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Effects of The Coach Approach intervention on psychosocial predictors of exercise and subsequent changes in glucose metabolism, cardiorespiratory functioning, and body composition: a pilot project of the interior health of British Columbia and a local YMCA

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Objective: Exercise typically improves overall health and reduces health risks; however, completion of even the minimum recommended volume of daily exercise is rare for most people. When recommended by medical professionals, patients may benefit from convenient, evidence-based, exercise-support processes. The aim of this study was to assess the preliminary effects of such an intervention when administered jointly by the Interior Health Authority of British Columbia and a local YMCA. ***Design:*** Participants were overweight or obese adult patients (N=92; mean age =59 years) who suffered from cardiovascular disease, diabetes, or renal disease and were referred by medical professionals. The Coach Approach - a standardized 6-month, cognitive-behavioral based protocol that is designed to provide support for maintained exercise - was individually administered through six 30-minute sessions at a variety of community health locations. ***Results:*** Significant within-group improvements in the psychosocial measures of self-regulatory skill usage, exercise self-efficacy, mood, and physical self-concept were observed. Also, improvements in exercise volume and measures of glucose metabolism, cardiovascular functioning, and body composition were found. Multiple regression analysis indicated that changes in self-regulation, self-efficacy, and mood accounted for a significant portion of the variance (R^2=0.24) in the change in volume of exercise. Significant linear bivariate relationships were observed between an increase in exercise volume and improvements in hemoglobin A1c, fasting glucose, and body mass index. ***Conclusion:*** These findings suggest that increases in exercise volume are associated with proposed psychosocial pathways. Based on the associated reductions in health risks, collaborations between public health agencies and community organizations could be used to address the need for evidence-based support of patients' exercise behaviors.

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Key Words: exercise; psychosocial factors; behavioral medicine; health behavior

INTRODUCTION

Maintained exercise has been associated with the prevention of and improvements in obesity, cardiovascular disease, insulin resistance, and some forms of cancer, each of which is highly prevalent in Canada, the United States, and other industrialized nations (1, 2). Previous research has suggested that exercise is the strongest predictor of sustained weight loss (3); however, studies using objective (i.e., accelerometer-based) population data have suggested that only 5% of Canadian (4) and less than 4% of American (5,6) adults complete even the minimum recommended volume of daily exercise. Cessation of

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exercise programs is typically high at 50 to 65% within just 3 to 6 months of the outset (7). Treatments that focus on the initiation and maintenance of physical activity have often lacked a theoretical foundation (8), with their minimal effects partially attributed to insufficient attention having been paid to accepted theories of behavior change (9).

The Coach Approach is a standardized treatment that consists of 6 monthly one-on-one sessions between a trained wellness specialist and a participant. This treatment is based on social cognitive and self-efficacy theory (10, 11), which emphasizes the interaction between the person, their environment, and their behavior. These theories suggest that individuals receive reinforcement from connecting behaviors to valued outcomes, and an association between perceived ability and behavioral change. The Coach Approach protocol is also consistent with an adaptation of those theories focused on linkages between exercise behavior change, psychosocial changes, and physiological improvements (12). Over time, results from the application of The Coach Approach have been tested and analyzed to enable refinement and maximize its effects. For example, although improvement in physical self-concept was identified as an important predictor of increased and sustained exercise in earlier research, a revised model proposed changes in self-regulatory skills usage, mood, and self-efficacy to be the primary predictors (13).

Fifty trials with The Coach Approach protocol were conducted in YMCA and fitness center facilities in the U.S., Canada, the U.K., and Italy, and the results revealed significant reductions (typically 40 to 50% percent) in the drop-out rate for those engaged in newly established exercise regimens, and large increases in volumes of exercise completed (14,15). However, the generalizability of these findings and the effects on indicators of health risks, such as glucose metabolism and blood pressure, have not been well-studied, especially in venues that may potentially be of value for large-scale community health change (16).

Therefore, the primary aim of this study was to report the effects of a 6-month application of The Coach Approach outside the fitness center setting and through the referral of specific patients by medical professionals based on certain health risks. The secondary aim was to further assess the prominence of the present set of psychosocial predictors of increased exercise. The following outcomes were expected:

(i) Participation in The Coach Approach intervention would be associated with significant improvements in self-regulatory skill usage for exercise; mood; self-efficacy for exercise; physical self-concept; exercise volume; and measures of glucose metabolism, cardiorespiratory functioning, and body composition.

(ii) Changes in self-regulation, mood, and self-efficacy would significantly predict changes in the volume of exercise.

(iii) Increased volume of exercise would be significantly associated with improvements in measures of glucose metabolism, cardiorespiratory functioning, and body composition.

MATERIAL AND METHODS

Participants

Men and women from the Okanagan region of British Columbia were referred by medical professionals from diabetes education programs, renal health clinics, and family physicians due to diagnoses of obesity along with cardiovascular disease, diabetes, or renal disease. Following are additional inclusion criteria used in this study: (i) age ≥18 years, (ii) no participation in a regular exercise program in the previous year, and (iii) medical clearance from their physician. Participants provided written informed consent, and a review of this process was completed by the Interior Health Authority of British Columbia. Moreover, a review of ethical principles to ensure compliance with the Declaration of Helsinki was completed. The participant group was composed of 58 women (i.e., 63%) and 34 men (i.e., 37%) with a mean age of 59.4±12.4 years and a mean body mass index (BMI) of 35.2±6.1 kg/m^2. Moreover, the group had the following racial/ethnic composition: 93% Caucasian, 3% Aboriginal, and 4% of other racial/ethnic groups. Most participants had yearly incomes in the range of $20,000 to $50,000, and 49% and 39% graduated from secondary and post-secondary school, respectively. Based on international standards, 66% and 22% of the participants had blood glucose results that were in the diabetes range and pre-diabetes range, respectively (17), and 30% met the criteria for hypertension (18).

Measures

Psychosocial measures: Self-regulation for exercise was measured using a modified version of a validated scale where items are based on intervention content (19). It required responses to 10 items (e.g., "I set physical activity goals") using a Likert scale ranging from 1 (i.e., never) to 5 (i.e., often). In a previous version, internal consistency (i.e., 0.75), test-retest reliability over 2 weeks (i.e., 0.77), and predictive validity were indicated (20). For the present version, the internal consistency was 0.79, and the test-retest reliability over 2 weeks was 0.78.

The Exercise Self-Efficacy Scale measured confidence

in terms of using internal psychological resources to overcome barriers to completing exercise. It required responses to 5 items that began with the stem, "I am confident I can participate in regular exercise when:" (e.g., "I feel I don't have the time") using a Likert type scale from 1 (i.e., not at all confident) to 11 (i.e., very confident). Internal consistencies were 0.82 and 0.76, and the test-retest reliability over 2 weeks was 0.90 (21, 22).

Total mood disturbance is an aggregate measure of mood derived from the six subscales of the Profile of Mood States - Short Form. Respondents rated their feelings over the previous week on 30 items using a Likert scale from 0 (i.e., not at all) to 4 (i.e., extremely). Internal consistency for the tension (e.g., "anxious"), depression (e.g., "sad"), fatigue (e.g., "weary"), confusion (e.g., "bewildered"), anger (e.g., "annoyed"), and vigor (e.g., "energetic") subscales ranged from 0.84 to 0.95, and test-retest reliability at 3 weeks averaged 0.69 (23).

The physical self-concept subscale of the Tennessee Self-Concept Scale was used to measure feelings of adequacy regarding the physical self through the rating of 14 items (e.g., "I have a healthy body" and "I am neither too fat nor too thin") using a Likert scale from 1 (i.e., always false) to 5 (i.e., always true). The internal consistency was 0.83, and test-retest reliability over 1 to 2 weeks was 0.79 (24).

Exercise: The volume of exercise in which participants engaged was measured by the Godin Leisure-Time Exercise Questionnaire (25), which requires participants to record weekly frequencies of strenuous (i.e., "heart beats rapidly") exercise (e.g., vigorous swimming), moderate (i.e., "not exhausting") exercise (e.g., fast walking), and light (i.e., "minimal effort") exercise (e.g., easy walking, yoga) for "more than 15 minutes" per session. These responses were multiplied by 9, 5, and 3 standard metabolic equivalents, respectively, and then summed. For adults, test-retest reliability over 2 weeks was 0.74 (25). Construct validity was supported by significant correlations between scores and accelerometer and maximal volume of oxygen uptake measurements.

Physiological measures: Hemoglobin A1c (HbA1c) was measured using high-pressure liquid chromatography and reported in terms of percentage of hemoglobin bound with glucose or glycohemoglobin. Blood glucose levels were measured after overnight fasting and reported in mmol/L. Systolic and diastolic blood pressure in mmHg, resting heart rate in beats/minute, and BMI in weight in kg/height in m^2 were assessed using standard methods.

Change scores on all measures were calculated by subtracting the baseline score from the score at the end of the program.

Procedure

After formally agreeing to participate, each individual was introduced to a certified YMCA wellness leader. The wellness leaders administered The Coach Approach exercise support protocol on an individual basis at a local YMCA, the Interior Health Authority office, a city recreation center office, or a community center. This approach involved 6 monthly meetings lasting 30 minutes each, incorporating a computer application that addressed the intervention's sequence of components.

As part of The Coach Approach protocol, no more than four long-term goals were broken down into a maximum of three process-oriented, short-term goals (e.g., increase cardiovascular exercise from 40 minutes per week to 80 minutes per week by the next scheduled meeting). Perceived progress on each long-term goal was documented, graphed, and reviewed during each meeting. A behavioral contract that indicated the agreed upon exercise plan and the connection between physical activity completion and goal attainment was also incorporated. This contract was revised at each meeting and signed by both the participant and wellness leader to indicate the participant's commitment. The contract also served as an ongoing reference for the participant. Instruction in a different self-management/self-regulatory skill, such as cognitive restructuring, stimulus control, dissociation from discomfort, self-reward, and preparing for occurrences of barriers to exercise (e.g., boredom or family responsibilities), was given during each meeting. Changes in dimensions of mood (e.g., anxiety and fatigue) as induced by the exercise program were also tracked over time. Exercise plans were individually developed with specific exercise modalities (e.g., walking or bicycling) chosen by the participants. Selected volume of exercise were cross-checked and adjusted if needed through a brief scale completed by the participants in order to ensure the association of exercise volume with positive (e.g., rejuvenated) rather than aversive (e.g., exhausted) states.

Surveys were privately administered by certified wellness leaders at baseline and weeks 12 and 24. Properly credentialed medical professionals administered physiological assessments at the same times. When self-reporting of weight was used, it was adjusted for expected bias based on previous research (26). All appropriate privacy regulations were followed. Personal identifiers were removed prior to data analyses and reporting.

Table 1. Results of Repeated Measures ANOVAs for Study Variables at 12 and 24 Weeks (N=92)

	Baseline (mean±SD)	Week 12 (mean±SD)	Week 24 (mean±SD)	$F_{1,91}$	p	η^2_p
Self-regulation for exercise	22.10±7.03[a]	27.60±6.67[b]	27.14±6.17[b]	57.13	<0.001	0.386
Exercise self-efficacy	33.39±9.81[a]	35.13±11.06	36.78±9.13[b]	10.16	0.002	0.100
Total mood disturbance	17.79±17.76[a]	11.21±14.96[b]	10.16±15.81[b]	25.79	<0.001	0.221
Depression	4.36±3.90[a]	3.36±3.30[b]	3.32±3.37[b]	10.71	0.002	0.105
Tension	4.68±4.13[a]	3.60±3.56[b]	3.82±3.57[b]	8.88	0.004	0.089
Fatigue	8.01±5.23[a]	6.46±4.94[b]	5.93±5.13[b]	22.11	<0.001	0.195
Vigor	7.86±4.46[a]	9.43±4.36[b]	9.85±4.24[b]	33.29	<0.001	0.268
Anger	3.87±3.69[a]	3.18±3.12[b]	3.07±3.10[b]	6.37	0.013	0.065
Confusion	4.73±3.24[a]	4.04±2.55[b]	4.01±2.81	5.55	0.021	0.057
Physical self-concept	42.36±8.08[a]	44.90±7.45[b]	45.58±7.31[b]	28.14	<0.001	0.236
Exercise volume	19.96±12.84[a]	25.91±14.66[b]	26.88±13.06[b]	32.82	<0.001	0.265
Hemoglobin A1c (%)	7.36±1.53[a]	7.11±1.36[b]	7.12±1.41[b]	9.14	0.003	0.091
Fasting glucose (mmol/L)	7.46±1.64[a]	7.19±1.51[b]	6.97±1.37[b]	14.30	<0.001	0.136
Blood press: systolic (mmHg)	133.39±16.02[a]	129.80±16.05[b]	129.62±14.89[b]	6.19	0.015	0.064
Blood press: diastolic (mmHg)	82.36±11.30[a]	80.47±10.81	80.00±11.11[b]	8.46	0.005	0.085
Body mass index (kg/m^2)	35.55±6.12[a]	34.75±6.28[b]	34.51±6.23[c]	39.95	<0.001	0.305
Resting heart rate (beats/minute)	72.00±11.16	71.51±11.50	71.08±11.59	1.99	0.161	0.021

Statistically significant score means by time are denoted by different superscripts. Effect sizes were reported as partial eta-squared (η^2_p), where 0.010, 0.059, and 0.138 represent small, moderate, and large effects, respectively. Results from the Profile of Mood States subscales are given below the results from total mood disturbance, which is an aggregate of those 6 subscales. Please note that only changes in total mood disturbance scores were used in the regression analysis as a predictor of change in exercise volume.

Statistical analysis

An intention-to-treat format was implemented where missing data were imputed using multiple imputation (27). Statistical significance was set at α=0.05 (2-tailed), unless otherwise noted, and the Bonferroni adjustment was applied. A power analysis suggested that a minimum of 76 participants was required to detect a moderate effect (f^2=0.15) at the statistical power of 0.80, α=0.05.

First, separate repeated measures ANOVAs were used to assess changes on each variable at the baseline, week 12, and week 24. Mood subscales were additionally reported. Next, changes in the psychosocial factors of self-regulation for exercise, self-efficacy for exercise, and overall mood were simultaneously entered as predictors of change in exercise volume. Each was first analyzed for problems associated with ceiling/floor effects and non-normal distributions; however, no such problems were identified.

Because physical self-concept change was previously identified as a significant predictor of exercise, we planned to evaluate it as a possible moderator where a significant beta-value occurred within the present model. As previously suggested (28), significant moderation required the interaction term between the predictor and moderator (after being centered and standardized; X-mean$_x$/SD$_x$) to significantly add to the variance presently explained. Linear bivariate analyses were used to assess the relationship between change in exercise volume and changes in each physiological factor measured.

RESULTS

Sixty-four participants (i.e., 70%) completed the intervention. Significant improvements were observed in each psychosocial variable (Table 1). BMI improvement progressed throughout the treatment, whereas significant improvements in HbA1c and fasting glucose occurred over the initial 12 weeks with no further significant improvements observed after that point. Blood pressure also significantly improved over 12 weeks (for systolic blood pressure) and 24 weeks (for diastolic blood pressure).

A significant portion of the variance in exercise volume (R^2=0.24) was accounted for by changes in self-regulation, self-efficacy, and mood (Table 2). Changes in physical self-concept did not significantly moderate the relationship between changes in self-regulation (i.e., the only predictor with a significant beta-value) and exercise volume (ΔR^2=0.001,

Table 2. Results of Hierarchical Multiple Regression Analyses for the Prediction of Changes in Exercise Volume (N=92)

	B	SE_B	β	R^2	F	df	p	ΔR^2	F	p
Model 1				0.24	9.17	3,88	<0.001			
Δ Self-regulation for exercise	0.75	0.19	0.42				<0.001			
Δ Exercise self-efficacy	0.03	0.12	0.03				0.804			
Δ Total mood disturbance	-0.11	0.08	-0.13				0.208			
Model 2				0.25	7.14	4,87	<0.001	0.01	1.05	0.308
Δ Self-regulation for exercise	0.79	0.19	0.44				<0.001			
Δ Exercise self-efficacy	0.07	0.02	0.06				0.581			
Δ Total mood disturbance	-0.13	0.09	-0.16				0.135			
Δ Physical self-concept	-0.23	0.23	-0.12				0.308			

The delta symbol (Δ) denotes the change in score from baseline to week 24.

p=0.833). The entry of physical self-concept change into the 3-predictor multiple regression model did not significantly strengthen it (Table 2). A significant linear bivariate relationship between change in exercise volume and changes in HbA1c (β=-0.26, p=0.007), fasting glucose (β=-0.25, p=0.008), and BMI (β=-0.23, p=0.012) was found. No significant linear bivariate relationship between change in exercise volume and blood pressure or resting heart rate was found.

Controlling for baseline scores yielded nearly identical results, so only findings from unadjusted scores have been reported. In a post hoc analysis, attendance at treatment sessions (mean=79.2±30.0%) was significantly related to change in volume of exercise (β=0.27, p=0.010).

DISCUSSION

These results supported the findings on the association of The Coach Approach intervention with increased volume of exercise occurring through psychosocial pathways (13, 20). A direct examination of changes in factors associated with effects has previously been suggested (9), but rarely completed. It added strength to the present findings of medically referred patients. As expected, the increased volume of exercise was significantly associated with improvements in cardiovascular health indices. Positive effects of exercise on glucose metabolism were also observed. Previous research has suggested the biological plausibility of these findings through corresponding effects of exercise on lean body mass (29).

Although any changes in participants' nutritional intake were not specifically considered in this investigation, and thus might be considered a limitation, exercise has been proposed to be an *independent* predictor of weight reduction (30). In a comprehensive review of weight-loss treatments and their overwhelming rate of failure, the need for an examination of exercise interventions without a nutritional component was specifically suggested (30). Other limitations of this pilot project were its field design, brief duration, and single-group format. A control condition will be required in future studies to better account for potential confounding factors such as expectation and social support effects. Longer-term effects on exercise volume, weight, blood glucose levels, and measures of cardiovascular health also require consideration. However, field-based research that has strong external validity and greater chances for rapid utilization in practice situations has been specifically advocated, and thus may be considered as a strength in this situation (31). Notably, considerable extension and replication will be required in order to test how age, race, ethnicity, and cultural factors may affect the generalizability of these findings because the sample was made up of primarily older Caucasian adults from Canada.

The ability of a public health agency to work in cooperation with a community service organization to apply an intervention requiring operational rigor was demonstrated on an observational level. This type of cooperation may be useful for the effective and widespread support of desired health behaviors for high-risk patients, especially those that medical professionals are not well-positioned to provide. For example, with appropriate policy change, physicians may have an array of community-based locations available where they may confidently refer patients requiring evidence-based programs that reliably increase exercise behaviors. Hopefully, reductions of highly prevalent health risks will become possible for many through the extension of the present processes and findings.

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