ORIGINAL ARTICLE

Weight Loss and Psychologic Gain in Obese Women—Participants in a Supported Exercise Intervention

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Abstract

Background: Physical activity is a predictor of maintained weight loss; however, causal mechanisms are unclear. Behavioral theories suggest that associated psychologic changes may indirectly affect weight loss.

Objective: We sought to test the association of a behaviorally based exercise support protocol (The Coach Approach [CA]), with and without a group-based nutrition education program (Cultivating Health), with adherence to exercise and changes in physiologic and psychologic factors, and to assess theory-based paths to weight and body-fat changes.

Setting: The study took place in YMCA wellness centers.

Study subjects: Study participation was open to formerly sedentary obese women.

Design: Study participants were randomly assigned to the CA Only (CA; *n* = 81), The CA Plus Cultivating Health (CA/CH; *n* = 128), or the control (*n* = 64) group. We contrasted dropout and attendance rates and changes in self-efficacy (SE), physical self-concept (PSC), total mood disturbance (TMD), body areas satisfaction (BAS), and select physiologic factors during a six-month period. We also analyzed proposed paths to weight loss.

Results: The CA and CA/CH groups had significantly lower exercise dropout rates ($\chi^2 = 44.67$, $p < 0.001$) and higher attendance rates ($F = 10.02$; $p < 0.001$) than the control group did. Improvements in body fat, body mass index (BMI), and waist circumference were significant for only the CA and CA/CH groups. Significant improvements in TMD, PSC, and BAS scores were found for all groups, with effect sizes greater in the groups incorporating the CA protocol. Within the five paths assessed, entry of changes in TMD and BAS scores into multiple-regression equations, along with SE and PSC scores, increased the explained variance in exercise session attendance from 5% ($p = 0.01$) to 16% ($p < 0.001$). Exercise session attendance was significantly associated with changes in body fat ($r = -0.41$; $p < 0.001$) and BMI ($r = -0.46$; $p < 0.001$).

Conclusion: Counseling based on social cognitive and self-efficacy theory may increase exercise adherence and improve variables indirectly related to weight and body-fat reductions. Although decreases in body fat and BMI were obtained, they appeared less pronounced than psychologic improvements. Additional research on interrelations of physical activity, psychologic factors, and weight change is warranted for development of obesity treatments.

Introduction

Approximately 65% of American adults are either overweight (body mass index [BMI], 25.0–29.9 kg/m^2) or obese (BMI ≥ 30 kg/m^2), with more women (33.4%) being obese than men (27.5%).[1] Obesity is a prominent modifiable risk factor for type 2 diabetes, heart disease, hypertension, and stroke. Although restriction of calorie intake and increase in energy expenditure will reduce weight, responses to diets and exercise programs have been problematic.[2] Persistence of requisite behaviors has been the major problem. Definitive reviews have concluded that diets alone are ineffective for sustained weight control, as are methods based on education in favorable eating and physical activity behaviors.[3]

The strongest predictor of sustained weight loss is regular physical activity,[4,5] although causal mechanisms of this are undetermined and the dropout rate is typically 50% to 65% within the first three to six months.[6–8] Although considered less important for weight loss than reduction in caloric intake,[9] exercise may


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have benefits not typically cited. It is possible that improvements in feelings of ability, or self-efficacy, often associated with success with an exercise program,[10] will induce persistence with caloric reduction.

Consistent with social cognitive and self-efficacy theory,[11,12] self-efficacy is thought to influence health behaviors through dimensions of task self-efficacy (ie, perceived physical capabilities) and self-regulatory efficacy (ie, perceived self-management competencies). Interventions based on self-efficacy theory use self-management and self-regulation to effectively deal with barriers to persistence, and they promote a sense of competence. Mood and body-image improvements, often associated with physical activity,[13] may also be related to adherence to a program of weight management. Physical activity may serve as an indirect mitigator of low mood and dysfunctional eating.[14] In extending self-efficacy theory, Baker and Brownell[15] proposed a model that included relationships between physical activity program participation, changes in psychologic and self-efficacy factors, exercise frequency, and weight loss. They suggested that improved mood would be associated with increased exercise and with an improved psychologic climate where caloric reduction becomes easier. They stated that "… positive changes in body image, irrespective of numbers on the scale, may help prevent discouragement and resignation. …"[15p322] Supporting this premise, improved self-perception and perceived physical attractiveness was found to be associated with an exercise program in females,[16,17] even when measured physical changes were minimal.[18] Addressing the possibility that positive perceptions emanating from physical activity participation may generalize to eating behaviors, Baker and Brownell stated that "… increases in exercise self-efficacy could influence eating self-efficacy and dietary compliance through a more general sense of weight-loss self-efficacy."[15p323] Improved self-management related to exercise, leading to enhanced self-efficacy and better results with weight management, has been previously supported.[19]

The Coach Approach (CA) is a structured exercise-support treatment based on principles of social cognitive and self-efficacy theory. It is administered through monthly meetings supported by a computer program. The CA has been associated with significantly improved adherence to newly initiated exercise through highlighting improvements in mood and incremental progress toward goals, pairing exercise regimens with reinforcing rather than punishing feelings, incorporating an array of self-management and self-regulatory skills, and facilitating social supports.[6,8] Whether findings generalize to exclusively obese samples is, however, unknown. Also unknown are results of the CA when paired with comprehensive instruction in appropriate nutritional practices.

Thus, our investigation contrasted three distinct conditions—the CA alone, The CA plus nutrition information classes, and a control group—on measures of adherence to exercise and on physiologic, self-efficacy, body satisfaction, and mood changes. Also assessed were proposed paths based on both self-efficacy theory[12,20] and Baker and Brownell's model.[15] Because community wellness centers often have the means to deliver standardized protocols to large numbers of individuals in need, thus possibly supporting traditional medical care, that venue was selected for study.

Specific hypotheses were as follows:

1. Groups incorporating the CA protocol would have significantly better exercise session attendance, lower dropout rates, and better improvements in body fat, waist circumference, resting heart rate, blood pressure, and BMI than a control group would.
2. The addition of a group nutritional treatment to the CA protocol would increase effects on the physiologic factors.
3. Improvements in mood, body satisfaction, and self-regulatory and task self-efficacy would be significantly greater for groups incorporating the CA protocol than for a control group.
4. Accounting for self-efficacy dimensions at baseline, and their changes during a six-month period, would significantly predict exercise session attendance in study treatment subjects. Also, accounting for changes in mood and body satisfaction would add to the explained variances in attendance.
5. Theoretically derived paths would indicate that the CA protocol was associated with significant improvements in the dimensions of self-efficacy, mood, and body satisfaction; these changes would be significantly associated with exercise session attendance; and attendance would be significantly negatively related to changes in body fat and BMI.

It was hoped that findings would suggest directions and priorities for future research—ultimately resulting in more effective and reliable behavioral weight-management interventions appropriate for large-scale dissemination.

… positive perceptions emanating from physical activity participation may generalize to eating behaviors …

Methods

Study Subjects

Women volunteered by responding to newspaper advertisements. Inclusion criteria were: 1) being age 21 to 65 years, 2) being obese with a BMI of 30 to 45 kg/m^2, 3) having partaken in no regular exercise (≤ 1 session/week) within the previous year, and 4) reporting a goal of weight loss. Exclusion criteria were 1) having inadequate physical conditions for exercise, 2) being pregnant or planning to become pregnant soon, and 3) taking medications for weight loss. A written statement from a physician regarding adequate physical health to participate was required. Appropriate institutional review board approval and consent from all study subjects were received.

Study subjects were randomized into three groups. Each group was provided access to similar YMCA wellness centers. Space limitations of respective facilities yielded slightly different group sample sizes. The CA Only group (CA; n = 81) was assigned to the behaviorally based exercise counseling protocol. The CA Plus Cultivating Health group (CA/CH; n = 128) additionally incorporated group nutrition information sessions. The control group (n = 64) was provided only typical wellness center practices. No significant differences were found between groups on the following variables. Overall, the age range was 22 to 65 years (mean, 43.2; SD, 10.0). BMI was 30.0 to 44.9 kg/m^2 (mean, 36.6 kg/m^2; SD, 4.1). The racial makeup was 44% African American, 50% White, and 6% other racial groups; 87% of participants were in the lower-middle to middle socioeconomic class.

Measures

Exercise Dropout and Attendance

Consistent with previous research,[6,8] dropout was defined as a 30-day period of no exercise sessions recorded during the six-month study time frame. Exercise session attendance was the ratio of sessions attended divided by the "ideal" number of sessions or 72 (3 sessions assigned per week × 24 weeks), expressed as a percentage. Exercise sessions completed were recorded electronically through a system that was suggested as valid through strong significant correlations (r values, 0.42–0.55), with changes in measures of cardiorespiratory function (eg, aerobic capacity, blood pressure, resting heart rate).[18]

Self-Efficacy

Consistent with previous research,[21] the two dimensions of self-efficacy—self-regulatory efficacy and task self-efficacy[12,20]—were separately measured. The Exercise Self-Efficacy Scale (SE)[22] was used to measure exercise barriers self-efficacy, or confidence in using one's psychologic resources to overcome barriers to completing exercise (ie, self-regulatory efficacy). SE required responses to five items that began with the stem "I am confident I can participate in regular exercise when:" (eg, "I feel I don't have the time") on a scale ranging from 1 (not at all confident) to 7 (very confident). Internal consistencies were 0.82 and 0.76, and test–retest reliability over a two-week period was 0.90.[23]

The Physical Self-Concept Scale (PSC) of the Tennessee Self-Concept Scale[24] measured feelings of adequacy regarding the physical self (ie, task self-efficacy). PSC required responses to 14 items (eg, "I have a healthy body," "I am neither too fat nor too thin") on a scale ranging from 1 (always false) to 5 (always true). The internal consistency was 0.83, and test–retest reliability over a one- to two-week period was 0.79.[24] Significant correlations with the Psychasthenia scale of the Minnesota Multiphasic Personality Inventory (MMPI), Body Shape Questionnaire, and Nash Body Image Scale suggested concurrent validity in women.[24,25]

Body Satisfaction

The Body Areas Satisfaction Scale (BAS) of the Multidimensional Body-Self Relations Questionnaire[26] evaluated satisfaction with aspects of the body (eg, lower torso [buttocks, hips, thighs, legs], weight). BAS required responses to five items on a scale ranging from 1 (very dissatisfied) to 5 (very satisfied). The internal consistency for females was 0.73, and test–retest reliability was 0.74.[26]

Mood

Total mood disturbance (TMD) is an aggregate measure of negative mood derived from subscales of the Profile of Mood States—Short Form.[27] Respondents rated feelings over the preceding week on 30 items on a scale ranging from 0 (not at all) to 4 (extremely). Internal consistency for the Tension, Fatigue, Depression, Confusion, Anger, and Vigor subscales ranged from 0.84 to 0.95, and test–retest reliability at three weeks averaged 0.69.[27] The factor structure demonstrated consistency, and concurrent validity was suggested through contrasts with measures such as the Beck Depression Inventory, Manifest Anxiety Scale, and MMPI.[27p13-5]

Physiologic Factors

A recently calibrated digital scale (Tanita Corporation, Arlington Heights, IL) and tape measure were used to measure waist circumference (cm) and BMI. Body-fat percentage was measured using Lange Skinfold Calipers (Beta Technology, Santa Cruz, CA) at three sites (abdomen, ilium, and triceps), applying the Jackson-Pollock equation. Resting heart rate was assessed after a minimum of five minutes of rest. An aneroid sphygmomanometer with attached stethoscope (MDF Instruments USA, Agoura Hills, CA) was used to measure systolic and diastolic blood pressure (mmHg). Measurements were each taken at a similar time of day by the same technician.

Change scores for all measures were calculated by subtracting the baseline score from the score at week 24.

Procedure

Study subjects were provided access to YMCA wellness centers in the area of Atlanta, Georgia, that included a variety of cardiovascular exercise apparatus, group exercise classes, and areas for walking and running. All study subjects were assigned an initial meeting with a credentialed exercise leader who completed a one-day training session and a minimum of ten hours of supervised practice in their assigned treatment. Quality assurance of treatments was provided by a supervisor and study investigator. All institutional and governmental regulations concerning the ethical use of human volunteers were followed.

In the CA group, a series of six one-hour meetings with an exercise leader, spaced across six months, was provided. These one-on-one sessions included an orientation to available exercise apparatus and administration of the cognitive-behavioral protocol designed to support maintenance of exercise. Initially, a brief survey assessed propensity for early dropout on the basis of: 1) present ability to tolerate exercise-related discomfort, 2) existing social supports, and 3) self-management/self-regulatory abilities.[28] A supporting computer program (FitLinxx, Norwalk, CT) adjusted subsequent treatment components on the basis of responses. The general format of each meeting was similar. Goal-setting followed suggestions by Locke and Latham.[29] Long-term goals were set and reduced into specific short-term goals that were documented. Feedback methods were used that tracked process-related goal progress such as cardiovascular exercise time and changes in energy, fatigue, and stress over time.

Exercise plans accounted for individual preference, and modifications of intensities and durations were made to increase probabilities of maintaining exercise on the basis of responses on a 12-item acute feeling scale.[30] A behavioral contract was incorporated to increase commitment. Appropriate group exercise classes were suggested to promote feelings of social cohesion—a correlate of adherence.[31] Instruction in a different self-management/self-regulatory skill such as cognitive restructuring, stimulus control, or dissociation from discomfort was given each meeting. The Coach Approach protocol was intended to increase feelings of mastery, competence, and self-efficacy related to exercise—strong predictors of adherence.[10,20]

Nutrition and weight-loss information provided to the CA group was limited to brief review of a one-page summary of suggestions from the American College of Sports Medicine.[32] Topics included: 1) percentage of loss in body weight that should be sought initially (ie, 5%–10%), 2) recommended reduction of caloric intake (ie, 500–1000 kcal/d), 3) restriction of fat intake (ie, approximately 30% of total caloric intake), and 4) the lack of evidence for the effectiveness of specific macronutrient combinations (eg, low-carbohydrate diets).

In the CA/CH group, in addition to behavioral protocol described above, registered dietitians provided six biweekly one-hour nutrition information sessions in small groups. The standardized protocol (Cultivating Health) was supported by a 49-page workbook.[33] Curriculum components included: 1) understanding calories, carbohydrates, protein, and fats; 2) calculating caloric needs for weight loss; 3) using the food guide pyramid; 4) developing a plan for appropriate snacking; and 5) menu planning. Although the group was focused on weight loss, no specific caloric or fat restrictions were imposed.

In the control group, typical participant–professional contacts were incorporated that consisted of instruction on how to complete specific exercises, their associated benefits, exercises completed to date, and monthly appointments to adjust exercise regimens.[34] Nutrition and weight-loss information provided was the same as for the CA group.

The Coach Approach protocol was intended to increase feelings of mastery, competence, and self-efficacy related to exercise—strong predictors of adherence.[10,20]

For each group, three exercise sessions per week were assigned, and contact time with exercise leaders was similar. Cardiovascular exercise progressed to ≥30 minutes per session by the third month. All assessments were administered in a private area at baseline and at week 24.

Data Analysis

An intention-to-treat design was implemented where missing data associated with dropout were imputed using the "last observation carried forward" method.[35] Other missing data were imputed using the expectation-maximization approach.[36] This conservative analytic format protected against type I error due to overrepresentation of treatment "compliers" and retained the maximum experimental power possible given the goals of the investigation.

Chi-square and one-way analysis of variance (ANOVA) were first used to contrast group differences in dropout and exercise session attendance percentage, respectively. Analyses of both within- and between-group changes in SE, PSC, BAS, and TMD scores and physiologic factors were then conducted retaining actual baseline scores. Because direct calculation of effects for within-group changes was advantageous, separate within- and between-group analyses were chosen over mixed-model repeated-measures ANOVA. Effect sizes were reported for χ^2 analysis using Cramer's V [$V = \sqrt{\chi^2/N(k-1)}$], for the one-way ANOVAs using eta-squared [$\eta^2 = t^2/t^2 + df$], and for the dependent *t*-tests using Cohen's d [$d = \text{mean}_1 - \text{mean}_2/\text{SD}_1$].

Hypothetical paths derived from social cognitive and self-efficacy theory[11,12] and from Baker and Brownell's model[15] were next assessed by pooling findings from the two treatment groups (CA and CA/CH). Whether self-regulatory efficacy (ie, SE scores) and task self-efficacy (PSC scores) at baseline significantly predicted exercise session attendance and, following, body-fat and BMI reduction, was first tested using regression analysis. The theoretically derived paths of the intervention with changes in SE, PSC, BAS, and TMD; exercise session attendance; and finally, body-fat and BMI changes, were then assessed (see Figure 1 for details and graphic representations of the path analyses).

Statistical significance was set at $\alpha = 0.05$ (two-tailed) throughout. The approximately normal distributions of change scores (skewness and kurtosis < 2.0 SE) was appropriate for the analyses chosen. On the basis of the exploratory nature of the investigation and of previous suggestions,[37] no adjustments were made for multiple *t*-tests. A power analysis suggested a sufficient sample size to detect a small-to-moderate effect ($f^2 = 0.10$) at the 0.05 alpha level.

Results

Adherence to Exercise

The number of dropouts significantly differed by group [χ^2 ($df = 2$; $N = 273$) = 44.67; $p < 0.001$; $V = 0.29$]. Follow-up testing with Bonferroni correction indicated that the CA (38.27%), the CA/CH (28.12%), and the control (62.50%) groups significantly differed from one another. Exercise session attendance significantly differed by group [$F(2, 270) = 10.02$; $p < 0.001$; $\eta^2 = 0.07$]. Follow-up testing using the Tukey HSD method indicated that attendance in both the CA (mean, 43.16%; SD, 30.54) and the CA/CH (mean, 50.97%; SD, 30.03) groups was significantly greater than the control group (mean, 31.07%; SD, 25.04).

Changes in Physiologic Factors

For the CA group, significant within-group improvements were found for body-fat percentage, waist circumference, and BMI (Table 1).

Table 1. Changes in physiologic factors from baseline to week 24

	Baseline		Week 24				
Physiologic factor	Mean	SD	Mean	SD	*t*	p	*d*
The Coach Approach only group (*n* = 81)							
Body-fat percentage	38.33	5.36	36.52	6.08	–4.06	<00.001	0.34
Waist circumference (cm)	109.37	21.18	107.32	21.26	–4.78	<0.001	0.10
Resting heart rate (beats/min)	81.89	14.42	81.04	14.48	–0.95	0.35	0.06
Blood pressure—systolic (mmHg)	132.23	19.69	129.41	19.88	–1.67	0.10	0.14
Blood pressure—diastolic (mmHg)	84.21	9.63	83.57	10.58	–0.49	0.63	0.07
Body mass index (kg/m²)	38.12	5.86	37.39	6.24	–4.00	<0.001	0.12
The Coach Approach plus Cultivating Health group (*n* = 128)							
Body-fat percentage	37.42	4.32	34.67	4.98	–6.09	<0.001	0.64
Waist circumference (cm)	108.76	13.49	104.48	13.92	–6.84	<0.001	0.32
Resting heart rate (beats/min)	82.72	15.54	78.10	11.72	–3.55	<0.001	0.30
Blood pressure, systolic (mmHg)	132.28	18.14	129.02	17.10	–2.39	0.02	0.18
Blood pressure, diastolic (mmHg)	80.02	7.82	77.98	8.20	–2.03	0.04	0.26
Body mass index (kg/m²)	37.85	5.97	36.93	6.18	–4.64	<0.001	0.15
Control group (*n* = 64)							
Body-fat percentage	38.63	5.56	38.51	6.06	–0.13	0.90	0.02
Waist circumference (cm)	110.44	14.22	109.41	13.85	–1.87	0.07	0.07
Resting heart rate (beats/min)	82.64	12.61	80.92	12.31	–1.20	0.23	0.14
Blood pressure, systolic (mmHg)	131.48	14.44	129.67	15.91	–1.25	0.22	0.13
Blood pressure, diastolic (mmHg)	81.52	8.46	83.63	12.19	1.64	0.11	–0.25
Body mass index (kg/m²)	35.81	5.24	35.66	5.15	–1.35	0.18	0.03

For the CA/CH group, the preceding factors, in addition to resting heart rate, systolic blood pressure, and diastolic blood pressure, demonstrated a significant within-group improvement. For the control group, no significant within-group change was found. For changes in each physiologic factor tested, greater effects were observed in the CA/CH group, followed by the CA group (Table 1).

No significant group difference (p values > 0.05) was found for any physiologic factor at baseline. Separate one-way ANOVAs were calculated to assess group differences in physiologic factors using within-group score changes. An overall significant difference was found for changes in waist circumference [$F(2, 270) = 7.69$; $p < 0.001$; $\eta^2 = 0.05$]. Follow-up testing using the Tukey HSD method indicated a significantly greater reduction in the CA/CH group than in either the CA group or the control group. An overall significant difference was also found for changes in BMI [$F(2, 270) = 3.32$; $p = 0.038$; $\eta^2 = 0.02$]. Follow-up testing indicated a significantly greater reduction in the CA/CH group than the control group. Finally, an overall significant difference was found for changes in body-fat percentage [$F(2, 270) = 8.03$; $p < 0.001$; $\eta^2 = 0.06$]. Follow-up testing indicated a significantly greater reduction in the CA and CA/CH groups than in the control group.

Table 2. Changes in psychologic factors from baseline to week 24

	Baseline		Week 24				
Psychologic factor	**Mean**	**SD**	**Mean**	**SD**	***t***	**p**	***d***
The Coach Approach only group (*n* = 81)							
Total mood disturbance	11.90	13.64	6.66	11.02	–4.47	<0.001	0.38
Tension	3.58	3.41	2.88	2.33	–2.26	0.03	0.21
Anger	4.20	3.20	3.10	2.36	–4.22	<0.001	0.34
Fatigue	6.60	4.89	4.91	4.16	–4.42	<0.001	0.35
Vigor	7.19	3.60	8.35	3.94	2.72	0.01	0.32
Confusion	2.19	2.43	1.80	1.96	–2.22	0.03	0.16
Depression	3.32	0.69	3.14	0.85	–2.29	0.02	0.26
Physical self-concept	42.48	5.98	45.06	6.67	4.84	<0.001	0.43
Body areas satisfaction	10.12	2.43	11.15	2.71	5.30	<0.001	0.42
Self-efficacy	16.84	3.82	17.26	4.55	1.01	0.32	0.11
The Coach Approach plus Cultivating Health group (*n* = 128)							
Total mood disturbance	15.61	13.63	5.38	13.71	–6.38	<0.001	0.75
Tension	4.34	3.21	3.07	2.67	–4.59	<0.001	0.40
Anger	3.87	3.36	2.93	3.31	–2.43	0.02	0.28
Fatigue	7.48	4.22	4.77	4.27	–5.71	<0.001	0.64
Vigor	5.64	3.50	8.95	4.42	7.50	<0.001	0.95
Confusion	2.98	2.60	2.05	1.96	–3.80	<0.001	0.36
Depression	2.53	1.44	1.51	1.00	–3.80	<0.001	0.71
Physical self-concept	37.33	7.42	39.27	6.11	3.78	<0.001	0.26
Body areas satisfaction	9.81	2.34	11.51	2.87	6.98	<0.001	0.73
Self-efficacy	15.82	4.57	16.27	4.32	1.12	0.26	0.10
Control group (*n* = 64)							
Total mood disturbance	12.00	11.16	8.59	10.46	–3.14	<0.001	0.31
Tension	4.06	3.14	3.16	2.27	–3.70	<0.001	0.29
Anger	3.22	2.70	2.72	2.10	–1.85	0.07	0.19
Fatigue	6.44	3.80	6.16	4.16	–0.65	0.52	0.07
Vigor	7.69	3.87	8.66	3.70	2.60	0.01	0.25
Confusion	2.34	2.26	2.16	2.11	–1.52	0.13	0.08
Depression	3.63	0.93	3.06	1.01	–3.58	<0.001	0.61
Physical self-concept	44.06	8.26	45.75	8.62	3.52	<0.001	0.20
Body areas satisfaction	11.09	3.03	12.28	3.51	4.37	<0.001	0.39
Self-efficacy	15.91	4.68	15.94	4.21	0.08	0.94	0.01

Note: total mood disturbance = [(Σ tension, anger, fatigue, confusion, depression) – vigor].

Changes in Psychologic Factors

No significant group difference (p values > 0.05) was found on any psychologic factor at baseline. TMD scores were significantly reduced for each group (Table 2). Changes in Profile of Mood States subscales are also given. One-way ANOVA indicated an overall significant difference in changes in TMD, by group [$F(2, 270) = 6.55$; $p < 0.001$; $\eta^2 = 0.05$]. Follow-up testing indicated a significantly greater improvement in the CA/CH group than in either the CA or control groups. Each group demonstrated significant within-group improvements in PSC and BAS scores (Table 2). ANOVA indicated no significant differences by group [$F(2, 270) = 2.28$; $p = 0.10$; $\eta^2 = 0.02$ and $F(2, 270) = 0.43$; $p = 0.65$; $\eta^2 = 0.003$, respectively]. Within-group improvement in SE scores did not reach statistical significance for any group.

Relations of Cognitive Behavioral Treatment, Psychologic Factors, Exercise Attendance, and Changes in Body Composition

For the CA and CA/CH groups pooled ($n = 209$), significant improvements in PSC, BAS, and TMD scores were found, and changes in SE approached statistical significance (p values < 0.10). Findings from regression models, with simultaneous entry of the theory-based predictors of exercise session attendance (Table 3), were next entered into five proposed paths (for actual regression values and graphic representations of proposed paths, see Figure 1). The explained variance in exercise session attendance was significant in each regression model. Approximately the same portion of the variance was accounted for by entry of SE and PSC scores at baseline (7%; model 1) and by changes in scores on these measures from baseline to week 24 (5%; model 2). Inclusion of changes in BAS (model 3) and TMD (model 4) scores, individually, increased the explained variance in exercise session attendance to 12% and 13%, respectively. When changes in BAS and TMD scores were together simultaneously entered, creating a four-factor model (model 5), 16% of the overall variance in exercise session attendance was accounted for.

Standardized beta weights suggested significant unique contributions to the overall explained variance in exercise made by entry of change scores in BAS and TMD (Table 3), also supported through contrasts of adjusted R^2 values. Strong negative correlations were found between exercise session attendance and changes in body fat ($r = -0.41$; $p < 0.001$) and BMI ($r = -0.46$; $p < 0.001$). The total effect of The Coach Approach protocol on changes in body fat and BMI were significant in each model (p values ≤ 0.001).

Table 3. Results of simultaneous linear multiple-regression analyses for prediction of exercise session attendance

Model variables	β	R	R^2	R^2_{adj}	F	p
Model 1		0.27	0.07	0.06	6.74	0.002
Self-efficacy	0.13					0.10
Physical self-concept	–0.28					<0.001
Model 2		0.22	0.05	0.04	4.46	0.01
Δ self-efficacy	0.07					0.36
Δ physical self-concept	0.22					0.004
Model 3		0.35	0.12	0.11	8.20	<0.001
Δ self-efficacy	0.03					0.65
Δ physical self-concept	0.02					0.82
Δ body areas satisfaction	0.34					<0.001
Model 4		0.36	0.13	0.11	8.40	<0.001
Δ self-efficacy	0.07					0.31
Δ physical self-concept	0.16					0.04
Δ total mood disturbance	–0.29					<0.001
Model 5		0.40	0.16	0.14	8.37	<0.001
Δ self-efficacy	0.05					0.53
Δ physical self-concept	0.03					0.75
Δ body areas satisfaction	0.25					0.01
Δ total mood disturbance	–0.21					0.01

Note: the delta symbol (Δ) denotes change in score from baseline to week 24.
adj = adjusted R^2 values

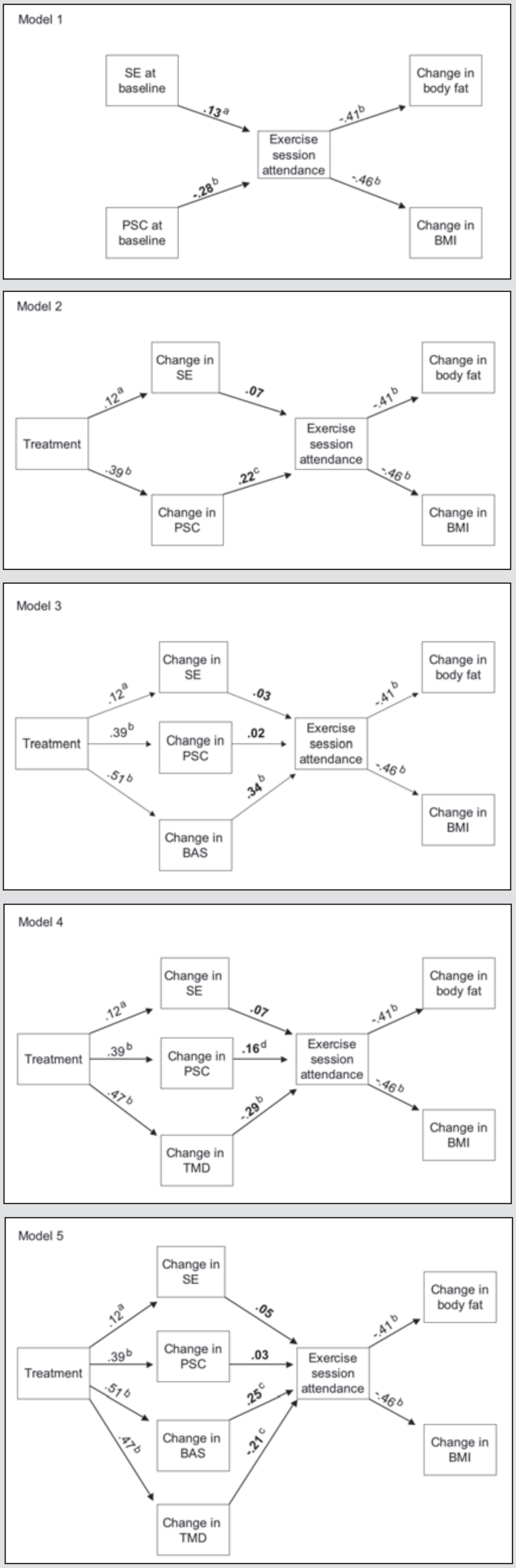

Figure 1. Path representations of relations of physical activity participation; self-efficacy, mood, and body satisfaction; exercise attendance, and changes in body fat and body mass index (BMI): models 1 through 5.

Values in bold type denote beta weights. All other values denote linear bivariate correlations. BAS = Body Areas Satisfaction scale of the Multidimensional Body-Self Relations Questionnaire; PSC = Physical Self-Concept scale of the Tennessee Self-Concept Scale; SE = Exercise Self-Efficacy scale; TMD = Total Mood Disturbance scale of the Profile of Mood States. $^{a}p < 0.10$; $^{b}p < 0.001$; $^{c}p < 0.01$; $^{d}p < 0.05$.

For use in the path representations, changes in psychologic factors associated with the Coach Approach (CA) protocol, expressed as *t* values, were first converted $[r = \surd t^2/t^2 + df]$. Changes in SE and PSC scores alone, then additionally entering changes in BAS and TMD scores first alone, then together, were next incorporated into separate multiple-regression equations. Finally, linear bivariate correlations between exercise session attendance and changes in body fat and BMI were added to the path models. For effect decomposition, total effects of the CA protocol on changes in body fat and BMI were estimated by regressing each variable of the respective model separately on body fat and BMI change scores and omitting the intervening variable of exercise session attendance. The significance of the beta value for the exogenous variable was used as the test for significance of the total effect. Consistent with previous research and with suggestions for analysis of longitudinal data under the present conditions, use of study subjects' changes in scores during the six months of the study, which retained actual baseline scores, was deemed preferable to statistically controlling for baseline differences. This method adequately accounted for changes under conditions consistent with the normal variations in baseline scores found in the present population.

The following references supported methodologies used for effect decomposition within the path analyses:

1. Alwin DF, Hauser RM. Decomposition of effects in path analysis. Am Sociol Rev 1975 Feb;40(1):37–47.
2. Cohen J, Cohen P, West SG, Aiken LS. Applied multiple regression/correlation analysis for the behavioral sciences. 3rd ed. Hillsdale, NJ: Lawrence Erlbaum; 2003.

The following references supported the use of unadjusted change scores:

1. Maris E. Covariance adjustment versus gain scores—revisited. Psychological Methods 1998;3:309–27.
2. Fitzmaurice GM, Laird NM, Ware JH. Applied longitudinal analysis. New York: Wiley; 2004.

Discussion

In the control group, exercise session attendance (mean, 31.1%) and dropout (mean, 62.5%) was similar to samples who were not exclusively obese.[6,8,18] Possibly the group nutrition education component increased participants' perceived value of exercise within the overall weight-loss process, resulting in the least dropout in the CA/CH group (mean, 28.1%). Moreover, when paired with the behavioral skills likely acquired through the CA protocol, subjects' persistence may have further benefited. The CA and CA/CH groups did not, however, significantly differ in exercise session attendance rates.

Unlike the control group, both treatment groups had significant decreases in body fat, waist circumference, and BMI. The corresponding mean changes in weight of approximately –0.2 kg/week (range, –1.8 to 0.4 kg/week) was less than the maximum recommended[32]; however, consideration should be given to the conservative intention-to-treat design used that retained data from even early treatment dropouts. Often analyses of weight-loss interventions include only individuals with high compliance. Although the larger effect sizes for reductions in body fat, waist circumference, and resting heart rate in the CA/CH group, relative to the CA group, may be attributable to dietary changes associated with the nutrition component, direct analyses of food intake was not made.

… the relations of exercise, psychologic factors, and weight loss are important to consider for the development of both weight-management theory and treatment.

The significant changes in TMD found in each group are consistent with research suggesting that once a minimum exercise frequency and duration is met (eg, 15 minutes, two times per week), additional improvements in mood are unlikely,[13] but inconsistent with a minority of studies suggesting a dose–response relationship.[38] These findings of mood improvements associated with moderate exercise may be useful to physicians and other health care practitioners. The similar effect sizes, across groups, in PSC and BAS are reconciled by research suggesting that participation in an exercise program, rather than physical activity output itself, predicts changes in perceptions of the physical self.[18] Little correspondence between perceived and actual physical changes was previously found in women initiating exercise.[39,40] Increases in SE scores were not significant and may be dependent on self-management and self-regulatory abilities unlikely to improve spontaneously (without adherence to corresponding training). The intention-to-treat design may have substantially affected mean changes in SE through inclusion of many study subjects with minimal treatment exposure. Direct measurement to clarify use of self-management/self-regulatory skills is planned for future related research.

The five proposed paths from exercise program participation to weight changes indicated that changes in self-efficacy constructs may predict exercise session attendance better when body satisfaction and mood changes are also accounted for. Findings support reinforcement and social cognitive theory, which suggests that when meaningful changes in physiologic and psychologic factors are perceived along with sufficient abilities (ie, efficacy beliefs), associated behaviors will be maintained. It will be important to better evaluate the probable coactive relationship of diet and exercise behavior with changes in weight and body composition.

Replication and determination of the generalizability of the present findings to other samples are required. Extensions of this research should better control for possible effects associated with the increased professional attention of the group nutrition information sessions. Additionally, experimental designs that systematically track changes in weight over several years are required to assess sustained effects. Our findings, however, strongly suggest that the relations of exercise, psychologic factors, and weight loss are important to consider for the development of both weight-management theory and treatment. ❖

Disclosure Statement

The author(s) have no conflicts of interest to disclose.

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