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# The Roles of Self-Efficacy and Motivation in the Prediction of Short- and Long-Term Adherence to Exercise Among Patients With Coronary Heart Disease

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***Objectives:*** Poor adherence to regular exercise is a documented challenge among people with heart disease. Identifying key determinants of exercise adherence and distinguishing between the processes driving short- and long-term adherence to regular exercise is a valuable endeavor. The purpose of the present study was to test a model of exercise behavior change, which incorporates motivational orientations and self-efficacy for exercise behavior, in the prediction of short- and long-term exercise adherence. ***Method:*** Male and female patients ($N = 801$) hospitalized for coronary heart disease were recruited from 3 tertiary care cardiac centers and followed for a period of 1 year after hospital discharge. A prospective, longitudinal design was used to examine the roles of motivation and self-efficacy (measured at recruitment and at 2 and 6 months after discharge) in the prediction of exercise behavior at 6 and 12 months. Baseline measures of exercise and clinical and demographic covariates were included in the analyses. ***Results:*** Structural equation modeling showed that both autonomous motivation and self-efficacy were important determinants of short-term (6-month) exercise behavior regulation, but that only autonomous motivation remained a significant predictor of long-term (12-month) exercise behavior. Self-efficacy partially mediated the relationship between motivation for exercise and 6-month exercise behavior. ***Conclusions:*** This research confirmed the roles of autonomous motivation and self-efficacy in the health behavior change process and emphasized the key function of autonomous motivation in exercise maintenance. Theoretical and cardiac rehabilitation program applications of this research are discussed.

*Keywords:* autonomous motivation, self-efficacy, exercise behavior regulation, cardiac rehabilitation, longitudinal design



The health benefits of regular exercise after the manifestation of coronary heart disease (CHD) are widely recognized (Leon et al., 2005). Exercise training in patients with CHD has been associated with significantly lower total and cardiac mortality rates compared with usual medical care (20% and 26% reductions, respectively; Taylor et al., 2004). Still, less than half of adults with CHD engage in recommended levels of regular exercise (Reid et al., 2006). Structured cardiac rehabilitation (CR) programs are effective in helping participants achieve recommended levels of exercise during the course of the program, but less effective in achieving maintained adherence to regular exercise (Lear et al., 2006). Only 15% to 50% of CR participants continue to exercise 3 to 6 months after program graduation and even fewer meet recommended levels of exercise beyond 12 months (Bock, Carmona-Barros, Esler, & Tilkemeier, 2003). For sustained health benefits, participation in regular exercise needs to be maintained over time. The determinants and processes underlying regulation of exercise behavior differ as one moves from initiation to maintenance of behavior change. Although the distinction between short- versus long-term adherence is relative, the longer one adheres to exercise the more it becomes a self-sustaining pattern of behavior or integrated habit. Accordingly, distinguishing the shifts in the determinants of exercise behavior regulation over time is an important avenue of research.

Different theoretical approaches offer explanations for the psycho–social mechanisms that influence people's efforts to regulate health behaviors. Rothman, Baldwin, and Hertel (2004) proposed four phases to delineate how psychological processes and determinants of health behavior change differ as one moves from initiation to maintenance of behavior. Motivation and perceived competence, or self-efficacy, are positioned as key—yet unique—factors across the phases of behavior change, with self-efficacy being more important for initiation and motivation for the maintenance of behavior. More specifically, during initial behavior change a heightened sense of self-efficacy is of prime importance in order for a person to transition from the *initial response* phase

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to the *continued response* phase. The *continued response* phase is defined by tension between one's self-efficacy and motivation as one strives to master the new behavior. With transition into the *maintenance* phase, the shift occurs where regulation of behavior becomes less a function of one's self-efficacy and more of one's motivation for the behavior. During the final *habit* phase, one's self-sustaining pattern of behavior is primarily the function of self-motivation.

*Self-efficacy* is defined by the social–cognitive theory (SCT; Bandura, 1997) as a measure of one's perceived ability, or confidence, to perform a specific behavior in a given situation and has been identified as an important correlate and predictor of exercise, with stronger evidence in support of its relationship to short- versus long-term behavior (e.g., McAuley & Blissmer, 2000; Schwarzer, Luszczynska, Ziegelmann, Scholz, & Lippke, 2008). The theoretical premise is that people are more likely to engage in activities for which they have high self-efficacy and less likely to engage in those for which they do not. Moreover, the relationship between self-efficacy and behavior is reciprocal, such that successful enactment bolsters people's efficacy beliefs, leading to further action, whereas failure experiences undermine self-efficacy (Bandura, 1997). This reciprocity allows self-efficacy to maintain a close relationship with behavior across time and hence be interpreted as a determinant, outcome, and/or a mediator of behavior change; it does not, however, explain why successfully enacted changes in behavior are not maintained. Self-efficacy related to overcoming barriers to exercise specifically has been linked to exercise adherence (e.g., Brawley et al., 2003). *Motivation* represents one's will or determination to act and is defined as the psychological energy that initiates and continuously directs behavior. Motivation is most comprehensively defined by the self-determination theory (SDT; Deci & Ryan, 2002), a broad theory of human motivation that delineates motives and their consequences according to the degree to which they are non-self-determined (NSDM) versus self-determined (SDM). Conditions supporting an individual's experience of the three basic needs of autonomy, competence and relatedness, are hypothesized to foster the most self-determined forms of motivation and engagement in activities, and conditions that thwart the individual's experience of the three psychological needs are hypothesized to foster non-self-determined forms of motivation. When people have no intention to act (amotivation), or act to avoid negative repercussions (external regulation) or feelings of guilt (introjected regulation), their motives for change are NSDM. In contrast, when people endorse the value of a behavior (identified regulation), align the desired behavior with other central values (integrated regulation), or experience the behavior as enjoyable (intrinsic motivation), change is a function of SDM motivation. Motivation operates at global (or personality), contextual (or life domain), and situational (or state) levels, and these levels influence each other through top-down and bottom-up processes (Vallerand, 1997). Self-determined motivation is reflected in greater effort, persistence, and commitment across circumstances (Pelletier, Fortier, Vallerand, & Briere, 2001) and is an important determinant of health behavior maintenance and desirable health outcomes (Fortier, Sweet, O'Sullivan, & Williams, 2007; Ng et al., 2012; Pelletier, Dion, Slovinec D'Angelo, & Reid, 2004; Ryan, Patrick, Deci, & Williams, 2008; Ryan, Williams, Patrick, & Deci, 2009; Teixeira, Carraça, Markland, Silva, & Ryan, 2012). Self-determined motivation has been consistently linked with higher levels of self-reported (e.g., Ingledew & Markland, 2008) and objectively assessed (e.g., Standage, Sebire, & Loney, 2008) exercise behavior. Although exercise can be *energized* by a combination of SDM and NSDM motives (Ryan et al., 2009), NSDM forms are largely unrelated to long-term adherence and SDM forms are linked to increased behavioral persistence (Vansteenkiste, Simons, Lens, Sheldon, & Deci, 2004). Furthermore, in line with Rothman et al. (2004), the SDT recognizes the unique roles of both SDM motivation and confidence in effective behavior regulation, emphasizing the relevance of the basic human need of competence in the development of SDM motivation and sustained behavior change (Ryan et al., 2009).

We previously applied Rothman et al.'s (2004) theory about health behavior change in the development and test of an exercise behavior change model in a sample ($N = 200$) of patients with CHD (Slovinec D'Angelo, Reid, & Pelletier, 2007). The study was cross-sectional and cognitive processes, namely intentions and planning, were used to represent initiation and maintenance of exercise behavior, respectively. Our results supported Rothman's thesis by confirming self-efficacy and autonomous motivation as distinct predictors of processes associated with initiation and maintenance of behavior change. The main purpose of the present study was to test Rothman et al.'s (2004) hypotheses about the distinctive roles of self-efficacy and motivation across the behavior change process in a larger sample of patients, using behavioral outcome measures and a longitudinal, prospective design. Self-efficacy and motivation, assessed at 2 months, were examined as determinants of exercise behavior at 6 and 12 months, to represent short- and long-term behavior change respectively. Our operationalization of short-term was analogous to Rothman's continued response phase as participants would have had up to 6 months to transition from the initial response phase. Long-term corresponded to Rothman's maintenance, potentially habit, phase. Accordingly, it was hypothesized that (a) self-efficacy would predict engagement in short-term behavior and SDM motivation would predict long-term behavior; and that (b) self-efficacy would have a larger effect on short-term behavior than motivation, but it would not have a significant effect on long-term behavior. By delineating the roles of self-efficacy and motivation in the prediction of exercise behavior over time, this study also put to test aspects of the SCT and SDT in the context of health behavior change. Based on the SDT, it was theorized that (c) SDM motivation would predict short- and long-term behavior. Finally, consistent with both Rothman's and SDT's suggestions, it was expected that (d) self-efficacy would partially mediate the effect of SDM exercise motivation on short-term behavior. These suppositions are depicted in our hypothesized model of exercise behavior regulation (see Figure 1). General motivational orientation was included in the model as an important antecedent of contextual motivation. Furthermore, because participation in exercise behavior can be influenced by demographic and clinical factors, we controlled for pertinent covariates. Reid et al. (2006) explored the trajectory of physical activity behavior in this patient sample at 2, 6, and 12 months after hospitalization for CHD and evaluated the effect of sex, age group ($\leq 65$ or $> 65$ years), level of education, reason for hospitalization (acute myocardial infarction [AMI], percutaneous coronary intervention [PCI], or coronary artery bypass graft [CABG]), congestive heart failure (CHF), diabetes, physical activity level before hospitalization, and participation in cardiac rehabilitation on the

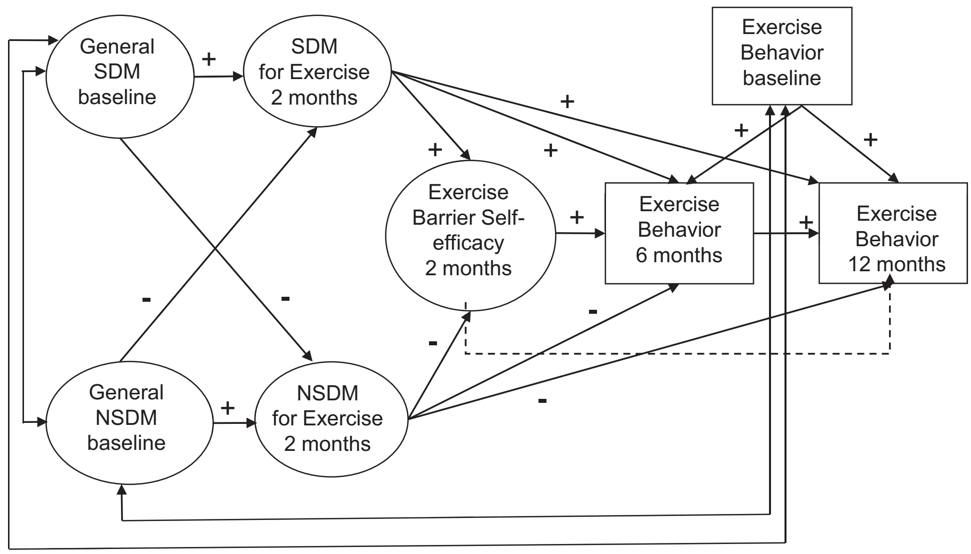


*Figure 1.* The hypothesized model of exercise behavior regulation. Note: SDM = self-determined motivation; NSDM = non-self-determined motivation. Solid lines indicate coefficients which were expected to be significant, and dotted lines represent coefficients which were expected to be nonsignificant.

trajectory. The investigators found that age group, education level, and CHF moderated the trajectory of physical activity behavior. Accordingly, we controlled for these variables in our analyses.

# Method

## Procedure and Design

Participants were enrolled in the Tracking Exercise After Cardiac Hospitalization (TEACH) study, a prospective trial designed to examine the patterns and predictors of exercise behavior after hospitalization in patients with CHD (Reid et al., 2006). Participants were recruited from three tertiary care cardiac centers in Eastern Ontario (University of Ottawa Heart Institute, The Ottawa Hospital, Kingston General Hospital) and followed for 12 months. Potential participants were identified based on the reason for a CHD-related hospitalization (AMI, PCI, or CABG). Patients with contraindications to exercise (i.e., unstable angina; uncontrolled cardiac arrhythmias; neuromuscular, musculoskeletal, or rheumatoid disorders exacerbated by exercise; uncontrolled diabetes; or chronic infectious diseases) were excluded. Participants completed self-report questionnaires at recruitment (baseline) and at 2, 6, and 12 months. They were asked whether they were currently participating in a structured CR program at each follow-up. Approval of the study protocol was obtained from the Research Ethics Committee at each site, and all participants provided written informed consent.

## Measurements

**Physical exercise behavior.** The Godin Leisure-Time Exercise Questionnaire (GLTEQ; Godin & Shephard, 1985) was used to obtain self-reported frequency of participation in mild (e.g., easy walking, yoga), moderate (e.g., brisk walking, leisure sports), and strenuous (e.g., running, competitive sports) exercise in bouts greater than 15 min during participants' free time in a typical week. Consistent with current exercise guidelines for patients with CHD (Stone & Arthur, 2005), frequencies of moderate and strenuous activities were summed. The GLTEQ was administered at baseline, 6, and 12 months after hospitalization. An independent evaluation of the GLTEQ found its reliability and validity to compare favorably with nine other self-report measures of exercise based on test–retest scores, objective activity monitors, and cardiorespiratory fitness indices (Jacobs, Ainsworth, Hartman, & Leon, 1993).

**General motivational orientation.** To measure participants' general tendencies to be SDM or NSDM in their daily interactions with the environment, the Global Motivation Scale (GMS; Pelletier et al., 2004; Slovinec D'Angelo et al., 2007) was administered at baseline. The GMS is an 18-item scale (nine items for SDM and nine for NSDM) comprised of six subscales (three items per subscale) to represent different forms of one's enduring regulatory orientations according to the self-determination continuum: intrinsic motivation ($\alpha = .72$); integrated ($\alpha = .68$); identified ($\alpha = .72$); introjected ($\alpha = .64$) and external ($\alpha = .70$) regulations; and amotivation ($\alpha = .72$). For the composite scores $\alpha = .86$ for SDM and $\alpha = .82$ for NSDM. Items were scored on a 7-point scale in response to the leading statement "In general, I do things . . .".

**Motivation for exercise regulation.** Self-determination within the context of exercise behavior was assessed using the Physical Activity Regulation Scale (PARS; Slovinec D'Angelo et al., 2007) at 2 and 6 months. The PARS is an 18-item scale comprised of six subscales to quantify each element of the self-determination continuum within the context of exercise regulation: intrinsic motivation ($\alpha = .93$); integrated ($\alpha = .85$–$.86$); identified ($\alpha = .89$–$.90$); introjected ($\alpha = .80$–$.81$) and external ($\alpha = .74$–$.79$) regulations; and amotivation ($\alpha = .68$–$.70$). For the composite scores the internal consistencies ranged from $\alpha = .91$ to $.94$ for SDM and $\alpha = .69$ to $.70$ for NSDM. The PARS is an adaptation of the Behavioral Regulation in Exercise Questionnaire (BREQ; Mullan, Markland, & Ingledew, 1997), which was extended by two subscales to include assessment of integrated regulation and amotivation. Items representing each form of motivation were scored on a 7-point scale in response to the leading statement "I am trying to exercise regularly because . . .". Respondents who were not trying to exercise regularly at the time of assessment could indicate so with high scores on the amotivation and external regulation items and low scores on SDM motivation items.

**Exercise barrier self-efficacy.** Barrier self-efficacy was assessed at 2 and 6 months after hospitalization using a 12-item scale (Slovinec D'Angelo et al., 2007) that represented emotional (e.g., feeling depressed), task-related (e.g., cannot notice improvements in fitness), social (e.g., have no support from family and friends), and physical (e.g., recovering from illness or injury that caused one to stop exercising) circumstantial barriers to exercise participation. The internal consistency for the scale was $\alpha = .96$ at both time points analyzed. Participants were asked to indicate (on a 7-point scale) how confident they were in their ability to engage in regular exercise over the next 4 weeks when they were faced with each such barrier.

**Demographic and clinical information.** Age and education (in years) were assessed at time of recruitment. Presence of CHF was identified a priori through discussions with clinicians.

## Analyses and Results

**Participant flow.** Over 18 months, 1,433 patients were approached and 826 agreed to participate. During the 12-month follow-up period, 25 patients died and were excluded from analyses. Of the 801 survivors, 68 patients (8.4%) were rehospitalized with a new cardiac event (AMI, PCI, or CABG), but were retained in the analyses. Complete data were available for 100%, 78%, 72%, and 72% of participants at baseline, 2, 6, and 12 months, respectively. Analyses examining the pattern of missing data for each psychosocial variable and exercise showed that data were missing at random (MAR: i.e., the probability of missing a data point was not related to its particular value, but was dependent upon other variables in the model). Because using listwise deletion with data MAR can lead to biased estimates, missing values were imputed using the expectation maximization algorithm (Allison, 2002) in LISREL 8.5.

**Characteristics of study sample.** Participants included 290 (36.2%) AMI, 301 (37.6%) PCI, and 210 (26.2%) CABG patients. The majority of the sample was male (75.4%), married (74.6%), unemployed (60.2%), not participating in a CR program (68.7%), and insufficiently active to meet current activity recommendations for CHD patients, as defined by GLTEQ scores lower than 24 (74.0%). Participants ranged in age from 25 to 85 years (mean age $= 61.4$ years; $SD = 10.0$) and 34.8% had postsecondary education. For 59.1% of the participants this was the first CHD hospitalization and 28.2% reported a history of CHF. Over the course of the study period 12.1%, 15.4%, and 16.9% participated in a CR program at 2, 6, and 12 months, respectively. At 6 and 12 months half of participants reported insufficient activity levels. The representativeness of the sample was confirmed against 446 nonparticipants (Reid et al., 2006).

## Examining the Roles of Self-Efficacy and Motivation in Exercise Behavior Regulation

### Testing the Model of Exercise Behavior Regulation (Hypotheses 1 to 3)

Confirmatory factor analysis (CFA) and structural equation modeling (SEM) were used to test the hypothesized model (see Figure 1) using AMOS statistical software. In the SEM analyses reported below, we chose several indices of fit based on the recommendations of Kline (1998): normed chi-squared ($\chi^2/df$), comparative fit index (CFI), non-normed fit index (NNFI or TLI), standardized root-mean-square residual (SRMR), and root mean square error of approximation (RMSEA). For $\chi^2/df$, values below 5 are considered adequate and values below 3 are considered good (Kline, 1998). For the CFI and TLI, values above .90 are considered adequate and values above .95 are considered good (Hu & Bentler, 1995). For SRMR, values below .10 are considered adequate and values below .05 are considered good (Hu & Bentler, 1995). For RMSEA, values below .08 are considered adequate and values below .05 are considered good (Browne & Cudeck, 1993). In addition, the AIC was used when comparing the fit of two models; the model with the smaller AIC is considered to be the model with better fit (Kline, 1998).

**Testing the measurement model.** A confirmatory factor analysis was performed to test the measurement model. This was a preliminary step to confirm the expected relations of the measured indicator variables to their respective latent variables, or factors. The model had five factors (general SDM and NSDM motivations; SDM and NSDM motivations for exercise; and barrier self-efficacy for exercise), each extracted from three indicators that consisted of randomly selected scale items (all items were used and each item was only used once). Indicators representing SDM motivations consisted of one intrinsic, one integrated, and one identified item. Indicators of NSDM motivations consisted of one external, one introjection, and one amotivation item. Three indicators were created to reflect self-efficacy, each consisting of four randomly selected scale items. This method of creating item parcels is referred to as the domain-representative approach and is considered superior when dealing with multidimensional constructs (Kishton & Widaman, 1994). Exercise at each time point was represented in the model by a single indicator. Results revealed that the measurement model had good fit: $\chi^2(df = 140, N = 801) = 345.74$, $p = .000$, so that the normed $\chi^2$ was $345.74/140 = 2.47$; CFI $= .98$; TLI $= .97$; SRMR $= .02$; and RMSEA $= .043$, 90% CI of RMSEA [0.037, 0.049]. Factor loadings were high, as shown in Table 1. The correlations between the variables appear in Table 2.

**Testing the hypothesized model.** In the test of the hypothesized model (see Figure 1), the measurement model was specified as per the results of the CFA. The final model, with its regression and correlation coefficients, is presented in Figure 4 (correlations between all pairs of independent variables were included in the analysis, but are not shown). Results revealed that the hypothesized model displayed a good fit to the data: $\chi^2(df = 159, N = 801) = 496.83$, $p = .000$, so that the normed $\chi^2$ was 3.13; CFI $= .96$; TLI $= .95$; SRMR $= .06$; and RMSEA $= .052$, 90% CI of RMSEA [0.046, 0.057]. General motivational orientations predicted participants' motivation within the context of exercise: general autonomy and general control had significant positive and negative effects, respectively, on autonomous regulation of exercise ($R^2 = .12$), and the opposite relationships were true for controlled regulation of exercise ($R^2 = .14$). Together, autonomous and controlled regulations of exercise explained 52% of self-efficacy for exercise, with autonomous regulation

Table 1
*Descriptive Statistics and Factor Loadings for Indicator Variables*

| | Mean | Std. deviation | Skewness | Kurtosis | Factor loading |
|---|---|---|---|---|---|
| General SDM motivation | | | | | |
| GSDM1 | 5.07 | 1.24 | −.74 | .72 | .83 |
| GSDM2 | 4.96 | 1.18 | −.58 | .31 | .84 |
| GSDM3 | 5.26 | 1.24 | −.94 | .98 | .81 |
| General NSDM motivation | | | | | |
| GNSDM1 | 3.37 | 1.32 | .25 | −.35 | .73 |
| GNSDM2 | 3.34 | 1.27 | .30 | −.23 | .82 |
| GNSDM3 | 3.66 | 1.30 | .08 | −.19 | .84 |
| Exercise SDM motivation | | | | | |
| EXSDM1 | 5.27 | 1.33 | −.98 | 1.07 | .94 |
| EXSDM2 | 5.25 | 1.28 | −.97 | 1.11 | .92 |
| EXSDM3 | 5.26 | 1.28 | −.83 | .74 | .94 |
| Exercise NSDM motivation | | | | | |
| EXNSDM1 | 3.12 | 1.08 | .17 | .23 | .78 |
| EXNSDM2 | 2.30 | .99 | .83 | 1.07 | .80 |
| EXNSDM3 | 2.88 | .97 | .36 | .52 | .65 |
| Barrier Self-efficacy for exercise | | | | | |
| SEE1 | 4.90 | 1.46 | −.60 | −.03 | .89 |
| SEE2 | 4.47 | 1.38 | −.32 | −.27 | .94 |
| SEE3 | 5.10 | 1.42 | −.73 | .22 | .91 |
| Exercise at baseline | 13.65 | 15.96 | 1.18 | .68 | |
| Exercise at 6 months | 22.94 | 18.09 | .79 | .25 | |
| Exercise at 12 months | 23.66 | 20.69 | .83 | .18 | |
| Age (years) | 61.35 | 10.02 | −.32 | −.45 | |
| Education (years) | 12.82 | 3.59 | .64 | .24 | |

*Note*. SDM = self-determined; NSDM = non-self-determined. General motivation units were obtained using the General Motivation Scale. Exercise motivation units were obtained using the Physical Activity Regulation Scale. Barrier self-efficacy units were obtained using the Exercise Barrier Self-Efficacy Scale. Exercise behavior units represent the frequency of moderate and strenuous activity measured using the Godin Leisure-Time Exercise Questionnaire (GLTEQ).

being positively and controlled regulation being negatively related to self-efficacy, as hypothesized. After controlling for baseline assessments of exercise behavior, age, education, and CHF, autonomous exercise regulation positively predicted both 6-month and 12-month exercise behavior. Controlled regulation of exercise was unrelated to behavior at either timepoint. Self-efficacy positively predicted shorter-term (6-month) exercise behavior, but was not related to 12-month exercise behavior. In total, the model (including control variables) explained 24% of exercise behavior measured at 6 months and 40% of exercise behavior measured at 12 months. When baseline exercise was not included in the model, the amount of variance explained was 22% and 42% for 6- and 12-month behavior, respectively.

## Confirming Self-Efficacy as a Partial Mediator Between Motivation and Exercise (Hypothesis 4)

We wished to determine whether there is a better fit to the data if self-efficacy is treated as the mediator between motivation and exercise, as we propose, or if motivation is treated as the mediator between self-efficacy and exercise, which might be an alternative

Table 2
*Correlations Between all Variables to Appear in the Hypothesized Structural Model*

| Variable | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1. General SDM at baseline | — | .45* | .27* | .08* | .24* | .08* | .08* | .07 | −.06 | .05 | .01 |
| 2. General NSDM at baseline | | — | −.06 | .36* | −.14* | −.02 | −.12* | −.13* | −.07 | −.27* | .02 |
| 3. Exercise SDM at 2 months | | | — | .14* | .68* | .31* | .36* | .36* | .05 | .12* | −.03 |
| 4. Exercise NSDM at 2 months | | | | — | −.10* | −.06 | −.04 | −.04 | .00 | −.20* | .05 |
| 5. Exercise barrier self-efficacy at 2 months | | | | | — | .29* | .39* | .33* | .02 | .19* | −.07* |
| 6. Exercise at baseline | | | | | | — | .39* | .37* | −.14* | .13* | −.04 |
| 7. Exercise at 6 months | | | | | | | — | .61* | −.17* | .20* | −.10* |
| 8. Exercise at 12 months | | | | | | | | — | −.15* | .17* | −.15* |
| 9. Age at baseline (years) | | | | | | | | | — | −.10* | .12* |
| 10. Education level (years) | | | | | | | | | | — | −.10* |
| 11. Congestive heart failure (yes/no) | | | | | | | | | | | — |

*Note*. SDM = self-determined motivation; NSDM = non-self-determined motivation.
* $p < .05$.

sequence. To perform this comparison, we ran the two models shown in Figure 2 (motivation measured at 2 months and self-efficacy as mediator measured at 6 months) and Figure 3 (self-efficacy measured at 2 months and motivation as mediator measured at 6 months) and compared their fit. We found that the model with self-efficacy as mediator had a better fit to the data ($\chi^2/df$ = 2.83, CFI = .99, TLI = .98, SRMR = .03, RMSEA = .048, 90% CI [.037, .059], AIC = 162.71) than did the model with motivation as mediator ($\chi^2/df$ = 3.93, CFI = .98, TLI = .97, SRMR = .06, RMSEA = .061, 90% CI [.051, .071], AIC = 207.30).

## Discussion

This research was designed to confirm the validity of a model of exercise behavior regulation (Slovinec D'Angelo et al., 2007) in a large sample of patients with CHD using a prospective, longitudinal design, and behavioral outcome measures. The model represented a test of Rothman et al.'s (2004) thesis that behavior change is a progression through distinct phases defined by shifts among key determinants of behavior. The model specified the distinct roles of self-efficacy and motivation in the regulation of short- and long-term exercise behavior. Our results provided empirical evidence in support of the model. Self-efficacy, defined by barriers to action, was proven to be more relevant during short-term behavior regulation and motivation, defined by self-determination, to be more relevant during long-term behavior regulation. Both self-efficacy and motivation significantly predicted exercise behavior at 6 months, but only SDM motivation remained a relevant indicator of behavior at 12 months. Furthermore, as hypothesized and consistent with previous research (Williams, 2002; Ng, 2012), barrier self-efficacy partially mediated the effect of exercise SDM motivation on 6-month exercise behavior. In agreement with the SDT, NSDM exercise motivation did not have an effect on exercise over time, but did have a negative effect on self-efficacy. These findings were consistent with previous research (Silva et al., 2011) and provided further evidence that all forms of motivation are not equally effective or ineffective in influencing self-efficacy or behavior. Relative to barrier self-efficacy, SDM forms of motivation enhance self-efficacy beliefs, whereas NSDM forms diminish these beliefs. With respect to behavior, SDM forms of motivation drive exercise behavior, but NSDM forms of motivation have no influence. General motivational orientations were demonstrated to be stable and powerful determinants of their contextual counterparts. In addition, general NSDM motivation had significant negative repercussions on exercise self-determination, demonstrating that a general NSDM orientation not only perpetuates a NSDM disposition within specific contexts, but also undermines contextual SDM motivation.

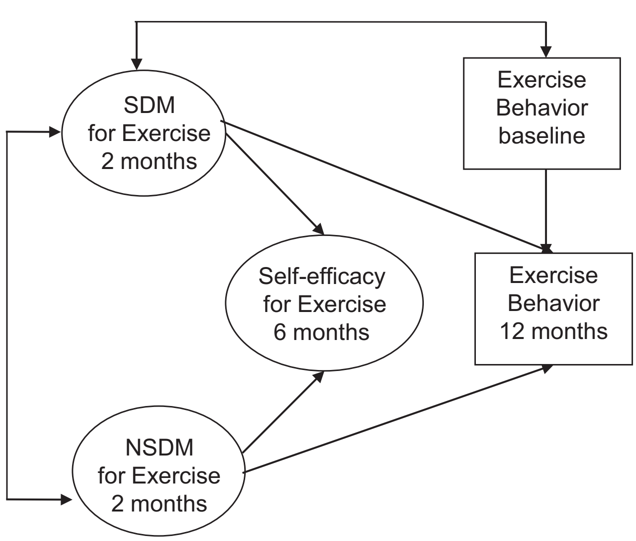


*Figure 2.* Model where self-efficacy is mediator between motivation and exercise behavior. Note: SDM = self-determined motivation; NSDM = non-self-determined motivation.

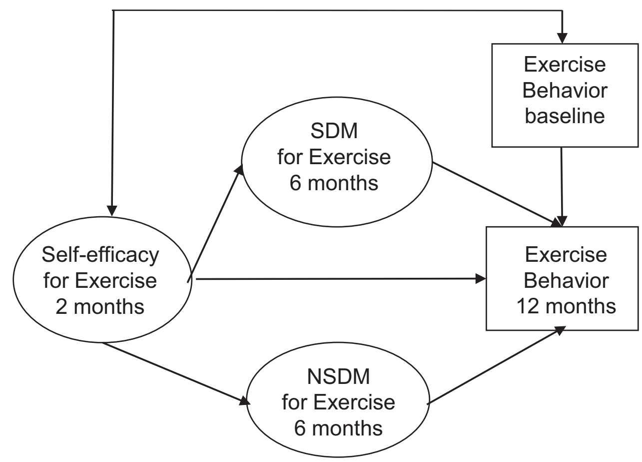


*Figure 3.* Model where motivation is mediator between self-efficacy and exercise behavior. Note: SDM = self-determined motivation; NSDM = non-self-determined motivation.

The present study results have important implications for theory, intervention design, and future research. From a theoretical perspective, they corroborate and illuminate the essential yet distinct roles of each self-efficacy and autonomous motivation in achieving and sustaining health behavior change. The results support the value of the SDT in predicting successful behavior regulation, the importance of barrier self-efficacy in behavior adoption, and provide support for Rothman et al.'s (2004) propositions regarding how the roles of efficacy and motivation unfold over time. The final model of exercise behavior regulation demonstrated that a higher sense of barrier self-efficacy furnished individuals with the confidence necessary to execute prescribed behaviors, and SDM motivation supplied them with the drive to attempt the behaviors and remain committed to newly acquired behavioral routines. Accordingly, in line with the SDT model of behavior change (Ryan et al., 2008; Williams, 2002), autonomous motivation remained important during both the initiation and maintenance phases of the behavior change process. Barrier self-efficacy was not found to be an important determinant of behavior maintenance. The predictive value of self-efficacy was lessened over time, because in the process of moving from initiation to maintenance of behavior individuals establish their ability to manage the required behaviors and will maintain them as long as they are motivated to do so (Rothman et al., 2004).

The distinction in the processes governing short- and long-term regulation of behavior illustrated by this research illuminates why

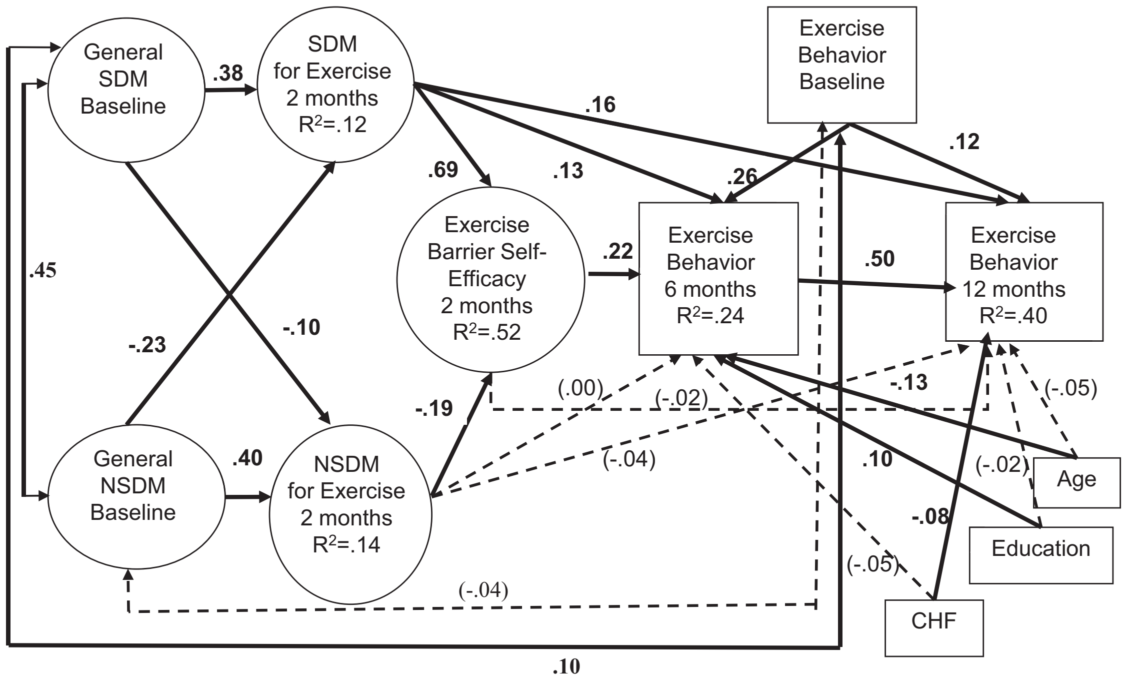


*Figure 4.* Structural model of exercise behavior regulation with parameter estimates. All independent variables (including general SDM, general NSDM, baseline exercise, age, education, and congestive heart failure) were allowed to intercorrelate in the analysis, but only some of the correlations are displayed for the sake of visual simplicity). Values on paths with single arrow represent standardized regression weights and those with double arrow represent correlations; solid lines with coefficients in bold indicate relationships which were significant at $p < .05$, and dotted lines with coefficients in parentheses represent relationships which were nonsignificant. Note: SDM = self-determined motivation; NSDM = non-self-determined motivation; CHF = congestive heart failure.

people succeed as well as why they might fail to succeed in maintaining intended behavioral changes. People continue to regulate desired behaviors when they feel competent to execute the behaviors and when they show self-determined motivation for specific behavior. They fail to regulate behavior over time, however, not because they lack the confidence to act, but because the motives behind their behaviors are NSDM. It follows then that individuals energized by SDM motives become more invested in the commitments they take on and are motivated to integrate, eventually internalize, intended behaviors and routines into their lives. Integration, and even more so internalization, is reflected in persistence and maintained behavior change. Non-self-determined regulation of behavior, on the other hand, is not manifested in the degree of commitment required for long-term regulation of behavior. At the root of successful (i.e., sustained) health behavior change lies strong commitment to act (Sheeran, Webb, & Gollwitzer, 2005). Our conclusions corroborate those of previous studies highlighting the importance of promoting autonomous self-regulation in order to achieve lasting behavior change (Edmunds, Ntoumanis, & Duda, 2008; Pelletier et al., 2004; Ryan et al., 2008; Slovinec D'Angelo et al., 2007; Williams, Gagné, Mushlin, & Deci, 2005).

It is noteworthy that although intrinsic motivation is always a golden goal, NSDM forms of motivation are relevant in the exercise domain where periods of extrinsically motivated practice are often required to develop skills. This was reflected in the negative relationship between NSDM motivation and self-efficacy: More extrinsic forms of motivation were associated with lower levels of barrier self-efficacy that coincide with evolving behavioral skills during the initial phase of behavior change. Indeed, many sport and exercise activities are, at least initially, extrinsically motivated. On average, exercise tends to be more extrinsically motivated than sport due to the fact that people generally engage in sport activities because they find them inherently interesting, challenging, and enjoyable, yet they tend to engage in exercise activities because they hope to gain something, such as improved health, looks, or to stay in shape (Ryan et al., 2009). This underscores the significance of targeting motivation in efforts to facilitate the progression from NSDM to SDM forms of exercise behavior regulation. That said, the potentially unique association of each type of NSDM motivation with behavioral regulation warrants further investigation as there are presently inconsistencies in the literature (Ng et al., 2012; Pelletier et al., 2004; Silva et al., 2011; Standage et al., 2008; Wilson, Sabiston, Mack, & Blanchard, 2012). Most notably, there is some evidence hinting at a potentially positive relationship between introjected regulation and short-term health behavior change (Ng et al., 2012; Silva et al., 2011). Based on previous research (Standage et al., 2008; Wilson et al., 2012) and theory (Deci & Ryan, 2002), we predicted that contextual NSDM motivation would be negatively related to exercise behavior. The results of the current study did not confirm this relationship, but showed that although NSDM motivation did not directly undermine the regulation of exercise behavior, it had a significantly negative indirect effect on 6-month behavior (as mediated by self-efficacy). Although this is a contribution to the presently limited evidence base regarding the role of NSDM motivation in behavioral regulation, it would be valuable for future research to confirm the unique role of each type of regulation in the health behavior change process.

In establishing barrier self-efficacy and self-determination as distinct predictors of short- and long-term behavior change, respectively, the present research has implications on the design, implementation, and evaluation of CR program intervention strategies. Cardiac rehabilitation efforts are mainly directed at increasing self-efficacy for exercise behavior. As demonstrated herein, however, maintenance of regular exercise is more dependent on SDM motivation for exercise behavior than on personal efficacy. Given that less than 50% of CR participants continue to exercise regularly, CR strategies might benefit from an overt emphasis on facilitating integration and internalization of exercise behavior and thereby participants' independent efforts to sustain behavior change. Previous studies have documented the value of targeting SDM motivation in the design and delivery of health promotion interventions. For example, Silva et al. (2011) showed that an intervention focused on increasing autonomous (i.e., SDM) motivation toward exercise in the service of weight control among a sample of women, yielded significantly higher levels of maintained exercise behavior change (1-year postintervention) compared with a general education control group. Prior research also demonstrated how SDM regulation of health behaviors can be fostered by directly assisting individuals' progress on the self-determination continuum toward more SDM forms of motivation as well as indirectly through motivational interviewing strategies (Markland, Ryan, Tobin, & Rollnick, 2005). Motivational interviewing is a client-centered approach to positive behavior change; it provides an autonomy supportive atmosphere that allows individuals to find their own source of motivation and set personally meaningful goals and action plans, and is thereby consistent with efforts directed specifically at increasing SDM motivation (Fortier, Duda, Guerin, & Teixeira, 2012; Silva et al., 2011; West et al., 2010). Fortier, Sweet, O'Sullivan, and Williams (2007) showed that an intensive SDT-grounded counseling intervention focused on promoting autonomous motivation for physical activity and delivered using some motivational interviewing techniques significantly increased activity levels at 6 and 13 weeks in a sample of primary care patients compared with brief autonomy supportive counseling by a family physician. Future research would do well to test an intervention specifically directed at facilitating progress on the SDT continuum toward more SDM regulations of exercise behavior in a large sample of cardiac patients and with long-term behavioral endpoints. Given that self-efficacy is an important intervention target during the initial stages of behavior change, health behavior change research might also want to examine different forms of self-efficacy, specifically relapse/recovery efficacy, in the trajectory of exercise and intervention design.

Other avenues for SDT intervention research would be to more closely examine how intervention components effect changes in SDM in different individuals based on their motivational tendencies (contextual and general), perceived competence and exercise levels at program intake; and how the changes in contextual SDM correspond to exercise regulation over time in different individuals. This would shed light on who might benefit most from this intervention approach and how the intervention could be tailored to individuals' motivational tendencies and exercise levels. For individuals who are SDM across life domains and feel confident about their ability to engage in exercise, intervention efforts could focus directly on promoting SDM in the context of exercise. For those who are generally SDM but lack the self-efficacy, efforts could focus on both promoting SDM and efficacy. Participants who are not generally SDM would gain most from intervention efforts aimed at enhancing SDM regulation of health behaviors overall. To this end, assessment of general motivation could also prove to be useful in multidisciplinary approaches for cardiac health promotion. Future research could expand on the work of Mata et al. (2009) regarding the motivational spill-over effects between health behaviors by examining the roles of general self-determination and exercise motivation in the prediction of simultaneous changes in other health behaviors, namely healthy eating, smoking cessation, and medication taking, among patients with CHD. Moreover, in light of our observed positive relationship between general SDM and NSDM, it would be interesting from a theoretical perspective for future studies to examine if SDM and NSDM are systematically positively related or if this is something that is specific to our sample.

Finally, future work can also address some limitations of the current research. One notable limitation is assessment of exercise behavior. In the present study participants self-reported the frequency of their exercise activity and self-evaluated their level of effort (i.e., mild, moderate, or strenuous). Tools such as accelerometers provide more accurate and objective assessments of physical activity and would add value to this study design by corroborating participants' self-reports. Furthermore, the present study did not consider the role played by the satisfaction or thwarting of individuals' three basic needs and more specifically the effects of increased autonomy or exercise engagement on health and health recovery. Examining these relationships should further substantiate the value of autonomous regulation of exercise behavior in this population.

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