What Distinguishes Weight-Loss Maintainers from the Treatment-Seeking Obese? Analysis of Environmental, Behavioral, and Psychosocial Variables in Diverse Populations

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Abstract

Background Understanding the factors that influence successful weight control is critical for developing interventions.

Purpose The purpose of the study was to provide a comprehensive understanding of the role of psychosocial, environmental, and behavioral variables in distinguishing weight-loss maintainers (WLM) from treatment-seeking obese (TSO).

Methods WLM (n = 167) had lost ≥10% of their maximum body weight, had kept the weight off for ≥5 years, and were now of normal weight. TSO-1 and TSO-2 had a history of dieting and body mass index ≥25. TSO-1 was predominantly Caucasian; TSO-2 was predominantly African-American. Bayesian model averaging was used to identify the variables that distinguished WLM from TSO-1 and TSO-2.

Results The variables that most consistently discriminated WLM from TSO were more physical activity (ORs = 3.95 and 2.85), more dietary restraint (ORs = 1.63 and 1.41), and less dietary disinhibition (ORs = 0.69 and 0.83). Environmental variables, including the availability of physical activity equipment, TVs, and high-fat foods in the home, also distinguished WLM from TSO.

Conclusions Obesity treatment should focus on increasing conscious control over eating, engaging in physical activity, and reducing disinhibition. Changes in the home environment may help facilitate these behavioral changes.

Keywords Multiple health behaviors, Weight control, Successful weight losers, Diverse populations

Introduction

The major problem in obesity treatment is failure to maintain long-term weight loss. To develop more effective interventions, it is critical to understand the factors that influence successful weight control. Research from the National Weight Control Registry (NWCR) has described the characteristics of over 6,000 successful weight losers. Successful weight losers in the NWCR consume a low-calorie, low-fat diet, eat breakfast regularly, participate in high levels of physical activity, weigh themselves frequently, and limit TV viewing [1–3]. NWCR members also report a high level of dietary restraint and low levels of dietary disinhibition [4]. Prospective evaluations of NWCR members indicate that failure to maintain these behaviors is related to weight regain over time [5]. A significant limitation of findings from the NWCR, however, has been the lack of an appropriate comparison group.

The few studies that have had comparison groups indicate that successful weight losers engage in more physical activity and self-monitoring and consume a lower-fat diet than obese controls [6, 7]. One comparative study also looked at psychological factors and found that successful weight losers utilized different coping strategies compared with obese controls [8]. However, these studies have generally included small sample sizes and been comprised of predominantly Caucasian individuals. Moreover, in the literature as a whole, more attention has been paid to behavioral (e.g., diet and physical activity) than to psychosocial (e.g., social support and depressive symptoms) or environmental (e.g., the home food and exercise environment) factors, despite all being frequently implicated in the development of obesity [9–11]. No study to date has simultaneously examined behavioral, psychosocial, and environmental variables; thus, the relative importance of these variables in defining successful weight control is unclear.

Cross-study collaborations provide a unique opportunity to address some of the limitations in the existing literature. Although there are methodological challenges to cross-study comparisons, including differences in participant recruitment and measurement selection, these drawbacks are overshadowed by

the benefits that include examination of multiple constructs, in diverse populations and settings, and combining sample sizes to strengthen validity and reliability [12].

The purpose of the proposed study was to provide a comprehensive understanding of the role of psychosocial (e.g., depressive symptoms), environmental (food and exercise equipment in the home), and behavioral variables (diet, exercise, TV viewing, and breakfast eating) in distinguishing a group of long-term weight-loss maintainers who have achieved a normal weight from two groups of treatment-seeking obese. We sought to identify the strongest discriminators of weight-loss maintainers and treatment-seeking obese and to examine whether the discriminators differed across various treatment-seeking obese populations using a cross-study comparative design.

Methods

Participants

In this paper, we consider a group of weight-loss maintainers and two groups of treatment-seeking obese, as described below. Their demographic characteristics are displayed in Table 1.

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Weight-Los Maintainers (N=167)

To be eligible for this group, weight-loss maintainers had to report a history of overweight or obesity (body mass index (BMI) ≥ 25) at some point in their lives, be currently normal weight (BMI 18.5–25), and must have lost ≥10% of maximum body weight. In addition, to identify individuals who were clearly succeeding at weight loss maintenance, they were required to have kept off a loss of ≥10% for at least 5 years and be weight stable (±10 lb) within the past 2 years. Eligibility was determined via phone screen.

Recruitment was conducted by placing advertisements in national and local publications and articles about the study published in media that target a general audience. Extensive efforts were made to recruit weight-loss maintainers from diverse populations, including numerous advertisements on the radio, in newspapers, magazines, and billboards targeting African-American populations, maintaining a promotional booth at a national minority health fair, and distributing brochures in waiting rooms in primary care offices servicing low-income and minority populations. Individuals interested in joining the study were asked to call a 1-800 number or to visit our website (www.nwcr.ws). Participants were located in all different parts of the USA, but predominantly in New England, California, and the Washington, D.C. area (>70%). Participants were paid $50 for completing the study assessments. The study was approved by the Institutional Review Board at the Miriam Hospital in Providence, Rhode Island.

Treatment-Seeking Obese

Two different treatment-seeking obese (TSO) populations were recruited prior to participation in two ongoing clinical weight loss trials. One group (TSO-1; $N = 153$) was recruited through a university-based treatment center in Providence, RI, prior to participation in a study examining the effects of changing both the physical and social factors within the home to promote long-term weight control. Participants in this sample were not paid for completing the study's baseline assessment. The study was approved by the Institutional Review Board at the Miriam Hospital in Providence, Rhode Island. The second group (TSO-2; $N = 153$) was recruited through primary care practices in the Philadelphia, PA, area prior to participation in a study examining effects of meal replacements and reduced energy density eating on long-term weight loss. Participants were not paid for completing the baseline assessments. The study was approved by the Institutional Review Board at Drexel University, Philadelphia, Pennsylvania. To be included in the current study, participants in both groups were overweight or obese ($BMI \geq 25$) and had reported a history of dieting, involving weight losses greater than 10 lb.

Measures

Measures were selected a priori based on previous literature indicating a potential relationship with successful weight control [4, 13–15]. All measures were administered at study enrollment (in weight-loss maintainers (WLM) group) and prior to beginning weight loss treatment (in TSO groups). Most variables were measured in common across all three groups, but there were some differences, as described below and indicated in Table 2.

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Demographics, Weight, and Height

Weight history was based on self-report. Weight and height was based on self-report in WLM and measured using calibrated digital scales and stadiometers in TSO-1 and TSO-2. Participants also provided demographic information about ethnicity/race (Hispanic/non-Hispanic, American Indian, Asian, Black/African-American, Native Hawaiian, White, or other) for descriptive purposes.

Food Intake

Diet was assessed using the Block Food Frequency questionnaire [16] in TSO-1 and 24-h dietary recall [17] in WLM and TSO-2. Both the Block and 24-h recall yield estimates of total daily caloric intake and percentage of calories from fat, protein, and carbohydrate. The 24-h recalls were completed by WLM and TSO-2 using the Nutrition Data System Software developed by the Nutrition Coordinating Center, University of Minnesota, Minneapolis, Minnesota. Strong linear relationships ($r = 0.96$) have been found between 24-h recalled food intake and independently observed food intake [18]. Moreover, high correlations (>0.66) have been found for all nutrients in comparing the multiple 24-h recalls and food diaries [19]. The Block Food Frequency questionnaire [16] was administered in TSO-1 and has been shown to correlate significantly with 24-h recall measures, with Pearson correlation coefficients having a median of 0.59 [20]. Nonetheless, as different dietary measures were used in analyses comparing WLM and TSO-1, results of dietary intake should be interpreted with caution.

Physical Activity

Physical activity was assessed using the Paffenbarger Activity Questionnaire (PAQ) [21] in WLM and TSO-1 groups. This measure yields estimates of the total energy expended in physical activity per week. The PAQ has been shown to have high test–retest reliability [22] and to be significantly correlated with measures of cardiovascular fitness [23]. In the TSO-2 group, physical activity was assessed using an instrument adapted from Jacobs et al. [24] that has been used in several large epidemiologic studies. The questionnaire lists 13 types of physical activity. Participants rate the average frequency with which they engaged in each activity for at least 20 min during the past year. The frequency per week for each activity is multiplied by its estimated intensity level in metabolic equivalents to produce the physical activity (PA) score. Products are summed across the 13 activities, with higher scores reflecting greater PA levels (based on frequency and intensity) [25].

Eating Behavior

The Eating Inventory [26] was used to assess levels of dietary restraint and disinhibition. Items on the restraint subscale reflect behaviors used to control dietary intake (e.g., “consciously control my intake” and “count calories”). The dietary disinhibition subscale measures a person’s reported loss of control while eating. Both scales have been found to have good test–retest reliability and internal consistency [26, 27].

Specific Weight Control Behaviors

Weekly frequency of breakfast consumption, fast-food consumption, and non-fast-food restaurant consumption as well as dietary consistency were assessed using single-item questions used in previous research [14, 28]. These questions have been found to significantly predict weight regain among successful weight losers in the NWCR [14, 28, 29].

Food Storage in Home

The Household Food Inventory checklist was used to assess food storage in the home. The checklist includes foods listed on the Block Food Frequency Questionnaire [30] and additional low-fat food choices (e.g., reduced-fat cakes and pies). Participants were asked to indicate if a given food was in their house, regardless of quantity. Responses were categorized into number of high-fat snacks (e.g., regular potato chips), high-fat spreads (e.g., regular mayonnaise), high-fat dairy (e.g., regular milk, regular cheese), and a number of low-fat fruits and vegetables (e.g., apples, oranges, and broccoli), low-fat spreads (e.g., reduced-fat mayonnaise), low-fat dairy (e.g., reduced-fat milk and reduced-fat cheese), low-fat cereals (e.g., cold cereals such as Corn Flakes, Rice Krispies, and Kix), and low-fat snacks (e.g., low- or reduced-fat potato chips). This questionnaire has been found to have acceptable test–retest and inter-rater reliability [15, 31].

Exercise Equipment in the Home

The Exercise Environment Questionnaire [32] was used to assess the amount and type of exercise equipment available in the home. The questionnaire lists various sports, recreation, and exercise equipment and asks participants to indicate whether these are present in the home. Subscales include number of pieces of home exercise equipment, individual recreation equipment, individual sports equipment, team exercise equipment, and athletic shoes. The measure has been found to have high levels of test–retest reliability, as well as high inter-rater reliability between adults within the home [32]. Moreover, past research has found a relationship between the presence of exercise equipment in the home and self-reported physical activity among adult men and women [32].

Social Support

Social support for physical activity and eating habits from friends and family were assessed with the Sallis Social Support Exercise and Eating Habits Surveys [33]. Participants rated how often family and friends engaged in acts that were supportive in the past 6 months, from 1 (none) to 5 (very often).

Participants could also select "does not apply." As recommended [33], family was defined as "members of the household," and friends were defined as "friends, acquaintances, or coworkers." Subscales include family or friend encouragement for physical activity and eating behaviors (e.g., "gave me encouragement to stick with my exercise routine" and "reminded me not to eat high fat, high calorie foods"), discouragement for physical activity and eating behaviors (e.g., "complained about the time I spent exercising" and "ate high fat or high calorie foods in front of me"), family or friend participation in physical activity (e.g., "changed their schedule so we could exercise together"), family or friend rewards for activity (e.g., "gave me rewards for exercising, brought me something or gave me something I like"). Scores were averaged across items separately for family and friends, with a possible range of 1 to 5 (higher = greater social support). Good test–retest reliability ($r = 0.57$ to $r = 0.86$) and internal consistency ($\alpha = 0.83$ to $\alpha = 0.87$) have been reported for this measure [33]. Criterion-related validity has also been reported in that social support for physical activity has been significantly associated with actual physical activity ($r = 0.23$ to $r = 0.46$) [33].

Depressive Symptoms

The 20-item Center for Epidemiologic Studies Depression scale (CES-D) [34] was used to assess levels of depressive symptomatology. The CES-D total score is calculated by adding the scores for all 20 items giving a range from 0 to 60, with the suggested cut-off of 16 as indicative of probable clinical depression. The validity of this scale in assessing such symptomatology has been reported in population-based studies [35].

Statistics

Demographic characteristics of the three study populations, WLM, TSO-1 and TSO-2, were compared using one-way analysis of variance (ANOVA) for continuous variables and Pearson's chi-square tests for categorical variables. We further compared the weight and BMI between TSO-1 and TSO-2 using Student's t tests.

Our analyses included two steps. First, we conducted receiver operator characteristics (ROC) analyses to evaluate the power of each variable (in Table 2) to distinguish WLM from TSO 1 and WLM from TSO 2. These ROC analyses were adjusted for age and gender. Specifically in this step, we regressed each variable in Table 2 on age and gender using a linear model and then used the residuals for constructing ROC curves. Each variable's distinguishing power was then captured by the area under the ROC curve (AUC). We used $AUC \geq 0.60$ as a criterion (highlighted in italics in Table 2) to select a set of potentially important variables to enter into subsequent multivariate analyses. In selecting these variables, we used subscales rather than total scores to reduce collinearity. Intercollinearity was examined using correlations and multiple R-square (Rs) values; those with $Rs > 0.40$ were excluded from multivariate analyses; percentage of calories from fat was the only variable that met this criterion and was, thus, excluded. We also examined correlations among the variables using Pearson's product moment correlation.

Next, we performed Bayesian model averaging (BMA) analysis [36] on the selected set of variables (having $AUC \geq 0.60$ in comparisons of WLM vs. TSO-1 and/or WLM vs. TSO-2) to evaluate their joint power in distinguishing TSO-1 and TSO-2 from WLM. In BMA, we used logistic regression to model the association between group status (WLM or TSO-1/TSO-2; as dependent variable) and behavioral, psychosocial, and environmental measures (as predictor covariates). Again, we adjusted the analysis for age and gender, by including them as predictor covariates. BMA examines the performance/fit of all possible models that can be applied to the selected variables. One feature of BMA is that, at the end of analysis, a few best-fitted models are reported as opposed to only one. BMA assigns a (posterior) probability to each of these models. The probability can be regarded as the "confidence" (or likelihood) that the model is plausible and should be used for making inferences. The distinguishing power of each variable in a model is characterized by the posterior probability (column "Pr." in Tables 3 and 4), which is the probability that the variable appears as a discriminator in the final models (1 = a strong discriminator and 0 = no distinguishing power). Variables with posterior probabilities of 1 indicate

their inclusion in 100% of all models generated. Odds ratios (OR) were also produced, which summarize the ORs across multiple models weighted by the posterior probabilities of the models.

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BMA has several advantages. It avoids the potential problem of model over-fitting and necessity of validation of usual model selection procedures (e.g. forward and back selection). The inferences by BMA take account of model uncertainty, and in theory, the average predictive performance is better than any single model that could be selected. We estimated relative strength of each discriminator in BMA by calculating effects sizes based on the absolute mean divided by the standard deviation of the posterior distribution (denoted by "E/V" in Tables 3 and 4). All statistical analyses were done using R (www.r-project.org). The BMA package for R is obtained from http://cran.r-project.org/web/packages/BMA/index.html and http://www.research.att.com/~volinsky/bma.html.

Results

Univariate Comparisons of WLM vs. TSO-1 and TSO-2

AUC analyses identified 30 discriminators with AUC $\geq$ 0.60 in one or both comparisons of WLM vs. TSO-1 and TSO-2 (Table 2). As illustrated in Table 2, weight-loss maintainers had higher dietary restraint and lower disinhibition, hunger, and depressive symptoms than the treatment-seeking obese groups. WLM reported more frequent self-weighing (assessed in TSO-1 only) and breakfast consumption and less frequent restaurant eating (assessed in TSO-1 only) and fast-food consumption. WLM also scored higher on several physical activity variables, including more calories expended in overall physical activity and less TV viewing hours per week.

A variety of home environmental variables also distinguished WLM from TSO-1 and TSO-2. WLM reported having more low-fat foods in the home overall, including more fruit and vegetables, and fewer high-fat foods, such as high-fat snacks and spreads. WLM also reported having fewer TVs in the home and more home exercise equipment. The social support variables (assessed in TSO-1 only) suggested that WLM were more likely to have a friend participate in physical activity but reported less family and friend encouragement for healthy eating. Table 2 illustrates group means and percentages and highlights in italics the discriminators with AUC ≥ 0.60 that were entered into subsequent BMA analyses.

We next also conducted preliminary correlational analyses to examine univariate relationships among behavioral, environmental, and psychosocial variables. Interestingly, similar correlational patterns emerged within the three samples. Physical activity, and high PA in particular, was significantly correlated with the home physical activity environment. For example, high physical activity was significantly correlated with number of pieces of individual sports equipment in the home of WLM ($R = 0.15$; $p = 0.04$) and with total number of pieces of exercise equipment in the homes of TSO-1 ($R = 0.20$; $p = 0.01$) and TSO-2 ($R = 0.205$; $p = 0.004$). Similarly, hours of television viewing per week was related to number of TVs in the homes of WLM ($R = 0.16$; $p = 0.03$), TSO-1 (0.15; $p = 0.05$), and TSO-2 (0.264; $p = 0.0001$). Friend participation in physical activity was also correlated with physical activity in WLM (0.16; $p = 0.02$) and TSO-1 (0.213; $p = 0.007$) but was not measured in TSO-2.

Significant correlations were also observed between macronutrient consumption and the home food environment. For example, percentage of calories from fat was significantly and inversely correlated with number of low-fat snacks (−0.284; $p = 0.0001$) and spreads (−0.263; $p = 0.0001$) in the homes of WLM, with number of low-fat dairy (−0.15; $p = 0.06$) in the homes of TSO-1, and number of high-fat spreads (0.29; $p = -0.0001$) in the homes of TSO-2. Higher dietary restraint was related to more low-fat snacks (0.289; $p = 0.0001$) and spreads (0.263; $p = 0.0001$) in the home of WLM and more low-fat spreads

(R = 0.18; p = 0.02) in TSO-2, but not TSO-1. Similarly, restraint was related to more low-fat spreads in the homes of WLM (0.263; p = 0.0001) and TSO-2 (0.224; p = 0.002) but not TSO-1.

Multivariate Comparisons of WLM vs. TSO-1 and TSO-2

We next sought to identify, among the significant univariate variables, which ones were independent discriminators of WLM vs. TSO-1; TSO-1 was the most demographically similar to WLM and completed the largest array of measures in common with WLM. As illustrated in Table 3, after controlling for age and gender, the strongest and most consistent independent discriminators of WLM from TSO-1 were higher dietary restraint (OR = 1.8) and more total calories expended in physical activity (OR = 1.99), followed by fewer TV hours per week (OR = 0.47) and less dietary disinhibition (OR = 0.62), TVs in the home (OR = 0.68), and social support [more friend participation in physical activity (OR = 1.08) and less family encouragement for healthy eating (OR = 0.72)] also discriminated WLM and TSO-1.

We next examined whether the same discriminators would emerge when comparing WLM with a more ethnically diverse TSO population (i.e., TSO-2). Table 4 shows results of BMA analyses using the smaller subset of variables administered in common across the three samples (WLM, TSO-1, and TSO-2). After controlling for age and gender, findings showed that the most consistent variables that discriminated WLM from both the TSO-1 and TSO-2 were more physical activity (ORs = 3.95 and 2.85), more dietary restraint (ORs = 1.63 and 1.41), and less disinhibition (ORs = 0.69 and 0.83). In these, analyses, environmental variables also discriminated WLM from the TSO groups, but the specific variables differed in the two treatment-seeking groups. Total pieces of exercise equipment (OR = 1.15) and high-fat food in the home (OR = 0.67) discriminated WLM from TSO-1, and TVs in the home (OR = 0.56) discriminated WLM from TSO-2.

Discussion

Given the difficulty in promoting long-term weight loss maintenance, identifying the variables that consistently distinguish weight-loss maintainers from treatment-seeking obese is critical in informing effective treatment targets. This study was the first to simultaneously examine a diverse array of behavioral, psychosocial, and environmental factors in distinguishing successful weight control from obesity. Findings indicated that the three strongest and most consistent discriminators that set weight-loss maintainers apart from two demographically diverse obese treatment-seeking populations were higher dietary restraint, lower dietary disinhibition, and higher total physical activity. The types of foods, number of TVs, and exercise equipment available in the homes also distinguished weight-loss maintainers from treatment-seeking obese groups.

Several studies have shown that successful weight losers score high on dietary restraint [3, 37] and that increases in restraint are associated with greater weight loss [38, 39] and weight loss maintenance [13, 28]. Likewise, increases in disinhibition have been related to weight regain in successful weight losers [37, 40]. The importance of high levels of physical activity (>60 min/day) in weight loss maintenance is well documented [13, 41], but fewer studies have examined TV viewing. Although TV viewing is often implicated as a cause and treatment target for obesity in children [42, 43], less attention has been paid to the role of TV viewing in successful weight losers [2], and intervention studies aimed to reduce TV viewing in adults are lacking.

An important new finding from this project is that environmental variables, including the home food environment and the home activity environment (exercise equipment and TVs), distinguished weight-loss maintainers from treatment-seeking obese. Although only a few environmental variables remained significant in the multivariate analyses, nearly all the environmental variables were significant discriminators in univariate analyses and were significantly correlated with many of the important behavioral variables, including fat intake, physical activity, and TV viewing. Both a higher number of

high-fat foods and a lower number of low-fat foods in the home discriminated the treatment-seeking obese from the weight-loss maintainers; similarly the treatment-seeking obese had more televisions in the home and were more likely to have TVs in the bedroom and also had fewer pieces of home exercise equipment than the weight-loss maintainers. The benefits of targeting environmental variables, such as number of pieces of exercise equipment and TVs in the home or the number of low-fat foods available, merits further investigation [44].

While the primary focus of this paper was on the differences between the weight-loss maintainers and the treatment-seeking obese, the differences between the two treatment-seeking obese groups in this study are also of interest. The TSO-2 sample included more African-Americans and represented a lower socio-economic group than TSO-1, but also differed from TSO-1 on several of the weight control variables under investigation. The TSO-2 group scored very high on the hunger subscale of the three-factor eating scale and also had higher restraint and lower disinhibition scores than TSO-1. The TSO-2 group was also the least likely to eat breakfast regularly and most likely to eat fast food and have a TV in the bedroom. These findings suggest that specific behavioral targets may need to differ for different subgroups of the obese population and may inform the development of more "culturally appropriate" interventions.

Findings from this study fit well within self-regulation theory. Broadly defined, self-regulation refers to the many processes involved in exerting self-control to achieve a desired goal or state [45]. Successful self-regulation involves monitoring one's behavior in relation to a goal and changing or maintaining the behavior to maintain a desired effect [46]. Without self-control, behavioral responses would be automatic or focused on immediate short-term gratifications rather than longer term goals [47, 48]. The weight-loss maintainers in this study clearly demonstrated a stronger ability to exert self-control, as reflected by their greater reported restraint from eating, lower disinhibition, and greater practice of weight control behaviors. The treatment-seeking obese, by contrast, were more likely to report disinhibition and eating in response to tempting food cues, which has been associated with poor general

self-control in other studies [49]. Although self-monitoring was not a significant discriminator in the multivariate models, it was a significant discriminator in univariate analyses, and other studies have underscored the importance of self-monitoring in promoting successful weight control [1, 50, 51]. Thus, the ability to self-regulate, involving exerting ongoing self-control and monitoring, appears to be a defining feature of successful weight loss maintenance.

Self-regulation theory further posits that individuals have a limited resource of self-regulatory "strength" [52]. Experimental studies have shown that exerting self-control on one task impairs performance on a subsequent task requiring self-control, due perhaps to a depletion in self-control resources [53, 54]. The reasons why the weight-loss maintainers in this study were able to exert greater self-control than the treatment-seeking obese remain unclear. It is possible that weight-loss maintainers have a greater "pool" of self-control resources and/or that they are better able to preserve existing self-control resources. The latter possibility is suggested by the differences we observed in the environmental variables. The home environment of the weight-loss maintainers contained fewer high-fat foods and televisions and, thus, may have demanded fewer self-control resources than the more "toxic" home environments of the treatment-seeking obese. A better understanding of how the environment can deplete or promote self-control and whether and how increasing or replenishing self-control strength can improve weight loss outcomes merits future investigation.

This cross-study comparison has several strengths, as well as some limitations. Two distinct obese treatment-seeking populations were examined and compared with a rare group of extremely successful weight-loss maintainers. An array of behavioral, psychosocial, and environmental variables were examined using statistical models that reduce uncertainty. However, the weight-loss maintainer group was self-selected and predominantly Caucasian and female. Thus, generalizability is limited, and it is unclear whether findings would differ in more diverse samples of successful weight losers. Measures in this study were based on self-report and different measures, although highly correlated, were used to assess dietary and physical activity variables across the samples. Moreover, social support, self-weighing,

and restaurant eating variables were not assessed in the TSO-2 group. Thus, the predictive power of these and other unmeasured variables in discriminating WLM from TSO is unknown. Finally, the groups in this study were assessed at one time point only, which limits more powerful prospective analyses.

In sum, this study found that weight-loss maintainers differed from treatment-seeking obese in their higher levels of dietary restraint and physical activity and lower levels of dietary disinhibition and TV viewing. Moreover, differences in the home environment, in both in the food and activity areas, also set the weight-loss maintainers apart from the obese individuals. While supporting treatment components that focus on increasing cognitive restraint [50, 55, 56] and physical activity [50, 57] and decreasing disinhibition [58, 59], and TV viewing [42, 43] are paramount, this study strongly suggests a need to determine both whether and how modifying home environmental stimuli can promote these behavioral actions associated with long-term successful weight control.

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Tables

Table 1. Characteristics of weight-loss maintainers and two treatment-seeking obese samples (TSO-1 and TSO-2)

	WLM (*n*=167)	TSO-1 (*n*=153)	TSO-2 (*n*=153)	*p* value
Age	47.1 (11.5)	49.9 (10.5)	46.2 (11.4)	0.01 [a]
Race (% Caucasian)	94	80	33	<0.001 [b]
Gender (% female)	86	78	86	0.10 [b]
Weight (kg)	62.0 (9.0)	102 (22.5)	109 (21.2)	<0.001 [a]; 0.01[c]
BMI	22.0 (1.7)	37.6 (7.3)	39.1 (6.3)	<0.001 [a]; 0.05[c]
Lifetime maximum weight (kg)	92.8 (18.6)	–	–	–
Duration of weight loss maintenance (years)	13.7 (9.4)	–	–	–

Continuous variables are summarized by means and (standard deviations)
[a]Calculated from F tests of one-way ANOVAs (all three samples)
[b]Calculated from Pearson's Chi-squared tests (all three samples)
[c]Calculated from Student's t tests (TSO-1 vs. TSO-2)

Table 2. Mean scores and area under the curve values for comparisons of weight-loss maintainers vs. treatment-seeking obese-1 and weight-loss maintainers vs. treatment-seeking obese-2

Variable	WLM Mean (SD)	TSO-1 Mean (SD)/AUC	TSO-2 Mean/AUC
Dietary restraint	14.7 (4.2)	*5.6 (3.6)/0.93*	8.8 (3.8)/0.85
Disinhibition	5.0 (3.5)	*8.4 (3.2)/0.77*	7.4 (3.8)/0.67
Hunger	3.7 (2.8)	*5.7 (3.3)/0.68*	10.9 (4.2)/0.93
CES-D (% ≥16)	7%	*15%/0.62*	24%/0.60
Self-weighing (at least weekly vs. not)	67%; 33%	*45%; 55%/0.66*	–
Breakfast (every day vs. not)	79%; 21%	*58%; 42%/0.66*	34%; 66%/0.76
Fast-food consumption (at least 1/week vs. not)	31%; 69%	*61%; 39%/0.74*	75%; 25%/0.84
Other restaurant eating/week	2.1 (2.1)	*3.1 (2.5)/0.65*	–
High-fat foods in the home	3.9 (2.3)	*6.3 (1.7)/0.76*	5.5 (2.3)/0.70
Number of high-fat snacks in the home	2.2 (1.5)	*3.8 (1.5)/0.75*	2.8 (1.7)/0.62
High-fat spreads	0.77 (0.76)	*1.30 (0.69)/0.71*	1.56 (0.66)/0.78
High-fat dairy	1.00 (0.65)	1.20 (0.49)/0.59	1.16 (0.66)/0.57
Low-fat foods in the home	11.7 (3.2)	*10.0 (2.5)/0.68*	9.8 (3.4)/0.66
Fruit/vegetable in home	8.3 (2.1)	*7.4 (2.1)/0.64*	7.5 (2.3)/0.60
Low-fat spreads	1.18 (0.82)	0.90 (0.71)/0.58	0.66 (0.77)/0.67
Low-fat dairy	1.44 (0.67)	1.28 (0.68)/0.53	0.90 (0.68)/0.70
Low-fat cereals	2.14 (0.76)	2.17 (0.87)/0.51	1.69 (0.82)/0.65
Low-fat snacks	0.74 (0.81)	0.44 (0.58)/0.57	0.74 (0.96)/0.52
Total calories expended in PA/week	2,877 (2,162)	*762 (1,126)/0.84*	1,003 (959)/0.79
Calories expended walking (blocks)	828 (978)	*214 (411)/0.75*	–
Moderate intensity PA	718 (1,120)	*146 (411)/0.71*	–
High-intensity PA	929 (1,383)	*142 (710)/0.69*	–
Light physical activity	151 (398)	*62 (399)/0.65*	–
Flight calories	251 (323)	197 (231)/0.55	–
Sitting hours/week	29.0 (20)	26.9 (20)/0.53	27.8 (22.0)/0.54
TV hours/week	12.8 (10.3)	*19.7 (13.2)/0.67*	17.7 (12.7)/0.61
TVs in home	2.6 (1.4)	*3.3 (1.4)/0.63*	3.5 (1.4)/0.67
TV in bedroom (% yes)	57%	*71%/0.63*	91%/0.66
Total pieces of exercise equipment in the home)	12.0 (5.0)	10.6 (5.1)/0.57	8.2 (5.2)/0.74
Home exercise equipment	3.8 (1.9)	*2.9 (2.0)/0.62*	2.9 (2.2)/0.65
Individual recreation equipment	3.62 (1.95)	3.23 (1.95)/0.56	1.97 (1.65)/0.75
Individual sports equipment	1.4 (1.2)	1.39 (1.14)/0.53	0.69 (0.96)/0.69
Team exercise equipment	1.4 (1.7)	1.70 (1.72)/0.56	1.12 (1.61)/0.56
Athletic shoes	1.26 (0.51)	1.28 (0.51)/0.51	1.20 (0.62)/0.51
Social support			
Family encouragement for eating healthy	8.5 (4.0)	*14.5 (5.0)/0.82*	–
Friend encouragement for eating healthy	8.3 (3.4)	*10.4 (4.3)/0.63*	–
Friend participate in physical activity	20.4 (8.5)	*17.3 (7.6)/0.62*	–
Family discouragement for eating healthy	10.6 (4.9)	11.6 (4.1)/0.58	–
Friend discouragement for eating healthy	11.2 (4.3)	10.0 (3.6)/0.57	–
Family participate in physical activity	22.2 (10.4)	23.2 (9.0)/0.56	–
Family reward/punish for physical activity	1.66 (1.39)	3.58 (1.09)/0.51	–
Total calories	1,693 (450)	1,929 (886)/0.54	2,028 (1,262)/0.55
Percentage of calories from fat	–	38 (8)/–	40 (8)/–
Dietary consistency (same on weekends as weekdays)	46%	38%/0.52	39%/0.50

AUC values ≥0.60 were considered significant univariate discriminators. If ≥0.60 in either group, it was entered into the BMA analyses.
Significant differences are indicated in italics
WLM weight-loss maintainer, *TSO* treatment-seeking obese, *AUC* area under the curve

Table 3. Discriminators of weight-loss maintainer and treatment-seeking obese (TSO-1) based on Bayesian model averaging analysis

	WLM vs. TSO-1			
	Pr.	OR	95% CI	E/V
Dietary restraint	*1.00*	*1.82*	*(1.49, 2.23)*	*5.77*
Disinhibition	*1.00*	*0.62*	*(0.49, 0.79)*	*3.94*
Breakfast	0.15	0.86	(0.34, 2.17)	0.31
CES-D	<0.01	–	–	–
Fast-food	<0.01	–	–	–
Restaurant	0.13	0.97	(0.82, 1.16)	0.30
Self-weighing	<0.01	–	–	–
High-fat foods in home	0.16	0.97	(0.80, 1.17)	0.32
Low-fat foods in home	0.08	1.01	(0.92, 1.10)	0.21
Total calories expended in PA/week (per log_{10} 1,000 cal.)	*1.00*	*1.99*	*(1.00, 5.14)*	*1.43*
Total pieces of exercise equipment in the home	0.02	1	(0.97, 1.04)	0.12
TVs in home	*0.93*	*0.68*	*(0.40, 1.14)*	*1.48*
TV hours/week (10 h/week)	*1.00*	*0.47*	*(0.24, 0.92)*	*2.20*
Friend encouragement for eating healthy	<0.01	–	–	–
Family encouragement for eating healthy	*1.00*	*0.72*	*(0.61, 0.85)*	*3.91*
Friend participate in PA	*0.99*	*1.08*	*(1.00, 1.18)*	*1.69*

Significant discriminators are indicated in italics
Pr the posterior probability that the variable is a discriminator, OR odds ratio, E/V effect size = posterior mean/posterior standard deviation

Table 4. Discriminators of weight-loss maintainer and two treatment-seeking obese groups (TSO-1 and TSO-2) based on Bayesian model averaging analysis

	WLM vs. TSO-1 (ref)				WLM vs. TSO-2 (ref)			
	Pr.	OR	95% CI	E/V	Pr.	OR	95% CI	E/V
Dietary restraint	*1.00*	*1.63*	*(1.42, 1.86)*	*7.15*	*1.00*	*1.41*	*(1.28, 1.56)*	*6.92*
Disinhibition	*1.00*	*0.69*	*(0.58, 0.82)*	*4.24*	*1.00*	*0.83*	*(0.75, 0.92)*	*3.41*
CES-D	0.04	1.00	(0.69, 1.44)	1.00	0.33	0.68	(0.19, 2.40)	0.6
Breakfast	0.06	0.97	(0.69, 1.37)	0.97	*1.00*	*4.86*	*(2.31, 10.2)*	*4.17*
High-fat food	*1.00*	*0.67*	*(0.53, 0.86)*	0.67	0.04	1.00	(0.97, 1.03)	0.01
Fast-food consumption (at least 1/week vs. not)	0.06	0.97	(0.70, 1.35)	0.97	*0.96*	*0.3*	*(0.12, 0.72)*	*2.68*
Low-fat food	0.06	1.01	(0.95, 1.07)	1.01	0.08	1.01	(0.96, 1.06)	0.22
Total calories expended in PA/week (per $\log_{10}$ 1,000 cal.)	*1.00*	*3.95*	*(1.88, 8.29)*	*0.81*	*1.00*	*2.85*	*(1.58, 5.16)*	*3.46*
TV hours/week (10 h/week)	0.39	0.81	(0.45, 1.46)	3.63	0.07	0.99	(0.88, 1.12)	0.18
TVs in home	0.16	0.96	(0.74, 1.23)	0.96	*1.00*	*0.56*	*(0.42, 0.75)*	*3.96*
Total pieces of exercise equipment in the home	*0.96*	*1.15*	*(1.03, 1.29)*	*1.15*	0.37	1.03	(0.95, 1.12)	0.66

Pr the posterior probability that the variable is a discriminator, *OR* odds ratio, *E/V* effect size=posterior mean/posterior standard deviation