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Physical activity and psychosocial function following cardiac rehabilitation: One-year follow-up of the ENHANCED study

Patrick J. Smith, PhD¹, Andrew Sherwood, PhD¹, Stephanie Mabe, MS¹, Lana Watkins, PhD¹, Alan Hinderliter, MD², and James A. Blumenthal, PhD¹

¹Department of Psychiatry and Behavioral Sciences, University of North Carolina at Chapel Hill, Chapel Hill, NC

²Department of Medicine, University of North Carolina at Chapel Hill, Chapel Hill, NC

Abstract

Objective—To examine the long-term association between physical activity (PA) and psychosocial functioning following completion of cardiac rehabilitation (CR) among participants in the ENHANCED study.

Method—ENHANCED was a 3-month clinical trial examining standard CR with and without stress management training (SMT). Participants completed the Leisure-Time Exercise Questionnaire (LTEQ), Beck Depression Inventory-II (BDI-II), and the Spielberger State-Trait Anxiety Inventory (STAI) at baseline, 3- and 12-months after randomization. Prospective associations between physical activity and psychosocial function, as well as treatment group differences, were examined using repeated measures mixed modeling.

Results—One hundred nineteen participants were available at 12 month follow-up. During the 12-month follow-up, PA remained higher compared to baseline (P<.001), with the majority of participants reporting that they engaged in PA on a regular basis. Depressive and anxious symptoms continued to remain lower than baseline (Ps <.001) Higher levels of PA at 12-month follow-up were associated with lower depressive (P = .032) and anxious (P = .003) symptoms.

Conclusions—Higher physical activity levels following CR are associated with lower depressive and anxious symptoms. Encouraging patients to sustain higher levels of PA may promote both cardiovascular and mental health.

Keywords

Cardiac rehabilitation; of	lepression; physical	l activity; anxiety	

Address for Correspondence: Patrick J. Smith PhD, Department of Psychiatry and Behavioral Sciences, Box 3119, Duke University Medical Center, Durham NC 27710. Tel: (919) 681-3006; Fax: (919) 684-8629; Patrick.j.smith@dm.duke.edu.

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Introduction

Coronary heart disease (CHD) remains one of the highest sources of disability, health care expenditures, and premature death in the United States and worldwide. It is estimated that nearly 20 million individuals die from cardiovascular-related diseases annually, representing the leading cause of global deaths at 31%. [1, 2] For patients experiencing a cardiac event, comprehensive cardiac rehabilitation (CR) is widely advocated for its ability to reduce cardiovascular mortality and improve quality of life. [3] Participation in a CR program has been shown to improve cardiorespiratory fitness, reduce re-hospitalizations, and lower rates of recurrent CVD events. [3] In addition to the cardiopulmonary benefits of CR, emerging evidence suggests that CR also may improve psychological outcomes. [4–8] For example, Lavie and colleagues have demonstrated that CR improves depression, anxiety, and other psychological risk factors. [9] Furthermore, despite the fact that most CR programs do not systematically integrate stress management training (SMT), the recently completed ENHANcing Cardiac rEhabilitation (ENHANCED) trial showed that SMT provided added benefits to comprehensive, exercise-based CR, including greater reductions in psychological stress and fewer clinical events. [10]

Despite the positive impact of CR on clinical and patient-centered outcomes, many individuals do not continue to exercise following completion of CR, with only one-third of patients engaging in regular exercise when assessed 6 months following CR completion. [11, 12] Exercise maintenance is a critical, yet understudied, component of long-term care, as any potential benefits from CR are likely lost among individuals who discontinue their regular exercise routines. Individuals who return to a sedentary lifestyle are likely to regain weight and lose the cardiorespiratory benefits that were achieved during CR. In addition, there is epidemiologic evidence that depression is associated with physical inactivity, and that discontinuation of exercise is associated with increased depressive symptoms. [13, 14] To our knowledge, few studies have examined the longer-term impact of CR on psychological outcomes and the relation between physical activity and psychological functioning. The present report describes the physical activity (PA) and psychological outcomes among individuals from ENHANCED trial, reassessed 12-months after joining a CR program. For the purposes of this special issue, we were primarily interested in the naturalistic association between PA and psychosocial functioning following completion of CR; however, because the dataset was derived from the ENHANCED trial we chose to present findings retaining the treatment group assignment as well as aggregating treatment groups in an analysis of the relation of PA and psychosocial functioning independent of group assignment.

Methods

The ENHANCED trial was designed to examine the added value of stress management training (SMT) when added to comprehensive CR on self-reported stress, cardiovascular biomarkers, and clinical outcomes. ENHANCED was a 3-month, randomized clinical trial in which participants enrolled in CR were randomized to conventional, exercise-based CR or to CR+SMT. The CR+SMT condition was comprised of standard CR plus weekly, group-based SMT sessions t. [15] The methods and primary results of the trial have been reported

previously. [10] The present report describes results for data collected nine months after completing CR (i.e., 12-months following randomization).

Participants

Outpatients with stable CHD were referred for CR by their personal physicians and underwent medical screening examinations to confirm eligibility. Eligibility requirements were described in several earlier publications. [15] Indications for CR included recent acute coronary syndrome, stable angina with angiographic evidence of coronary disease, and recent coronary revascularization (coronary artery bypass graft surgery or percutaneous coronary intervention). Exclusion criteria including surgery primarily for valve replacement or repair, heart transplant, left ventricular ejection fraction (LVEF) < 30%, and unrevascularized left main stenosis >50%. The protocol was approved by the respective Institutional Review Boards at Duke University and the University of North Carolina and written informed consent was obtained from all participants. The first patient was randomized on April 6, 2010 and the last follow-up assessment was completed on March 13, 2015.

One Year Follow-Up Assessment Procedures

Leisure Time Physical Activity—Participants completed the Godin Leisure-Time Exercise Questionnaire [16] in which they indicated the number of times they engaged in mild, moderate, and strenuous exercise for more than 15 minutes during a typical 7-day week. In order to characterize the amount of physical activity, we also classified activity levels as 'Active', 'Moderately Active', and 'Insufficiently Active' based on previously published cutoffs (24 units [14 kcal/kg/week], 14–23 units [7–14 kcal/kg/week], and <14 units [<7 kcal/kg/week], respectively). [17]

Depression—The 21-item <u>Beck Depression Inventory II</u> (BDI-II)[18]: is a widely used measure of depression with scores ranging from 0 to 63, with higher scores suggesting greater depressive symptoms; scores 14 are suggestive of clinically significant depressive symptoms.

Anxiety—The 20-item State-Trait Anxiety Inventory-State (STAI)[19] was used to assess levels of current (state) anxiety symptoms with scores ranging from 20 to 80; scores 40 suggest clinically significant anxiety symptoms in medical patients. [20]

Data Analysis

All data analyses were conducted in SAS 9.3 (Cary, NC) and R 3.3.1 (https://cran.r-project.org/). Examination of longitudinal changes in physical activity, depressive symptoms, and anxiety symptoms were examined using repeated measures, linear mixed modeling (PROC MIXED) in which changes over time were modeled as a fixed effect and individual trajectories modeled as a random effect. All analyses controlled for age, gender, ENHANCED treatment group, and use of psychotropic medications at baseline. In order to examine possible treatment group differences in psychosocial and physical activity outcomes, we also conducted a parallel set of repeated measures analyses in which baseline level of each outcome was controlled. When a time by treatment group interaction was

found, post-hoc testing was carried out to determine the pattern of group differences. Missing data were managed using multiple imputation methods available in SAS (PROC MI). Assumptions regarding normality and independence were assessed and found to be adequate for all models.

Results

Among the 151 participants in the ENHANCED trial, 119 (79%) were available for one-year follow-up assessments. Background and clinical characteristics of the sample are shown in Table 1. Participants who did not complete follow-up assessments were more likely to be younger (t = 2.17, P = .032) and randomized to standard, exercise-based CR control condition (χ^2 = 4.14, P = .042), with 11 patients (15%) in CR combined with Stress Management Training (CR+SMT) and 21 (28%) patients in CR alone failing to complete follow-up.

Leisure-Time Physical Activity

Longitudinal changes in LTEQ levels are shown in Table 2. Examination of LTEQ scores revealed a main effect of time (F = 41.31, P < .001), with higher activity levels 3 months after completing CR (before CR: mean LTEQ = 20.5 [14.9, 26.1]; after CR: mean LTEQ = 39.0 [33.2, 44.7]), and then decreasing somewhat at 1-year follow-up but remaining higher than prior to participating in CR (mean LTEQ = 28.9 [25.0, 32.7]). At baseline, the majority of participants reported engaging in regular activity 'Sometimes' (n = 55, 47%) or 'Never/Rarely' (n = 47, 40%), with few participants reporting that they 'Often' engaged in physical activity (n = 15, 13%). At 1-year follow-up, physical activity remained higher than baseline ($\chi^2 = 20.6$, P < .001), with more than three fourths of participants continuing to report engaging in activity 'Sometimes' (n = 56, 47%) or 'Often' (n = 37, 31%), and fewer reporting 'Never/Rarely' (n = 26, 22%). Participants in the SMT group exhibited higher levels of LTEQ following completion of CR (F = 4.26, P = .041) but were not different from those who participated in CR alone when assessed at 1-year (F = 2.12, P = .135).

Examination of LTEQ levels according to established cutoffs [17] demonstrated that, at baseline, 40% (n = 48) of participants were 'Insufficiently Active', 26% (n = 31) were 'Moderately Active' and 34% (n = 40) were 'Active'. At follow-up, more than half of participants continued to remain at the 'Active' level (n = 69, 58%), a higher percentage of participants fell in the 'Moderately Active' (n = 24, 20%) or 'Insufficiently Active' (n = 26, 22%) ranges compared to baseline.

Depressive Symptoms

Examination of BDI-II scores revealed a main effect of time (F = 18.0, P < .001), with modestly elevated levels at baseline (mean BDI-II = 8.5 [7.4, 9.6]), which decreased following CR (mean BDI-II = 5.4 [4.3, 6.5]) and remained lower at 1-year follow-up assessment (mean BDI-II = 5.5 [4.3, 6.7]). Twenty-seven (n = 27, 23%) of participants exhibited clinically elevated depressive symptoms (BDI-II = 14) at baseline. Following CR, only 9 (n = 9, 8%) participants continued to report clinically elevated levels of depression

and this number remained lower than baseline at the time of follow-up assessments, with 10 (n = 10, 8%) participants continuing to exhibit elevated depressive symptoms.

Examination of treatment group differences revealed that the CR-alone and CR+SMT groups did not differ significantly in overall depressive symptoms (F = 0.82, P = .379); however, we observed a marginally significant baseline BDI-II by treatment interaction (Figure 1, b = -0.15, P = .069), such that individuals with clinically elevated depressive symptoms (BDI 14) at baseline showed lower post-treatment levels of depression in the CR+SMT group compared to CR-alone (6.9 [4.0, 9.7] vs. 12.5 [9.4, 15.5]). Although depressive symptoms increased marginally at follow-up, the beneficial effects on depressive symptoms persisted, with the CR+SMT group continuing to exhibit lower depressive symptoms compared to CR-alone (9.5 [6.6, 12.4], vs. 13.7 [10.2, 17.1]).

Anxiety Symptoms

Examination of STAI levels demonstrated a main effect of time (F = 12.0, P < .001). STAI scores were modestly elevated at baseline (mean STAI = 35.2 [33.5, 36.9]), which decreased following CR (mean STAI = 32.1 [30.4, 33.8]) and remained lower at follow-up (mean STAI = 32.3 [31.3, 33.2]). Similar to the pattern observed for depressive symptoms, a large subset of participants exhibited clinically elevated levels of anxiety symptoms (STAI 40) at baseline (n = 35, 29%). The frequency of clinically-elevated anxiety symptoms dropped following completion of CR (n = 22, 19%) and continued to remain lower at follow-up (n = 24, 20%). We did not observe any evidence of treatment group differences over time (F = 1.43, P = .172) or any baseline by treatment group interaction (F = 0.44, P = .560)

Physical Activity, Anxiety symptoms, and Depressive Symptoms

Examination of changes in depressive symptoms revealed a strong association between higher physical activity levels and lower depressive symptoms (b = -2.01 [-3.84, -0.18], P = .032). As shown in Figure 2, greater levels of self-reported physical activity were associated with lower levels of depressive symptoms. Similarly, higher physical activity levels were associated with lower anxiety symptoms (b = -3.54 [-6.73, -0.35]. P = .003).

Discussion

Our findings demonstrate the greater PA levels are associated with less depressive and anxious symptoms in longer-term follow-up of individuals who completed a 3-month program of exercise-based CR. Physical activity levels 12 months after participating in CR were higher than pre-CR levels. However, a substantial number of participants (42%) fell below the 'Active' level, representing a decrease in PA from the levels exhibited after completing CR. The finding that physical activity levels declined over time is consistent with a large body of evidence suggesting that long-term maintenance of PA among CR participants remains low, with only 30–60% of patients continuing to exercise when assessed six months following completion of CR. [11, 12, 24, 25]

Depressive and anxious symptoms also were lower compared to baseline levels, and participants with higher levels of PA showed the lowest levels of depressive and anxious symptomatology. In addition, individuals randomly assigned to CR+SMT with elevated

depressive symptoms at baseline tended to show greater reductions in depressive symptoms following CR and after 12 months.

Previous studies have demonstrated that CR improves psychosocial functioning [21, 22] and quality of life. [3] Meta-analytic studies and systematic reviews have reported that participation in a structured, exercise-based CR program is associated with small-to-moderate improvements in depressive symptoms [6] and health-related quality of life. [3] Fewer studies, however, have examined the association between maintenance of PA and psychosocial outcomes. In a one-year follow-up of 105 CR participants, Yohannes and colleagues demonstrated that scores on the Hospital Anxiety and Depression Scale (HADS) were lower than their pre-rehabilitation levels, and that greater total energy expenditure was associated with lower HADS scores. [23] Our findings extend these results in a larger sample of patients, as well as demonstrating that higher PA levels over time were associated with lower depressive and anxious symptoms.

Because continued PA among CHD patients is associated with lower levels of depressive symptoms and anxiety symptoms, strategies to improve adherence to exercise after supervised CR is critical. Depressive and anxious symptoms have been associated with greater risk of subsequent cardiac events [24–29] and patients who continue to exhibit depressive or anxious symptoms following completion of CR have increased risk of mortality. [30] The present findings therefore suggest that future intervention studies could use physical activity maintenance interventions to reduce or prevent psychosocial distress following completion of CR. For example, a recent telehealth intervention for demonstrated a benefit on both exercise maintenance [31] and depressive symptoms, [32] although the association between physical activity levels and depressive symptoms was not examined.

Limitations

The present study had several limitations. First, PA levels were obtained from self-report and were not objectively verified at follow-up. However, as previously reported, self-reported activity was significantly associated with objectively measured physical activity using actigraphy-assessed physical activity, collected both at baseline and again following 3-months of CR after controlling for demographic characteristics and medical comorbidities. [10] Second, only 80% of participants were available at follow-up, although our findings were not altered when missing data were accounted for statistically using multiple imputation. Third, we were unable to obtain data on other possible psychological treatments during the 1-year follow up period (e.g., psychotherapy, psychotropic medication, etc.) that may have impacted depressive and anxious symptoms. Moreover, because we report the observed associations of PA and psychological functioning and did not randomize patients to a 'no-PA' condition, we are unable to assert any causal relationship between PA and psychosocial outcomes.

Conclusions

Greater physical activity following completion of supervised CR is associated with lower levels of depressive and anxious symptoms. Those patients who remain physically active after they completed a 3-month exercise-based CR program have lower levels of anxiety and

depression after 1 year compared to when they first enrolled in the program. Efforts to promote exercise and physical activity after completion of formal CR may not only reduce risk for adverse clinical events, but also may help patients maintain the psychological benefits resulting from participation in CR.

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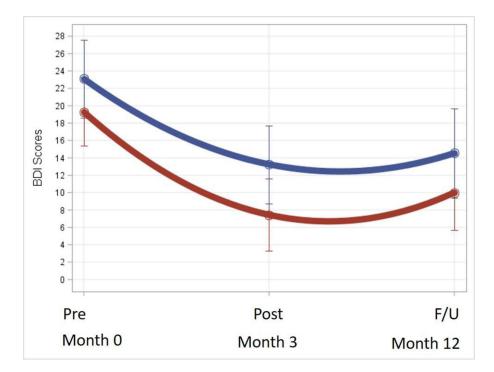


Figure 1. Changes in BDI-II score among individuals with clinically elevated symptoms at baseline.

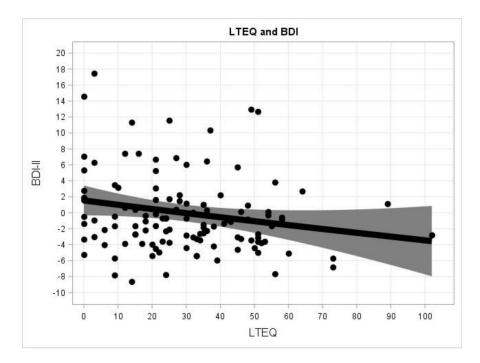


Figure 2.Association between leisure-time physical activity (LTEQ) and BDI-II at one-year follow-up. LTEQ values are in arbitrary units. Values were generated from multiple regression analyses controlling for age, gender, ENHANCED treatment group, and use of psychotropic medications at baseline.

Table 1

Background demographic and clinical characteristics (N = 119).

Variable	Mean (SD) or n (%)	
Age, y	61.0 (10.6)	
Female	55 (36%)	
White	109 (72%)	
Married or cohabitating	99 (66%)	
History of MI	81 (54%)	
History of Coronary Artery Bypass Grafting	38 (25%)	
LVEF, %	54.7 (8.6)	
Charlson Comorbidity Index	1.3 (1.0)	

Table 2

Treatment group levels of depression, anxiety, and physical activity over time. Values are reported as mean (SE).

Variable	CR+SMT	CR-Alone	All
BDI			
Baseline (Month 0)	8.1 (0.8)	8.8 (0.8)	8.5 (0.5)
Post-Treatment (Month 3)	5.0 (0.8)	5.9 (0.8)	5.4 (0.6)
Follow-up (Month 12)	5.1 (0.8)	5.9 (0.9)	5.5 (0.6)
STAI			
Baseline (Month 0)	35.1 (1.2)	36.0 (1.2)	35.6 (0.8)
Post-Treatment (Month 3)	30.0 (1.2)	33.0 (1.2)	31.5 (0.8)
Follow-up (Month 12)	32.2 (1.2)	33.1 (1.3)	32.7 (0.9)
LTEQ			
Baseline (Month 0)	22.9 (2.5)	18.1 (2.5)	20.6 (1.8)
Post-Treatment (Month 3)	42.8 (2.6)	34.8 (2.6)	38.9 (1.8)
Follow-up (Month 12)	27.7 (2.7)	30.9 (2.9)	28.9 (2.0)