

Contents lists available at [ScienceDirect](http://ScienceDirect)

# Body Image

journal homepage: [www.elsevier.com/locate/bodyimage](http://www.elsevier.com/locate/bodyimage)

## Change in body image and psychological well-being during behavioral obesity treatment: Associations with weight loss and maintenance

António L. Palmeira<sup>a,b,\*</sup>, Teresa L. Branco<sup>b</sup>, Sandra C. Martins<sup>b</sup>, Cláudia S. Minderico<sup>b</sup>, Marlene N. Silva<sup>b</sup>, Paulo N. Vieira<sup>b</sup>, José T. Barata<sup>b</sup>, Sidónio O. Serpa<sup>b</sup>, Luís B. Sardinha<sup>b</sup>, Pedro J. Teixeira<sup>b</sup>

<sup>a</sup> University Lusófona de Humanidades e Tecnologias, Lisbon, Portugal

<sup>b</sup> Faculty of Human Kinetics, Technical University of Lisbon, Lisbon, Portugal

### ARTICLE INFO

#### Article history:

Received 12 August 2009

Received in revised form 19 March 2010

Accepted 22 March 2010

#### Keywords:

Weight management

Body image

Psychological well-being

Women

### ABSTRACT

This study reports on outcomes from a behavioral obesity treatment program, evaluating if treatment-related changes in body image and psychological well-being are predictors of weight change during treatment and after follow-up. Subjects were 142 overweight/obese women ( $BMI = 30.2 \pm 3.7 \text{ kg/m}^2$ ; age =  $38.3 \pm 5.8$  years) participants in a behavioral treatment program consisting of a 4-month treatment period and a 12-month follow-up. Psychosocial variables improved during treatment and these changes were correlated with 4-month weight reduction. Short-term changes in body size dissatisfaction ( $p = .002$ ) and mood ( $p = .003$ ) predicted long-term weight loss. Additional results suggest that there might be a predictive role of short-term changes in body size dissatisfaction and self-esteem on long-term weight loss after accounting for initial weight change ( $p < .028$ ). We conclude that, along with weight changes, cognitive and affect-related processes influenced during obesity treatment may be related long-term success, in some cases independently of initial weight loss.

© 2010 Elsevier Ltd. All rights reserved.

### Introduction

Besides changes in weight, participants in weight loss programs often report improved life satisfaction and feeling more positive about their bodies and their new-learned abilities, such as being physically active and self-managing their weight. Research has shown that these psychological improvements can be associated with weight changes (Blaine, Rodman, & Newman, 2007; Maciejewski, Patrick, & Williamson, 2005). While treatment-related psychosocial changes (e.g., improved body image) are considered valuable outcomes *per se* and a natural consequence of losing weight, they are not necessarily viewed as mediators or enabling factors for behavior change. Stice and Shaw (2002) theorized on these possible influences, showing that two pathways illustrate the role of body dissatisfaction on the development of maladaptive eating behaviors, which may be related to poor weight control and obesity: the dieting and the negative affect path. For example, body dissatisfaction reductions might counteract extreme dieting patterns and negative affect that could arise during a weight loss program. Additionally, the results from

project EAT have shown that, in adolescent females, baseline lower body satisfaction predicted higher levels of dieting, unhealthy weight control behaviors and binge eating after 5 years (Neumark-Sztainer, Paxton, Hannan, Haines, & Story, 2006), leading the authors to conclude that body image enhancement should protect against the development of unhealthy behaviors linked to obesity. Therefore, cognitive and affect-related changes that occur during weight management may represent more than positive outcomes and can in fact also influence (i.e., mediate) the effects of an intervention (Palmeira et al., 2009). To the extent this occurs, these psychosocial changes should be investigated not only as dependent variables but also as behavior modification agents (Kahne-man, Diener, & Schwarz, 1999). This line of inquiry appears especially relevant for interventions that include regular physical exercise, considering its well-known positive effects on emotions, self-esteem, depression, and other psychological variables (Biddle & Mutrie, 2001).

The Reciprocal Effects Model is a theoretical framework used in educational psychology (Marsh & Craven, 2006), which could provide valuable insight to the understanding of behavior change in the context of weight management programs. This model describes the causal relation between a specific component of psychological well-being (e.g., fewer depressive symptoms) and a performance indicator (e.g., behavior or weight change) as dynamical and reciprocal. The reciprocal determinism proposed in Bandura's Social Cognitive Theory suggests similar processes,

\* Corresponding author at: Universidade Lusófona de Humanidades e Tecnologias, A/C: Faculdade de Educação Física e Desporto, 1749-028, Lisboa, Portugal. Tel.: +351 217 515 587; fax: +351 217 515 557.

E-mail address: [antonio.palmeira@ulusofona.pt](mailto:antonio.palmeira@ulusofona.pt) (A.L. Palmeira).

i.e., that behavior both influences and is influenced by individual factors and the environment (Bandura, 1997).

In weight management, the psychological variables that potentially could be involved in these causal associations include self- and body-esteem variables, mood, and depression (Kolotkin, Crosby, Williams, Hartley, & Nicol, 2001; Wadden, Brownell, & Foster, 2002). This statement is supported by several findings, which show that changes in psychosocial variables are not necessarily associated with weight loss. For example, improvements in body image (Foster, Wadden, & Vogt, 1997; Ramirez & Rosen, 2001), self-esteem (Maciejewski et al., 2005), and depression (Wadden et al., 1997) are inconsistently related to weight loss during obesity treatment (Maciejewski et al., 2005). Nevertheless, these improvements could be interpreted as influencing weight-related voluntary behaviors, at least for some individuals, for example by strengthening behavioral adherence to the program (Baker & Brownell, 2000), or possibly by the increment of psychosocial resources to cope with the demands of the treatment tasks. Schwartz and Brownell summarized this rationale when they stated that “one could readily imagine that the ability to lose weight would be improved by relief of depression, anxiety, poor self-esteem, or body image distress” (Schwartz & Brownell, 2004, p. 53).

To our knowledge, this has not been systematically evaluated and more studies are clearly needed, especially to ascertain whether treatment-related psychosocial changes predict long-term weight loss and maintenance. Teixeira et al. (2006) is one of the few studies that provided results for this question, reporting that changes in psychosocial variables related to exercise, eating and body image during a 4-month weight management program were predictive of 16-month weight loss. In this study, exercise-related motivational variables appeared to play a more important role in the long-term results, while some other psychosocial variables (e.g., eating behavior) were more predictive of 4-month weight changes.

Therefore, the focus of this study is to explore the hypothesis that improvements in psychological variables during obesity treatment are not only consequences but also an integral part of the causal behavioral chain that ultimately leads to long-term weight reduction. Specifically, the aim of this study is to analyze if short-term changes in body image and psychological well-being (self-esteem, mood, and depression) predict short and long-term weight change, in overweight and moderately obese women participating in a University-based weight management program. First, we evaluated if improvements in body image and psychological well-being occurred during the first 4 months of the program. Secondly, we assessed whether these psychosocial changes were associated with treatment-related weight change. Finally, we tested if short-term changes in psychosocial variables influenced long-term weight change, before and after accounting for treatment-related weight change.

## Methods

### Participants

Participants were recruited from the community for a weight management program through newspaper ads, a website, email messages, and flyers. Subjects were required to be older than 24 years, pre-menopausal, not pregnant, have a BMI between 25 and 40 kg/m<sup>2</sup>, and free from major disease to be eligible for the study. One hundred and fifty-five women volunteered to participate. After baseline measurements, some women were excluded ( $n = 6$  due to exclusion criteria detected during testing) and others ( $n = 7$ ) decided not to participate due to personal incompatibilities. Hence, a sample of 142 women ( $BMI = 30.2 \pm 3.7$  kg/m<sup>2</sup>; age =  $38.3 \pm 5.8$  years; 47.7% attended college) started the 16-month University-based behavioral obesity treatment program. During the first 4 months, all

participants received the same intervention, after which they were randomized into two maintenance programs: (a) monthly meetings; (b) monthly meetings plus two structured weekend exercise sessions; or to a control group with no further contact. The duration of this second phase was 12 months. Maintenance conditions and control were pooled together for the current analysis since weight change exclusively during maintenance was not different among groups (percent body weight change: control =  $1.3 \pm 4.3\%$ ; monthly meetings group =  $-0.7 \pm 5.3\%$ ; monthly meetings plus exercise group =  $-1.0 \pm 5.2\%$ ;  $p = .192$ ). Attrition was 6% at 4 months and 33% at 16 months. Data were analyzed for completers-only and also using data imputation methods (e.g., Last Observation Carried Forward), to control for attrition-related bias. However, since psychosocial changes during treatment were not different between completers and dropouts ( $p > .168$ ) and similar magnitude in correlations with 0–4 and 16 months' weight change was observed in both groups, we followed the more conservative completers-only procedure. Therefore, the sample under analysis was reduced to 96 participants ( $BMI = 30.1 \pm 3.6$  kg/m<sup>2</sup>; age =  $38.9 \pm 5.7$  years), who completed the 16 months duration of the program. All participants agreed to refrain from participating in any other weight loss program and gave written informed consent prior to participation in the study. The Faculty of Human Kinetics' Ethics Committee approved the study.

### Intervention

The main intervention included fifteen weekly meetings, which lasted 120 min. Attendance averaged 83% and each group included 32–35 women. The intervention was generally based on the LEARN weight management program (Brownell, 1997), and included educational content and practical applications in the areas of physical activity and exercise, diet and eating behavior, behavior modification, and have been partially described before (Palmeira et al., 2007; Teixeira et al., 2004). Physical activity topics included learning the energy cost associated with typical activities, increasing daily walking and lifestyle physical activity, planning and implementing a structured exercise plan, and choosing the right type of exercise, among many others. Examples of covered nutrition topics were learning the caloric, fat, and fiber content and the energy density of common foods, the role of breakfast and meal frequency for weight control, reducing portion size, and preventing binge and emotional eating. Cognitive and behavioral skills including self-monitoring, self-efficacy enhancement, dealing with lapses and relapses, enhancing body image, using contingency management strategies, and eliciting social support were also part of the curriculum.

The sessions were conducted by the same team to all treatment groups, and was composed by two Ph.D.- and six M.S.-level exercise physiologists, psychologists, and dieticians. Participants were informed that weight reduction should be understood as a long-term goal, and that a 5–10% weight loss was an appropriate goal to be sought at the end of the program.

### Instruments

#### Psychosocial variables

Data were collected at baseline and at the end of treatment. Participants were required to attend two laboratory sessions in order to complete all psychosocial assessments, in each evaluation period. The instruments were Portuguese validated versions of some of the most commonly used psychosocial instruments in obesity research.

#### Body image

Body image was evaluated by three questionnaires, considering its multidimensional nature. Body size dissatisfaction was

measured with the Body Image Assessment questionnaire (BIA; Williamson, Davis, Bennett, Goreczny, & Gleaves, 1989), which consists of nine silhouettes of increasing size, from which subjects are asked to choose their current (i.e., perceived actual body size) and ideal figures. The difference was used as a measure of dissatisfaction. The Body Shape Questionnaire (BSQ; Cooper, Taylor, Cooper, & Fairburn, 1987), a 34-item instrument with a 6-point Likert scale was used to measure affective, cognitive, and behavioral dimensions of body image, especially regarding the experience of, and preoccupation with “being fat”. The total score was used ( $\alpha = .95$ ), where higher values represent greater preoccupation with body shape. The Physical Self-Perception Profile (PSPP; Fox & Corbin, 1989) addresses five different dimensions of the physical self-concept based on 30 items, rated on a structured alternative scale. We used two of these dimensions: Physical Self-Worth (the higher order construct of this scale) and Body Attractiveness ( $\alpha$  estimates of .75 and .80, respectively).

*Psychological well-being*

Self-esteem was assessed with the Rosenberg Self-Esteem Scale (RSES; Rosenberg, 1965), composed by 10 items answered on a 4-point Likert scale. Higher scores of the RSES represent greater self-esteem ( $\alpha = .84$ ). Mood disturbance was assessed with the Profile of Mood States (POMS; McNair, Lorr, & Droppleman, 1971), which measures the transient emotional state through 65 items on a 5-point Likert scale. The questionnaire assesses 6 dimensions of mood that can be used to calculate a Total Mood Disturbance score (sum of the negative emotions subtracted by the positive Vigor dimension,  $\alpha = .92$ ), which was used in the present study (higher scores represent greater total mood disturbance). Questions pertain to emotional states of the previous month. Depression was evaluated with the Beck Depression Inventory (BDI; Beck & Steer, 1987), a 21-item inventory measuring several symptoms of depression. It uses a 4-point ordered scale and results in a total score ( $\alpha = .80$ ), where higher scores represent greater level of depressive symptoms.

*Body habitus*

Body weight was measured with a standardized procedure at baseline, treatment’s end (4 months), and at follow-up (16 months), using an electronic scale (SECA model 770, Hamburg, Germany). Three different variables were calculated to represent weight outcomes: baseline to 4-month weight change (short-term, treatment weight change); baseline to 16-month weight change (overall, long-term weight change); and 4–16-month weight change (an indicator of weight stability after treatment).

*Statistical procedures*

All psychosocial variables were expressed as residuals of the 4-month value regressed on the baseline value. Weight change was calculated by the same procedure at 0–4 months and also for 16 months data. A weight maintenance variable was calculated using the 16-month weight value regressed simultaneously on the baseline and the 4-month values, to adjust for initial weight and weight change during treatment. Using such “residualized” change scores creates a value that is orthogonal to the independent variable score and represents a better measure of change, when compared with pre–post subtraction procedure (Cohen, Cohen, West, & Aiken, 2003).

Changes in weight and psychosocial variables were assessed by paired *t*-tests and effect sizes, which were classified as small (<0.30), medium (0.30–0.80), and large (>0.80) (Cohen et al., 2003). To evaluate whether these changes were associated with actual weight loss, Pearson correlation coefficients were calculated. To study the predictive value of treatment-related changes in psychosocial variables on long-term weight change (before and after accounting for treatment-related weight change) we used multiple linear regression (stepwise method, *F* to enter,  $p < .05$ ) and analysis of covariance (ANCOVA).

**Results**

Weight change from baseline to 4 months was  $-3.7 \pm 3.9\%$  ( $p < .001$ , ranging from  $-17.7\%$  to  $6.3\%$ ), and from baseline to 16 months was  $-4.5 \pm 6.7\%$  ( $p < .001$ , ranging from  $-26.4\%$  to  $13.1\%$ ) with large individual variability. These weight changes were not associated with age ( $p < .857$ ), baseline weight ( $p < .505$ ), or education level ( $p < .529$ ). No significant change was observed in the 4–16 months analysis ( $p = .622$ ). Forty-five percent of the participants reached the 5% weight loss goal at follow-up while 21.1% reached the 10% objective.

Results for psychosocial variables showed that all body image variables improved during the intervention (medium effect sizes, see Table 1). Body size dissatisfaction showed the greatest change, with a reduction of more than one-half of a standard deviation ( $d = -0.52$ ,  $p < .001$ ). All psychological well-being measures improved, especially depression ( $d = -0.43$ ,  $p < .001$ ) and mood disturbance ( $d = -0.45$ ,  $p < .001$ ).

Associations between changes in psychosocial variables and weight showed that changes in body attractiveness, body size dissatisfaction, and total mood disturbance had the strongest association with 4-month weight change ( $p < .001$ , see Table 2). Changes in physical self-worth and depression showed weaker

**Table 1**  
 Change in psychosocial variables during treatment (Lisbon, Portugal, 2003–2005).

	Baseline	4 months	<i>t</i>	<i>d</i>
	<i>M</i> ± <i>SD</i>	<i>M</i> ± <i>SD</i>		
Body image				
Body size dissatisfaction (BIA)	2.26 ± 0.84	1.84 ± 0.77	5.43***	-0.52
Body shape concerns (BSQ)	92.32 ± 27.49	84.04 ± 22.90	2.61**	-0.33
Body attractiveness (PSPP)	10.94 ± 2.78	12.14 ± 3.11	-4.65***	0.41
Physical self-worth (PSPP)	11.95 ± 3.77	13.03 ± 3.45	-2.93**	0.30
Psychological well-being				
Self-esteem (RSES)	22.38 ± 3.58	23.04 ± 4.11	-1.73 <sup>¥</sup>	
Depression (BDI)	7.18 ± 5.61	5.07 ± 4.30	4.96***	-0.43
Total mood disturbance (POMS)	24.03 ± 31.37	10.87 ± 27.27	5.61***	-0.45

Notes:  $n = 96$ ; paired *t*-test; *d*, Cohen’s *d*: effect size; BIA: Body Image Assessment Questionnaire; BSQ: Body Shape Questionnaire; PSPP: Physical Self-Perception Profile; RSES: Rosenberg Self-Esteem Scale; BDI: Beck Depression Inventory; POMS: Profile of Mood States.

\*\*  $p < .01$ .  
 \*\*\*  $p < .001$ .  
<sup>¥</sup>  $p = .087$ .

**Table 2**  
 Correlations between weight changes and psychosocial changes during treatment (0–4 months; Lisbon, Portugal, 2003–2005).

Psychosocial variables	Weight change		
	0–4 months	0–16 months	4–16 months
<b>Body image</b>			
Body size dissatisfaction (BIA)	0.37***	0.42***	0.21*
Body shape concerns (BSQ)	0.17	0.01	-0.17
Body attractiveness (PSPP)	-0.37***	-0.25*	0.02
Physical self-worth (PSPP)	-0.23*	-0.22*	-0.08
<b>Psychological well-being</b>			
Self-esteem (Rosenberg)	-0.08	-0.19	-0.20*
Depression (BDI)	0.22*	0.21*	0.09
Total mood disturbance (POMS)	0.39***	0.37***	0.14

Notes:  $n = 96$ ; paired  $t$ -test. BIA: Body Image Assessment Questionnaire; BSQ: Body Shape Questionnaire; PSPP: Physical Self-Perception Profile; RSES: Rosenberg Self-Esteem Scale; BDI: Beck Depression Inventory; POMS: Profile of Mood States.

\*  $p < .05$ .  
 \*\*\*  $p < .001$ .

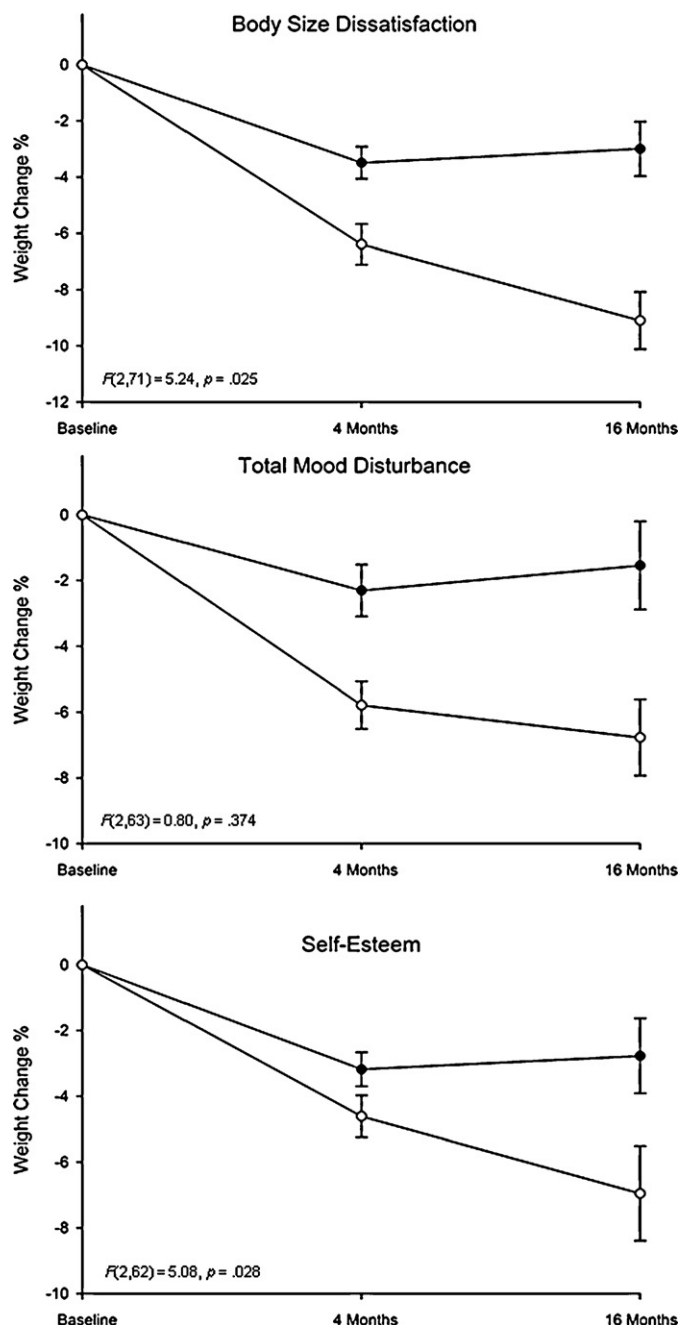
associations, albeit significant, with weight change during treatment ( $p < .05$ ). Changes in body shape concerns and self-esteem were not associated with weight loss during treatment. All previous associations were maintained for long-term weight change (0–16 months), although with some reductions in the strength of the correlations (Table 2). Changes in body size dissatisfaction and self-esteem were associated with weight change during the maintenance period (4–16 months).

The previous results showed that changes in body size dissatisfaction, total mood disturbance, and self-esteem were the associated with long-term weight management. For a more detailed analysis of these associations, we have followed the methods present in the paper by Teixeira et al. (2006), creating three groups of similar size, based on a tertile-split of each of these three psychosocial variables (“residualized” 4-month score), and weight change calculated for each group. To reduce the influence of using arbitrary cut-offs, only the two extreme groups were compared (Fig. 1). This procedure followed the methods present in the Teixeira et al. (2006) paper; by showing the amount of weight change obtained by the tertiles of change in the psychosocial variables we have a clearer view of the impact of these changes in the weight loss.

In the short-term, as expected, the group that decreased the most in body size dissatisfaction and total mood disturbance had the greatest weight loss (both  $p < .001$ ). The same pattern was seen for long-term weight losses in the groups with stronger 0–4-month improvements in body size dissatisfaction ( $p < .001$ ), total mood disturbance ( $p = .005$ ), and self-esteem ( $p = .025$ ). Improvement in body size dissatisfaction ( $p = .025$ ) and self-esteem ( $p = .028$ ) were associated with group differences in long-term weight loss, independently of short-term weight change. Contrarily, results for total mood disturbance indicated that the association with long-term weight change is dependent on initial weight loss success; when adjusting for 0–4-month weight change, the prospective associations were no longer significant.

The last set of analysis evaluated the multivariate association between changes in psychosocial variables and weight change (Table 3). Three stepwise multiple regression models were computed with the same set of predictors, i.e., change in psychosocial variables during treatment. These variables were used to predict weight changes at 4, 16, and between 4 and 16 months, after controlling for the 0–4 month’s weight change.

The first model explained 29.2% of 0–4-month weight change ( $p < .001$ ), with total mood disturbance as the strongest predictor (8.2% of unique variance explained –  $sr^2$ ). Changes in body dissatisfaction ( $sr^2 = 7.6\%$ ) and body attractiveness ( $sr^2 = 7.3\%$ ) also



**Fig. 1.** Weight loss after treatment (0–4 months) and after follow-up by treatment-related changes in body size dissatisfaction, total mood disturbance, and self-esteem. For each analysis, the sample was tertile-split into three groups based on treatment changes in body size dissatisfaction, total mood disturbance, and self-esteem. Weight change for the two extreme groups are displayed (mean and SEM). 16-Month weight change was compared between groups, after adjusting for 4-month weight change (ANCOVA, indicated in each graph).

loaded significantly and independently on this model. The second model explained 23.8% of weight change from baseline to follow-up ( $p < .001$ ). Of this, 11.3% was independently explained by changes in body size dissatisfaction ( $p = .002$ ) and 10.2% by changes in total mood disturbance ( $p = .003$ ). No predictor significantly entered the regression model for 4–16 months weight change ( $R^2 = 2.8\%$ ,  $F(1,83) = 3.38, p = .069$ ). However, considering the results for the bivariate analysis (Table 2), we built a regression model where the significant or near-significant variables – changes in body size dissatisfaction and self-esteem – were forced in, to

**Table 3**

Multiple regression analysis for the prediction of weight change during treatment and after follow-up, from psychosocial changes during treatment (Lisbon, Portugal, 2003–2005).

Psychosocial variables	0–4 months		
	$\beta$	$p$	$sr^2$
Total mood disturbance (POMS)	0.27	.008	8.2%
Body size dissatisfaction (BIA)	0.25	.011	7.6%
Body attractiveness (PSPP)	–0.25	.013	7.3%
$R^2$ ( $R^2$ adj.)	.29 (.26)		
Model's $F$	11.29 < .001		
	0–16 months		
	$\beta$	$p$	$sr^2$
Body size dissatisfaction (BIA)	0.32	.002	11.3%
Total mood disturbance (POMS)	0.30	.003	10.2%
$R^2$ ( $R^2$ adj.)	.24 (.22)		
Model's $F$	12.96 < .001		

Notes:  $n = 96$ ;  $sr^2$ : squared semi-partial correlation. BIA: Body Image Assessment Questionnaire; PSPP: Physical Self-Perception Profile; POMS: Profile of Mood States.

predict 4–16 months' weight change. This model did not reach significance ( $p = .055$ ), explaining 6.4% of weight change during follow-up, with body size dissatisfaction as the strongest predictor ( $sr^2 = 3.3\%$ ,  $p = .082$ ), followed by self-esteem ( $sr^2 = 2.1\%$ ,  $p = .167$ ).

## Discussion

The present study analyzed the magnitude of changes in body image and psychological well-being during a behavioral 4-month weight loss program, evaluating the extent to which these changes were predictive of short- and long-term success in weight loss, in middle-aged women. Main findings showed that most psychosocial variables improved significantly during the course of treatment and psychosocial changes were generally correlated with changes in body weight during treatment, except for self-esteem and body shape concerns, and that improvements in body size dissatisfaction and mood disturbance were significant predictors of 0–16 months weight change. Additional results suggest that there might be a predictive role of short-term changes in body size dissatisfaction and self-esteem on long-term weight loss after accounting for initial weight change.

During treatment, significant and positive changes were observed on most putative psychosocial predictors. Together, these constructs provide a broad characterization of participants' well-being and psychological functioning in some of the most relevant domains in obesity and health psychology research. The greatest improvements were observed in body size dissatisfaction, depression symptoms, and mood. Body image improvements are in line with previous reports (Foster et al., 1997; Ramirez & Rosen, 2001) and can be considered a consistent outcome of weight loss programs. Positive changes in depression symptoms and mood disturbance also find support in previous studies. For example, Wadden and Tanco reported lower depression symptoms after treatment in obese women (Tanco, Linden, & Earle, 1998; Wadden et al., 1997). Similarly, mood improvements in the present study replicate findings by Rippe et al. (1998) and Wing, Epstein, Marcus, and Kupfer (1984).

However, other studies have shown non-supportive data. For example, a recent meta-analysis by Maciejewski et al., reported no improvements in depression based on eight randomized controlled trials that used the BDI, and mixed results were reported for mood changes in three studies that used the POMS (Maciejewski et al., 2005). Importantly, these authors proposed that 5–10% improvements in psychosocial measures are adopted as a marker of success, mirroring established targets for weight loss (NHLBI,

1998). If we follow the most stringent 10% boundary, we observed that the present treatment was successful for 39% of all participants for depression, 52% for mood, and 54% for body size dissatisfaction (data not shown). It is noteworthy that for the same time period (i.e., 0–4 months), these psychological improvements clearly surpassed those observed for weight loss: 38% of the women reached the 5% goal while only 4% reached the 10% objective. These results support previous recommendations, which suggest a broader definition of success in weight management in order to include psychosocial and behavioral, in addition to physiological/clinical variables (Hill & Billington, 2002; Teixeira, Going, Sardinha, & Lohman, 2005).

Since weight loss was an explicit goal of the program, one could expect that changes in weight generally correlated with improvements in psychological well-being. Bivariate associations showed that most changes in psychosocial measures were in fact associated with short- and also with long-term weight outcomes. During the treatment phase, changes in body dissatisfaction, body attractiveness and mood disturbance were especially associated with weight change. To a lesser degree, a similar pattern of association was observed for depressive symptoms and physical self-worth. These results are similar to the ones recently reported by Teixeira et al. (2006), who used a comparable methodology and found that body shape concerns, physical self-worth, and body attractiveness were significantly associated with treatment-related weight outcomes. In the present study and using multivariate analysis changes in mood disturbance, body dissatisfaction and body attractiveness emerged as independent significant predictors, reflecting a closer association between changes in these variables and short-term weight loss. Following the tenets of the reciprocal determinism paradigm (Bandura, 1997) and the Reciprocal Effects Model (Marsh & Craven, 2006), we hypothesize that the dynamical reciprocity between weight outcomes and these psychological variables is more predominant than for other variables. That is, some of the resources used to lose weight were likely motivated by improvements in those body image variables and by the overall positive psychological state achieved (Palmeira et al., 2009). Indeed, our results add empirical support the proposition that the ability to reach meaningful weight reduction should directly benefit from a healthier psychological profile (Schwartz & Brownell, 2004).

Causality between weight and psychosocial changes is difficult to assert during the treatment phase, as changes coexist temporally. Conversely, the prospective associations between short-term treatment psychological changes and long-term weight outcomes are more adequate models to explore potential cause-effect relationships and a relatively unique feature of this study. Bivariate analyses showed that most short-term predictors maintained their associations with long-term weight change. To an extent, this was expected as 0–4- and 0–16-month weight change share common variance. However, an interesting pattern of association was noted for change in self-esteem, where no correlations were found with short-term weight outcomes, while for long-term results the associations became stronger (although with marginally significant  $p$  values). This might partially be a result of the questionnaire used, since the RSES is a relatively broad measure of self-esteem. This could have limited our ability to capture all dimensions of the construct that might be associated with (and be relevant to) weight change. Self-esteem, a relatively stable aspect of one's personality, may take longer to positively influence behavioral adherence aspects (e.g., improved eating and exercise), which ultimately determine long-term weight control. Self-esteem showed a particularly interesting set of results as it proved to discriminate between the most and least successful participants at the end of the program, *independently* of initial weight change. A similar pattern was observed for body size

dissatisfaction. In other words, those individuals who improved self-esteem and body dissatisfaction the most had a higher likelihood of finishing among the most successful weight loss group, to an extent independently of their initial weight loss. The present findings can be viewed as endorsing the development of interventions that more proactively aim at improving psychological well-being, not merely weight loss, something which has been recommended before but with little supportive empirical evidence (Hill & Billington, 2002; Wadden et al., 2002). Specifically, the treatments should include body image-related contents, in line with the suggestions by Rosen and colleagues (Ramirez & Rosen, 2001; Rosen, 2003; Wadden et al., 2002), because body image improvements could facilitate the use of psychosocial resources and lead to better adherence to the weight management tasks (Palmeira et al., 2009; Schwartz & Brownell, 2004).

## Conclusions

Clearly, there is a need to further investigate the interaction between weight loss and psychological well-being. To our knowledge, only one previous study analyzed the association of short-term psychological change with long-term weight outcomes (Teixeira et al., 2006). It showed that initial changes in exercise intrinsic motivation were predictive of long-term weight results, above and beyond change in variables related to eating behavior (e.g., cognitive restraint and disinhibition) and some body image variables. The present results suggest that positive changes in body dissatisfaction, mood and depression, physical self-worth and body attractiveness can, to different degrees, predict long-term weight change in women undergoing behavioral weight management. Future studies should evaluate if some of these variables add explained variance (of key health behaviors) to that reached by more established health behavior change models (Bougart & Delahanty, 2004). From a methodological point of view, benefit could be gained from the evaluation of reciprocal determinism (among individual, behavioral and environmental factors) using the methods developed to analyze the Reciprocal Effects Model; this could be performed with multilevel techniques, mediation analyses, and/or using a larger number of data points during intervention and/or follow-up, for both psychosocial and weight variables (Marsh & Craven, 2006).

The average weight loss observed in obesity treatment programs is generally short-lived, which highlights the need to investigate predictors of long-term success (Elfhag & Rossner, 2005; Teixeira et al., 2009). The current findings suggest that changes in psychological well-being taking place during weight management programs might independently contribute to long-term success. Because causal paths between psychosocial and behavioral/weight changes are most likely closely intertwined (Palmeira et al., 2009), concepts such as *reciprocity* and *dynamics* (Marsh & Craven, 2006) could be useful to better understand how change occurs during behavioral obesity treatment management and other health behavior change interventions.

## Conflict of interest statement

The authors state that there is no conflict of interest regarding the present manuscript.

## Acknowledgements

This study was funded by the Portuguese Science and Technology Foundation and by the Oeiras City Council. The investigators are grateful to Roche Pharmaceuticals Portugal, Becel Portugal, and Compal Portugal for small grants and donations. We

also wish to thank all women who participated in the trial for their commitment to this research project.

## References

- Baker, C. W., & Brownell, K. D. (2000). Physical activity and maintenance of weight loss: Physiological and psychological mechanisms. In C. Bouchard (Ed.), *Physical activity and obesity* (pp. 311–328). Champaign, IL: Human Kinetics.
- Bandura, A. (1997). *Self-efficacy. The exercise of control*. New York: WH Freeman and Company.
- Beck, A. T., & Steer, R. A. (1987). *Manual for the Beck depression inventory*. New York: Psychological Corporation.
- Biddle, S. J., & Mutrie, N. (2001). *Psychology of physical activity: Determinants, well-being and interventions*. London: Routledge.
- Blaine, B. E., Rodman, J., & Newman, J. M. (2007). Weight loss treatment and psychological well-being: A review and meta-analysis. *Journal of Health Psychology, 12*, 66–82.
- Bougart, L. M., & Delahanty, D. L. (2004). Psychosocial models. In Boll, T. J., Franck, R. G., Baum, A., & Wallander, J. L. (Eds.), *Handbook of health psychology: Models and perspectives in health psychology* (vol. 3). Washington, DC: American Psychological Association. pp. 201–248.
- Brownell, K. D. (1997). *The LEARN program for weight control*. Dallas, TX: American Health Publishing Company.
- Cohen, J., Cohen, P., West, S. G., & Aiken, L. S. (2003). *Applied multiple regression/correlation analysis for the behavioral sciences* (3rd edition). Mahwah, NJ: Laurence Erlbaum Associates.
- Cooper, P. J., Taylor, M. J., Cooper, Z., & Fairburn, C. G. (1987). The development and validation of a Body Shape Questionnaire. *International Journal of Eating Disorders, 6*, 485–494.
- Elfhag, K., & Rossner, S. (2005). Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obesity Reviews, 6*, 67–85.
- Foster, G. D., Wadden, T. A., & Vogt, R. A. (1997). Body image in obese women before, during, and after weight loss treatment. *Health Psychology, 16*, 226–229.
- Fox, K. R., & Corbin, C. B. (1989). The physical self-perception profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology, 11*(4), 408–430.
- Hill, J. O., & Billington, C. J. (2002). It's time to start treating obesity. *American Journal of Cardiology, 89*, 969–970.
- Kahneman, D., Diener, E., & Schwarz, N. (Eds.). (1999). *Well-being: Foundations of hedonic psychology*. New York: Russel Sage Foundation.
- Kolotkin, R. L., Crosby, R. D., Williams, G. R., Hartley, G. G., & Nicol, S. (2001). The relationship between health-related quality of life and weight loss. *Obesity Research, 9*, 564–571.
- Maciejewski, M. L., Patrick, D. L., & Williamson, D. F. (2005). A structured review of randomized controlled trials of weight loss showed little improvement in health-related quality of life. *Journal Clinical Epidemiology, 58*, 568–578.
- Marsh, H. W., & Craven, R. G. (2006). Reciprocal effects of self-concept and performance from a multidimensional perspective. *Perspectives on Psychological Science, 1*, 133–163.
- McNair, D. M., Lorr, N., & Droppleman, L. F. (1971). *Manual for the Profile of Mood States*. San Diego: EdITS.
- Neumark-Sztainer, D., Paxton, S. J., Hannan, P. J., Haines, J., & Story, M. (2006). Does body satisfaction matter? Five-year longitudinal associations between body satisfaction and health behaviors in adolescent females and males. *Journal of Adolescent Health, 39*, 244–251.
- NHLBI. (1998). *Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults: The evidence report*. Washington, DC: NIH—National Heart, Lung, and Blood Institute.
- Palmeira, A. L., Teixeira, P. J., Branco, T. L., Martins, S. S., Minderico, C. S., Barata, J. T., et al. (2007). Predicting short-term weight loss using four leading health behavior change theories. *International Journal Behavior Nutrition and Physical Activity, 4*, 14.
- Palmeira, A. L., Markland, D. A., Silva, M. N., Branco, T. L., Martins, S. C., Minderico, C. S., et al. (2009). Reciprocal effects among changes in weight, body image, and other psychological factors during behavioral obesity treatment: A mediation analysis. *International Journal Behavior Nutrition and Physical Activity, 6*, 9.
- Ramirez, E. M., & Rosen, J. C. (2001). A comparison of weight control and weight control plus body image therapy for obese men and women. *Journal of Consulting and Clinical Psychology, 69*, 440–446.
- Rippe, J. M., Price, J. M., Hess, S. A., Kline, G., DeMers, K. A., Damitz, S., et al. (1998). Improved psychological well-being, quality of life, and health practices in moderately overweight women participating in a 12-week structured weight loss program. *Obesity Research, 6*, 208–218.
- Rosen, J. C. (2003). Improving body image in obesity. In J. K. Thompson (Ed.), *Body image, eating disorders, and obesity: An integrative guide for assessment and treatment* (pp. 425–440). Washington, DC: APA.
- Rosenberg, M. (1965). *Society and the adolescent self-image*. Princeton, NJ: Princeton University Press.
- Schwartz, M. B., & Brownell, K. D. (2004). Obesity and body image. *Body Image, 1*, 43–56.
- Stice, E., & Shaw, H. E. (2002). Role of body dissatisfaction in the onset and maintenance of eating pathology: A synthesis of research findings. *Journal of Psychosomatic Research, 53*, 985–993.
- Tanco, S., Linden, W., & Earle, T. (1998). Well-being and morbid obesity in women: A controlled therapy evaluation. *International Journal of Eating Disorders, 23*, 325–339.

- Teixeira, P. J., Palmeira, A. L., Branco, T. L., Martins, S. S., Minderico, C. M., Barata, J. T., et al. (2004). Who will lose weight? A cross-cultural reexamination of predictors of weight loss in women. *International Journal Behavior Nutrition and Physical Activity*, 1, 12.
- Teixeira, P. J., Going, S. B., Sardinha, L. B., & Lohman, T. G. (2005). A review of psychosocial pre-treatment predictors of weight control. *Obesity Reviews*, 6, 43–65.
- Teixeira, P. J., Going, S. B., Houtkooper, L. B., Cussler, E. C., Metcalfe, L. L., Blew, R. M., et al. (2006). Exercise motivation, eating, and body image variables as predictors of weight control. *Medicine Science in Sports and Exercise*, 38, 179–188.
- Teixeira, P. J., Silva, M. N., Coutinho, S. R., Palmeira, A. L., Mata, J., Vieira, P. N., et al. (2009). Mediators of weight loss and weight loss maintenance in middle-aged women. *Obesity (Silver Spring)* Advance online publication. doi:10.1038/oby.2009.281.
- Wadden, T. A., Vogt, R. A., Andersen, R. E., Bartlett, S. J., Foster, G. D., Kuehnel, R. H., et al. (1997). Exercise in the treatment of obesity: Effects of four interventions on body composition, resting energy expenditure, appetite, and mood. *Journal of Consulting and Clinical Psychology*, 65(2), 269–277.
- Wadden, T. A., Brownell, K. D., & Foster, G. D. (2002). Obesity: Responding to the global epidemic. *Journal of Consulting and Clinical Psychology*, 70, 510–525.
- Williamson, D. A., Davis, C. J., Bennett, S. M., Goreczny, A. J., & Gleaves, D. H. (1989). Development of a simple procedure for assessing body image disturbances. *Behavioral Assessment*, 11, 433–446.
- Wing, R. R., Epstein, L. H., Marcus, M. D., & Kupfer, D. J. (1984). Mood changes in behavioral weight loss programs. *Journal of Psychosomatic Research*, 28, 189–196.