.

Studies examining differences in macronutrient composition of the diet have not found a specific macronutrient composition that appears to enhance weight loss. As all examined diets reduce energy intake, outcomes from each of these studies suggest that the degree of energy reduction may be the most important dietary factor for weight loss.<sup>31,42-44</sup>

## Meal replacements

Diets using meal replacements have been used to increase dietary adherence to an energy-restricted, low-fat diet.<sup>13</sup> One challenge in adherence to any dietary prescription is consuming foods of an appropriate portion size to meet the prescribed dietary goals, as weighing and measuring all foods and beverages consumed is burdensome to participants.<sup>45</sup> Using meal replacements (eg, liquid shakes, meal bars) assists with portion control and may increase success at reducing intake to assist with weight loss.<sup>46-50</sup> Besides assisting with portion control, meal replacements may aid in reducing energy intake by increasing the structure of the diet and enhancing the ease of pre-planning meals and snacks, an important behavioral strategy. Most meal replacement dietary prescriptions are considered to be a partial meal replacement prescription because a meal replacement product is used for two meals and one meal includes conventional foods, as determined by the participant.<sup>13,50</sup> Commonly, the meal replacement is a portion-controlled product in a liquid<sup>51-54</sup> or solid<sup>53-55</sup> form. Regardless of form, meal replacements are a successful tool to promote weight loss.

A meta-analysis of the effect of meal replacements on weight loss found that at the 3- and 12-month follow-up, the meal replacement conditions reported significantly more weight loss than more traditional dietary prescriptions, many of which were isocaloric to the meal replacement condition.<sup>50</sup> Due to outcomes from this meta-analysis, the Look AHEAD trial described earlier used meal replacements in the intervention. One year outcomes from Look AHEAD showed the number of meal replacements consumed for the year was associated with weight loss at 52 weeks ( $r = 0.30$ ,  $P < 0.001$ ).<sup>56</sup> Furthermore, Look AHEAD participants in the highest quartile for meal



replacement use had four times greater odds of reaching the 7% weight loss goal.

Consistently, diets that reduce energy intake successfully produce weight loss; however, dietary adherence over time may be reduced and weight regain occurs. Dietary adherence is a challenge across all dietary interventions. A systematic review by Barte and colleagues<sup>57</sup> included 22 intervention groups from twelve studies that were a minimum duration of 1 month and had an unsupervised follow-up after the intervention of at least 1 year; this review found that the average percentage maintenance ( $[\text{weight loss from baseline to end of the unsupervised follow-up} \div \text{weight loss during the intervention}] \times 100\%$ ) was 54%. The issues with long-term adherence to lower energy intake continue to make it challenging for many participants to achieve long-term weight loss maintenance.<sup>58</sup> Thus, novel dietary interventions that promote long-term weight loss maintenance are needed.

## Novel Dietary Interventions

To reduce energy intake, but also increase dietary adherence, several novel dietary prescriptions have been explored. These dietary interventions offer innovative methods focused on dietary variety, energy density, and eating frequency, all which may reduce energy intake, but need further investigation.

### Dietary variety

Basic eating research demonstrates that greater variety within a meal results in increased consumption, with the proposed mechanism due to enhanced exposure to varied sensory properties of food.<sup>59</sup> Greater variety within a meal diminishes the occurrence of sensory-specific satiety, and this is theorized to be a consequence of a reduction in habituation.<sup>60</sup> Habituation is a basic form of learning, in which behavioral and physiological reactions decrease in response to repeated presentations of a stimulus, with the decrease in response unrelated to sensory adaptation/fatigue or motor fatigue.<sup>61</sup> Decreasing food variety, which should enhance repeated exposure to the same food, ought to increase habituation, thereby eliciting a diminished response of consumption and reducing energy intake.

A standardized methodology for how to define dietary variety has not been established. Thus, dietary

variety has been defined by the number of different foods within a meal,<sup>59</sup> the number of different types of entrees served at the same meal (ie, dinner) across days,<sup>60</sup> and the number of different foods within a food group,<sup>62</sup> or alternatively, the overall number of different foods consumed within the diet.<sup>60</sup>

One randomized controlled trial has tested a limited dietary variety prescription on weight loss in adults. Raynor and colleagues<sup>63</sup> conducted an 18-month trial, in which 202 overweight and obese participants were randomized to a lifestyle condition (1,200–1,500 kcals/day, 30% kcals from fat) or lifestyle plus limited variety condition (limited non-nutrient-dense, high-energy-dense foods [ie, cookies, chips, ice cream] to two choices). This trial found that the limited variety prescription did produce a significant reduction in energy intake of the targeted foods as compared to the lifestyle condition at 6, 12, and 18 months; however, this difference did not translate to a greater overall reduction in energy intake between the two conditions at 18 months. Additionally, no difference in weight loss occurred between the conditions at any assessment time points. This suggests that while reducing variety did decrease energy intake in the targeted area of the diet, the prescription to limit variety may need to target more areas of the diet to reduce overall energy intake and enhance weight loss.

### Energy density

Energy density is the amount of energy per gram of food and has been identified as a strategy to reduce energy intake for weight loss.<sup>64,65</sup> It is proposed that consumption of low-energy-dense foods allows for a greater weight of food to be consumed relative to energy, which is believed to increase satiation, and thereby reduce excess energy intake.<sup>66</sup> Thus, a diet low in energy density may reduce energy intake and BMI,<sup>65,67,68</sup> and it may also reduce feelings of deprivation and hunger, thereby improving long term weight loss maintenance.

Energy density is determined by the amount of water, fat, and fiber in a food.<sup>69</sup> Foods such as fruits, vegetables, and whole grains, are higher in water and/or fiber content, but lower in fat content and are low-energy-dense foods. Alternatively, foods high in fat content, but low in water and fiber content, include foods such as chips, candy, and cookies, and are



considered high-energy-dense foods. A systematic review of the evidence between energy density and body weight by the United States Dietary Guidelines Advisory Committee resulted in the 2010 Dietary Guidelines for American recommending the consumption of a diet low in energy density.<sup>70</sup>

Consistently, basic eating research has found that when adults are provided meals composed of low-energy-dense foods, energy intake within the meal is lower as compared to meals in which high-energy-dense foods are provided.<sup>66,69,71</sup> While there is substantial basic eating research regarding the relationship between energy density and energy intake, less intervention research on energy density has been conducted. The first randomized controlled trial to investigate the impact of dietary energy density on weight loss was conducted by Ello-Martin and colleagues<sup>64</sup> in 97 adults randomized to a reduced-fat (RF) or a reduced-fat plus increased fruit and vegetable (RF + FV) condition for 1 year. Seventy one participants completed the study and significantly ( $P < 0.001$ ) lost weight (RF:  $-6.4 \pm 0.9$  kg; RF + FV:  $-7.9 \pm 0.9$  kg), but weight loss was not different between conditions. Energy density decreased significantly over time with a larger reduction in the RF + FV condition as compared to the RF condition ( $\Delta$ RF:  $-0.36 \pm 0.08$  kcals/g versus  $\Delta$ RF + FV:  $-0.41 \pm 0.06$  kcals/g,  $P = 0.019$ ). Of greater interest, participants in the RF + FV condition consumed significantly more (225 g,  $P = 0.025$ ) food than the RF condition. Additionally, hunger ratings significantly ( $P = 0.030$ ) decreased over time in the RF + FV condition from baseline, but not the RF condition.

A novel energy density prescription was tested by Raynor and colleagues<sup>72</sup> in a 3-month pilot randomized trial. Forty-four adults were randomly assigned to one of three groups: (1) Low-energy-density (ED) (consume  $\geq 10$  foods  $\leq 1.0$  kcal/g and  $\leq 2$  foods  $\geq 3.0$  kcals/g per day); (2) Low-Energy, Low-Fat (consume 1,200–1,500 kcals/day,  $\leq 30\%$  kcals from fat); (3) or Low-ED, Low-Energy, Low-Fat (prescribed all dietary goals). Participants in the Low-ED group lost significantly ( $P < 0.05$ ) more weight than the Low-ED, Low-Energy, Low-Fat group (Low-ED  $-20.5 \pm 7.0$  lbs; Low-Energy, Low-Fat  $-16.9 \pm 10.1$  lbs; Low-ED, Low-Energy, Low-Fat  $-12.5 \pm 6.5$  lbs).

## Eating frequency

Eating frequency is typically viewed as the number of differing eating bouts (meals and snacks) occurring per day.<sup>73</sup> Two hypotheses surround how eating frequency may impact energy intake and weight management. Originally, eating frequently, commonly referred to as ‘grazing,’ was hypothesized to assist with controlling hunger via homeostatic mechanisms. Preventing excessive hunger would then reduce the occurrence of overeating, thus assisting with keeping energy intake at an appropriate level for weight management.<sup>74,75</sup> Alternatively, it has more recently been hypothesized that when trying to consume an energy-restricted diet, eating three times a day, rather than five or more times a day, could help with adhering to an energy-restricted diet via behavioral mechanisms, such as stimulus control (ie, reducing the number of times during a day in which one is exposed to food).<sup>76</sup>

National dietary survey data from the United States shows the number of eating occasions in a day has increased from  $3.8 \pm 0.03$  occasions per day in 1977–1978 to  $4.9 \pm 0.04$  occasions per day in 2003–2006 in the United States.<sup>77</sup> At this time, current evidence about the impact of eating frequency on energy intake and weight status is inconsistent, and there is a recommendation that research is needed in this area.<sup>78</sup> Cross-sectional data show an inverse relationship between eating frequency and BMI in adults;<sup>79</sup> however, some data support no relationship<sup>74</sup> or a positive relationship.<sup>75</sup> Bachman and Raynor<sup>76</sup> investigated the impact of eating frequency during weight loss treatment with 51 adults randomized to a three meal or grazing condition (eating every 2–3 hours), with both conditions prescribed an identical energy-restricted, low-fat diet. Outcomes showed the grazing condition significantly reduced hunger over 6-months; however, reductions in energy intake and BMI were not significantly different between conditions. Interestingly, at 6-months the three meal condition had a lower BMI than the grazing condition (three meal:  $29.8 \pm 4.4$  kg/m<sup>2</sup> versus grazing:  $31.3 \pm 5.3$  kg/m<sup>2</sup>) with a small to medium effect size ( $d = 0.308$ ).

While the energy-restricted, low-fat diet is considered the conventional diet for weight loss, newer novel dietary interventions are being developed and tested to improve to long-term weight loss outcomes. Furthermore, novel interventions may improve



additional outcomes, such as diet quality, compared to more traditional prescriptions.

## Physical Activity Goals in Behavioral Lifestyle Interventions

Physical activity is considered an important part of a comprehensive behavioral lifestyle intervention as it increases overall energy expenditure, which assists with weight loss. Currently, the recommendations for physical activity for weight loss are approximately 150–250 minutes per week of moderate- to vigorous-intensity physical activity.<sup>80</sup> Moreover, during obesity treatment, regular engagement in physical activity is important to minimize the loss of fat-free mass that occurs as weight is reduced.<sup>81–83</sup> Since fat-free mass is a large determinant of resting metabolic rate, minimizing loss of fat-free mass during weight loss is important to enhance weight loss outcomes.<sup>83</sup> As adults naturally lose muscle mass as they age, a process known as sarcopenia,<sup>84</sup> weight loss without the inclusion of physical activity may also be detrimental to physical functioning, especially for older adults. In a study by Chomentowski and colleagues,<sup>85</sup> 25 overweight or obese adults (60–75 years old) with impaired glucose tolerance or impaired fasting glucose were randomized to a 4-month, diet-induced weight loss intervention (WL) or a weight loss and exercise intervention (WL/EX). Both groups were given individual energy-restricted diets based on their baseline weight. The WL/EX group also performed 30–45 minutes of physical activity at 65%–75% of the participants' maximum heart rate on 5 days per week, with 3 days being supervised in a facility, and 2 days being unsupervised. BMI decreased significantly in both conditions, but the WL intervention lost significantly ( $P = 0.044$ ) more fat-free mass than the WL/EX intervention.

While engaging in physical activity during weight loss is important for preservation of fat-free mass, engaging in physical activity is also important for successful weight loss maintenance<sup>6,80,86,87</sup> and improvement of obesity-related metabolic conditions,<sup>9</sup> specifically those related to cardiovascular health.<sup>81,88</sup> To encourage physical activity, several strategies, such as modifying exercise bout duration, using a pedometer, and increasing access to home exercise equipment, have been investigated. Additionally, to enhance outcomes in the area of elevating energy expenditure via

preserving or maintaining fat-free mass, the impact of resistance training has been explored.

## Exercise bout duration

Lack of time has been suggested as a primary reason for lack of engagement in physical activity; thus it has been suggested that multiple smaller bouts of physical activity may increase adherence.<sup>89,90</sup> Jakicic and colleagues<sup>91</sup> randomized 56 obese females (25–50 years old) to either a short bout (SB) or long bout (LB) condition, during a 20-week behavioral weight control program. Total physical activity minutes per day increased incrementally from week to week until at 8 weeks the goal of 40 minutes was achieved, with the SB performing multiple 10-minute bouts of physical activity and the LB condition performing one continuous bout of physical activity. Engaging in physical activity in multiple SBs per day improved physical activity adherence: the SB condition reported being active on a greater number of days ( $87.3 \pm 29.5$  days versus  $69.1 \pm 28.9$  days;  $P < 0.05$ ) and for a greater total duration ( $223.8 \pm 69.5$  min/week versus  $188.2 \pm 58.4$  min/week;  $P = 0.08$ ) than the LB condition. There was a main effect of body weight over time, with a trend favoring the SB condition (SB:  $-8.9 \pm 5.3$  kg versus LB:  $-6.4 \pm 4.5$  kg,  $P = 0.07$ ).

Schmidt and colleagues<sup>92</sup> randomized 48 overweight, non-exercising female students to one of four conditions: (1) a non-exercising control group (control); (2) a 30-minute daily continuous exercise group, with one bout lasting 30 minutes ( $1 \times 30$ ); (3) a 30-minute daily accumulated exercise group, with two bouts each lasting 15 minutes ( $2 \times 15$ ); or (4) a 30 minute daily accumulated exercise group with three bouts, each lasting 10 minutes ( $3 \times 10$ ), for 12 weeks. Groups with multiple bouts were required to wait at least 4 hours between exercise bouts. All intervention groups were prescribed an energy-restricted diet and exercised at 75% of their heart rate reserve and incrementally worked toward the full time goal for their assigned group, which was achieved at week 5. Mean weight loss and BMI significantly declined from baseline to post-treatment in all exercise groups, but not the control. The change in body weight and BMI for each exercise group was significantly different than that of the control group, but not each other.





## Pedometers

Pedometers, small devices that are worn to measure total daily steps and physical activity, may assist with increasing physical activity via their ability to objectively monitor physical activity. This objective monitoring assists with self-monitoring of physical activity, a key behavioral strategy. Richardson and colleagues<sup>93</sup> conducted a meta-analysis to examine the effect of pedometer-based walking interventions on weight loss. A total of 307 participants in nine studies were included in the meta-analysis, and the average intervention length was 16 weeks. Across cohorts an unadjusted weight loss of  $-1.42$  kg was found, but only five of nine studies had a statistically significant ( $P = 0.05$ ) weight change over time. An average increase in daily steps varied from 1,827 per day to 4,556 per day, which translated to an increase in physical activity of approximately 1–2 miles of walking. A strong linear association ( $\beta = -0.05$ ,  $P = 0.003$ ) existed between pedometer-based walking intervention length and magnitude of weight change, with longer interventions associated with greater weight change. Thus, the use of a pedometer to monitor steps during a walking intervention for weight loss appears to increase daily steps.

## Home exercise equipment

The availability and access to exercise equipment may contribute to increased levels of physical activity. Based on stimulus control, a behavioral strategy, seeing or encountering exercise equipment may serve as a cue to be active, and having closer proximity to activity equipment increases the time being active.<sup>94</sup> Furthermore, engagement in physical activity has been positively correlated with amount of home exercise equipment, specifically with women.<sup>95</sup> Perri and colleagues<sup>96</sup> randomized 49 obese, regularly inactive women to a behavioral weight loss program with group-based exercise or home-based exercise for 15 months. The exercise regimen was similar between groups—30 minutes per day, at least 5 days per week, at a heart rate target level of 60%–70% of maximum heart rate. Participants assigned to group-based exercise were asked to engage in exercise in groups of two to seven at a clinic facility by engaging in three sessions per week for weeks 0–26, and at least two sessions per week for weeks 27–52; individual brisk walking sessions were prescribed to

supplement group sessions in order to reach the goal of 150 minutes per week. The home-based exercise group was similar except exercise was to be completed in the participant's home or work environment. The home-based exercise condition reported significantly higher percentage of exercise completion compared to the group-based condition (83.8% versus 62.1%,  $P < 0.04$ ). For weight loss, a significant main effect of time occurred, with the home-based condition losing significantly more weight than the group-based condition (home:  $-11.9 \pm 9.1$  kg versus group:  $-9.2 \pm 8.2$  kg,  $P < 0.05$ ).

Similar results were found in a study by Jakicic and colleagues<sup>97</sup> who randomized 148 sedentary, overweight women in a weight control program to long-bout exercise group (LB), short-bout exercise group (SB), or short-bout plus exercise equipment group (SBEQ), for 18-months. The LB group was prescribed 40 minutes of physical activity, 5 days per week. The SB group was prescribed the same total minutes, with daily minutes broken into two to four exercise bouts per day. Participants in the SBEQ group followed the SB physical activity prescription and received a treadmill maintained by investigators during the 18 months of the study. Interestingly, weight loss was not significantly different between LB or SB at 6 or 18 months; however, within participants following the SB prescription, the SBEQ group lost significantly more weight than the SB at 18 months (SBEQ:  $-7.4 \pm 7.8$  kg versus SB:  $-3.7 \pm 6.6$  kg,  $P < 0.05$ ).

## Resistance training

Resistance training increases fat-free mass; however, without energy restriction, resistance training is believed to have a limited role in weight loss and a greater role in body composition changes.<sup>6,98</sup> Since resistance training promotes an increase in muscle mass, including resistance training in a physical activity prescription during a behavioral lifestyle intervention could help minimize loss of lean muscle mass as weight loss occurs. This could potentially help preserve resting metabolic rate, which in turn could improve weight loss outcomes. Ho and colleagues<sup>99</sup> randomized 97 overweight or obese individuals to one to four conditions for 12 weeks: (1) a control (no exercise); (2) aerobic (30 minutes of aerobic activity, 5 days per week); (3) resistance (30 minutes of resistance exercise, 5 days per week); or (4) a combination



(15 minutes of aerobic and 15 minutes of resistance exercise, 5 days per week). No conditions were given a dietary intervention for weight loss. At week 12 the combination group had significantly lower body weight compared to the control ( $-1.6\%$ ,  $P = 0.044$ ) and resistance ( $-1.6\%$ ,  $P = 0.044$ ) groups, but not the aerobic group.

The importance of physical activity has been established, particularly to assist with weight loss maintenance, yet adherence and maintenance to an increased level of physical activity is still challenging.<sup>100</sup> As physical activity is a leisure-time behavior, more attention is being focused on examining how participants spend their leisure time, and how those choices may impact on energy expenditure and weight loss.

## Novel Energy Expenditure Interventions

More recently sedentarism has emerged as a public health concern separate from that of the lack of physical activity.<sup>101–104</sup> Understanding the difference between sedentary behavior and physical activity is essential because individuals can achieve high levels of physical activity and still have high levels of sedentary behavior.<sup>103</sup> Sedentary behaviors are characterized by minimal movement and a very low level of energy expenditure ( $<1.5$  metabolic equivalent units [METs]), similar to that which is required to sit quietly.<sup>101,105</sup> Other common sedentary behaviors include watching television (TV), reading, lying down, using a computer, and driving. Recent epidemiological research indicates that the more time spent being sedentary, independent of time engaging in physical activity, the greater the risk of weight gain<sup>106–108</sup> and obesity.<sup>109,110</sup> Thus, decreasing sedentary behavior and increasing physical activity may both need to be part of a lifestyle intervention.

Sedentary behaviors, particularly TV viewing, may be a specific target of lifestyle interventions due to the large amount of time spent watching TV.<sup>111</sup> In the United States in 2011, watching TV was the leisure activity that most occupied adults  $\geq 15$  years (2.8 hours per day).<sup>112</sup> Non-experimental data have demonstrated the positive association of television viewing and overall sedentary behavior,<sup>113</sup> obesity risk,<sup>111</sup> and health outcomes.<sup>114</sup> Currently, only one, 3-week randomized controlled trial has examined

how reducing TV watching impacts weight in overweight/obese adults.<sup>115</sup> In this study, TV watching was the only behavior targeted for change; thus there were no dietary or physical activity goals provided, and results found that while there was a trend for a reduction in BMI as TV watching was reduced, it was not significant. Future research is needed to evaluate if reducing sedentary behavior within a lifestyle intervention can improve weight loss outcomes.

Physical activity is a core component of behavioral lifestyle interventions; however, adherence to physical activity prescriptions, as with dietary prescriptions, continues to be a challenge. Incorporating methods of activity to enhance preservation of fat-free mass during weight loss may be helpful for long-term weight loss maintenance. Also, including a focus on reducing sedentary behavior may enhance weight loss outcomes.

## Translation

Due to the high prevalence of obesity in the United States, translating efficacious lifestyle behavioral approaches, such as the DPP, to settings accessible to the public is necessary to have the greatest public health impact. The RE-AIM (reach, efficacy/effectiveness, adoption, implementation, and maintenance) framework has been established to understand important dimensions of translation.<sup>116</sup> In totality, the dimensions of RE-AIM address the ability of an intervention to translate into multiple settings. Each setting has its own needs, but often translation from a research to a more community-based setting may require a reduction in treatment intensity or consideration of alternate treatment modalities for intervention delivery, due to issues related to cost (eg, trained personnel, materials) and time. Since the DPP is considered an efficacious behavioral lifestyle intervention, research has been conducted regarding how to best translate the DPP into a variety of settings in order to expand its reach to the population of individuals with pre-diabetes. Several examples of research designed to translate the DPP are shared to highlight how treatment intensity and delivery modality of the DPP can be modified for successful translation. Provided examples include translational studies that have implemented the DPP in the primary care, workplace, and church setting.



## Intensity

The intensity of a lifestyle behavior intervention is related to both the interventionist (eg, time, personnel, program materials) and participant (eg, time, amount of behavioral change) resources required to implement the intervention. The intensity at which behavioral lifestyle obesity treatment interventions are delivered is perhaps the greatest challenge for translation. Due to the frequent contact and use of a trained interventionist in the DPP, the DPP can be a costly program to replicate.<sup>10,117</sup> Thus, translating any efficacious program requires a balance between efficacy and effectiveness.<sup>118</sup> Efficacious programs are internally valid estimates of program effects and are conducted under highly controlled and optimal conditions.<sup>119</sup> Effectiveness is the ability to generalize the effects of an efficacious program in real-world settings.<sup>120</sup> To increase effectiveness, many settings modify programs by reducing frequency of contact during an intervention, or training less-skilled workers to deliver the intervention. For example, the DPP has been altered by decreasing frequency of contact (ie, three individual sessions plus newsletters or six individual sessions versus 16 individual sessions) to meet the needs of the setting. Results from a systematic review and meta-analysis of 28 programs translating the DPP into community-based settings show it is still effective, based on an overall mean weight change of  $-4.0\%$  ( $-5.2\%$  to  $-2.8\%$ , 95% confidence interval).<sup>117</sup> Furthermore, this meta-analysis reported a mean weight loss of  $-4.0\%$  at 12 months across all translational studies.

## Modalities

Another way to reduce cost of a program is to consider alternate methods for intervention delivery. Due to the reduction of personnel time required, delivery of obesity treatment via the Internet is one treatment modality that can potentially minimize cost.<sup>121,122</sup> McTigue and Colleagues<sup>121</sup> conducted a 12-month pilot intervention to evaluate the adaptation of DPP for online delivery. Fifty overweight and obese adults with a history of at least one physician-diagnosed, weight-related cardiovascular risk factor were enrolled. At 12 months, participants who completed the study ( $n = 45$ ) lost on average of  $-4.79$  kg ( $-7.96$  to  $-2.22$ , 95% confidence interval). Most important is to note that during the most intensive phase of the pilot intervention—the

allocation of coaching—one full time coach per 80 participants resulted in a lower staffing level than the one coach per 20–27 participants in the DPP.<sup>12</sup> This reduction in personnel time may assist in reducing the delivery cost of the DPP. These findings suggest the Internet may be an important tool for translating evidence-based counseling interventions to the clinical setting.

An innovative method of translation of the DPP is combining the Internet with television viewing. Project Not Me™, a multi-site randomized controlled trial, is evaluating the translation of DPP with very minimal patient contact using television, scales with blue-tooth technology, and Internet for treatment modalities.<sup>123</sup> Findings from this study are yet to be published; however, Not Me™ will be made publicly available for a cost by the Diabetes Prevention and Control Alliance.

## Examples of translation

The DPP has forged the way for demonstrating the successful adoption of an efficacious intervention into a variety of alternate settings. The examples below demonstrate how the DPP has been translated into a primary care, worksite, and church setting. While many examples of translation of the DPP exist, the following illustrations showcase how treatment intensity and modality can be altered for translation.

A primary care setting is limited by time and trained personnel in trying to deliver a behavioral lifestyle intervention for obesity treatment. Thus, the Evaluation of Lifestyle Interventions to Treat Elevated Cardiometabolic Risk in Primary Care (E-LITE) program investigated the use of a self-directed DVD to eliminate the need for trained personnel, which also reduced time required to deliver the intervention.<sup>124</sup> The number of sessions was reduced from the original DPP manual. The DPP-adapted E-LITE randomized 241 overweight and obese adults to a 12-week, coach-led, face-to-face group intervention, a self-directed DVD intervention, or a standard care intervention. For the coach-led group intervention, in addition to the 12 weekly, face-to-face sessions, a guided 30–45 minute physical activity session was provided. Additionally the group and self-directed DVD interventions used the American Heart Association's free Heart360 web portal. BMI significantly decreased in all three interventions,



with significant differences occurring between all three interventions (coach-led =  $-2.2 \pm 0.3$  kg/m<sup>2</sup>; self-directed DVD =  $-1.6 \pm 0.3$  kg/m<sup>2</sup>; standard care =  $-0.9 \pm 0.3$  kg/m<sup>2</sup>;  $P < 0.05$ ). Within the study, 37% ( $P = 0.003$ ) in the coach-led intervention, 35.9% ( $P = 0.004$ ) in the self-directed DVD intervention, and only 14.4% in the standard care group achieved a 7% weight loss, as recommended by the DPP. Furthermore, E-LITE was evaluated based on its reach (proportion and representativeness of individuals willing to participate) and adoption (proportion and representativeness of locations and intervention staff willing to initiate and adopt an intervention), components of RE-AIM in the primary care setting and deemed fair-to-good in real world applicability.<sup>125</sup>

Similar to the primary care setting, translation to a workplace can be limited not only by time, but also resources (eg, trained personnel, finances for materials). Furthermore, a program of high treatment intensity (eg, many sessions, large changes in behavior) may also reduce participation. Thus, DeJoy and colleagues<sup>126</sup> conducted formative work with their employees to understand how to best translate the DPP into a worksite setting. This step facilitated translation by providing a program at a treatment intensity desired by workers. Outcomes from formative work indicated that workers wanted a self-study module. Providing intervention in this form eliminated the cost of trained personnel delivering the intervention. Additionally, this method of intervention delivery allowed employees to engage in the intervention when they had time. The formative work led to the development of the program *FUEL your Life*. Based on the DPP, *FUEL your Life* was developed as a self-study intervention, with the opportunity for all employees ( $n = 168$ ) to participate. A self-study participant manual was developed that provided materials on each session, questions to be answered by the participant about the sessions, and forms for tracking weight, food intake, and activity. The program was available to all employees, but only 67 employees engaged in the initial session. The initial session included a 1-hour visit with a dietitian or health educator to set personal goals related to weight loss or physical activity for the program. Additionally, six brief group presentations related to behavioral strategies, such as finding time to be physically active, were provided at staff meetings and posters with key lesson

concepts were placed in high-traffic areas to serve as prompts as for participants. The expectation was for employees to complete 16 sessions over 24 weeks. At 12 months, participants from the *FUEL your Life* pilot study had a significant decrease in body weight ( $-1.4 \pm 4.4$  kg,  $P < 0.04$ ).

As with the other settings, translating the DPP into church settings can be cost prohibitive, due to treatment intensity (eg, trained personnel, individual sessions). Additionally, modifications to the intervention are required to address spiritual needs. Five African American Baptist churches in rural communities modified DPP to overcome these barriers.<sup>127</sup> The original DPP curriculum was modified to a group-based design, with the addition of time for prayer and group interaction. To further reduce costs, volunteers with a psychology or medical background lead the group sessions that were offered over six or 16 sessions. Two churches participated in a six-session intervention ( $n = 177$ ) and three churches participated in a 16-session intervention ( $n = 265$ ). Combined weight significantly decreased by  $-1.9 \pm 8.3$  kg ( $P = 0.02$ ) from baseline to 12 months.

## Future Directions

In addition to research examining the optimal diet and physical activity prescription to enhance weight loss outcomes, and a focus on translating outcomes to settings with a broader reach, research in behavioral lifestyle interventions continues to examine other areas to improve outcomes.

## Individualized treatment

While general goals are a key component of lifestyle behavioral obesity treatment programs, future interventions may individualize treatment based on a participant's needs and progress toward weight loss goals. A stepped-care approach is one method used to customize a weight-loss intervention based on a participant's achievement of a predetermined weight loss goal, with intensity of intervention increasing when goals are not achieved.<sup>128-130</sup> Carels and colleagues<sup>130</sup> randomized 55 overweight adults to one of two 6-month interventions, a standard behavioral weight loss program, or a standard behavioral weight loss program plus stepped-care; participants in the latter failing to meet weight loss goals received individual motivational interviewing sessions until the weight



loss goal was achieved. Participants in the standard behavioral weight loss program plus stepped-care lost significantly more weight than participants in the standard behavioral weight loss program ( $-4.5 \pm 3.0$  kg versus  $-2.1 \pm 2.8$  kg,  $P < 0.05$ ). Similarly, Jakicic and colleagues<sup>128</sup> randomized 363 adults to either a stepped-care weight loss intervention or standard behavioral weight loss intervention over 18-months. The stepped-care approach modified contact frequency, contact type, and weight loss strategies pending the participants' achievement of weight loss goals at 3-month intervals, using six steps that increased in intervention intensity. The percent change in weight loss from baseline to 18-months was not significantly different between groups ( $-8.1\%$  standard intervention versus  $-6.9\%$  stepped-care intervention). While weight loss between groups was not significantly different, the stepped-care approach was significantly ( $P < 0.001$ ) less expensive than the standard intervention from a payer perspective (stepped-care: \$358 per person versus standard: \$494 per person); thus, customizing an intervention to the success of an individual may be a more cost-effective approach for the treatment of obesity. Furthermore, a cost-effective approach will allow for translation of findings into settings where intervention costs may be a barrier for implementation.

### Real-time feedback

Self-monitoring is a key component of behavior therapy as it provides the ability to increase awareness and provide feedback on accomplishment of goals. However, new technology (ie, smart phones) has advanced the ability to provide real-time feedback regarding energy intake and/or expenditure, which may assist with decision making during obesity treatment.<sup>131–133</sup> Burke and colleagues<sup>134</sup> conducted a 24-month behavioral weight loss intervention with participants randomized to one of three conditions: (1) self-monitoring with a paper diary (PAPER); (2) self-monitoring using a PDA (PDA); or (3) self-monitoring using a PDA with feedback (PDA + FB). Weight loss was significantly greater over time in the PDA + FB condition ( $-2.32\%$ ,  $P = 0.02$ ), but not in the PDA or PAPER condition.<sup>134</sup> Adherence to monitoring significantly predicted weight loss at all time points, and immediate feedback may enhance adherence to self-monitoring, which has implications for weight loss.<sup>134</sup>

Additionally, equipment such as the SenseWear™ armband that uses galvanic skin response to report energy expenditure can provide real-time feedback about energy expenditure, which in turn could improve outcomes. Shuger and colleagues<sup>135</sup> randomized 197 adults to one of four groups; (1) standard care, (2) group-based behavioral weight loss program, (3) SenseWear™ armband alone, or (4) the group-based behavioral weight loss program plus the SenseWear™ armband. All three intervention groups significantly reduced weight, but only the group-based behavioral weight loss program plus the SenseWear™ armband lost significantly more weight than standard care.<sup>135</sup>

New technologies allow an individual to readily self-monitor eating and physical activity behaviors, which is considered a key component to behavior therapy. The information monitored by these technologies provides the opportunity for real-time feedback to the individual, which can prompt a more immediate change in behavior. As technology advances, using equipment that provides real-time feedback may assist with translation due to the diminished need for intervention personnel.

### Conclusion

A comprehensive behavioral lifestyle modification can produce clinically-significant weight loss of at least 7% from initial body weight. Both DPP<sup>11</sup> and Look AHEAD<sup>14</sup> are interventions that include the three core components of behavioral lifestyle interventions—behavior therapy, dietary goals, and physical activity goals. While traditional dietary interventions exist, more novel dietary interventions are needed to improve long-term weight loss maintenance. Additionally, physical activity is an important component of a behavioral intervention; however, the impact of reducing sedentary behavior and strategies to preserve fat-free mass on weight loss need to be examined. Furthermore, to increase the public health impact of behavioral lifestyle interventions, examining the best methods of translating these interventions into a variety of settings is needed.

### Author Contributions

Wrote the first draft of the manuscript: SL, HR. Contributed to the writing of the manuscript: SL, HR. Agree with manuscript results and conclusions: SL, HR. Jointly developed the structure and arguments



for the paper: SL, HR. Made critical revisions and approved final version: SL, HR. All authors reviewed and approved of the final manuscript.

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