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ORIGINAL RESEARCH

Short- and Long-Term Weight Loss Among Women Is Unrelated to Completed Exercise Within an Obesity Intervention Focused on Self-Regulation

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Abstract

INTRODUCTION: The aim of this study was to evaluate 1) if completed exercise amounts were associated with short- and long-term weight loss within a cognitive behavioral intervention and 2) if changes in theory-based psychosocial factors significantly explained weight change.

METHODS: A total of 110 women with obesity participated in a yearlong treatment focused on self-regulation and were grouped based on their amount of completed exercise and assessed on changes in weight, self-regulation, and self-efficacy.

RESULTS: There were significant overall improvements in all study measures from baseline–month 6 and baseline–month 12. Overall weight loss means (–5.8 and –5.3 kg, respectively) did not significantly differ across groups averaging the equivalent of < 2.5; 2.6–4.5; 4.6–7.0; and > 7.0 moderate-intensity exercise sessions per week. Similarly, psychosocial improvements did not significantly differ by exercise amount grouping. Increase in exercise self-regulation significantly predicted eating self-regulation gains over both 6 and 12 months. Over the same time periods, the significant prediction of weight loss by eating self-regulation increase was mediated by change in eating self-efficacy.

CONCLUSION: Results suggest attainment of government-recommended amounts of exercise are not associated with significantly greater weight loss than lower amounts of exercise within an intervention focused on self-regulation. Associations of exercise with psychosocial correlates of weight loss should be a treatment consideration.

Introduction

Weight loss via behavioral (nonpharmacological, nonsurgical) means has generally been ineffectual beyond the initial weeks or months.[1,2] However, exercise has proven to be a productive component that is predictive of better-sustained outcomes than attempts at controlling eating alone.[3,4] Exercise amounts recommended for weight loss range

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James J Annesi, PhD, FAAHB, FTOS, FAPA, conceptualized the study, analyzed the data, and wrote the initial draft of the article. Patricia G Sevene, PhD, contributed to the data interpretation and revised the article for important intellectual content. Both authors approved the submitted draft.

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from ≥ 150 minutes per week of moderate-intensity exercise,[5] to ≥ 225 minutes per week.[6] Those amounts are equivalent to at least 5 and 7 30-minute sessions per week, respectively. Because adherence to exercise has been problematic with > 50% attrition within the initial 3–6 months of starting a program,[7,8] and attainment of the recommendation of ≥ 150 minutes per week of exercise has occurred in < 10% of the US adult population (lower in women than men),[9,10] the probability of completing a sufficient amount of exercise to meaningfully impact weight via energy expenditure is low.[11] In comprehensive reviews,[12,13] along with having obesity, greater intensity and effort associated with exercise was associated with reduced adherence to exercise; while knowledge of the value of exercise for health (an assumed behavioral prompt) was unrelated to its maintenance.

Although these recommendations of exercise amounts for weight loss persist, some research failed to demonstrate a dose (exericse)–response (weight loss) relationship.[14,15] For example, although the assigned exercise amounts of 150, 225, and 300 minutes per week were poorly adhered to in a sample of 298 adults with obesity, there was no significant difference in weight change over 12 months, by group.[15] The actual completed means were 129, 153, and 179 minutes per week, respectively.[15] Research has not accounted for the realization that assigned/suggested exercise amounts are rarely followed. Thus, it was suggested that investigations would benefit from analyses of completed, rather than assigned, exercise.[16] The basis for retaining recommendations for high amounts of exercise might come, in part, from post hoc, cross-sectional findings of those who atypically retained substantial amounts of lost weight.[17]

Exercise is a robust, if not the strongest, predictor of weight loss.[18] However, some research suggests that, even within obesity treatment environments that provide behavioral support, the *direct* effect of exercise-associated energy expenditures on weight loss is minimal.[16] It has been posited that the benefit of exercise in weight reduction is largely through psychosocial change, rather than energy expenditure, pathways.[16,19,20] More specifically, the self-regulation needed to overcome lifestyle-related obstacles to maintaining exercise, even in dosages below those recommended, can carry over to eating-related improvements in self-regulation and more healthy eating behaviors.[21] This is consistent with the construct of "coaction," which can be defined as the advancement of a second health behavior emanating from success at improving an initial health behavior (eg, improved eating proceeding from a newly established regimen of exercise).[22] This explanation of the linkage of exercise with weight loss is further reinforced by the knowledge that weight is more readily reduced via reduced energy intakes (eating behavior changes) as opposed to energy expenditures (exercise).[4]

Even though the phenomenon of coaction from exercise to other health behaviors has been observed absent specific treatment attempts to generalize self-regulation from one context to another,[23] research suggests effects will be greater in the presence of such an intentional focus.[16] Self-regulation theory (which posits benefits of the use of limited existing self-regulatory resources and the development and strengthening of new self-regulation skills),[24] social cognitive theory (which suggests reciprocal relations between psychosocial, environmental, and behavioral factors during change processes),[25,26] and health behavior research[16,19] advocate for the development of self-regulatory skills to counter persistent challenges to behavioral changes. Thus, interventions have been suggested that first facilitate self-regulated exercise then, several weeks/months later, seek to carry over the same (but adapted) self-regulatory skills to better-controlled eating.[16] Consistent with social cognitive theory,[25] self-efficacy theory (which posits that feelings of ability/mastery to accomplish behavioral changes fosters persistence),[27] and field research,[20,21] mechanisms mediating the transfer of exercise-related self-regulation to eating-related self-regulation could involve an increase in self-efficacy associated with newly gained feelings of behavioral control over personal challenges and barriers.

Even though researchers have acknowledged a need for a better understanding of the dynamics of theory-driven behavioral and psychosocial changes within weight-change processes,[28,29] little is known about the importance of exercise amounts completed and their possible interactive effects with changes in self-regulation and self-efficacy in predicting and/or shaping weight loss. Such increased knowledge within a context of a behavioral obesity treatment over both an initial period of expected weight loss (eg, 6 months[16,21]) and extended beyond that time frame to account for anticipated regains (eg, 12 months and beyond), could inform future intervention foci and positively impact lagging outcomes.[1,2] This could be especially useful in health-promotion settings positioned for widespread applications.

RESEARCH QUESTION/HYPOTHESES

While it was unclear whether greater amounts of completed exercise would be associated with more lost weight over the short term and/or long term, it was expected that a treatment-associated increase in exercise self-regulation would predict increased eating self-regulation. It was further posited that significant associations between increased eating-related self-regulation and reduced weight would be mediated by self-efficacy changes.

Methods

PARTICIPANTS

This study comprised a secondary analysis of data emanating from an ongoing program of field-based research in the United States investigating behavioral obesity-management methodologies in community-based environments.[16] Based on the focus of this investigation, and acknowledgement that psychosocial aspects of weight-loss processes differ based on participants' sex (and thus might require separate analyses),[30] women ≥ 21 years old with Class 1 or 2 obesity (BMI = 30.0–39.9 kg/m^2) and reporting ≤ 2 exercise sessions per week at baseline were included. Additional criteria of no medical contraindication for full participation and no present/soon-planned pregnancy were also required. For the purposes of this study, groups were formed, post hoc, based on recalled exercise amounts aggregated from month 3 and 6 data for assessment of weight change over 6 months, and from months 3, 6, and 12 data for assessment of weight change over 12 months. Calculations yielded the 4 designated groupings. Corresponding conversions to number of moderate-intensity sessions per week were coded as 1: < 2.5 sessions; 2: 2.6–4.5 sessions; 3: 4.6–7.0 sessions; and 4: > 7 sessions. They are further described in the statistical analyses subsection and summarized in Table 1. The overall sample size was N = 110. Demographic data indicated no significant group difference and are given in the results section.

MEASURES

Exercise was measured using the Godin-Shephard Leisure-Time Physical Activity Questionnaire (LTPAQ).[31] The number of exercise bouts of ≥ 15 minutes completed in the previous 7 days was recalled by the respondent. Each response requires designation of its corresponding intensity, such as "mild exercise (minimal exertion)," "moderate exercise (heartbeat faster than resting but not exhausting)," and "strenuous exercise (heart beats rapidly)." They were coded 3, 5, and 9 metabolic equivalents (METs, a measure of physical intensity/energy expenditure),[32] respectively, multiplied by the corresponding number of reported bouts of that intensity, then summed. For example, 4 bouts of mild exercise (4×3 METs) and 2 bouts of moderate exercise (2×5 METs) = 22. Predictive validity of the LTPAQ was previously indicated through its score correspondences with treadmill testing, accelerometry, and body fat values in adults.[33–37] LTPAQ score change also significantly predicted weight change over 6 months in adults with Class 2 and 3 obesity.[38] Test–retest reliability over 2 weeks was reported at 0.74.[37] Based on international recommendations for health, the developers of the LTPAQ designated a score of < 14 as "low benefits," 14–23 as "some benefits," and ≥ 24 as "substantial benefits."[31]

Group	n	LTPAQ score		95% CI for M
		M	SD	
Month 3 and 6 data aggregated				
1. Minimal benefit	12	10.98	4.01	8.43, 13.52
2. Some benefit	28	20.62	2.95	19.47, 21.76
3. Substantial benefit	32	29.48	3.29	28.30, 30.67
4. ACSM recommendation for weight loss	38	48.14	11.45	44.38, 51.91
Month 3, 6, and 12 data aggregated				
1. Minimal benefit	10	11.95	2.11	10.44, 13.46
2. Some benefit	29	19.99	2.63	18.99, 20.99
3. Substantial benefit	37	29.55	4.03	28.20, 30.89
4. ACSM recommendation for weight loss	34	47.36	10.43	43.72, 51.00

Table 1: Exercise completed, by group (N = 110)

ACSM = American College of Sports Medicine; 95% CI = 95% confidence interval; LTPAQ = Leisure-Time Physical Activity Questionnaire; M = mean; SD = standard deviation.

Exercise self-regulation and eating self-regulation were measured using 10 items, each, derived from a taxonomy of self-regulatory techniques.[39] In the present case, they were congruent with social cognitive theory.[25] Items such as "I set physical activity goals" for the exercise-related measure and "I keep a record of my eating" for the eating-related measure had response options that ranged from 1 (never) to 4 (often), and were summed. Internal consistencies were reported at 0.79 and 0.81, respectively.[38] Test–retest reliabilities over 2 weeks were reported at 0.78 and 0.74, respectively.[38] In the present sample, the corresponding internal consistencies were 0.76 and 0.79.

Eating self-efficacy measured self-perception of one's ability to control their eating via the 20-item Weight Efficacy Lifestyle Scale.[40] Item groupings of the scale relate to perceived abilities to self-manage eating when under conditions of high food availabilities, physical discomforts, positive activities, negative emotions, and social pressures such as "I can resist eating when I am depressed (or down)" and "I can resist eating even when I have to say 'no' to others." Response options ranged from 0 (not confident) to 9 (very confident), and were summed. Internal consistencies were reported at 0.76–0.82.[40] In the present sample, the internal consistency was 0.81.

Body weight was measured by a noninstructional study staff member using a recently calibrated, self-zeroing, digital floor scale (Health o meter Professional 800 KL, Atlanta, GA). Measurement was to the nearest 0.10 kg. Participants were requested to first remove their shoes and any heavy outer clothing.

PROCEDURE

The 12-month treatment protocol was administered in office and conference room settings by community health-promotion instructors with at least 1 national certification and training in the present protocol. There were 5 1-on-1 meetings of 30 minutes each, through month 3, focused on exercise adherence. The treatment goal of that initial component was addressed primarily through building participants' self-regulatory skills (eg, proximal goal setting, incremental progress tracking, relapse prevention, stimulus control, cognitive restructuring) to counter their lifestyle barriers and challenges to completing regular exercise. A final summary session occurred at month 6. During each session, there was reference made to the governmental recommendation of ≥ 150 minutes per week of moderate-intensity exercise/physical activity for health[5] and the American Academy of Sports Medicine recommendation of ≥ 225 minutes per week for weight loss.[6] However, instructors also indicated that *any* increase in exercise beyond what was presently completed could be advantageous. Exercise modality was based on each participant's preference. Moderate-intensity walking was the most frequent selection.

At the start of month 4, small group sessions of 12–15 participants and 1 instructor focused on eating behavior change. This second treatment component consisted of 18 50-minute meetings held every 2 weeks, through month 12. Sessions primarily concentrated on adapting the previously covered self-regulatory skills (for exercise) for controlling eating. However, suggestions were also made to increase (nonfried) fruit and vegetable consumption (a proxy for the health of the overall diet)[41,42] and adjust energy intake to 1200–1500 kcal/d (based on current weight). Education on how to log foods and drinks consumed and their corresponding energy intakes was provided. There was also a requirement for each person to self-weigh at least once per week (however, those data were not used within study-related analyses). Both treatment components were adapted from interventions accepted into the Evidence-Based Cancer Control Program of the National Institutes of Health/National Cancer Institute.[43]

Noninstructional study staff administered study measures in a private area at baseline and months 3, 6, and 12. They also completed structured protocol fidelity checks on 12% of the exercise and eating behavior change treatment sessions. Strong compliance was indicated, requiring only minor adjustments mostly associated with the mandated durations of sessions. Ethical mandates of the World Medical Association Declaration of Helsinki and the American Psychological Association were upheld throughout. Kennesaw State University's institutional review board confirmed that the present analyses of deidentified data could be completed without further ethics review.

STATISTICAL ANALYSES

Based on previously established criteria,[44] there was no systematic bias in study participants with vs without any missing data (14% missing cases overall). Thus, those missing data were classified as missing-at-random.[44] This finding satisfied compulsory criteria for use of the expectation–maximization algorithm for imputation.[45] This facilitated the intended intention-to-treat study format.[46] Considering the planned analytic framework and the anticipated effect size based on related research,[16] an overall sample size of 108 was required to detect the moderate effect of Cohen's $f^2 = 0.15$ at the conservative statistical power of 0.90.[47] Acceptable multicollinearity in the data set were implied through variance inflation factor scores < 2.00. Based on previous suggestions,[48] there was no adjustment for baseline values within gain (change) scores.

Because the exercise component of the self-regulation–focused intervention was administered predominantly from baseline–month 3 (predicting eating-related changes through months 6 and 12; see the Procedure subsection for additional information), and based on suggestions for lagged variable analyses (ie, early changes predicting longer-term changes),[49] baseline–month 3 scores were employed for the exercise self-regulation measure. Exercise amount groupings were developed, post hoc, by calculating the mean of the LTPAQ scores from months 3 and 6 for analyses of changes from baseline–month 6 (and baseline contrasts), and from months 3, 6, and 12 for analyses of baseline–month 12 changes. Group designations and descriptors (given in quotation marks) of 1 (LTPAQ score ≤ 14.0 [< 2.5 moderate sessions per week]; "minimal benefit"), 2 (LTPAQ score = 14.1–24.0 [2.6–4.5 moderate sessions per week]; "some benefit"), 3 (LTPAQ score = 24.1–35.0 [4.6–7.0 moderate sessions per week]; "substantial benefit"), and 4 (LTPAQ score ≥ 35.1 [> 7 moderate sessions per week]; "ACSM recommendation") were derived from the LTPAQ developer and previous research.[6,31]

One-way ANOVA and χ^2 analyses first evaluated differences in personal characteristics and study measures at baseline. Mixed-model repeated measures ANOVAs then appraised the overall significance of change scores from baseline–month 6 and 12 in weight, eating self-regulation, and eating self-efficacy; and change from baseline–month 3 in exercise self-regulation. Time × group interactions (ie, evaluations of score changes while additionally considering participant grouping) were also assessed. These were followed up with planned Bonferroni-adjusted contrasts if significance was detected.

Bivariate relations between changes in eating self-regulation and weight were next appraised using aggregated data. Group was entered in step 2 of those regression models to determine if it significantly increased the explained variance. The prediction of changes in eating self-regulation by exercise self-regulation change was then evaluated. Group was again entered in those equations' step 2. Mediation of the exercise self-regulation change→eating self-regulation change relationships by changes in eating self-efficacy were next evaluated. In follow-up analyses, group was entered as a possible moderator of each of the embedded paths within the corresponding models.

Statistical significance was set at $\alpha < 0.05$, 2-tailed, throughout. SPSS version 28.0 (IBM, Chicago, IL) was used for statistical testing, incorporating the Process 4.1 macroinstruction model 4 (for mediation) and model 59 (for moderated mediation within each embedded path).[50] For the establishment of 95% confidence intervals (CI) within the mediation/moderated mediation models, 20,000 percentile method-based bootstrap resamples of the data were utilized.[50]

Results

COMPLETED EXERCISE AMOUNTS, BY GROUP

Table 1 displays exercise data for groupings based on aggregates of months 3 and 6; and months 3, 6, and 12.

GROUP CONTRASTS AT BASELINE

Regarding demographic variables, there was no significant between-group difference ($p > 0.35$) in age (overall M = 47.44 years, SD = 8.79), BMI (overall M = 34.79 kg/m^2, SD = 3.19), race and ethnicity (overall 73% White, 23% Black, 3% Hispanic, and 1% other), and yearly family income (median = $67,000 per year [nearly all participants were within a middle-income range]).

Regarding study measures, there was no significant between-group difference in baseline weight ($F_{3, 106} = 0.60$, $p = 0.615$); eating self-regulation ($F_{3, 106} = 1.06$, $p = 0.371$); eating self-efficacy ($F_{3, 106} = 0.11$, $p = 0.953$); or exercise self-regulation ($F_{3, 106} = 1.02$, $p = 0.386$). Corresponding descriptive data are given in Table 2.

SCORE CHANGES, CONTRASTED BY GROUP

There were significant overall reductions in weight from baseline–month 6 ($F_{1, 106} = 147.52$, $p < 0.001$) and from baseline–month 12 ($F_{1, 106} = 75.50$, $p < 0.001$). However, there was no significant time × group interaction ($F_{3, 106} = 1.97$, $p = 0.123$ and $F_{3, 106} = 2.38$, $p = 0.074$, respectively). There were significant overall increases in eating self-regulation from baseline–month 6 ($F_{1, 106} = 167.78$, $p < 0.001$) and from baseline–month 12 ($F_{1, 106} = 108.81$, $p < 0.001$). There was no significant time × group

Measure[a]	M	SD	M	SD	M	SD	d
	Baseline		Month 6		ΔBaseline-Month 6		
Weight (kg)							
1. Minimal benefit group	92.27	11.20	87.91	9.85	-4.36	3.70	1.18
2. Some benefit group	97.06	10.71	92.52	11.41	-4.54	3.84	1.19
3. Substantial benefit group	95.15	11.61	88.93	12.28	-6.22	4.38	1.42
4. ACSM recommend group	93.74	13.74	87.00	12.78	-6.74	4.68	1.44
Aggregated data	94.83	12.08	89.06	12.05	-5.77	4.34	1.33
Eating self-regulation							
1. Minimal benefit group	22.92	5.28	31.17	4.80	8.25	8.24	1.00
2. Some benefit group	22.79	5.69	30.23	4.88	7.44	6.61	1.13
3. Substantial benefit group	23.34	5.82	32.38	4.33	9.03	6.54	1.38
4. ACSM recommend group	21.11	5.45	32.86	4.56	11.75	6.38	1.84
Aggregated data	22.38	5.61	31.86	4.67	9.48	6.84	1.39
Eating self-efficacy							
1. Minimal benefit group	90.42	34.96	119.00	32.03	28.58	35.09	0.81
2. Some benefit group	92.46	31.86	127.13	27.44	34.66	32.03	1.08
3. Substantial benefit group	99.69	36.95	135.09	24.67	35.41	34.46	1.03
4. ACSM recommend group	87.74	31.95	140.74	21.97	53.00	31.53	1.66
Aggregated data	92.71	33.66	133.26	26.07	40.55	33.76	1.20
	Baseline		Month 3		ΔBaseline-Month 3		
Exercise self-regulation							
1. Minimal benefit group	20.50	6.57	30.42	4.85	9.92	9.30	1.07
2. Some benefit group	21.61	5.81	31.43	4.73	9.82	6.96	1.41
3. Substantial benefit group	21.47	5.30	33.16	3.46	11.69	5.22	2.24
4. ACSM recommend group	19.45	5.87	33.47	4.48	14.03	7.09	1.98
Aggregated data	20.70	5.77	32.53	4.40	11.83	6.98	1.70

Table 2: Score changes in study variables, by exercise groupings based on month 3 and 6 data

[a]Minimal benefit group n = 12; some benefit group n = 28; substantial benefit group n = 32; ACSM recommend group (those completing exercise within the range suggested by the American College of Sports Medicine for weight loss) n = 38.

ACSM = American College of Sports Medicine; d = Cohen's measure of effect size for within-group change, where 0.20, 0.50, and 0.80 are designated as small, moderate, and large effects, respectively; M = mean; SD = standard deviation; Δ = change during the designated temporal interval.

interaction ($F_{3, 106} = 2.50$, $p = 0.064$ and $F_{3, 106} = 2.49$, $p = 0.064$, respectively). There were significant overall increases in eating self-efficacy from baseline–month 6 ($F_{1, 106} = 120.20$, $p < 0.001$) and from baseline–month 12 ($F_{1, 106} = 77.30$, $p < 0.001$). There was a significant time × group interaction for baseline–month 6 change ($F_{3, 106} = 2.90$, $p = 0.038$); however, there was no significant group difference detected within the planned follow-up contrast ($p > 0.16$). There was no significant time × group interaction for baseline–month 12 change in eating self-efficacy ($F_{3, 106} = 2.33$, $p = 0.079$). There was a significant overall increase in exercise self-regulation ($F_{1, 106} = 249.84$, $p < 0.001$) but no significant time × group interaction ($F_{3, 106} = 2.43$, $p = 0.070$). Corresponding descriptive data are given in Table 2 (baseline and month 3 and 6 data) and Table 3 (baseline and month 3, 6, and 12 data).

EFFECTS OF INCREASED EATING SELF-REGULATION ON WEIGHT LOSS

Increase in eating self-regulation significantly predicted weight reductions from baseline–month 6 ($R = 0.39$, $R^2 = 0.15$, $F_{1, 108} = 19.52$, $p < 0.001$), and from baseline–month 12 ($R = 0.31$, $R^2 = 0.10$, $F_{1, 108} = 11.82$, $p < 0.001$). Entry of group classification in step 2 of those equations did not significantly increase their explained variances ($R^2_{change} = 0.02$, $F_{1, 107} = 2.29$, $p = 0.133$ and $R^2_{change} = 0.03$, $F_{1, 107} = 3.40$, $p = 0.068$, respectively).

EFFECTS OF EXERCISE SELF-REGULATION INCREASE ON HEIGHTENED EATING SELF-REGULATION

Increase in exercise self-regulation significantly predicted eating self-regulation increases from baseline–month 6 ($R = 0.53$, $R^2 = 0.28$, $F_{1, 108} = 42.50$, $p < 0.001$), and from baseline–month

Measure[a]	Baseline		Month 6		ΔBaseline-Month 6			Month 12		ΔBaseline-Month 12		
	M	SD	M	SD	M	SD	d	M	SD	M	SD	d
Weight (kg)												
1. Minimal benefit group	93.59	13.11	88.47	10.88	-5.12	4.31	1.19	90.07	11.38	-3.52	4.29	0.82
2. Some benefit group	98.23	9.80	93.87	10.97	-4.36	3.84	1.13	94.14	11.36	-4.08	4.38	0.93
3. Substantial benefit group	92.60	11.64	86.47	11.98	-6.13	3.92	1.56	87.63	12.87	-4.97	4.74	1.05
4. ACSM recommend group	94.74	13.78	87.96	12.61	-6.78	4.98	1.36	87.62	13.01	-7.12	6.37	1.12
Aggregated data	94.83	12.08	89.06	12.05	-5.77	4.34	1.33	89.57	12.57	-5.27	5.28	1.00
Eating self-regulation												
1. Minimal benefit group	22.00	6.00	29.40	5.80	7.40	8.45	0.88	29.70	5.58	7.70	5.72	1.35
2. Some benefit group	23.10	5.33	31.21	4.39	8.10	6.98	1.16	29.72	5.87	6.62	7.47	0.89
3. Substantial benefit group	22.81	5.86	32.15	4.31	9.34	5.85	1.60	29.89	5.68	7.08	7.18	0.99
4. ACSM recommend group	21.41	5.55	32.84	4.78	11.43	7.03	1.63	32.35	4.61	10.94	7.02	1.56
Aggregated data	22.38	5.61	31.86	4.67	9.48	6.84	1.39	30.59	5.47	8.21	7.24	1.13
Eating self-efficacy												
1. Minimal benefit group	108.40	29.33	127.10	38.87	18.70	34.47	0.54	129.70	39.34	21.30	34.67	0.61
2. Some benefit group	90.86	36.70	125.02	27.54	34.16	30.49	1.12	123.62	29.85	32.76	31.16	1.05
3. Substantial benefit group	93.27	32.08	134.84	22.11	41.57	33.53	1.24	124.22	23.26	30.95	37.57	0.82
4. ACSM recommend group	89.06	33.93	140.38	23.01	51.32	33.54	1.53	137.15	26.07	48.09	34.12	1.41
Aggregated data	92.71	33.66	133.26	26.07	40.55	33.76	1.20	128.55	27.88	35.85	35.27	1.02

	Baseline		Month 3		ΔBaseline-Month 3		
Exercise self-regulation	M	SD	M	SD	M	SD	d
1. Minimal benefit group	20.20	7.44	31.70	5.25	11.50	9.23	1.25
2. Some benefit group	21.79	5.37	31.59	4.63	9.79	7.02	1.40
3. Substantial benefit group	21.16	6.04	32.27	3.86	11.11	5.91	1.88
4. ACSM recommend group	19.41	5.26	33.85	4.38	14.44	6.81	2.12
Aggregated data	20.70	5.77	32.53	4.40	11.83	6.98	1.70

Table 3: Score changes in study variables, by exercise groupings based on month 3, 6, and 12 data

[a]Minimal benefit group n = 10; some benefit group n = 29; substantial benefit group n = 37; ACSM recommend group (those completing exercise within the range suggested by the American College of Sports Medicine for weight loss) n = 34.

ACSM = American College of Sports Medicine; d = Cohen's measure of effect size for within-group change. where 0.20, 0.50, 0.80 are designated as small, moderate, and large effects, respectively; M = mean; SD = standard deviation; Δ = change during the designated temporal interval.

12 (R = 0.45, $R^2 = 0.20$, $F_{1, 108} = 27.04$, $p < 0.001$). Entry of group classification in step 2 of those models did not significantly increase their explained variances ($R^2_{change} = 0.01$, $F_{1, 107} = 1.63$, $p = 0.205$ and $R^2_{change} = 0.01$, $F_{1, 107} = 1.48$, $p = 0.227$, respectively).

Change in eating self-efficacy significantly mediated relationships between exercise self-regulation change and changes in eating self-regulation from baseline–month 6, 95% CI = 0.04, 0.21, and from baseline–month 12, 95% CI = 0.04, 0.21. Each of the overall models predicting eating self-regulation changes were significant ($R^2 = 0.36$, $F_{2, 107} = 29.95$ and $R^2 = 0.31$, $F_{2, 107} = 23.59$, respectively, $p < 0.001$; see Figure 1A and B). In follow-up analyses, group designation was not a significant moderator of the models' path a, 95% CI = –0.77, 0.73 and –1.00, 0.75; path b, 95% CI = −0.04, 0.03 and –0.02, 0.06; or path c, 95% CI = −0.14, 0.14 and –0.12, 0.21, respectively.

Discussion

Findings indicate that, in the presence of a cognitive behavioral obesity treatment with emphases on building self-regulatory skills, weight loss over both 6 and 12 months (ie, –6.1% and –5.6% of baseline weight, respectively) did not significantly differ in women based on the amount of exercise they completed. Exercise amount group classifications within this research varied considerably, from the equivalent of < 2.5 moderate sessions per week to > 7 moderate

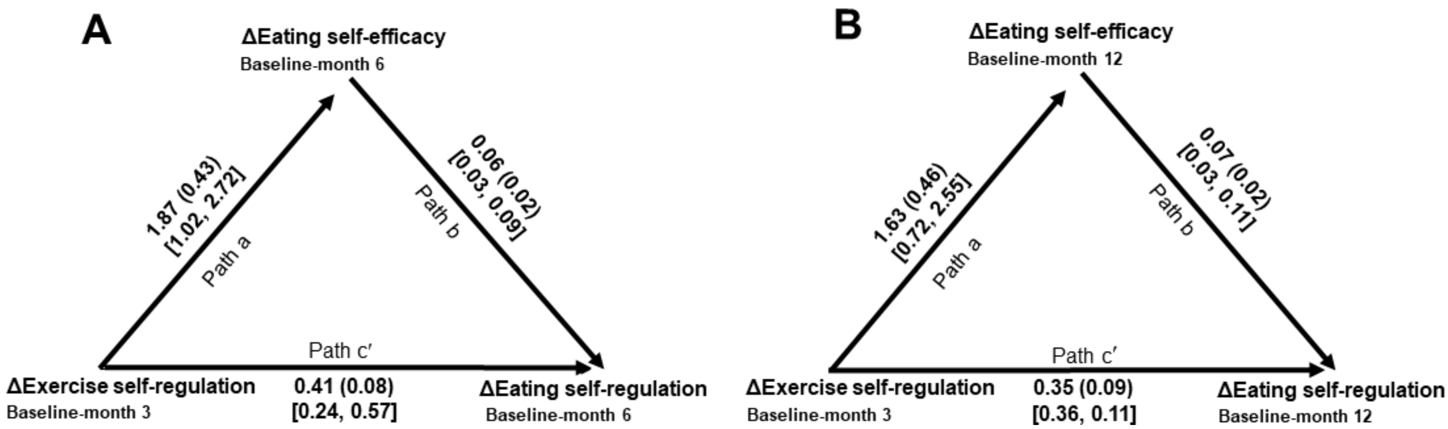

Figure 1: Mediation models assessing change in eating self-efficacy as a mediator of the prediction of eating self-regulation change over 6 months (Figure 1A) and 12 months (Figure 1B) by earlier change in exercise self-regulation. Path data are given as unstandardized Beta (SE_{Beta}) [95% confidence interval for Beta]. All paths were significant at $p < 0.001$.

sessions per week. That lack of a dose–response effect supports previous research indicating no significant association between assigned/completed exercise and weight loss.[14,15] However, it is contrary to suggestions from authoritative sources suggesting that from 150–225 minutes of exercise per week is the minimum required for meaningful weight loss,[5,6] along with some supporting randomized[51] and descriptive[52] research. Given that < 10% of the overall adult population in the United States, objectively evaluated through accelerometry, completed even the lower end of that range,[9,10] this could be a positive for behavioral treatments for women with obesity. This is especially relevant because that subgroup tends to achieve some of the lowest volumes of regular exercise.[53]

Improvements in self-regulation and self-efficacy were significant, but also unaffected by exercise amount grouping. The premise that exercise program–associated psychosocial changes, rather than energy expended through exercise, is primarily associated with weight loss was supported. Specifically, and consistent with findings on coaction,[22] increase in exercise-related self-regulatory skills developed in the early months of treatment appeared to generalize to heightened eating-related self-regulation during both the initial 6 months where weight loss is expected, and over 12 months where regain of initially lost weight is common.[1,2] Future research is required to determine the extent this “carry over” occurs spontaneously vs when it is purposefully nurtured (as within the present treatment). As expected, and consistent with other research,[16,19] increase in eating self-regulation was significantly linked to weight loss, also with no interaction effect from exercise amount grouping.

In efforts to maximize efficiency and standardize large-scale, community-based interventions, more research on what specific self-regulatory skills (eg, cognitive restructuring, relapse prevention) perform best for 1) supporting exercise, 2) inducing controlled eating, and 3) transferring skills from an exercise context to an eating context, is warranted. It is possible that individual differences are present that can be conveniently accounted for within treatment adaptations. Although there has been some research on self-regulatory processes within weight-loss treatment settings, most evaluated exercise and eating behavior changes distinctly and in a cross-sectional manner.[19] Thus, the attention to transfer from an exercise to an eating context within a longitudinal research format sensitive to the dynamic changes within weight-loss processes was a strength of this study. Additionally, it represents an advancement over characteristics linked to post hoc observations of atypical weight loss successes that are presently the basis of many practitioners’ suggestions (eg, eating breakfast, high levels of exercise every day).[54]

In seeking a mechanism of the carry over of changes in exercise self-regulation to eating self-regulation, eating-related self-efficacy change was a significant mediator. This is consistent with theory.[27] In addition to demonstrating to the self newly acquired abilities to regulate through life-style challenges (termed, “mastery experience”), self-efficacy theory suggests additional ways in which self-efficacy can be increased. These include highlighting successes from similar individuals also seeking weight loss and has been termed "vicarious experience."[27] This attention to fostering self-efficacy increases might be an additional target of future behavioral obesity treatments. Overall, the typical (failed) treatment approaches, which principally depend on education on the need to exercise at a prescribed volume/method and adherence to a severely reduced-energy diet (often of a imposed macronutrient combination), might yield to a more self empowerment-focused paradigm based on the present findings and other related research.[16] Thus, the optimal proportion of education and behavioral skills development is a suggested topic for future research.

While this field-based investigation made contributions to the extant knowledgebase regarding the relationship of exercise amount with short- and long-term weight loss, limitations should be acknowledged. These include 1) reliance on self-report measures, 2) possible expectation/volunteerism/social support effects, 3) a specific sample type, and 4) a need for longer follow-up times to determine resilience of learned self-regulatory skills and analyses targeting weight regain after loss. To address these shortcomings, extensions of this research might utilize accelerometry, incorporate a control condition to increase confidence in identified treatment-associated changes, include male participants and those with psychological conditions such as binge eating and/or depressive disorders, and include analyses of changes from months 6–24 and beyond. However, quests toward more reliable behavioral obesity treatments that are applicable within large-scale settings, such as YMCAs and other community-based, health promotion venues, should continue. Ideally, such structured programs will also serve as a referral source for medical professionals who are limited in their time to systematically address the behavioral changes required for weight reduction in their many patients with obesity.

PRACTICAL APPLICATIONS

Based on the present findings, physicians, nurse practitioners, and other medical professionals with an interest in preventive medicine should seek to provide evidence-based support of their patients' obesity-reduction efforts. Specifically, they should consider advocating regular exercise in manageable amounts to facilitate psychosocial changes that can carry over to improvements in eating behaviors. Rather than undermining efforts by insisting upon burdensome exercise volumes that are achievable by only a small percentage of the adult population,[9,10] and based on the present findings, instruction in basic self-regulatory skills to support exercise early in treatment processes can be adapted and transferred to an improved eating focus.[16,21] Feelings of ability (ie, self-efficacy) emanating from this self-empowerment process can also be nurtured to enhance the identified linkage between exercise-related and eating-related self-regulation.

Success with weight loss behavior changes is a process that typically involves more than simply educating patients on exercise and eating mandates.[16,19,20] Hopefully, community-based organizations with an interest in health promotion, including addressing the escalating medical condition of obesity and its related comorbidities (eg, type 2 diabetes, depression), will avail themselves of evidence-driven protocols that enable them to become an efficient and economical referral source for physicians and other health professionals with limited intervention time. Such might also be made available for low- and no-cost self-referrals.

Conclusion

This field-based research reinforced the previously proposed focus of incorporating exercise for weight loss via its psychological change vs energy expenditure properties.[16] Although adherence is essential, exercise in moderate amounts appeared as suited to supporting meaningful amounts of weight loss in women with obesity as the relatively high amounts recommended by the government[5] and the American College of Sports Medicine.[6] Based on the present findings, supplying means for systematically addressing first exercise-related, then eating-related self-regulatory skills appears to be a promising approach with possibilities for reducing the threat that the increasing prevalence of obesity has on public health in America.

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