REGULAR ARTICLE

Psychosocial Predictors of Weight Loss and Psychological Adjustment Following Bariatric Surgery and A Weight-Loss Program: The Mediating Role of Emotional Eating

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ABSTRACT

Objective: To examine a structural equation model of the effects of personal and interpersonal factors on treatment outcome of bariatric surgery and weight-loss program.

Method: Forty-four participants of the surgery group and 47 participants of the diet group completed questionnaires before treatment and 1 year afterward. Predictor measures are as follows: social support, motivation for control, sense of control, self-esteem, neuroticism, fear of intimacy, and emotional eating (EE).

Outcome measures: Weight loss, quality of life, and mental health.

Results: Neurotic predisposition (NP), a latent variable indicated by neuroticism, low self-esteem, and fear of intimacy, had an effect on weight loss that was fully mediated by EE. NP also had an effect on quality of life improvement that was fully mediated by EE and weight loss in both treatment groups.

Discussion: Both NP and EE predict outcome of obesity treatments, but EE is the more proximal variable that mediates the effect of NP. © 2008 by Wiley Periodicals, Inc.

Keywords: bariatric surgery; weight-loss program; emotional eating; psychosocial predictors

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Introduction

Obesity is increasingly recognized as a chronic disease and consequently, much effort had gone into its treatment: Diet and behavior modification programs have been refined and bariatric surgery has become safer.[1] However, most patients treated with current techniques regain most of their weight.[2,3] One of the important issues for improving the treatment of obese patients is the identification of variables that predict outcome. This can provide theoretical insights into processes of change and facilitate the development of customized programs that consider individual differences and provide alternative interventions for treatment nonresponders.

Our study is based on a 1-year follow-up of two interventions: bariatric surgery and a weight-loss program. The main objective beyond the comparison of outcomes, which will be reported in a separate publication (Canetti et al., unpublished data), was to test a theoretically based and empirically structural equation model composed of several predictors and mediational paths. We will present the theoretical rationale for our selection of predictors and for the mediation hypotheses, to be followed by a graphic presentation of the model.

First, we looked for personality characteristics that could affect outcome. In general, the obese population is heterogeneous and there are no consistent findings of specific personality characteristics.[4] Yet, two variables that could be hypothesized to affect outcome are emotional eating (EE) and a general personality factor of neurotic predisposition (NP). Of these two, EE—the tendency to eat in response to emotional distress and during stressful life situations—appears to be the more proximal variable. EE is common in highly obese individuals seeking treatment. It is often precipitated by negative emotions and is done secretively, usually at home.[5,6] EE also occurs in normal-weight persons and is correlated with bulimic eating attitudes.[7] Evidence has been found for a decrease in EE following weight reduction diet[8] and bariatric sur-

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gery.[9] These findings suggest that EE plays an important role in eating disturbances; however, the effect of EE on weight-loss programs or surgery outcome has not yet been investigated. The study of EE as an outcome mediator is an original contribution of this study.

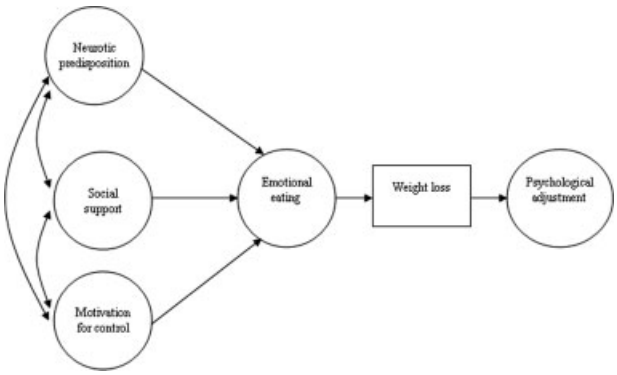
EE is associated with feelings of inadequacy and interpersonal difficulties,[7] neuroticism and low conscientiousness,[10] and binge eating behavior.[11] Binging obese patients display significantly more personality disorder pathology than do nonbinging patients.[12] These results support the hypothesis that, NP may have an effect on the more proximal variable of EE and that EE may hinder treatment outcome.

The concept of NP as a higher order construct of negative affectivity follows a series of studies and a literature review that showed strong correlations among self-esteem, neuroticism, locus of control, and generalized self-efficacy.[13] A single factor explained the relationships among these traits, whose measures each accounted for little incremental variance in predicting external criteria relative to the higher order NP construct. In this study, we assessed NP with measures of self-esteem, neuroticism, sense of control, and fear of intimacy.

Specific measures of self-efficacy that assess beliefs and expectations related to weight loss were shown to predict weight loss.[14] There are no such studies of generalized self-efficacy, but sense of control, which is thematically close to this construct, was found to be associated with overweight.[15] As for self-esteem, it was found to predict weight-loss program outcome.[16] The study of neuroticism as predictor of weight loss following bariatric surgery yielded more ambiguous results[17] and this trait was not studied in weight-loss programs. We included fear of intimacy as another indicator of NP as it is also highly correlated with negative affects and associated with bulimic symptoms that include binge-eating.[18]

Another personality characteristic expected to have an effect on outcome was motivation for control. Persons high in motivation for control were found to display higher level of aspirations and performance expectancies and to set more realistic goals than persons with low control motivation.[19] Moreover, participants with high desire for control exerted greater effort and persisted longer in response to difficult and challenging tasks. As losing weight is a difficult task demanding considerable effort and persistence, we hypothesized that persons high in motivation for control will be more likely to achieve better weight loss. Because this variable has not been previously investigated in relation to weight loss, it was included as an exploratory component in this research and we also explored the possibility that its effect would be mediated by EE.

FIGURE 1. The theoretical model.



Outcome may also be influenced by one's interpersonal surroundings; hence, we added the variable of perceived social support: a consistently significant predictor of psychological adjustment and quality of life.[20,21] Social support is a predictor of binge eating onset[22] and we hypothesized that perceived low levels of support will predict EE and outcome. In studies of bariatric surgery, social support predicted satisfaction with outcome and positive mood.[23,24] Although, social support did not predict weight loss in these studies, a study of partner support demonstrated its association with weight loss after surgery.[25] Furthermore, studies of weight-loss programs found consistent positive correlations between support from family and friends and weight-loss maintenance and physical activity.[26]

The hypothesized model is presented in Figure 1. In terms of assessing outcome, we followed Kral's[27] suggestion for a multidimensional assessment.

Method

Participants

Fifty-one individuals who underwent bariatric surgery and 51 who participated in a weight-loss program were weighed and assessed with questionnaires. Forty four of the surgery group and 47 of the diet group were weighed and assessed one year later. No significant differences on initial measures were found between drop outs and the others. There were two surgery procedures: silastic ring vertical banded gastroplasty (n = 44) and laparoscopic adjustable gastric banding (n = 7). The dieting group participated in a commercial program with medical supervision that combines diet, behavior modification, and physical exercise, with a special emphasis on physi-

TABLE 1. Sociodemographic data, initial weight, and initial levels of quality of life and mental health for the surgery and the diet group

Variable	Surgery ($n = 51$)	Diet ($n = 51$)	p
Gender, (%)			
Women	44 (86.3%)	33 (64.7%)	<.05
Men	7 (13.7%)	18 (35.3%)	
Age, mean years (SD)	34.2 (10.0)	42.8 (11.5)	<.001
Marital status, (%)			
Married	29 (56.9%)	36 (70.6%)	ns
Single	18 (35.3%)	11 (21.6%)	
Divorced/widowed	4 (7.8%)	4 (7.8%)	
Education, mean years (SD)	12.8 (1.9)	14.5 (2.2)	<.001
Country of origin, (%)			
Israel	35 (68.6%)	46 (90.2%)	<.05
Asia-Africa	7 (13.7%)	1 (2.0%)	
Western countries	6 (11.8%)	2 (3.9%)	
East Europe	3 (5.9%)	2 (3.9%)	
Income (SD)	3.04 (1.0)	4.2 (0.9)	<.001
Age of onset of obesity, (%)			
Childhood	12 (23.5%)	7 (13.7%)	<.05
Adolescence	9 (17.6%)	11 (21.6%)	
Adulthood	29 (56.9%)	23 (45.1%)	
Menopause	1 (2.0%)	10 (19.6%)	
Weight	124.7 (23.9)	101.1 (26.2)	<.001
BMI	45.1 (7.7)	35.4 (7.2)	<.001
Quality of life	64.49 (16.86)	71.09 (13.35)	<.05
Mental health	174.04 (28.92)	170.94 (28.64)	ns
Psychological distress	51.12 (16.38)	50.73 (14.67)	ns
Well being	57.16 (14.08)	53.67 (14.95)	ns

Notes: SD, standard deviation; ns, not significant. Two-tailed student t tests for independent samples and χ^2 tests were used.

cal activity. The surgical patients were significantly younger, less educated, with lower income, and a younger age of onset of obesity compared with the dieting patients (see Table 1). They also had a higher proportion of women and a lower proportion of Israeli born. Surgical participants weighed more, had higher body mass index (BMI), and had lower quality of life at the start of the study, but there were no significant differences in measures of mental health.

Measures

A sociodemographic questionnaire asked about age, marital status, country of origin, education, income (1, very low class; 2, low class; 3, middle class; 4, high-middle class; 5, upper class), age of onset of the obesity problem, and its duration.

BMI is a NIH recommended method for assessing obesity is calculated as weight in kilograms divided by the square of height in meters.

Receiving Social Support, is a 10-item scale developed by Abbey et al.[28] that assesses social support provided by the closest person the subject meets at least once a week. Studies of the effects of stressful conditions on mental health that included additional reports from spouses and significant others supported the scale's validity.[29] It was translated to Hebrew and validated by Elizur et al.[30] In the present study, the internal consistency of social support was $\alpha = 0.93$. For the structural analyses described later, the social support latent factor was indicated by three indicators, each consisted of the mean of three or four of the items from the scale (α's ranging from 0.77 to 0.84).

Shapiro Control Inventory is a 187-item multifaceted, multidimensional Control Profile of a person who was shown to be reliable and valid.[31] It was translated to Hebrew using back translation technique (Ada Zohar, personal communication, 1997). We used two scales: sense of control and motivation for control. The first is a 16-item scale of positive sense of control (the person's perceived self-efficacy, including setting and achieving meaningful goals, and an appropriate level of self control) and negative sense of control (loss of control, lack of control, and too much control from others). The second is an 11-item scale addressing the extent to which one aspires to achieve and maintain control, both over oneself and over others and the environment. In the present study, we found high-internal consistency for the sense of control scale ($\alpha = 0.90$), and good internal consistency for the motivation for control scale ($\alpha = 0.74$). For the structural analyses, the motivation for control latent factor was indicated by one indicator ($\alpha = 0.74$).

Neuroticism is one of the five factors of the NEO-Personality Inventory Revised.[32] The inventory's Hebrew version was validated by Montag and Levin.[33] The shortened version of the neuroticism scale comprises 12 items measuring anxiety, angry hostility, depression, self-consciousness, and vulnerability. In the present study, internal consistency was $\alpha = 0.86$.

Rosenberg Self-esteem (RSE) scale[34] is a 10-item self-evaluation of one's characteristics, abilities, satisfaction, and respect. It was translated to Hebrew and validated by Nadler et al.[35] Higher scores reflect lower self-esteem. In this study, the scale had high internal consistency ($\alpha = 0.89$).

Fear of Intimacy Scale is a 35-item assessment of fear of intimacy in close relationship or at the prospect of a close relationship. It was developed by Descutner and Thelen,[36] who found adequate test–retest reliability and internal consistency, and showed its correlation with established measures of intimacy and self-disclosure. The items ask about the person's inhibitions and anxieties related to the exchange of personally significant thoughts and feelings with a valued other. It was translated to Hebrew for the present study using the back translation technique. In the present study, the scale had high internal consistency ($\alpha = 0.94$).

In NP, following Judge et al.'s research,[13] this higher order construct of negative affect or neuroticism was assessed by fear of intimacy, self-esteem, sense of control, and neuroticism. These variables were positively correlated in the present study (r's ranging from .40 to

.81), whereas there were no significant correlations with motivation for control and social support, which supported discriminant validity.

EE is a seven-item scale developed for the study by the first author. Participants were asked whether food gives them consolation and/or relief from anxiety and whether they eat when they feel nervous, worried, angry, disappointed, and/or hopeless. Every item is rated from 0 to 7, and the final score is the mean of all seven items. The internal consistency of the scale was $\alpha = 0.85$. For the structural analyses, the EE latent factor was indicated by two indicators, each consisted of the mean of three to four EE items ($\alpha = 0.77$ and 0.76).

Medical Outcomes Study Short Form-36 (SF-36) is a well-established scale to measure quality of life. This 36-item questionnaire includes eight scales which measure physical and emotional problems.[37] In our study, psychometric support was found for the use of a total score of all 36 items. The Hebrew version was validated by a large community survey.[38] In the present study, the total score was found to have a high internal consistency ($\alpha = 0.91$ before surgery/diet and $\alpha = 0.92$ 1-year afterward). For the structural analyses, the quality of life latent factor was indicated by three indicators, each consisted of the mean of 12 of the items from the scale (α's ranging from 0.72 to 0.77).

Mental Health Inventory (MHI) is a 38-item questionnaire composed of two inversely correlated scales: psychological distress (24 items including anxiety, depression, and loss of behavioral emotional control) and well being (14 items including general positive affect and emotional ties). Psychometric support was found for the use of a total score of all 38 items.[39] The two scales were scored so that higher scores reflect more psychological distress in the first scale and more well being in the second scale. Higher scores in the total score reflect more well being. The Hebrew version was tested in a large community study that confirmed its hierarchical structure and demonstrated a high internal consistency ($\alpha = 0.96$) and external validity.[40] In our study, the internal consistency of the scale was the same ($\alpha = 0.96$ before surgery/diet and 1-year afterward).

Procedure

Surgical patients were recruited among applicants to bariatric surgery at the surgery clinic of Hadassah University Medical Center. All individuals who were fluent in Hebrew and able to fill out questionnaires were asked to participate in the study. Only one individual refused to participate in the study. Weight-loss program individuals were recruited among participants of a commercial program for weight reduction at the Wingate institute. All individuals attending the program were asked to participate, 80% agreed to take part in the study. All surgical and dieting participants volunteered to the study. All participants completed questionnaires and were weighed at the start of the study and one year afterwards. The study was approved by the Helsinki Committee of the Hadassah University Medical Center. All participants signed an informed consent.

Analytic Strategy

The theoretical model linking predictive and outcome variables were tested by a confirmatory structural equation modeling (SEM) analysis using EQS program.[41] The SEM analysis provides simultaneous estimation of the hypothesized effects using the estimated covariance matrix generated on the basis of the observed covariance matrix of the measured variables. The estimated matrix is also used for evaluating the goodness of fit between the data and the model. To confirm the model, we expect the χ^2 not to be significant. In reporting the results of SEM, we followed the guidelines suggested by Raykov et al.[42] and provide three goodness of fit indices: normed fit index (NFI), nonnormed fit index (NNFI), and comparative fit index (CFI). We also examined one misfit measure: root mean-square error of approximation (RMSEA). Fit indices that exceed 0.90 and a RMSEA of 0.06 or below are indicative of an acceptable model fit.[43]

Results

As will be reported elsewhere,[4] at 1-year follow-up postsurgery participants lost a mean weight of 45.07 kg ($\pm$23.87), and showed a statistically significant improvement in mental health (MHI total score and well-being scale), quality of life (all SF-36 scales and total score), and RSE. The diet group lost a mean weight of 10 kg ($\pm$10.85) and significantly improved in three SF-36 scales and total score. Postsurgery participants lost significantly more weight and showed significantly greater improvement in the well being scale, RSE and SF-36 compared with the diet group. Consequently, we examined the prediction of change. **Tables 2** and **3** present the partial correlation coefficients between all predictor (personality and interpersonal) variables and the outcome variables of weight loss, quality of life, and mental health in the surgery and diet groups, respectively. As the initial levels of the outcome variables were strongly correlated with improvement, partial correlation coefficients were calculated between predictor and outcome variables, controlling for the initial level of the outcome variable.

In the surgery group that appears in **Table 2**, higher EE predicted less weight loss, whereas fear of intimacy predicted less improvement in well-

TABLE 2. Surgery group: Partial correlation coefficients between personality and interpersonal variables and weight loss, quality of life improvement and mental health improvement ($n = 44$)

Variable	Weight Loss	Quality of Life	Mental Health	Psychological Distress	Well Being
Social support	0.14 ns	−0.43**	0.09 ns	0.10 ns	0.10 ns
Neuroticism	−0.10 ns	−0.03 ns	0.13 ns	0.20 ns	−0.05 ns
Fear of intimacy	−0.16 ns	−0.29 ns	−0.26 ns	−0.17 ns	−0.34*
Self-esteem	−0.12 ns	0.08 ns	0.13 ns	0.07 ns	0.07 ns
Sense of control	0.22 ns	0.08 ns	−0.02 ns	−0.10 ns	0.12 ns
Motivation for control	0.01 ns	−0.09 ns	−0.20 ns	0.13 ns	−0.24 ns
Emotional eating	−0.42**	0.12 ns	−0.12 ns	−0.17 ns	−0.10 ns

Notes: ns, not significant.
* $p < .05$; ** $p < .01$.

TABLE 3. Diet group: Partial correlation coefficients between personality and interpersonal variables and weight loss, quality of life improvement and mental health improvement ($n = 47$)

Variable	Weight Loss	Quality of Life	Mental Health	Psychological Distress	Well Being
Social support	0.31*	−0.006 ns	0.15 ns	0.13 ns	0.18 ns
Neuroticism	−0.34*	−0.02 ns	−0.13 ns	0.15 ns	−0.11 ns
Fear of intimacy	−0.42**	−0.28 ns	−0.35*	−0.30*	−0.38*
Self-esteem	−0.34*	−0.01 ns	−0.05 ns	−0.08 ns	−0.04 ns
Sense of control	0.44**	0.10 ns	0.13 ns	0.10 ns	0.17 ns
Motivation for control	−0.08 ns	−0.16 ns	−0.27 ns	−0.31*	−0.18 ns
Emotional eating	−0.46**	−0.15 ns	−0.44**	−0.43**	−0.39*

Notes: ns, not significant.
* $p < 0.05$; ** $p < 0.01$.

being. Surprisingly, less social support predicted improvement in quality of life. This result may be explained by the association between social support and quality of life at the start of the study ($r = .26$, $p = .06$). The lower the initial quality of life, the greater the improvement in quality of life in the surgery group ($r = -.80$, $p < .001$). All other predictors, contrary to expectations, were not associated with the outcome variables.

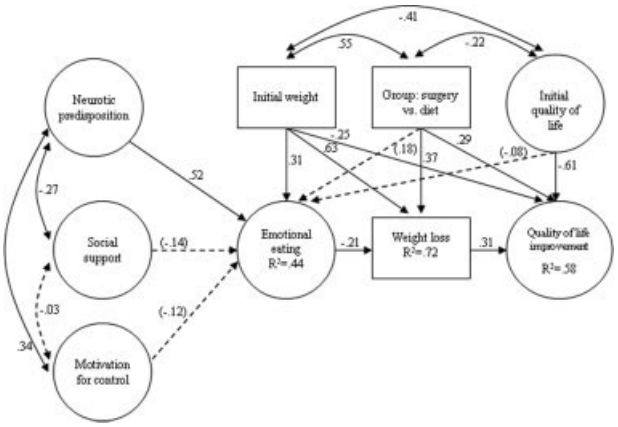
In the diet group that is presented in **Table 3**, all variables except motivation for control were associated with weight loss in the predicted direction. Motivation for control and EE were negatively correlated with improvement in mental health. Other variables were not associated with mental health and none predicted improvement in quality of life.

Figure 2 presents the testing of our theoretical model, whereas the correlation matrix of all measured variables that were used in the structural model is presented in Appendix. Three control variables were included in the structural model: initial weight, initial quality of life and group (diet or surgery). Initial weight and initial quality of life were included because these variables were correlated with the predicted variables: Initial weight was positively correlated with weight loss ($r = .79$, $p < .01$) and with EE ($r = .28$, $p < .01$), and initial quality of life was negatively correlated with improvement in quality of life ($r = -.57$, $p < .001$), and with EE ($r = -.52$, $p < .001$). In addition, the weight-reduction technique had an effect on weight loss: postsurgery patients had a significantly greater weight loss compared with diet participants ($t_{(89)} = 8.92$, $p < .001$) thus it was essential to estimate the contribution of treatment to the model.

Before testing the structural model, we tested the measurement model. Initially, sense of control was one of the four indicators of NP, but the model did not fit the data (most goodness-of-fit indices $< .90$). The reason was that the sense of control scale was not only exclusively related to NP but was also strongly related to other factors such as social support. Consequently, we took it out of the measurement model. Similarly, we needed to take out mental health as an indicator of psychological adjustment. The final measurement model showed a good fit to the data: χ^2 (52, $N = 102$) = 69.7, not significant, NFI = 0.92; NNFI = 0.97; CFI = 0.98; RMSEA = 0.06.

The subsequent testing of the structural model yielded acceptable goodness-of-fit values on all measures: χ^2 (81, $N = 102$) = 93.1, not significant, *NFI* = 0.92; NNFI = 0.98; CFI = 0.99; RMSEA = 0.04. This model explained 44% of the variance of EE, 72% of weight loss and 58% of quality of life improvement. As predicted, NP predicted high EE ($\beta = 0.56$). Contrary to our hypotheses, social support and motivation for control were not significant predictors of EE ($\beta s = -0.14, -0.12$, respectively). According to our hypotheses, EE was a significant

FIGURE 2. The final model: Solid and broken lines represent, respectively, statistically significant ($p < 0.05$) and not significant paths that were included in the model.



predictor of weight loss ($\beta = -0.21$) and weight loss was a significant predictor of the improvement in quality of life ($\beta = 0.31$). The treatment technique (surgery vs. dieting) had a direct effect on quality of life improvement as well as an indirect effect via weight loss.

The theoretical model applies to both groups: In both surgery and diet program groups, the relationship between NP and EE was significant ($r = .47$, $p < .01$, and $r = .56$, $p < .01$, respectively), and there were no significant correlations between motivation for control and EE or between social support and EE. Moreover, the association between EE and weight loss was similar in both groups (see **Tables 2** and **3**). The only outstanding difference between the groups was in the association between weight loss and quality of life improvement: significant ($r = .38$, $p < .01$) in the diet program group and insignificant ($r = -.19$) in the surgery group. This lack of correlation was apparently related to a shortened range: most operated participants lost much weight resulting in a large improvement in the quality of life; hence, the variance in these two variables was small.

Next, we applied the procedure suggested by Holmbeck[44] to test the mediation hypothesis that NP has an effect on weight loss via EE. This procedure suggests three steps, but we adopted Shrout and Bolger's[45] recommendation (see also Refs. 46 and 47) to set aside the first step of testing a direct association between the independent variable (NP) and the dependent one (weight loss). First we assessed the full model with both direct and indirect effects of NP on weight loss (NP → EE → weight loss and NP → weight loss) and found acceptable fit: χ^2 (80, $N = 102$) = 92.9, not significant, NFI = 0.92; NNFI = 0.98; CFI = 0.99; RMSEA = 0.04. The paths from NP to EE and from EE to weight loss were significant ($\beta = 0.52$ and $\beta = -0.23$, respectively), but the path from NP to weight loss was practically zero ($\beta = 0.03$). Second, we examined whether the full model provides a significant improvement in fit over our theoretical model (see **Fig. 2**) in which the NP → weight loss pass was constrained to zero. There was no significant difference between the models ($\Delta\chi^2_{(1)} = 0.13$, ns). These analyses supported our theoretical model in which the effect of NP on weight loss is fully mediated by EE. This procedure was also applied to testing the impact of EE on quality of life via weight loss. The full model (EE → weight loss → improvement in quality of life and EE → improvement in quality of life) had acceptable fit: χ^2 (80, $N = 102$) = 92.8, not significant, NFI = 0.92; NNFI = 0.98; CFI = 0.99; RMSEA = 0.04. The paths from EE to weight loss and from weight loss to improvement in quality of life were significant ($\beta = -0.21$ and $\beta = 0.29$, respectively), but the path from EE to improvement in quality of life was practically zero ($\beta = -0.05$). Finally, the full model did not provide a significant improvement in fit over our theoretical model (see **Fig. 2**) in which the EE → improvement in quality of life pass was constrained to zero: $\Delta\chi^2_{(1)} = 0.25$, ns. These results supported our theoretical model in which the effect of EE on quality of life improvement is fully mediated by weight loss.

Discussion

The major theoretically based findings of this study were that NP and EE had an overall effect on weight loss and quality of life improvement. NP was the more distal variable whose effect on weight loss was fully mediated by EE, whereas EE's effect on quality of life improvement was fully mediated by weight loss. There was no such overall effect of social support and motivation for control on EE or the outcome variables. These results indicate that personality traits play a role in weight reduction and the psychological adjustment of persons who attend these programs. They also suggest that EE may be involved in the process of change. In both the dieting program and in the surgery groups, individuals high on EE remained heavier than their counterparts even when the dramatic weight loss of surgery overshadowed other variables. This focus on EE is in line with psychosomatic theories of obesity[48,49] which assume that for some obese individuals eating constitutes a refuge from external and internal pressures, as well as a mean to regulate

emotions, and a mean for consolation and compensation.

The partial correlation analysis indicated that social support predicted weight loss only in the dieting program group. These results suggest that social support could be a predictor of outcome in some type of programs but not in others. It is possible that in dieting programs that demand high-level discipline and stress management social support has greater impact on outcome compared with the surgery intervention. This explanation is supported by studies of dieting programs in which social support predicted perseverance, especially by spouses[50] whereas programs characterized by partner participation had greater short-term effect than those without this component.[51] Interestingly, most participants (70%) in our diet program group chose the spouse as their closest friend. This strengthens Elizur and Hirsh's[20] conclusions that spouse support has larger impact in health related coping than more general variables of social support.

The partial correlation analysis also suggested that NP's effects on outcome may be different in the two groups: fully mediated by EE in the surgery group and partially mediated by EE in the diet program group.

Some group differences can be explained by the considerable effect of surgery on weight loss, an effect that overshadowed personality and social factors. This explanation corresponds with Herpertz et al.'s[52] review of research, which concluded that personality traits did not predict surgery outcome and psychiatric comorbidity was not identified as a negative predictor of weight loss. Of course, an influence of personality and interpersonal factors on outcome may be found in much longer follow-ups. Interestingly, personality and interpersonal variables predicted weight loss in the dieting program group. These latter results, which contrast with inconsistent findings of previous outcome research of such variables,[53] fit our theoretical model.

Neuroticism, poor self-esteem, and fear of intimacy were negatively associated with weight loss in the dieting program. Neuroticism which is associated with negative affective states and less adaptive coping probably diminishes adherence and perseverance with the demands of dieting programs. This notion accords with previous findings of an association between elevated MMPI scores and weight loss.[4] As for the self-esteem component, it appears to have reciprocal relationship with obesity: Obesity possibly contributes to poor self-esteem and poor self-esteem plays a part in obesity in that self-devaluation might lead to self-destructive behaviors such as unhealthy eating habits[54] that might undermine dieting program's effectiveness. Similarly, the undermining effects of fear of intimacy may be explained by its association with an avoidant attachment style,[55] which predicts difficulties with both affect regulation and coping with stress.

The positive association between sense of control and outcome in the dieting program group fits with previous research that showed a similar association between self-efficacy and weight loss.[14] At the same time, the present finding is innovative because sense of control is a personality trait, whereas self-efficacy measures reflect self-beliefs concerning weight loss. Hence, they have a stronger state component that is influenced by the program's attempts to change eating behaviors and cognitions.

The foremost practical implication of this study is to stress the role of EE in the prediction of outcome. It appears to be an important variable to assess and to consider when devising treatment for participants who do not do well to in weight loss programs. The related construct of NP is also important and perhaps some persons may benefit by interventions that address the person who is interested in losing weight and how EE may be related to more engrained personality characteristics. In addition, social support appears to be an important variable to be addressed in participants of dieting programs where outcome is more strongly related to personal and interpersonal resources.

This study has two main limitations. A longer follow-up in the surgery group could contribute to a better estimation of the contribution of personality and interpersonal variables. We found a large weight loss in all operated participants and it is possible that this effect masked the influence of personality and social support. Since after 5 years 50–60% of operated participants regain much of their weight,[2,56] it is possible that in the long run these variables influence weight loss maintenance. The second limitation concerns the number of participants that took part in the study: When the cases/parameters ratio is less than 10:1 and absolute sample sizes less than 100, the estimates are considered less stable[57]; therefore our results should be regarded as preliminary. Hence, the present findings should be tested in a larger sample study that would also enable multiple-group analyses to test for interaction effects by intervention group. Nonetheless, the results of this study do suggest group differences to be explored in subsequent research, whereas the testing of the model with the whole sample indicates that EE is an important proximal variable that mediates personality related effects.

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Appendix

TABLE A1. Correlation matrix for all measured variables that were used in the structural model, their means, and standard deviations

Variable	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Initial quality of life	1														
2. QOL improvement (1)	−0.52**	1													
3. QOL improvement (2)	−0.52**	0.79**	1												
4. QOL improvement (3)	−0.55**	0.77**	0.81**	1											
5. Initial weight	−0.39**	0.31**	0.33**	0.37**	1										
6. Weight loss	−0.20	0.37**	0.38**	0.45**	0.79**	1									
7. Neuroticism	−0.54**	0.10	0.18	0.22*	−0.15	−0.04	1								
8. Self-esteem	−0.58**	0.18	0.20	0.22*	0.14	−0.06	0.81**	1							
9. Fear of intimacy	−0.25*	−0.26*	−0.22*	−0.14	0.18	−0.08	0.47**	0.40**	1						
10. Social support (1)	0.20	0.12	0.11	0.05	−0.10	0.33**	−0.20	−0.27**	−0.39**	1					
11. Social support (2)	0.21*	0.10	0.08	0.003	−0.14	0.25**	−0.15	−0.25*	−0.39**	0.82**	1				
12. Social support (3)	0.19	0.11	0.07	0.02	−0.14	0.33**	−0.17	−0.21*	−0.36**	0.84**	0.86**	1			
13. Motivation for control	−0.35**	0.18	0.19	0.22*	0.02	0.27**	0.31**	0.21*	0.19	−0.02	−0.03	−0.01	1		
14. Emotional eating (1)	−0.43**	0.28**	0.32**	0.26*	0.30**	0.19	0.35**	0.33**	0.28**	−0.18	−0.11	−0.17	0.21*	1	
15. Emotional eating (2)	−0.51**	0.24*	0.23*	0.21*	0.37**	0.32**	0.42**	0.47**	0.32**	−0.08	−0.10	−0.09	0.19	0.67**	1
Mean	67.79	0.39	0.39	0.39	40.26	9.61	30.27	1.78	65.05	4.11	4.03	4.30	52.93	0.41	0.29
Standard deviation	15.49	0.53	0.50	0.54	8.91	9.03	10.0	0.54	24.77	0.97	0.98	0.85	11.14	0.39	0.35

Notes: QOL, Quality of life.
*$p < 0.05$; **$p < 0.01$.