

**Title: A Randomized Controlled Trial of a  
Psychological Intervention to Reduce Weight Bias  
Internalization in the Context of Behavioral Weight Loss**

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**Title: A Randomized Controlled Trial of a Psychological Intervention to Reduce Weight Bias Internalization in the Context of Behavioral Weight Loss**

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**1. STUDY OBJECTIVE**

To evaluate, in a 16-session (26 week) randomized controlled trial, the efficacy of a psychological intervention, combined with behavioral weight loss (BWL), on reducing weight bias internalization (WBI).

**2. BACKGROUND**

**2.1 Weight bias and stigma are pervasive.**

The term *weight stigma* refers to societal scorn and devaluation of individuals with overweight and obesity.<sup>1</sup> This includes discrimination (e.g., being denied employment), bullying/teasing, social exclusion and avoidance (e.g., rejection from peers), and other forms of unfair treatment due to excess weight. Common stereotypes and prejudicial (or *weight-biased*) beliefs include perceptions that persons with obesity are lazy, incompetent, weak, and lacking willpower.<sup>11</sup> These beliefs lead individuals with obesity to be mistreated across multiple settings in their daily lives, including: disparagement in educational settings from students and educators; discrimination in hiring, firing, and promotions; social avoidance (e.g., on public transportation); criticism from family members, spouses, and friends; and negative representation in media.<sup>2-6</sup>

The high rates of obesity and overweight in the US population are accompanied by high rates of weight-based stigmatization. Estimates indicate that rates of weight-based discrimination have increased by 66% from 1995 to 2006 and, among women, are comparable to rates of discrimination based on race and age.<sup>7,8</sup> Due to the pervasiveness of weight bias in daily life, some individuals may internalize stigmatizing attitudes; this occurrence is referred to as *weight bias internalization (WBI)*, or self-directed stigma.<sup>9</sup> A recent large-scale study estimated that approximately 40% of US adults internalize weight bias to some extent, and 20% to a high degree.<sup>10</sup> Internalizing stigma involves: 1) awareness of and agreement with stereotypes; 2) applying of those stereotypes to oneself; and 3) devaluing oneself due to the stigmatized trait (i.e., weight).<sup>11</sup> For example, someone who is unable to successfully maintain weight loss may

attribute weight regain to laziness and weakness, and have lower self-esteem due to assigning these stereotypical characteristics to oneself.

## **2.2 Weight bias internalization contributes to poor mental and physical health.**

Higher levels of WBI are also associated with more symptoms of psychopathology (e.g., depression) and poorer mental and physical health-related quality of life (HRQOL).<sup>9,12-14</sup> Prior research suggests that WBI is a better predictor of psychological distress and poor health than is exposure to weight stigma alone.<sup>15,16</sup> For example, Latner et al found that only WBI, and not perceived weight discrimination, was associated with worse health-related quality of life for individuals with high BMIs.<sup>17</sup> Studies also suggest that internalizing stigma may increase risk for poor cardiometabolic health.<sup>18-20</sup> In a study recently published in *Obesity*,<sup>21</sup> my colleagues and I demonstrated that WBI was associated with heightened risk for metabolic syndrome and high triglycerides among treatment-seeking individuals with obesity. Specifically, when controlling for BMI, depression and demographic variables, individuals categorized as having high WBI were three times more likely to have metabolic syndrome and six times more likely to have high triglycerides, than were individuals with low levels of WBI.

## **2.3 Weight stigma impedes weight control.**

Individuals with obesity who experience and internalize weight stigma may benefit from weight loss to improve their health, yet may face stigma-specific barriers to weight loss. In two longitudinal studies, individuals who reported experiencing weight discrimination at baseline were three times more likely to remain obese<sup>22</sup> and gained 1.7 more kg than individuals who did not report weight discrimination.<sup>23</sup> Recent studies have also illustrated that patients who have experienced and/or internalized weight stigma, in comparison to those who have not, have poorer long-term weight loss outcomes with both behavioral and surgical weight loss interventions.<sup>24-27</sup> For example, in a study of 49 adults with  $BMI \geq 27 \text{ kg/m}^2$  who received behavioral weight loss (BWL) treatment, higher frequency of receiving weight-stigmatizing comments from others was associated with less weight loss and less physical activity.<sup>24</sup> Proposed pathways for these effects include a combination of physiological stress responses that increase inflammation and appetite, and maladaptive behavioral coping responses such as increased caloric intake and avoidance of physical activity.<sup>21</sup>

Acute and long-term studies have shown that weight stigma (particularly WBI) is associated with reduced self-efficacy for dietary control,<sup>28</sup> with increased caloric consumption (particularly of unhealthy foods),<sup>28-30</sup> and with worse dietary adherence following bariatric surgery.<sup>31</sup> In addition, individuals who experience weight stigma feel more self-conscious in fitness settings and are more prone to anticipating future stigmatization in these settings, thus increasing avoidance of physical activity.<sup>32-34</sup> In prior work, my colleagues and I have also shown associations between WBI and reduced self-efficacy to engage in physical activity, along with reduced exercise motivation and engagement.<sup>35</sup> In other words, if individuals with obesity believe that they are lazy and lack willpower (internalized stereotypes), they lose confidence in their ability to follow through on their weight management-related behavioral goals and are, thus, less likely to engage in their planned healthy behaviors (e.g., physical activity).<sup>35,36</sup>

## 2.4 Addressing weight stigma in weight loss interventions.

Weight stigma is not addressed as part of standard behavioral weight loss treatment. The few studies that have investigated the effects of weight loss on WBI have found an approximate  $\frac{1}{2}$  point reduction on the 7-point Weight Bias Internalization Scale following BWL,<sup>37,38</sup> suggesting minimal improvement. This is consistent with prior research showing that the benefits of weight loss tend to be greater for physical health than for mental health and other aspects of psychosocial functioning<sup>39,40</sup>. In contrast to BWL, recent preliminary evidence suggests that targeted psychological interventions may reduce WBI in patients with obesity. A pilot study of the Weight Bias Internalization and Stigma (BIAS) program showed that, in 8 patients with obesity and high levels of WBI, an 8-week cognitive-behavioral intervention reduced scores on the WBIS by approximately 1 point.<sup>41</sup> This change was significantly greater than that found in a quasi-control group of 6 patients (partial eta<sup>2</sup> = .36). The BIAS program also led to significantly greater reductions in negative stereotype endorsement (partial eta<sup>2</sup> = .39) and increases in weight self-efficacy (partial eta<sup>2</sup> = .47) than the quasi-control group.

Additionally, weight losses achieved with BWL treatment are not maintained, on average, in the long-term.<sup>42,43</sup> Weight regain may be associated with deterioration in HRQOL and increases in WBI.<sup>44,45</sup> An intervention that combines traditional BWL with a program to reduce WBI could produce clinically meaningful short- and long-term reductions in self-stigmatization, along with other psychological benefits, that persist independent of weight loss and regain. Additionally, given, the evidence reviewed that individuals who have experienced and/or internalized weight stigma have reduced self-efficacy for and engagement in weight management behaviors (e.g., physical activity), an intervention targeting weight stigma may improve long-term weight loss. Overall, an intervention that incorporates elements from both BWL and stigma-reduction approaches could provide patients with multifaceted health benefits.

## 3. SPECIFIC AIMS

**Aim 1.** To test, in a 16-session (26-week) randomized controlled trial of 72 adults with obesity and high levels of WBI, the effects on weight bias internalization (WBI) of the BIAS program combined with behavioral weight loss (BWL), in comparison to BWL alone.

*H1a: Participants who receive BWL + BIAS program will show significantly greater reductions in WBI after 12 weekly sessions than participants who receive BWL alone.*

*H1b: Participants in the BWL + BIAS program will continue to show greater improvements in WBI at 26 weeks (following an additional 2 biweekly sessions and 2 monthly sessions), compared to participants in the BWL group.*

**Aim 2.** To explore the effects of BWL + BIAS program, compared to BWL alone, on depression, perceived stress, health-related quality of life, and weight-related self-efficacy.

*H2: Participants in the BWL + BIAS program will show greater improvements in depression, perceived stress, health-related quality of life, and weight self-efficacy than participants in the BWL group at 12 and 26 weeks.*

## Secondary Aims

**Aim 3.** To examine the effects of BWL + BIAS program, compared to BWL alone, on weight loss.

*H3: Participants in the BWL + BIAS program will have a higher percent weight loss than participants in the BWL group at 26 weeks.*

**Aim 4.** To examine the effects of BWL + BIAS program, compared to BWL alone, on cardiometabolic risk factors.

*H4: Participants in the BWL + BIAS program will sustain greater reductions in blood pressure and waist circumference than participants in the BWL group at 26 weeks.*

**Aim 5.** To compare the effects of the BWL+BIAS program versus BWL alone on WBI, psychosocial outcomes (e.g., depression), weight, and cardiometabolic risk factors at week 52.

*H5: Participants in the BWL + BIAS program will sustain greater improvements on all outcomes than participants in the BWL group at 52 weeks.*

## 4. STUDY DESIGN

### 4.1 General Design

This is a randomized controlled trial to test the effects on WBI of a novel psychological intervention combined with standard BWL treatment, as compared to BWL alone. Participants will be a total of 72 men and women seeking weight loss, ages 18-65 years, with a body mass index (BMI) of 30 kg/m<sup>2</sup> or above, a history of experiencing weight bias, and elevated levels of WBI. Participants will attend a screening visit in which they will complete a behavioral evaluation with a psychologist and a medical history that will be reviewed by a nurse practitioner or physician. Questionnaires assessing experiences and internalization of weight bias, with confirmation by interviewer assessment during the behavioral evaluation, will be used to determine whether participants meet criteria for having high levels of WBI. Eligible consenting participants will be randomly assigned to the standard BWL intervention (n = 36) or the BWL + BIAS program (n = 36). All participants will attend weekly, 90-minute group meetings for 12 weeks (12 visits). In the BWL + BIAS intervention, 60 minutes will be devoted to BWL and 30 minutes to weight stigma. In the standard BWL treatment group, the additional 30 minutes will be devoted to sharing recipes and food preparation tips. Following 12 weeks of weight loss treatment, participants will attend group meetings focused on weight loss maintenance, every-other-week from weeks 13-16 (2 visits), and monthly from weeks 17-26 (2 visits). Maintenance sessions in the BWL + BIAS group will continue to incorporate discussion of WBI. Assessments – which include questionnaires and measurements of body weight – will occur at baseline and weeks 12 and 26. Additional assessments will also occur at week 52. Weight will be measured at every group meeting for clinical purposes.

### Other Medical Therapies:

Participants will be expected to use medications (prescribed by their primary care providers) to control traditional cardiometabolic risk factors (e.g., hypertension, hypercholesterolemia, etc) and other co-morbid conditions. In all cases, the subjects' primary care provider (PCP) will be asked at the study's outset to keep medication dose constant throughout the study, whenever possible. Participants will be expected to have been on their medication regimen (including the dose) for 3 months prior to entering the dietary group lifestyle modification program.

## 5. PARTICIPANT SELECTION

### 5.1 Participant Recruitment

Participants will be recruited from advertisements in local media outlets (newspapers, radio), as well as flyers posted at the University. We also will advertise the study to health care providers who work in Penn's Clinical Care Associate practices, with whom we have collaborated previously.<sup>46</sup>

### 5.2 Inclusion/Exclusion Criteria

#### Key Inclusion Criteria

Eligible participants will be men and women ages 18-65 years. Participants must have obesity (defined as a BMI  $\geq 30 \text{ kg/m}^2$ ); report a history of experiencing weight bias as assessed by self-report questionnaire and in-person interview; and have elevated levels of WBI as indicated by an average score of 4 (midpoint) or above on the Weight Bias Internalization Scale (WBIS)<sup>9</sup> and by in-person interview. Participants must be seeking weight loss. If currently taking medications, dosages must be stable for at least 3 months. Participants will be eligible to participate if they exhibit mild to moderate severity of depression, anxiety, or binge eating disorder, as determined by the behavioral evaluation and the screening measures (Beck Depression Inventory-II and Questionnaire for Eating and Weight Patterns; see below for details). Elevated WBIS scores are often associated with these variables.<sup>47</sup> Participants taking anti-depressant medication will be eligible if their dose has been stable for a minimum of 3 months.

Eligible female patients will be:

- non-pregnant, evidenced by a negative urine dipstick pregnancy test
- non-lactating
- surgically sterile or postmenopausal, or they will agree to continue to use a method of birth control during the study

Participants must:

- have a PCP who is responsible for providing routine care
- have reliable telephone service with which to participate in conference calls
- understand and be willing to comply with all study-related procedures and agree to participate in the study by giving written informed consent

#### Key Exclusion Criteria:

Applicants will be excluded if they have: a diagnosis of type I or II diabetes; uncontrolled hypertension (blood pressure  $\geq 160/100 \text{ mm Hg}$ ); experienced a cardiovascular event (e.g., stroke, myocardial infarction) in the last 12 months; lost  $\geq 5\%$  of their initial weight in the last 6 months; or have participated in individual or group psychotherapy in the last 3 months (due to the potentially confounding effects of receiving a simultaneous cognitive-behavioral intervention). Applicants who have recently participated in or are currently receiving counseling for concerns unrelated to mood, self-esteem, or weight (e.g. career, marriage, or grief counseling; caregiver support) may be eligible per Principal Investigator's discretion. Applicants with *severe* symptoms of mood (for example, BDI-II score  $\geq 29$ ), anxiety, or binge eating disorder, and any severity of thought or substance use disorders will not be accepted into the study, as these symptoms may interfere with individuals' ability to adhere to a weight loss program. Clinician

judgment will be used to determine severity of mood disorder symptoms independent from obesity-related concerns and complications (e.g., fatigue), and decisions about applicants' eligibility based on psychiatric symptoms will fall within the Principal Investigator's discretion. Individuals with bulimia nervosa will not be eligible to participate, because weight loss may be contraindicated. Applicants with current, active suicidal ideation, and/or a suicide attempt within the past year will be excluded from the study and referred to psychiatric treatment facilities in the greater Philadelphia area. Applicants will not be eligible if they have a history of bariatric surgery. Women who are nursing, pregnant, or planning to become pregnant in the next 12 months are not eligible to participate.

## **6. STUDY PROCEDURES**

### **6.1 Screening Procedures**

All applicants will be screened by phone to determine whether they potentially meet eligibility criteria. We will obtain a waiver of written documentation of consent for the telephone screen. Those who remain interested in the trial will be scheduled for an in-person interview. The Weight and Lifestyle Inventory (WALI), a paper-and-pencil inventory that assesses general eating and lifestyle behaviors, the Weight Bias Internalization Scale (WBIS; 11 items, rated 1-7), and the Beck Depression Inventory (BDI) will be mailed to eligible participants following the phone screen and completed by them prior to their screening/informed consent visit. The in-person interview will be conducted by a psychologist, who will obtain informed consent and evaluate participants' behavioral eligibility (i.e., willingness and appropriateness to participate). This will include our assessment of the applicant's mood (as measured by interview and the BDI) and suicidality (including history of suicidal ideation and behavior).

Participants who remain interested and pass this portion of the assessment will proceed to provide a medical history, which will be reviewed by the study physician or nurse practitioner to determine medical eligibility. Participants may be asked to also provide medical clearance from their primary care physician, upon request from the study physician or nurse practitioner.

**Screening visit.** The following procedures will be completed at the screening visit as discussed above: informed consent, medical history, weight, height, and meeting with psychologist whose assessment will be used as a part of determining the subject's eligibility for the study. This medical history will be reviewed by the study physician or nurse practitioner determine whether there are any contraindications to weight loss. These contraindications include but are not limited to: any major active kidney, liver, cardiovascular, or cerebrovascular disease; type 2 diabetes; or the use of any medications that significantly affect weight (weight loss or weight gain, including steroids). Female participants will be ineligible for the study if they are pregnant or nursing. Upon request from the study physician or nurse practitioner, participants may also be asked to supply a letter from their primary care physician providing medical clearance for them to participate in this study.

### **6.2 Randomization**

Following the screening visit, participants who meet all eligibility criteria and provide informed consent will be randomized to one of the two treatment groups in a 1:1 ratio by a biostatistician. Investigators and participants will not be blinded to participants' assigned

conditions.

### **6.3 BWL Intervention**

Participants in this group will be provided with 12 weekly BWL sessions, based on the Diabetes Prevention Program (DPP) manual,<sup>48</sup> followed by 2 every-other-week weight loss maintenance sessions and 2 monthly sessions (for a total of 16 visits over 26 weeks). A diet of 1200-1499 calories per day will be prescribed for participants < 250 lb, and 1500-1800 for those  $\geq 250$  lb.<sup>48,49</sup> Participants will be instructed to eat a balanced deficit diet with approximately 15-20% of kcal from protein, 20-35% from fat (less than 10% from saturated fat), and the remainder from carbohydrates.<sup>48</sup> Session topics during the first 12 weeks will include self-monitoring, stimulus control, slowing eating, social support, cognitive restructuring, portion sizes, and goal-setting.<sup>48</sup> Those during weeks 13-26 will focus on continued self-monitoring and skills required for weight loss maintenance and relapse prevention. BWL sessions will last 60 minutes, with an additional 30 minutes devoted to discussing recipes and food preparation.

Physical activity will be prescribed at a level consistent with data showing that  $\geq 250$  min/wk is associated with improved long-term weight loss.<sup>50-53</sup> Activity will begin at week 2 with 60 min/wk, and will gradually progress by 10 minutes over 1-2 week intervals until achieving 150 min/wk by week 12, and 200-250 min/wk by week 26. Participants will be instructed to spread the 150-250 minute doses of activity equally across at least 5 days, and to accumulate their structured physical activity in bouts that are  $\geq 10$  minutes in duration. Moderate intensity will be prescribed with an emphasis on walking; the vast majority of our research participants self-select this form of activity.

Participants who cannot attend any given group session will be offered a brief (10-20 minute) make-up session during the week with the group leader or a study staff member. Participants may also meet briefly with the group leader individually, outside of group sessions, up to 3 times during the initial 12-week study period if they have not lost at least 1% of their body weight by week 4, report difficulty controlling their eating, or describe other challenges preventing them from adhering to the program that cannot be fully covered during group sessions.

### **6.4 BWL + BIAS Intervention**

Participants in this group will receive the same BWL program described above, which will be combined with a stigma-reduction intervention. During the initial 12 weeks, the 60-minute BWL sessions will be followed by 30 minutes devoted to stigma-related content. Session topics will be based on those tested in a previous pilot study, including: psychoeducation about weight and weight stigma; challenging myths and cognitive distortions related to weight; strategies for coping with instances of stigma; and increasing empowerment and body esteem. The effects of weight stigma on health behaviors will be discussed, and sessions will focus specifically on helping participants overcome stigma-related barriers to weight management. For example, they will be given strategies to cope with anticipated stigma while exercising in public spaces (e.g., while walking), as well as to challenge self-critical beliefs (e.g., that they are lazy) which may otherwise lead them to avoid engaging in physical activity. These concrete strategies, along with reducing WBI and improving self-confidence, are intended to increase participants' self-efficacy for and engagement in weight management behaviors. In the every-other-week and monthly weight loss maintenance sessions from weeks 13-26, strategies for coping with weight

stigma and challenging internalized beliefs will be reviewed, and participants will be encouraged to use these strategies specifically in the context of weight management.

As with the BWL Intervention, participants who cannot attend group sessions or are experiencing difficulties adhering to the program will be eligible for brief individual meetings with the group leader or study staff (as described above).

## 6.5 Outcome Assessment Visits

Participants will be expected to attend 3 assessment visits throughout the course of the study: at baseline, week 12, and week 26. Blood pressure, pulse, weight, and waist measurement will be measured at all outcome assessment visits. Questionnaires will also be completed online or administered/returned via mail or at scheduled group sessions.

In addition to the main assessment visits, participants will be invited to complete another assessment at week 52. Participants will be asked to complete online questionnaires and, if available, attend an assessment visit.

## 6.6 Outcome Measures

**Primary outcome.** *Weight bias internalization.* Participants will complete the WBIS (described previously) at screening and weeks 12 and 26 (as well as at week 52). Secondary weight bias and stigma questionnaires will include the Fat Phobia Scale (a measure of stereotype endorsement)<sup>54</sup> and the Weight Self-Stigma Questionnaire (WSSQ),<sup>55</sup> which is another measure of weight bias internalization. The WBIS, Fat Phobia Scale, and WSSQ are widely used and well validated.<sup>22,56-61</sup> Additionally, an assessment of weight stigma coping strategies<sup>62</sup> will be completed to assess the frequency with which participants engage in adaptive and maladaptive behaviors (e.g., exercising more vs. avoiding physical activity) in response to weight stigma. At baseline, participants will also complete the Everyday Discrimination Scale, which is a 10-item assessment of unfair treatment in daily life for a variety of reasons including weight,<sup>63</sup> and the Weight Stigma Timing of Life Questionnaire developed for this study assessing experiences of weight stigma at different developmental stages.

**Secondary outcomes.** Participants will complete the Impact of Weight on Quality of Life Questionnaire-Lite (IWQOL),<sup>64</sup> which contains five subscales that include items assessing distress due to weight-stigmatizing situations and weight-based discrimination. Participants will also complete the Perceived Stress Scale (PSS)<sup>65</sup> to determine self-reported daily stress, the Eating Disorders Examination Questionnaire (EDE-Q)<sup>66</sup> to assess disordered eating, the Patient Health Questionnaire (PHQ-9)<sup>67</sup> to assess symptoms of depression, and the Generalized Anxiety Disorder-7 questionnaire<sup>68</sup> to assess symptoms of anxiety. Participants will also complete the Appearance Subscale of the Multidimensional Body-Self Relations Questionnaire (MBSRQ-AS)<sup>69</sup> and the Body Appreciation Scale<sup>70</sup> as measures of body image, and the Rosenberg Self-Esteem Scale. Rejection sensitivity will also be measured at baseline, and treatment acceptability will be assessed at week 26. Participants in the BWL + BIAS intervention group are predicted to show greater reductions in all measures of stigma and distress than participants in the BWL group at weeks 12 and 26 (and at week 52).

We will also assess for potential changes in self-efficacy for and engagement in healthy weight management behaviors. Self-efficacy will be assessed with the Self-Efficacy for Exercise Scale<sup>71</sup> and Weight and Lifestyle Efficacy-Short Form (WEL-SF),<sup>72</sup> which measure individuals' confidence in their ability to overcome barriers to exercising and controlling their weight. Questionnaires will assess changes in self-reported eating (e.g., the Eating Inventory Questionnaire<sup>73</sup>) and exercise motivation. Self-reported physical activity will be assessed with the International Physical Activity Questionnaire (IPAQ).<sup>74</sup> Weekly food records of daily caloric intake will also be collected for all participants. Greater self-efficacy for and self-reported dietary adherence and physical activity are expected in the BWL + BIAS intervention vs. BWL group at weeks 12 and 26 (and at week 52).

Percent weight loss from baseline to week 26 (and to week 52) will be an exploratory outcome. Duplicate measures of height (with a wall-mounted stadiometer; Veeder-Root, Elizabethtown, NC) will be obtained at screening, and weight (with a digital scale; Detecto, model 6800A) will be measured at screening, baseline (week 1) and at weeks 12 and 26. Weight will also be measured at all group sessions. To determine potential changes in cardiometabolic risk in response to the BIAS program, blood pressure will be measured using an automated Dinamap monitor (Johnson & Johnson, XL model 9300) at three, 1-minute intervals after  $\geq 5$  minute rest, using measures described previously.<sup>75</sup> Waist circumference will be measured (to the nearest 0.1 cm) in duplicate with flexible tension-controlled measuring tape midway between the iliac crest and lowest rib. Participants in the BWL + BIAS group are expected to maintain greater weight loss and, thus, greater cardiometabolic improvements at week 26 than participants receiving BWL alone.

## 6.7 Safety Measures

### Risks

The risk of adverse medical or psychiatric events should be minimized by the careful screening procedures to be used. The principal risks during the group lifestyle modification program include:

**Risk of gallstones.** Rapid weight loss may increase the risk of gallstones. The risk of gallbladder disease will be reduced by limiting weight loss to no more than 3 pounds per week for 3 consecutive weeks. Weight loss will be monitored at all group sessions. Patients will be asked to slow or stop their weight loss if there are concerns about the rate of their weight loss.

**Psychological distress.** Participants may become distressed by learning about and discussing their experiences with weight-based discrimination and stigma.

**Confidentiality and loss of privacy.** All efforts will be made to protect participant confidentiality and privacy. We cannot guarantee total privacy. Personal information may be given out if required by law.

### Ongoing medical visits and safety measures

A physician/nurse practitioner will be available if participants notice any side effects of weight loss. Participants who report significant depression or emotional distress will be

evaluated by the study's psychologist or psychiatrist and referred to their PCP for further evaluation and treatment. Participants will be referred to their PCP if their mood is significantly disrupting their normal function (as reflected by symptoms that include feeling blue, not enjoying usual activities, trouble sleeping or concentrating, or having thoughts of dying or harming oneself).

## 7. STATISTICAL ANALYSIS

### 7.1 Sample Size Calculation

A power analysis was conducted for the **primary outcome: reduction in Weight Bias Internalization Scale (WBIS) scores at week 12**. Estimated group means, attrition rate, intraclass correlation (ICC), and variances were derived from data from prior studies conducted at our Center.<sup>75</sup> Specifically, we predict a 12-week reduction of 1.5 points on the WBIS in the BWL + BIAS group and 1 point in the BWL group, with expected standard deviations of 1.<sup>37,38,41</sup> Based on these estimates, a baseline sample size of 72 participants (36 per group), assuming a 20% attrition rate, will give us 95% power to detect a between-treatment group difference at week 12 of 1 point to be significant at alpha = 0.05. The power analysis was conducted using G\*Power 2. All secondary outcomes will be considered exploratory and will provide valuable findings that will help to inform larger studies. This study has not been powered to detect differences in changes in other psychosocial and behavioral outcomes, weight loss, and cardiometabolic outcomes.

### 7.2 Analysis Plan

Data quality and integrity will be checked by assessing the data for missing and out-of-range values with basic statistical procedures, including univariate statistics and visual graphical displays (e.g., scatter plots). We will investigate all questions of data quality and integrity prior to performing any statistical modeling. To test the adequacy of randomization, preliminary analyses will include a comparison of all participant demographic and baseline characteristics by randomized treatment groups (t-tests or Wilcoxon rank sum tests for continuous variables and Chi-Square test or Fisher's Exact test for categorical data). If imbalances are observed, the relevant variables will be included as covariates in the final analyses.

All data will be analyzed under the intention-to-treat principle. Analyses will be two-tailed with a significance level of 0.05, and will be conducted using SPSS version 24.0 or SAS version 9.4. Participants who were randomized but did not attend a group meeting will not be included in the analyses, as they will not have received a dose of treatment. We will include as baseline covariates any variables that differ significantly between the treatment groups at baseline and show significant relationships with the outcome. To assess changes in WBIS scores across the 26-week trial, a mixed effects model will be fit with Treatment Group (*BWL+BIAS, BWL*) as a between subjects factor and Time (*Weeks 12 and 26*) as a categorical within-subjects factor. We will use the group x time interactions with the time main effect to estimate and test treatment group differences at each time point. In fitting a mixed effects model with residual maximum likelihood (REML), a variance-covariance structure must be selected. The criteria for selecting the best form of the variance-covariance structure will be based on criteria such as the Akaike's Information Criterion (AIC). The results from the mixed model will be summarized by mean (SE) for each treatment group at each time point. Residual analyses will be conducted to check for outliers and

influential points and violations in the normality assumption. If violations are detected, variance-stabilizing transformations will be considered.

The second aim of assessing changes in other psychosocial and behavioral outcomes, and the secondary aims of assessing changes in weight loss and cardiometabolic risk factors, will be analyzed using the same methods as described above. Changes in all outcomes will be summarized by mean (SE) for each treatment group at each time point.

## **8. SAFETY AND ADVERSE EVENTS**

At each contact with participants, the study personnel will seek information on adverse events by specific questioning and, as appropriate, by physical examination. Information on all adverse events will be recorded immediately in the source document, and also in the appropriate adverse event module of the case report form (CRF). All clearly related signs, symptoms, and abnormal diagnostic procedures results will be recorded in the source document, though should be grouped under one diagnosis.

All adverse events occurring during the study period will be recorded. The clinical course of each event will be followed until resolution, stabilization, or until it has been determined that the study treatment or participation is not the cause. Serious adverse events that are still ongoing at the end of the study period will be followed up to determine the final outcome. Any serious adverse event that occurs after the study period and is considered to be possibly related to the study treatment or study participation will be recorded and reported immediately. All serious adverse events will be reported to the IRB within 10 working days.

## **9. DATA HANDLING AND RECORD KEEPING**

Information about study participants will be kept confidential and managed according to the requirements of the Health Insurance Portability and Accountability Act of 1996 (HIPAA). Those regulations require a signed subject authorization informing the subject of the following:

- Protected health information (PHI) collected from subjects in this study
- Who will have access to that information and why
- Who will use or disclose that information
- The rights of research participants to revoke their authorization for use of their PHI
- View of PHI will be limited to individuals at the University of Pennsylvania directly involved in the study. The company donating the study product will not have access to PHI.

In the event that a participant revokes authorization to collect or use PHI, the investigator, by regulation, retains the ability to use all information collected prior to the revocation of subject authorization. For participants who have revoked authorization to collect or use PHI, attempts will be made to obtain permission to collect at least vital status (i.e. that the subject is alive) at the end of their scheduled study period.

## **10. STUDY MONITORING, AUDITING, AND INSPECTING**

The investigator will permit study-related monitoring, audits, and inspections by the EC/IRB, government regulatory bodies, and University compliance and quality assurance groups of all study related documents (e.g. source documents, regulatory documents, data collection

instruments, study data, etc.). The investigator will ensure the capability for inspections of applicable study-related facilities (e.g. pharmacy, diagnostic laboratory, etc.).

A Data Safety and Monitor (consisting of a reviewer not involved in the study) will provide additional study oversight. Before beginning the study, the Monitor will review the human subjects' protections. The Monitor will review the study's progress, enrollment, and de-identified group-level data for differential rates in key outcomes and Adverse Events (AEs) twice per year. This Monitor will be responsible for monitoring the safety and efficacy of this trial, executing the data safety and monitoring (DSM) plan, and complying with Public Health Service (PHS) reporting requirements. Review of the rate of subject accrual and adherence to inclusion/exclusion criteria will occur at this time.

Participation as an investigator in this study implies acceptance of potential inspection by government regulatory authorities and applicable University compliance and quality assurance offices.

## 11. REFERENCES

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