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Promoting Self-Determined Motivation for Exercise in Cardiac Rehabilitation: The Role of Autonomy Support

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Objective: Using self-determination theory (SDT), we examined relationships between cardiac rehabilitation (CR) participants' perceived autonomy support, motivation for exercise, and exercise behavior. ***Research Method/Design:*** Male CR outpatients ($N = 53$; $M_{age} = 62.83 \pm 10.78$ years). The design was correlational (cross-sectional and prospective), examining relationships between perceived autonomy support and motivation for exercise at Week 4 of CR participation as well as motivation and CR attendance and other indicators of exercise behavior (frequency, duration, total exercise time) at a 1-week follow-up, 10 weeks later. ***Results:*** Perceived autonomy support was correlated with self-determined motivation, $r(53) = .32$, $p < .05$. Self-determined motivation predicted total exercise volume at follow-up, $r(53) = .34$, $p < .05$, as well as length of exercise session duration ($R^2 = .27$; $\beta = .52$, $p < .001$). ***Conclusion:*** Results support SDT and the potential for autonomy support from interventionists to affect self-determined motivation and exercise behavior of participants involved in CR.

Keywords: cardiovascular disease, physical activity, self-determination theory

Cardiac rehabilitation (CR) has been widely recognized as an important and effective treatment modality for individuals diagnosed with cardiovascular disease, including those with acute myocardial infarction, revascularization therapy (e.g., coronary artery bypass graft, percutaneous coronary intervention), stable angina, and chronic heart failure (McKelvie, 2008; Taylor et al., 2004; M. A. Williams et al., 2006). Through risk factor stratification, CR programs provide education, counseling, and training directed at health behavior modification targeting diet, smoking cessation, stress management, and exercise.

A primary component of CR programs is physical exercise. Considerable evidence supports the health benefit of regular exercise for the general population (Warburton, Nicol, & Bredin, 2006) and cardiac patients, in particular (Jolliffe et al., 2001; Taylor et al., 2004). Regular exercise not only improves cardiovascular efficiency, but it also has favorable effects on other heart disease risk factors such as high blood pressure, dyslipidemia, hyperglycemia, obesity, and depression (Bittner & Sanderson, 2006; Leon et al., 2005). As a result, participating in exercise-based CR has been shown to be associated with reduced morbidity and mortality, increased functional capacity, and improved quality of life (Bittner & Sanderson, 2006; Pasquali, Alexander, & Peterson, 2001; Taylor et al., 2004; M. A. Williams et al., 2006).

Despite the known benefits of regular exercise for cardiac patients (Jolliffe et al., 2001) and the delivery of CR programs to facilitate exercise participation, not all eligible patients enroll in CR (Daly et al., 2002), and for those who do participate, 50% are estimated to drop out within the first few months of the program (G. E. Moore, Durstine, & Marsh, 2002). In addition, exercise participation levels have been reported to decline over time following program completion, with up to 80% of patients failing to maintain regular exercise within the first year following CR (Bock, Carmona-Barros, Esler, & Tilkemeier, 2003; S. M. Moore, Dolansky, Ruland, Pashkow, & Blackburn, 2003; S. M. Moore et al., 2006). These trends underscore the need to develop an understanding of modifiable social, psychological, and environmental variables that help explain exercise participation among people with cardiovascular illness.

Self-determination theory (SDT; Deci & Ryan, 1985b; Ryan & Deci, 2002) is one psychosocial framework that considers the interaction of personal and environmental characteristics as determinants of behavior. A cornerstone of the SDT perspective is that people's motivation can be classified into two types—controlled and self-determined (or autonomous) motivation. *Controlled motivation* pertains to a desire to receive rewards or to avoid punishments as a result of engaging in the behavior, whether they be external (e.g., to gain acceptance from others) or internal (e.g., to avoid feeling guilty; Deci & Ryan, 2008). In contrast, *self-determined motivation* stems from a person's natural tendency to take an active role in directing his or her behavior (Deci & Ryan, 2008). Through a process known as *internalization*, the individual grasps the meaning or relative importance behind a behavior and makes the behavior more congruent with other personally held values and needs such that the behavior emanates from oneself (Ryan & Deci, 2002). Although both forms of motivation are known to affect behavior, self-determined motivation is likely to be associated with greater success in long-term behavioral maintenance (Deci & Ryan, 2008).

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In the exercise domain, self-determined motivation has been found to be associated with self-reported exercise behavior among individuals recruited from the community (Wilson, Rodgers, Blanchard, & Gessell, 2003). In an illustrative study, Thøgersen-Ntoumani and Ntoumanis (2006) found that individuals who reported to have been exercising regularly for longer than 6 months scored higher on measures of self-determined motivation and lower on controlled motivation compared with people who reported exercising less regularly. Higher scores for self-determined motivation have also been found to predict stronger intentions to engage in exercise behavior (Thøgersen-Ntoumani & Ntoumanis; Wilson & Rodgers, 2004).

SDT further postulates that certain social–contextual conditions can nurture this form of motivation to self-regulate and facilitate behavioral maintenance (Ryan, Patrick, Deci, & Williams, 2008). One social–contextual variable that has been examined extensively in previous applications of SDT to understanding health behavior is autonomy support. *Autonomy support* refers to a “mode of communication and persuasion in which the persuader fully acknowledges and respects the selfhood of the pursuadee” (Sheldon, Joiner, Pettit, & Williams, 2003, p. 306). In past research, higher levels of perceived autonomy support have been linked to greater self-determined motivation as well as attainment of health-related goals that include better glycemic control in patients with diabetes (G. C. Williams, McGregor, Zeldman, Freedman, & Deci, 2004), diet and exercise adherence in patients with chest pain (G. C. Williams, Gagné, Mushlin, & Deci, 2005), and greater success in smoking cessation (e.g., G. C. Williams et al., 2006).

Given that CR settings allow for regular interaction between exercise leaders or interventionists and program participants, there is potential for establishing an environment that can be supportive of patients’ autonomous self-regulation of exercise. For instance, autonomy support in CR could be manifested by providing relevant information regarding the benefits of exercise and realistic expectations of the program, providing informative and contingent feedback regarding progress, displaying an honest understanding of challenges faced by the patients and providing options on how to address their concerns, and encouraging patients to ask questions and get involved with their health behavior decisions. Thus, as a process, autonomy-supportive instructional styles on the part of exercise interventionists may play an important role in developing CR participants’ self-determined motivation to adopt patterns of regular exercise.

To date, we are not aware of any existing literature examining perceived autonomy support in CR. However, self-determined motivation has been found to be associated with positive exercise-related cognitions and behavior in CR contexts. A previous study examining self-determination for exercise found that cardiac patients who reported a greater degree of self-determined motivation also reported greater exercise intentions and more specific plans for future exercise (Slovinec D’Angelo, Reid, & Pelletier, 2007). Self-determined motivation has also been found to predict independent, home-based exercise behavior following discharge from a CR program (Russell & Bray, 2009). Those findings indicate that self-determined motivation may be important for patients as they make a transition from interventionist-supervised exercise in CR to self-managed exercise at home. Because autonomy support should help facilitate self-determined motivation for behavioral regulation (Ryan et al., 2008), it may be an important modifiable social–environmental factor that can have an indirect impact on exercise adherence in CR. That is, greater autonomy support should encourage greater self-determined motivation to exercise, which in turn should increase the amount of exercise one does.

The present study had two objectives. First, we examined the relationship between perceived autonomy support provided by CR exercise interventionists and participants’ motivation to exercise during the initial months of participation in CR. On the basis of past findings by Williams and colleagues (e.g., G. C. Williams, Grow, Freedman, Ryan, & Deci, 1996; G. C. Williams et al., 2006), we hypothesized that perceived autonomy support would be positively associated with self-determined motivation and negatively related, or unrelated, to controlled motivation.

Second, we examined relationships between motivation (controlled and self-determined) and indicators of exercise behavior. One indicator was participants’ attendance at the CR program over a period of 8 weeks. In line with previous research (Russell & Bray, 2009) and theorizing by Slovinec D’Angelo et al. (2007), we expected self-determined motivation, and not controlled motivation, to be positively associated with CR program attendance. We also operationalized exercise behavior on the basis of participants’ self-reports of their exercise behavior in a 1-week study follow-up period. Specifically, exercise behavior was segmented into a frequency component, represented by the number of exercise sessions performed; a duration component, represented by the amount of time spent exercising during sessions; and an overall exercise indicator, represented by the total amount of time spent exercising during the week. Again, on the basis of previous research (Russell & Bray, 2009) and theorizing by Slovenic D’Angelo et al., we expected self-determined motivation to be positively associated with exercise frequency, duration, and total exercise volume.

Method

Participants

Male participants inducted into a supervised exercise-based CR program at a major urban hospital in southern Ontario between October 2007 and February 2008 were invited to participate in the study. Participants had documented evidence of myocardial infarction, angioplasty, coronary artery bypass surgery, valve replacement, or were identified by a physician as being “at risk” for cardiovascular disease. Only male participants were included given a disproportional number of men enrolled in the CR program (~80%) and conflict with a parallel study that limited access to women involved in the program.

Of 116 eligible participants, 67 agreed to participate in the study. Twenty-one individuals dropped out of the CR program prior to the onset of the study, and 28 did not accept the invitation to participate. Lack of interest in participating in the study was the main reason for declining participation. Of 67 who completed a consent form and baseline measures, 14 (21%) were lost to attrition. Six individuals left the study because of personal illness or injury, one left because of spousal illness, and one died before study completion. The remaining six study dropouts were also dropouts of the CR program and despite efforts to contact those individuals, their reasons for leaving the program or the study could not be determined. Thus, the final sample size consisted of

53 participants. The sample had a mean age of 62.83 years (SD = 10.78, range = 44 to 87 years). Additional demographic characteristics of the sample can be found in Table 1.

Measures

Perceived autonomy support. A shortened, six-item version of the original 15-item Health Care Climate Questionnaire (G. C. Williams et al., 1996) was used to assess participants' perceptions of autonomy support provided by their exercise leaders for engaging in exercise. The six-item scale has been used in place of the original 15-item version in previous research (G. C. Williams, McGregor, King, Nelson, & Glasgow, 2005) and has been shown to have good psychometric characteristics. Participants responded to each item on a 7-point Likert-type scale (1 = *strongly disagree* to 7 = *strongly agree*). An example item was "Since beginning my CR program, my exercise leader conveys confidence in my ability to make changes regarding how much physical activity I engage in." Item scores were averaged, with higher mean scores indicating higher levels of perceived autonomy support. The scale showed good internal consistency in the present study, with a Cronbach's alpha of .95 (Tabachnick & Fidell, 2001).

Motivation for exercise. The Exercise Self-Regulation Questionnaire, which has been previously adapted from self-regulation questionnaires introduced by Ryan and Connell (1989), was used to assess participants' autonomous and controlled motivation for exercising. The Exercise Self-Regulation Questionnaire was adapted to include four additional items reflecting a form of motivation termed *integrated regulation*, which recently has been shown to be an important autonomous form of behavioral regulation in the exercise domain (Wilson, Rodgers, Loitz, & Scime, 2006). Following the stem "There are a variety of reasons why people choose to be physically active. Please indicate how true each of these reasons is for why you are exercising," participants responded to each item on a 7-point Likert-type scale (1 = *not at all true* to 7 = *very true*), with each item reflecting varying degrees of autonomous motivation. Example items of controlled motivation for exercising included "Because others would be angry at me if I did not," and "Because I would feel bad about myself if I did not." Items reflecting self-determined motivation included "Because I feel like it's the best way to help myself," "Because it is consistent with my life goals," and "Because I enjoy exercising." Subscale scores were calculated by averaging the items representing each subscale (eight items for controlled, 12 items for self-determined). Cronbach's alphas for the controlled motivation and self-determined motivation subscales were .85 and .91, respectively.

Table 1
*Demographic Characteristics of Study Participants (*N *= 51)*

Variable	*n*	%
Ethnicity		
Caucasian	51	96
Other	2	4
Marital status		
Married	43	81
Separated, divorced	4	7
Single	3	6
Common-law	2	4
Widowed	1	2
Employment status		
Employed	24	45
Retired	29	55
Most invasive cardiac procedure		
Angiogram only	5	9
Angioplasty	15	28
CABG	28	53
Valve replacement	3	6
"At risk" only	2	4
Occupation		
Sales, service	18	34
Trades, transport	12	23
Education, government	6	11
Other	12	23
Not indicated	5	9

Note. CABG = coronary artery bypass graft.

CR program attendance. Program attendance was determined from hospital records for the CR program. Attendance for each participant was calculated by dividing the number of supervised exercise sessions attended by the number of scheduled sessions (20 sessions) from Week 5 to Week 12 of program participation. For example, if a participant attended 15 of 20 scheduled sessions, his attendance score was 75%.

Exercise behavior. Exercise behavior was assessed using the 7-day Physical Activity Recall (PAR) questionnaire (Blair et al., 1985). Participants completed the PAR questionnaire, estimating the frequency and duration of activities engaged in over the previous 7 days (e.g., walking, bicycling), as well as the intensity at which they rated each activity (i.e., light, moderate, heavy). Because they were making a transition from the CR program to independent exercise, some study participants were still attending some exercise sessions at the CR facility; therefore, exercise reportedly carried out during CR sessions attended during that week was also included in the recall measure. The PAR has been previously validated against objective measures such as accelerometer data (Hayden-Wade, Coleman, Sallis, & Armstrong, 2003). Given recommendations for people with, or at risk for, cardiovascular illness (Stone & Arthur, 2005) and the primary emphasis in the CR program, aerobic exercise performed at the moderate to vigorous intensity levels was of interest. Three indicators of exercise behavior were created. First, frequency of exercise was calculated by summing the number of days on which the participant reported doing moderate or vigorous exercise lasting 10 min or longer. Second, the amount of time spent exercising during each session (reported in minutes) was averaged across the number of exercise sessions performed. Third, a measure of total moderate or vigorous exercise was created by summing the number of minutes of exercise performed during the week.

Procedure

The study protocol was reviewed and approved by the joint university and hospital research ethics board. Exercise interventionists employed at the CR program were informed of the eligibility criteria and study procedures, and provided a study information sheet and contact information for the study coordinator (first author) to eligible and interested participants during their second week of enrollment in the CR program. During Week 3 of program participation, the information sheet and consent form were reviewed with each participant by the first author and, on agreement to participate in the study, signed the informed consent. An appointment was scheduled for the following week (Week 4 of participation in the CR program), at which time the first questionnaire package that assessed demographic information, perceived autonomy support, and motivation for exercise was completed. Program attendance was tracked for the subsequent 8 weeks (Weeks 5–12 of CR). Two weeks later (i.e., 10 weeks after the baseline measures were obtained), participants completed the PAR self-report of their exercise behavior for the previous 7 days. Participants were then debriefed about the study objectives and thanked for their participation.

Results

Descriptive statistics and bivariate correlations for measures of autonomy support, controlled and self-determined motivation, program attendance, and exercise behavior are presented in Table 2. Participants reported generally strong perceptions of autonomy support received from their CR interventionists, with a mean of 5.72 ($SD = 1.18$). Participants also reported high levels of self-determined motivation for exercise ($M = 5.87$, $SD = 0.96$) and relatively lower levels of controlled motivation. Overall, participants attended 76.06% of their supervised CR classes during the 8-week recording window and reported exercising on 4 of 7 days, with an average of 51 min per exercise bout during the 1-week study follow-up period.

As hypothesized, there was a significant positive correlation between perceived autonomy support and self-determined motivation, $r(53) = .32$, $p < .05$, whereas the relationship between autonomy support and controlled motivation was not significant. There was also a positive correlation between perceived autonomy support and average exercise session duration, $r(53) = .27$, $p < .05$.

Self-determined motivation was positively correlated with average exercise session duration, $r(53) = .52$, $p < .01$, as well as total exercise volume, $r(53) = .34$, $p < .05$, during the 1-week recall period. Contrary to predictions, self-determined motivation was not correlated with CR attendance or exercise frequency. No significant correlations were evident between controlled motivation and the exercise variables.

We had originally expected that self-determined motivation would predict CR adherence as well as home-based exercise frequency; however, because these measures of exercise behavior were not correlated with self-determined motivation, we performed no prediction analyses. Self-determined motivation was significantly correlated with total exercise volume and exercise duration during the 1-week follow-up exercise period. Simple linear regression analysis was used to assess the prospective relationship between self-determined motivation and total exercise volume. That analysis revealed that self-determined motivation accounted for 11.3% of the variance in total exercise volume, $F(1, 52) = 6.50$, $\beta = .34$, $p < .05$.

The relationship between self-determined motivation and exercise duration during the 1-week recall period was investigated using hierarchical linear regression analysis. This analysis strategy was necessary to control for the effect of perceived autonomy support, which was also correlated with exercise duration. As shown in Table 3, results of the regression model predicting average exercise session duration showed a significant effect for self-determined motivation ($R^2 = .27$; $\beta = .49$, $p < .001$), but no direct effect of autonomy support on exercise behavior with self-determined motivation in the model ($\Delta R^2 = .01$; $\beta = .12$, $p > .05$).

Discussion

The purpose of the study was to examine the relationship between perceived autonomy support received from exercise interventionists and participants' self-determined motivation to exercise while involved in CR as well as relationships between self-determined motivation and several indicators of physical activity behavior during CR. Results showed that perceived autonomy support was positively related to self-determined motivation. Self-determined motivation reported in the early stages of CR was positively related to the duration of time participants exercised in their exercise sessions as well as a measure of total exercise volume during a 1-week period at the completion of CR. Together, the results support SDT and its application to understanding factors that influence motivation to exercise and the role of self-determined motivation in exercise participation in CR.

We hypothesized two major sets of findings in the present study. The first was that participants who reported higher levels of perceived autonomy support from their interventionists would report higher levels of self-determined motivation for exercising. This hypothesis was supported and, although the effect size representing the relationship was small to medium (Cohen, 1992), the

Table 2
Descriptive Statistics and Relationships Between Perceived Autonomy Support, Motivation, Program Attendance, and Exercise Behavior Variables

Variable	*M* (*SD*)	Range	1	2	3	4	5	6	7
1. Perceived autonomy support	5.72 (1.18)	1.67–7.00	—	.32*	.15	.10	.09	.27*	.19
2. Autonomous motivation	5.87 (.96)	3.33–7.00		—	.38**	.16	.21	.52**	.34*
3. Controlled motivation	3.22 (1.37)	1.00–6.25			—	.07	.06	.16	.10
4. Program attendance (%)	76.06 (16.93)	25.00–100.00				—	.13	.08	.12
5. Exercise frequency (days)	4.19 (1.93)	0.00–7.00					—	.25	.83**
6. Exercise duration (min)	51.04 (17.69)	0.00–94.29						—	.62**
7. Exercise total volume (min)	222.13 (131.41)	0.00–660.00							—

Note. $N = 53$.
* $p < .05$. ** $p < .01$.

Table 3
Hierarchical Regression Analysis Predicting Average Duration of Exercise Sessions During 1-Week Follow-Up Period

Criterion: Average exercise session duration	Model R^2_{Adj}	$R^2\Delta$	β	t
Step 1: Self-determined motivation	.26	.27	.52	4.39^{***}
Step 2: Self-determined motivation	.26	.01	.49	3.86^{***}
Perceived autonomy support			.12	0.96

Note. $N = 53$. Exercise session duration determined by 1-week Physical Activity Recall questionnaire. Step 1, $t(1, 52)$; Step 2, $t(2, 51)$.
$^{***}\ p < .001$.

results suggest that autonomy-supportive influences in CR follow a pattern predicted by SDT. These findings also serve to buttress those of previous correlational studies examining perceived autonomy support in asymptomatic samples in the exercise domain (e.g., Edmunds, Ntoumanis, & Duda, 2006; Wilson & Rodgers, 2004).

Although supportive correlational evidence is important in the early stages of research, the causal role of autonomy support in the development of self-determined motivation requires further exploration. Indeed, Wilson, Mack, and Grattan (2008) have argued a need for more experimental studies to clarify the role that autonomy support can have on self-regulation of exercise. In one of the few studies to investigate manipulations of exercise instructors' autonomy-supportive behaviors, Edmunds, Ntoumanis, and Duda (2008) did not find an effect for autonomy support on the rate of change in participants' self-determined motivation for exercise. However, more evidence is required before firm conclusions can be drawn. In the area of CR, autonomy support appears to be an important social–contextual variable in the promotion of cardiac patients' self-determined motivation for exercise as a component of secondary prevention. Repeated exposure to an environment supportive of autonomy while participating in a CR program would likely strengthen cardiac patients' motivation to play an active role in planning and adopting exercise into their daily routines over time (Deci & Ryan, 2008; Edmunds et al., 2008). Future research investigating causal relationships between autonomy support from exercise interventionists, self-determined motivation, and behavior in structured exercise rehabilitation settings such as CR is encouraged.

Our second set of hypotheses predicted that self-determined motivation would be positively related to exercise behavior that was supervised in CR as well as unsupervised at home. These hypotheses were partially supported. One compelling finding is the small to medium effect size representing the relationship between self-determined motivation and total exercise volume performed by CR participants in a 1-week follow-up period 10 weeks after measuring motivation. These results indicate that the more CR participants felt they were exercising for intrinsic reasons, the more exercise they did. It is important to note that the measure of total exercise volume was determined from a combination of exercise sessions performed during the CR program and the exercise participants performed on their own. Participation in CR has proven benefits for people with cardiovascular illness; however, CR programs are typically short-duration interventions that eventually discharge participants to manage their own exercise behavior. Our results suggest that the extent to which CR participants feel self-determined in their motivation to exercise during the early stages of CR may help ingrain an important pattern of exercise behavior that extends beyond the prescribed exercises undertaken during their supervised CR classes.

The measure of total exercise volume in this study was a composite representation of weekly frequency of exercise sessions and the duration of those sessions. Contrary to hypotheses, the relationship between self-determined motivation scores and exercise session frequency was not statistically significant. However, participants who reported higher levels of self-determined motivation for exercise in the early stages of CR reported engaging in cardiovascular exercise at moderate and vigorous intensities for longer periods of time when they chose to exercise. Exercising for a sufficient duration of time (i.e., 30–60 min per session) is an essential element in the exercise prescription for participants in CR (Smith et al., 2006; Stone & Arthur, 2005). Given that the average duration of exercise sessions reported by participants was about 50 min, this result provides a positive indication that greater self-determination leads CR participants to plan or implement exercise sessions that are at the higher end of the prescribed continuum and therefore may lead to greater cardiovascular training benefits.

The positive relationship between self-determined motivation, total exercise volume, and exercise session duration supports findings from previous work examining CR participants' exercise intentions and behavior (Russell & Bray, 2009; Slovinec D'Angelo et al., 2007). From a theory standpoint, greater self-determined motivation has a positive effect not only on one's ability to initiate engagement in a new behavior, but more important, on one's ability to maintain behavior over time (Deci & Ryan, 2008). Thus, patients in CR who acknowledge the relative importance behind exercise and integrate it into their behavioral repertoire so that they actively and volitionally engage in exercise will likely have more success in maintaining exercise as they transition from supervised to independent exercise (Russell & Bray, 2009).

A finding that did not support our hypotheses was a lack of relationship between self-determined motivation and CR program attendance. We expected participants who had internalized their motivation to exercise more strongly would have attended their CR program more fastidiously. However, these results may not be surprising considering the sample comprised participants coping with the impact of a cardiac event or cardiac disease-related diagnosis who had been informed of the risks and benefits of CR. Given their proximity to serious health threat, all participants may have been highly motivated to follow their doctors' orders and attend as many of the CR program sessions as possible. Indeed, attendance was high, with over 75% of classes attended. CR programs usually represent only a fraction of the exercise prescription for people with cardiovascular disease as participants are encouraged to exercise frequently outside of CR (Smith et al., 2006; Stone & Arthur, 2005). Adherence to such a prescription may require considerable organization and coordination with other activities. Stronger correlations with total exercise volume suggest that greater self-determined motivation for exercise may encourage a more integrated view of exercise behavior that encompasses CR classes as well as other activities.

Considered together, the results of the study provide encouraging evidence that higher levels of autonomy support are linked to greater self-determined motivation to exercise in the early stages of CR. The prospective results also suggest that greater self-determined motivation may encourage higher levels of exercise behavior. Nonetheless, some study limitations should be noted. One limitation relates to the relatively small convenience sample of CR participants who were all men. This characteristic of the sample somewhat constrains the generalizability of the study's findings. However, given that the majority of participants in CR programs are men (Halm, Penque, Doll, & Beahrs, 1999; Jackson, Leclerc, Erskine, & Linden, 2005), the results should be considered relevant to a large proportion of CR participants. A growing number of women are developing heart disease (Lloyd-Jones et al., 2009) and will be candidates for CR; therefore, future research examining autonomy support, self-determined motivation, and exercise in CR should involve female participants.

A second limitation relates to the correlational nature of the data. Causal relationships between variables such as autonomy support from exercise interventionists and participants' self-determined motivation in CR cannot be determined without repeated assessments of constructs and behavior over time or a randomized control trial. For example, we found that autonomy support at our baseline predicted self-determined motivation. However, changes in autonomy support and self-determined motivation are likely to occur over time. The degree to which autonomy support or self-determined motivation changes during CR may also provide important information about behavioral outcomes such as program adherence and independent exercise behavior. Future research along these lines as well as a longer follow-up period over which to investigate exercise behavior is encouraged.

In addition, other variables identified within the SDT framework could affect relationships between the variables examined in this study and would be beneficial to include in subsequent research. For example, general causality orientations that describe the extent of one's natural tendency to be "autonomy-oriented" and, thus, more attuned to autonomy-supportive behavior (Deci & Ryan, 1985a, 2008) could be a factor underlying autonomy support scores in the present study. Also, SDT proposes that the effect of autonomy support on self-determined motivation may be mediated by psychological needs satisfaction. As noted by Edmunds, Ntoumanis, and Duda (2007), satisfaction of the need for competence may be an important pathway through which autonomy support may exert an impact on self-determined motivation. Sources and consequences of psychological need satisfaction during CR should be examined in future studies. Finally, although CR interventionists may be a focal source of interaction and autonomy support during CR program attendance, other sources of autonomy support (e.g., spouse, friend, family physician) may also have important influences on CR participants' motivational orientations and subsequent exercise behavior. Other sources of autonomy support for exercise in CR should be investigated in future research.

The results of the present study support the utility of the SDT framework for predicting the exercise behavior of participants in CR. We found that CR participants who reported higher levels of autonomy support from their exercise interventionists had higher self-determined motivation to exercise. Higher self-determined motivation was, in turn, associated with higher levels of exercise, both as a function of the duration of time people engaged in exercise as well as the overall amount of exercise they performed during a 1-week follow-up period. Results suggest the nature of interactions between CR interventionists and participants can play an important role in developing feelings of self-determination. Rehabilitation interventionists are encouraged to be cognizant of their behaviors when interacting with participants and to modify those behaviors to support participants' autonomy and develop greater self-determination and adherence to exercise.

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