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Clinical Study

Changes in Theory-Based Psychological Factors Predict Weight Loss in Women with Class III Obesity Initiating Supported Exercise

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Background. Psychological factors' effect on weight loss is poorly understood, in general, and specifically in the severely obese. *Objective*. To examine whether a behavioral model based on tenets of social cognitive and self-efficacy theory will increase understanding of the relationship between exercise and weight loss. *Methods*. Fifty-one women with severe obesity participated in a 24-week exercise and nutrition information treatment and were measured on changes in psychological factors and exercise attendance. *Results*. A significant portion of the variance in BMI change (adjusted for number of predictors) was accounted for by the behavioral model ($R^2_{\text{adj}} = 0.23$). Entry of exercise session attendance only marginally improved the prediction to 0.27. Only 19% of the weight lost was directly attributable to caloric expenditure from exercise. *Conclusions*. Findings suggest that participation in an exercise program affects weight loss through psychological pathways and, thus, may be important in the behavioral treatment of severe obesity.

1. Introduction

Class III, or severe (extreme), obesity (BMI $\geq$ 40 kg/m^2) occurs in approximately 7% of the U.S. female population (with some subgroups as high as 14%), and appears to be increasing [1]. It is associated with a high incidence of diabetes, high blood pressure, high cholesterol, and asthma [2]. Weight loss treatments focused primarily on caloric restriction have been ineffective [3], and bariatric surgery is now commonly considered for severe obesity [4]. There is an incomplete understanding of the psychosocial correlates of successful behavioral treatment for weight loss, in general, and specifically for those with Class III obesity. Exercise is associated with weight loss, and is the strongest predictor of sustaining loss of weight [5], but it is not always an integral part of treatments. Because of the low amounts of physical exertion typically possible for deconditioned persons [6], it has been suggested that an exercise program may be associated with weight reduction mostly due to improvements in psychological factors that may moderate overeating such as mood, self-efficacy, and self-concept [7], rather than the associated energy expenditure itself [8]. Thus, it is not known whether the amount of exercise completed, or simply participation in a program, may be associated with weight loss through proposed psychological pathways.

Change in psychological constructs postulated in behavioral theories may provide alternate explanations for weight loss to that achieved by energy expenditure. For example, social cognitive theory [9] proposes reciprocal relationships between person, environment, and behavior; and suggests that individuals receive reinforcement value from connecting behaviors (e.g., physical activity, appropriate eating) to valued outcomes (e.g., improved health, a more attractive body) [10]. Self-efficacy theory [11], which is embedded in social cognitive theory, posits that confidence in completing behaviors of interest will lead to accomplishing those behaviors (e.g., completing regular exercise; controlling intake of food). Considering social cognitive and self-efficacy theories, Baker

and Brownell suggested a model of the relationship of exercise and improvements in mood, perceptions of the body, and self-efficacy; and relations of improvements in those psychological factors with weight loss [7]. In a recent investigation limited to the possible mediation effects of psychological changes (based on Baker and Brownell's model) on the relationship between a treatment and adherence to exercise, the specific constructs measured were self-efficacy to overcome barriers to exercise, physical self-concept, body satisfaction, and overall mood [12]. Although preliminary investigation suggested the usefulness of the Baker and Brownell model [8], testing did not include women with extreme obesity—who might have the most severe health risks but react differently to physical exertion compared to those of a lower weight.

Thus, the present research assessed women with Class III obesity on changes over 6 months in psychological factors consistent with the Baker and Brownell model. The model's ability to predict weight loss, both with and without accounting for compliance with the assigned exercise frequency, was evaluated.

Table 1: Results of simultaneous multiple regression analyses for prediction of BMI change over 24 weeks.

Measure	β	R^2	R^2_{adj}	F	P
Model 1		0.293	0.232	4.777	.003
Δ Total Mood Disturbance	0.367				.046
Δ Exercise Barriers Self-Efficacy	−0.096				.514
Δ Physical Self-Concept	−0.065				.681
Δ Body Areas Satisfaction	−0.141				.417
Model 2		0.347	0.274	4.780	.001
Δ Total Mood Disturbance	0.398				.028
Δ Exercise Barriers Self-Efficacy	0.000				.999
Δ Physical Self-Concept	−0.047				.749
Δ Body Areas Satisfaction	−0.048				.782
Exercise session attendance	−0.263				.061

The Delta symbol (Δ) denotes change from baseline to Week 24.
Adjusted $R^2(R^2_{adj}) = 1-(1-R^2)(N-1)/(N-k-1)$, where k denotes number of predictors in the model. This allows comparison of multiple models with a different number of predictors.

2. Methods

2.1. Participants. Participants were 51 women (mean age = 43.9 ± 9.8 years) with Class III obesity (mean BMI = 43.8 ± 2.8 kg/m^2) who initiated a 6-month exercise and nutrition information program administered through YMCAs in the Atlanta, Georgia area. Women using medications for weight loss or a psychological condition were excluded. Racial make-up was 53% White, 39% African American, and 8% other races/ethnicities. Institutional review board approval, written physician approval to participate, and informed consent from participants were obtained. Procedures conformed to the requirements of the Declaration of Helsinki.

2.2. Measures. The Total Mood Disturbance scale measured overall negative mood. The scale aggregates scores from the Profile of Mood States subscales of Depression, Tension, Fatigue, Vigor, Confusion, and Anger [13]. Internal consistency of the 30-item scale (range = −20–100) for females averaged 0.90, and test-retest reliability averaged 0.74 [13]. The Exercise Self-Efficacy Scale [14] measured perceived psychological resources (e.g., self-regulatory skills) to overcome barriers to exercise. Internal consistencies of the 5-item measure (range = 5–35) were 0.82 and 0.76, and test-retest reliability was 0.90 [14]. The Physical Self-Concept subscale of the Tennessee Self-Concept Scale [15] measured perceptions of physical abilities. Internal consistency of the 14-item measure (range = 14–70) was 0.83, and test-retest reliability was 0.79 [15]. The Body Areas Satisfaction subscale of the Multidimensional Body-Self Relations Questionnaire [16] measured satisfaction with areas of one's body. Internal consistency of the 9-item measure (range = 9–45) for women was 0.73, and test-retest reliability was 0.74 [16].

A recently calibrated scale and stadiometer were used to measure BMI (kg/m^2). Exercise session attendance was the ratio of sessions attended divided by the assigned number of sessions, or 72 (3 sessions assigned per week × 24 weeks). Attendance at exercise sessions was recorded electronically through a computer system suggested to be valid through strong correlations with cardiorespiratory fitness measures such as $VO_{2\,max}$, blood pressure, and resting heart rate [17].

2.3. Procedure. Participants were given access to YMCA wellness facilities that included cardiovascular exercise apparatus and areas for walking and running. An exercise support protocol emphasizing goal setting and progress tracking, exercise that induced improvements in mood, and self-regulatory skills (e.g., cognitive restructuring, dissociation from discomfort) [12], was administered by trained wellness specialists monthly during six 60-minute one-on-one sessions over 24 weeks. Thus, goals of the exercise support protocol were to improve participants' (1) self-efficacy to overcome barriers to exercise (e.g., boredom, self-consciousness), (2) perceptions of physical ability to complete exercise, (3) perception of their bodies, and (4) moods (e.g., depression, fatigue). For each participant, three sessions per week of moderate intensity cardiovascular exercise (progressing to 30 minutes per session) were assigned.

Six nutrition information sessions, based on guidelines from the American College of Sports Medicine and the American Dietetic Association, were provided in groups. Measurements were taken at baseline and at Week 24 in a private area.

2.4. Data Analyses. Statistical significance was set at $\alpha = 0.05$. An intention-to-treat design with baseline-carried-forward imputation for missing data was used. All change scores were Week 24 minus baseline scores. Multiple regression equations assessed the variance in BMI change accounted for by simultaneous entry of changes in Exercise Self-Efficacy, Physical Self-Concept, Body Areas Satisfaction, and Total Mood Disturbance; both without (Table 1, Model 1), and with (Table 1, Model 2), entry of exercise session attendance.

Values in the text are expressed as mean ± standard deviation.

3. Results

Change in BMI ($-1.62 \pm 2.87\,\text{kg/m}^2$; range = -8.05–$1.91\,\text{kg/m}^2$) was significant, $t(50) = 4.02$, $P < .001$. Exercise session attendance was 53.84 ± 26.35% (range = 17–100%).

Each regression model accounted for a significant portion ($P < .01$) of the variance in BMI change (Table 1). After adjusting the number of predictors in the models, entry of exercise attendance improved the R^2_{adj}-value modestly (.232 to .274). In both regression models, only changes in Total Mood Disturbance demonstrated significant unique contributions to the explained variance in BMI change.

A post hoc test was conducted where each participant's kcal expenditure from exercise (adjusted for body weight) was first derived [18], then divided by 7700 kcal, which was estimated to predict 1 kg of weight loss for persons of this weight [19]. Based on this formula, only 19% of the mean loss in weight could be directly attributed to caloric expenditure from exercise.

4. Discussion

Findings suggest the usefulness of Baker and Brownell's adaptation of self-efficacy and social-cognitive theories for the prediction of weight loss in women with severe obesity initiating supported exercise. The psychological changes in exercise barriers self-efficacy, physical self-concept, body satisfaction, and mood, associated with moderate exercise supported by cognitive-behavioral means were, together, significant predictors of BMI change, explaining an adjusted 23% of the variance. Inspection of beta values indicated that mood change made the only significant, independent contribution to the explained variance in weight change in the regression equations. Although this preliminary investigation was not powered for further analyses, other research suggests that mood changes may strongly covary with changes in the other psychological factors tested [12].

Given the finding that exercise session attendance had only a minor effect on weight loss directly through associated caloric expenditure, it is likely that it's small improvement in the explanatory power was due simply to heightened engagement with the present exercise support treatment. This premise is further supported because the direct effect exercise volume had on weight loss was small. Thus, further research is required to increase the precision of explanatory models of relations between exercise-induced psychological changes and weight loss [3]. Replication will also be required with larger samples and across participant types, as it is possible that sex, initial weight, and possibly, race/ethnicity, will affect results.

5. Conclusion

Although this study was preliminary, a theoretical rationale was made for an appropriately supported program of moderate exercise early in the treatment of severe obesity in women. As the present research is extended, better confidence in precisely what exercise-induced psychological factors will induce weight loss may help to improve effect and reliability.

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