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Mediators of Exercise Maintenance after Cardiac Rehabilitation

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Abstract

PURPOSE—Exercise maintenance after completing Phase II cardiac rehabilitation (CR) is challenging for many patients. A telephone-based maintenance intervention improved exercise participation compared to a control group at 12 months post-CR discharge. We examined the 6-month mediators of intervention effects on exercise.

METHODS—In a randomized controlled trial, 130 patients who had completed CR (mean age: 63.6 years [SD=9.7], 20.8% female) were randomized to Maintenance Counseling (n=64) or contact control (n=66). Putative mediators examined included: self-efficacy, behavioral processes of change, decisional balance index, social support for exercise, and enjoyment of exercise.

RESULTS—Multiple mediation analyses showed that the intervention significantly increased social support from friends at 6 months but not the other constructs. Decreasing support from friends mediated greater exercise participation in Maintenance Counseling vs. Contact Control at 12 months.

CONCLUSIONS—Social support from friends functioned as a suppressor mediator for exercise maintenance among cardiac patients.

Keywords

exercise maintenance; cardiac rehabilitation; mediators; psychosocial constructs

Cardiovascular disease (CVD) is the leading cause of death and disability in older men and women in the U.S.¹ Patients who have survived myocardial infarctions, patients with stable angina, and those who had coronary bypass surgery participate in Phase II (outpatient) cardiac rehabilitation (CR) services.² During CR, patients participate in monitored exercise training and receive risk factor education. Although continued exercise participation is required to sustain improved exercise tolerance,² by 6 months only 30-60% of patients report regular exercise.³⁻⁵ In a randomized controlled trial of a theory-based 6-month counseling intervention offered to patients completing Phase II CR, we found that the intervention led to significantly higher exercise participation at 12 months compared to a

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contact control condition (mean group difference=80 minutes/week).⁶ We found significant correlations between self-reported exercise and objective accelerometer data in this trial.⁶

Although others have offered interventions to support exercise maintenance post-CR, little is known about whether effects are due to changes in the theoretical constructs targeted by the intervention (eg, social support) or other variables. If the targeted constructs are the mechanisms through which interventions work, then the constructs are considered to be “mediators” of the relationship between the intervention and exercise behavior change.^{7,8} Hence, mediational analyses address why interventions work.

Our maintenance intervention was based on constructs from Social Cognitive Theory (SCT)⁹ and the Transtheoretical Model (TTM).¹⁰ The intervention aimed at improving self-efficacy (construct from SCT) or the degree of confidence an individual has in his/her ability to remain physically active. Participants were encouraged to use behavioral processes of change (TTM) which are overt strategies and techniques that people use as they progress through the adoption and maintenance of exercise.¹¹ Our intervention also aimed at improving the decisional balance or the individual's evaluation of the benefits and barriers of exercise (a construct used as part of the TTM).¹² Finally, our intervention targeted social support and promoting enjoyable exercise activities to help participant adherence to the exercise prescription received at CR discharge.

Researchers have examined mediators of exercise as a behavior change in non-clinical populations.^{13,14} In a review of 22 studies, self-regulation constructs (ie, behavioral processes, planning for exercise) had the most evidence for mediation.¹⁵ Reviewing 8 studies that examined TTM-based constructs, Rhodes and Pffaeffli¹⁵ concluded that TTM had mixed results for intervention efficacy and in tests of mediation of its constructs. The role of social variables has been examined in the form of support from others to exercise and as subjective norms (ie, perceived pressure to exercise). There is some evidence for the mediation capacity of the former in exercise but not for the latter.¹⁵ In a study (not included in the review¹⁵) that focused on exercise maintenance using a phone-based intervention among healthy 50-70 year old adults, self-efficacy, enjoyment of exercise, and integration into the self-concept were identified as mediators of intervention effects at 6, 12 and 24 months.¹⁶

We examined the potential role of self-efficacy for exercise, behavioral processes, decisional balance (all TTM constructs) and 2 additional constructs, enjoyment of exercise, and social support from family and friends at 6 months (6M) as mediators of exercise maintenance among CR patients at 12 months (12M). We were also interested in examining how these variables would operate in multivariate mediational analyses in this clinical population. Based on the literature we hypothesized that: a) our intervention would successfully change exercise participation and the putative mediators at 6M. This is also referred to as the Action theory test (ie, did the intervention change the mediators?);¹⁷ b) that these variables at 6M would mediate the relationship between group and exercise participation at 12M; and c) that the multivariate analysis would show that behavioral processes and self-efficacy at 6M would be the strongest mediators in the model. This is also referred to as the Conceptual theory test (ie, which of the constructs predicted change in exercise participation?)¹⁷

METHODS

Following completion of a Phase II CR program, 130 patients received brief advice from the CR case managers to maintain exercise participation. They were then randomized to either the Maintenance Counseling (MC) or Contact Control (CC) group. Assessments were conducted at baseline, 6M, and 12M. Institutional Review Boards at the Miriam Hospital (RI) and St. Anne's Hospital (MA) approved the study which was conducted in accordance with the Helsinki Declaration. Data were collected in 2005-2010 and were analyzed in 2012.

Recruitment

Case managers offered a study invitation to patients who were scheduled to complete Phase II CR. Interested patients contacted the Research Assistant (RA) who conducted a telephone screen for eligibility, and if eligible and interested, patients provided written informed consent. Patients aged 40 years were eligible for study participation if they (1) participated in supervised Phase II CR (generally a 12-week program), (2) were scheduled to complete Phase II CR in the next 4 weeks, (3) were able to read and speak English, (4) provided consent for medical chart review, (5) were able to walk unassisted, and (6) had access to a telephone. Of the 548 patients who were invited to participate: 249 were screened for eligibility (not interested/eligibility unknown, n=56, ineligible, n=39, eligible, n=154), 158 were not interested in study participation (too busy=18.3%; traveling/moving out of state=7.6%; did not like to be on the phone=4.4%; transportation problems=4.4%; and other reasons such as too tired, returned to work, etc.=10.1%; and no reason provided=54.4%) and 141 did not respond to the invitation. Of the 154 eligible participants, 130 (84.4%) were randomized using a stratified scheme to ensure balance across age (<65 years vs. ≥65 years), gender, and cardiovascular risk.² Twenty-four participants were not randomized (see previously published flow chart for reasons).⁶

Procedures

Case managers were trained to deliver a brief motivational counseling protocol (based on the 5As counseling strategy).^{18,19} After patient baseline assessments were completed, the CR case managers provided the patients an exercise prescription (based on patient maximal stress test conducted at CR discharge) and advised the patients on the importance of exercise adherence. The participants were then randomized to one of the 2 study groups.

Maintenance Counseling Group (MC)—Following randomization, the interventionist reviewed the patient's exercise prescription, and provided instructions on using home logs to monitor exercise participation and a pedometer to wear during exercise activities that involved walking. Each participant received calls over 6M (weekly over the first 2 months, biweekly for the next 2 months, and monthly for the last 2 months, a total of 14 calls) from the interventionist to promote adherence to prescribed aerobic exercise. The calls were based on the TTM¹⁰ and SCT⁹ and were tailored to each participant motivational readiness.²⁰ Action stage was defined as exercising at levels at or above the exercise prescription. Self-efficacy for exercise was promoted through setting achievable goals, developing plans to overcome barriers to regular exercise and receiving reinforcement from the interventionist. The interventionist also helped patients to develop a positive decisional balance for exercise

(that is, identifying the “pros” of staying physically active and overcoming the “cons” of regular exercise). To prevent boredom with exercise, the interventionist provided information on a variety of enjoyable activities. Patients were encouraged to obtain support from family and/or friends to sustain exercise routines they had learned during CR. If the lack of support was perceived as a barrier, the participant was helped to problem solve this barrier. After 6M, the interventionist provided bimonthly phone calls (3 calls over the remaining 6 months) to prompt and reinforce regular exercise. Participants were mailed an exercise tipsheet and 1 on cardiovascular health for each call during the 6-month program. Finally, a feedback report was sent to them at Weeks 4, 8, 12, 16, and 20.

Contact Control Group (CC)—To provide equal number of contacts with the 2 groups, these participants also received calls from the interventionist at the same intervals and the same tipsheets on cardiovascular health as MC participants. During the calls, the interventionist administered the Symptom Questionnaire.²¹ After completing the 12M assessment, participants received the exercise tipsheets.

Fidelity in Intervention Delivery

All telephone calls to participants were audiotaped. Two senior researchers reviewed 25% of the tapes to ensure fidelity to intervention content and process.

Measures

At baseline, demographic information was obtained and disease and treatment variables were extracted from medical records. Participants received a total of \$60 for completing the assessments. The RA who conducted the assessments was “blind” to the participant group assignments. The assessments at baseline, 6M, and 12M included:

- a. Seven Day Physical Activity Recall (7 Day PAR).²² This valid interviewer-administered measure²³ assesses the time spent in moderate, hard, and very hard activity in the past 7 days. For this study, we focused on whether or not participants met USDHHS guidelines²⁴ for regular exercise participation (defined as 150 min/week of at least moderate-intensity activity) at 12M.
- b. Self-efficacy for exercise was assessed using an internally consistent and reliable 5-item exercise self-efficacy measure.²⁵ Patients were asked their level of confidence that they could exercise in various situations using a 5-point scale. Mean scores range from 1-5. Higher scores indicate higher self-efficacy. Internal consistency at baseline was $\alpha=0.83$.
- c. Processes of Exercise. Processes of exercise were measured by a 40-item questionnaire with high internal consistency.¹¹ The instrument assesses 10 processes of change that people use in exercise adoption and maintenance: 5 behavioral processes (counter-conditioning, helping relationships, reinforcement management, stimulus control, and self-liberation), and 5 cognitive/experiential processes (these were excluded from the current analyses on exercise maintenance because they are more relevant to exercise adoption than maintenance.^{11,20} Patients were instructed to think back over the past month and to rate the frequency of

occurrence of each item on a 5-point Likert scale. Mean scores range from 1-5. Internal consistency at baseline was $\alpha=0.81$.

- d. **Decisional Balance.** Decisional Balance for Exercise was assessed using a 16-item measure.¹² Higher scores on the “pro” scale (10 items) indicate perceptions of high benefits from exercise; high scores on the “con” scale (6 items) indicate perceptions of high costs of exercise (mean scores range from 1-5). A decisional balance index was calculated by subtracting the Cons score from the Pros score. Internal consistency at baseline was $\alpha=0.87$.
- e. **Social Support.** Participants completed the Social Support for Exercise Survey, a reliable instrument that has 2 subscales assessing support from friends (10 items) and support from family members for exercise (10 items).²⁶ The mean scores range from 1-5. We used the Family Participation [SS(Family)] and Friend Participation [SS(Friends)] subscales where higher scores indicate greater social support. Internal consistency (α) at baseline was 0.89 and 0.92, respectively.
- f. **Physical Activity Enjoyment.** This construct was assessed using the 18-item Physical Activity Enjoyment Scale.²⁷ Participants were asked to rate “how you feel at the moment about the physical activity you have been doing,” using a 7-point bipolar rating scale. The range of scores is 18 to 126. Higher scores reflect greater levels of enjoyment. Internal consistency at baseline was $\alpha=0.47$.

Analyses

Between-group differences in all baseline measures were assessed using graphical methods, non-parametric and parametric tests (χ^2 and analysis of variance) as appropriate. For the potential mediators, unadjusted means (SDs) were examined and summarized overall and by group at baseline and 6M. In addition, using linear regression models controlling for baseline, we examined whether there were between group differences in the potential mediators at 12M. For this study, the primary outcome measure was whether or not participants met national exercise recommendations at 12M (as reported on the 7-day PAR) and the hypothesized mediators were absolute scores of self-efficacy, decisional balance index, behavioral processes, social support, and enjoyment at 6M. Between-group differences in the primary outcome at 12M have been previously reported.⁶ There was a trend in the effect of the intervention on meeting exercise guidelines at 12M, such that those randomized to the MC group had an increased odds of reporting 150 min/week of exercise compared to those in the CC group (AOR=2.23, 95% CI: 0.89-5.60, $P=.09$).⁶ Mediation models, however, do not require significant overall treatment effects.²⁹

Mediation models assume that changes in the mediator precede changes in the outcome (temporal precedence). As the outcome of interest was meeting exercise guidelines at 12M, data on the potential mediators were analyzed at 6M (controlling for baseline). Models additionally controlled for baseline exercise and potential confounders of the intervention effect (gender and age). All analyses were conducted using STATA SE 12 and significance level was set *a priori* at $\alpha=0.05$.

Using the product of coefficients method,²⁸ we fit a multiple mediation model to simultaneously test the effects of the potential mediators. Corresponding standard errors were calculated using bootstrapping (10,000 bootstrapped samples). An important advantage of using a multiple mediation model is that it simultaneously tests the effect of a set of mediators, while controlling for the effects of the others and thus, do not involve multiple comparisons. In addition, a multiple mediation model allows for a comparison of the effects of the mediators to determine the relative influence of each mediator. This approach mimics theory in that theory postulates that the mediators work together to influence outcome and do not work in isolation (as is suggested by single mediation models). Finally, a multiple mediation model can be thought to account for the potential collinearity among mediators.

The effect of the intervention on the mediators at 6M (*a* path), the effects of the mediators on meeting exercise guidelines at 12M (*b* path), the total effect (*c* path) of the intervention on meeting guidelines at 12M, and the indirect effect (*ab*) of the intervention on outcome were examined. Following Preacher and Hayes guidelines,²⁸ a construct was considered a mediator of the intervention effect if the *indirect* effect of treatment through that construct was significantly different than zero. Analyses were conducted on the intent-to-treat sample (N=130).

RESULTS

At baseline, 130 participants were randomized to MC (n=64) or CC groups (n=66). Participants were 63.6 years old on average (SD=9.7) and predominantly male (79.2%). At baseline, 68.7% of MC participants met exercise guidelines compared to 59.1% of CC participants ($P>.05$). There were no significant between-group differences in the baseline demographics, psychosocial constructs or exercise (Table 1).

Unadjusted mean values of the psychosocial constructs are presented by study group at baseline and 6M in Table 2. Differences in 6M scores are presented as part of the mediation model (see below). Additionally, there were significant between group differences (favoring the MC group) in behavioral processes ($B=0.244$, $SE=0.12$, $P=.04$) and SS(Family) ($B=3.96$, $SE=1.76$, $P=.03$) and a trend towards significance in self-efficacy at 12M ($B=0.33$, $SE=0.19$, $P=.08$).

Effects of the Intervention on the Mediators at 6M (*a* path)

Multiple mediation analyses showed a significant intervention effect on SS(Friends) at 6M (*a* path coefficient, $a=3.82$, $se=1.66$, $t=2.31$, $P=.02$), when controlling for baseline values of the outcomes and all potential mediators. The MC group reported greater SS(Friends) at 6M compared to the CC group. There were no other significant *a* path coefficients (see Table 3).

Effects of the Mediators at 6M on Outcomes at 12M (*b* path)

Results indicate that SS(Friends) at 6M was significantly associated with meeting exercise guidelines at 12M (*b* path coefficient), when controlling for baseline, such that greater SS(Friends) was associated with lower odds of meeting guidelines (see Table 3 for *b* path coefficients for each of the potential mediators). Once all other potential mediators were included in the model, SS(Friends) was the only significant *b* path.

Total and Indirect Effects of the Intervention on 12M Outcomes

The total indirect effect of the intervention through the mediators was -0.08 at 12M (95% CI: -0.25-0.11). Results suggest that the indirect effect of the treatment through SS(Friends) was considered a significant suppressor effect ($ab = -0.11$, 95% CI: -0.22- -0.004). Of note is the fact that the indirect effect is negative (and comparatively, the total effect is positive). This is an example of inconsistent mediation.²⁹ Table 4 summarizes the indirect effect of each of the potential mediators on intervention effects at 12M.

DISCUSSION

Our goals were to examine the effects of an exercise maintenance intervention on putative mediators at 6M and to identify the constructs that mediated meeting exercise guidelines at 12M. Our results showed that the intervention had significant positive effects only on SS(Friends) at 6M. In contrast to our hypothesis that behavioral processes and self-efficacy would mediate intervention effects at 12M, we found that decreasing support from friends mediated meeting exercise guidelines in the MC vs CC group at 12M.

To interpret the results, it is important to understand a suppressor effect and inconsistent mediation. A suppressor effect by definition is a variable that if omitted, would reduce the total effect and occurs when the sign of the indirect effect is the opposite of the total effect.³⁰ The opposing signs are what are referred to as inconsistent mediation. The intervention positively impacted SS(Friends) at 6M and met the Action test for mediation. This variable mediated exercise participation at 12M but in the negative direction. It is not clear why SS (Friends) functioned as a suppressor for intervention effects. First, it is plausible that the statistically significant effect on SS(Friends) at 6M may not have been a meaningful effect. Second, we could speculate that the MC group received support for exercise from the interventionist and may no longer have needed support from friends. Third, one could speculate that increased social interactions with friends may reduce exercise. Finally, in comparing our finding with those of other studies, the utility of social support as a mediator is mixed¹⁵ with social support meeting the test of mediation effects in 1 study.³¹

Our study results contrast with mediators identified using other analytic approaches (eg, structural equation modeling) among healthy adults.^{14,16} In a study using multiple mediation among healthy adults, Lewis et al³² found that behavioral processes were a mediator of exercise, but self-efficacy and decisional balance were not. Similar results were reported in another study among healthy adults in which behavioral processes and exercise-induced feelings (revitalization) were mediators of exercise at 12M but self-efficacy, decisional balance, cognitive and behavioral processes, social support, and enjoyment were not.¹³

Although it was surprising that the intervention did not significantly impact self-efficacy and related theoretical constructs at 6M (but did improve behavioral processes and social support at 12M), it is possible that ceiling effects may have reduced our ability to detect effects (our sample had higher baseline self-efficacy, decisional balance and behavioral processes scores than sedentary healthy adults).^{13, 32} Our findings are restricted to the variables assessed but there may be other constructs that influence exercise maintenance such as environmental

variables and life stress (see Nigg et al³³). Others have suggested that intrinsic motivation is important for long-term change³⁴ while the decisional balance index is more indicative of extrinsic motivation. Similarly, we used a 5-item self-efficacy measure whereas others recommend a multidimensional approach that includes efficacy for dealing with barriers such as care-giving tasks and relapse self-efficacy.³³ Finally, the hypothesized mediators may have had unexpected effects because our intervention helped MC participants to sustain exercise while the CC group decreased their exercise over time.

The strengths of this study were the use of theoretical bases for the intervention, reliable and valid measures of putative mediators administered in a temporal sequence to test for mediation at 12M and a reliable measure of self-reported exercise. However, the results are limited to a sample of well-educated, predominantly male patients who completed an on-site supervised CR program.

Exercise maintenance for patients with cardiac disease is key to secondary prevention.²⁴ In examining mediators for exercise maintenance, we found that social support (friends) acted as a suppressor variable in a telephone-counseling intervention. Clearly, more work needs to be done to assess constructs that may be unique to exercise maintenance and mediate long-term behavior change in patient populations.

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CONDENSED ABSTRACT

A 12-month randomized controlled trial tested the efficacy of a theory-based intervention on exercise maintenance among 130 patients who had completed Phase II CR. In examining the theory-based mediators of intervention effects, we found that social support from friends functioned as a suppressor mediator for exercise maintenance among these patients.

Table 1

Baseline demographics by study arm

	MC group (N=64)	Contact Control group (N=66)	Overall (N=130)
Age	62.9 (9.3)	64.3 (10.0)	63.6 (9.7)
Gender (% Male)	80.3%	78.1%	79.2%
Race/ethnicity (% Non-Hispanic White)	95.3%	92.4%	93.8%
Marital status (% Married/living with partner)	73.4%	77.3%	75.4%
Education (% at least some college)	78.1%	66.7%	72.3%
Income (% >=\$40,000)	70.0%	70.5%	69.7%
Baseline exercise (min/week)	233.4(199.1)	198.6 (138.0)	215.8(171.1)
Cardiac risk status ^a			
Low	53.1%	57.6%	55.4%
Intermediate	34.4%	33.3%	33.8%
High	12.5%	9.1%	10.8%
BMI	29.0(5.3)	29.2(5.1)	29.1(5.2)
Anti-hypertensive medication			
Prescribed	85.9%	84.8%	85.4%
Not prescribed	14.1%	15.2%	14.6%
Type 2 diabetes			
Yes	23.4%	27.3%	25.4%
No	76.6%	72.7%	74.6%
Adherence to Phase II	91.1%	93.2%	92.2%

MC = Maintenance Counseling

^a Cardiac risk status per guidelines²

Table 2

Unadjusted mean values of the psychosocial constructs over time

	Baseline Mean (SD)	6 months Mean (SD)
Self-efficacy		
MC	3.38 (0.96)	3.56 (0.87)
CC	3.22 (0.75)	3.20 (1.01)
Decisional balance index		
MC	2.02 (1.05)	2.07 (1.26)
CC	1.75 (0.93)	1.86(1.15)
Behavioral processes		
MC	3.14 (0.62)	3.10 (0.74)
CC	3.10 (0.63)	2.97 (0.71)
Enjoyment		
MC	102.48 (22.11)	102.35 (17.78)
CC	102.24(22.91)	97.39 (23.90)
Social support (Friends)		
MC	1.30 (0.75)	1.24 (0.56)
CC	1.25 (0.64)	1.20 (0.52)
Social support (Family)		
MC	1.49 (1.03)	1.57 (0.98)
CC	1.65 (1.08)	1.47 (0.78)

Abbreviations: MC, Maintenance Counseling; CC, Contact Control

Table 3Summary of *a* and *b* paths for multiple mediation model

<i>a</i> path coefficients		
Variable	Beta^a (SE)	<i>P</i>-value
Self-efficacy	0.23(0.19)	.23
Decisional balance index	0.05(0.24)	.83
Behavioral processes	0.05(0.11)	.64
Enjoyment	5.27(4.30)	.22
Social Support (Friends)	3.82(1.66)	.02
Social Support (Family)	3.12(1.76)	.08
<i>b</i> path coefficients		
Variable	Beta^a (SE)	<i>P</i>-value
Self-efficacy	0.43(0.47)	.36
Decisional balance index	0.63(0.42)	.13
Behavioral processes	0.47(0.71)	.51
Enjoyment	0.02(0.02)	.46
Social Support (Friends)	−0.14(0.05)	.01
Social Support (Family)	−0.02(0.05)	.64

Models are adjusted for baseline exercise and baseline values of the mediators.

^a Betas are regression coefficients. Mediators are 6 month scores.

Table 4

Summary of indirect effects on 12 month outcomes

Indirect effect of intervention on meeting exercise guidelines at 12 months (<i>ab</i>)		
Variable	Indirect effect	95% CI
Self-efficacy	0.02	−0.06 - 0.10
Decisional balance index	0.01	−0.06 - 0.08
Behavioral processes	0.01	−0.06 - 0.07
Enjoyment	0.02	−0.06 - 0.10
Social Support (Friends)	−0.11	−0.22 - −0.004
Social Support (Family)	−0.01	−0.10 - 0.06