Self-efficacy for Exercise in Cardiac Rehabilitation

Review and Recommendations

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Abstract

Despite the numerous physical and psychosocial benefits of exercise for coronary heart disease survivors, non-adherence to cardiac rehabilitation (CR) exercise is a major problem. Adherence to the lifestyle behavior change associated with CR involves both physical and self-regulatory skills. While self-regulatory efficacy is clearly linked to exercise adherence and adjustment, the literature on the relationship between self-efficacy and exercise among CR participants has not been systematically reviewed. A search of relevant databases identified 41 CR studies. Few studies measured self-regulatory efficacy for actions that facilitate adherence. Most studies examined self-efficacy during the intensive center-based phase of CR, with little attention to long-term maintenance. The CR literature could benefit by examining (a) self-efficacy as a major rehabilitation outcome, (b) measurement of self-regulatory efficacy for behavior change, (c) suspected moderators of self-efficacy (i.e. gender, age), and (d) self-efficacy relative to maintenance.

Keywords

- *cardiac rehabilitation*
- *exercise*
- *physical activity*
- *review*
- *self-efficacy*

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ACCORDING to the American Heart Association (AHA) (2005), an estimated 700,000 Americans will have a new myocardial infarction this year, and another 500,000 will experience a recurrent event. In addition, heart disease accounted for the deaths of more than 147,500 people in the United Kingdom in 2003 (British Heart Foundation, 2005) and 74,626 Canadians in 2002 (Statistics Canada, 2004). In the USA, the economic cost of cardiovascular disease (CVD) for 2005 is projected to be $393.5 billion (AHA, 2005). Remarkably, more than 14 percent of this cost is due to lost productivity from temporary or permanent disability. Given the burgeoning incidence of CVD, attention must be paid to enhancing the effectiveness of cardiac rehabilitation (CR) programs in order to manage related morbidity and economic consequences.

CR programs frequently represent a multi-component process that includes systematic attempts to change behavior in order to produce desirable physical health outcomes (e.g. improved physiological and physical function, return to work) and mental health outcomes (e.g. improved quality of life, reduced transitory depression; American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), 1999). While it is well established that CR exercise therapy can lead to reliable changes in both physiological and functional outcomes, adherence to these programs is problematic (AACVPR, 1999; Mullinax, 1995). Furthermore, adherence to long-term lifestyle change is necessary to maintain the benefits of physical activity (Rothman, 2000; Wing, 2000).

Participant motivation is frequently identified as one explanation for adherence and maintenance problems. Motivation is inferred from behavioral manifestations of adherence such as effort, persistence, strategy changes, and focused attention. Clearly, many of these behaviors are required of the CR participant if their adherence is to result in successful health outcomes. One set of beliefs known to be related to exercise adherence behavior is self-efficacy beliefs (McAuley & Mihalko, 1998). Self-efficacy beliefs represent individuals' judgments of their capacities to perform specific actions (Bandura, 1997). According to self-efficacy theory, individuals' perceptions of their capabilities in particular domains are postulated to influence their choice of activity, effort expenditure, and persistence in the face of adversity.

Behavior is also affected by the outcomes individuals expect from their actions (i.e. outcome expectancies). These outcomes can take physical (e.g. symptom improvement), social (e.g. approval/disapproval of a CR interventionist or a spouse), and self-evaluative (e.g. positive/negative self-evaluation of health status) forms. Bandura (2004) notes that motivation is increased by helping individuals to understand that behavioral changes are in the interest of outcomes they personally desire and consistent with larger goals they value (e.g. sticking with rehabilitative physical activity will improve a CR participant's mobility and exercise tolerance which will lead to the larger goal of improved cardiovascular health). For the purposes of this review, we will only focus upon self-efficacy beliefs and their relationship to exercise and physical activity in the context of cardiac rehabilitation. Consequently, we have limited our attention to the relation of self-efficacy to physical activity behaviour. Parenthetically, much less systematic research in CR has been conducted on the relationship between physical activity and outcome expectancies. However, the reader is referred to a recent review of outcome expectancies (Williams, Anderson, & Winett, 2005).

Although the context of CR and the characteristics of its participants differ from the social context in which asymptomatic participants engage in exercise, it is instructive to understand the relationship between adherence and exercise participation in that context. Perceptions of personal efficacy have been consistently identified as determinants of exercise adherence in asymptomatic, younger, and older populations (McAuley & Mihalko, 1998). As well as being a determinant of exercise, self-efficacy is also influenced by the exercise experience such that mastery exposures are posited to enhance self-efficacy (Bandura, 1997). Accordingly, both acute and long-term bouts of exercise have been demonstrated to enhance self-efficacy perceptions in asymptomatic samples (McAuley & Blissmer, 2000). However, it is unclear whether the short-term increases in task self-efficacy reported in the literature are actually related to the maintenance of exercise behavior (Rothman, 2000).

It is also noteworthy that a distinction has been made between task and self-regulatory efficacy (Bandura, 1997). Specifically, an individual will have self-efficacy beliefs about different types of performances (i.e. task and self-regulatory performances). Self-regulatory efficacy reflects confidence for such performances as scheduling and planning exercise sessions and adapting when pressed for time (Brawley et al., 2003; Maddux & Gosselin, 2003; McAuley & Mihalko, 1998). To date, self-efficacy beliefs about both task and self-regulatory performances have been shown to predict exercise behavior (McAuley & Mihalko, 1998; McAuley, Pena, & Jerome, 2001). Moreover, efficacy beliefs about self-regulatory performance accomplishments related to the regular performance of health behaviors (e.g. exercise) have been identified as the more crucial efficacy beliefs to measure (Bandura, 1995, 2004; Maddux, 1995).

Inasmuch as exercise therapy in CR reflects a systematic intervention to improve physical function, the mastery experiences of participants engaged in such a program generate efficacy beliefs about their personal exercise capabilities. In fact, these beliefs have been shown to be strongly predictive of certain CR outcomes (Ewart, 1995). For these reasons, Berkhuysen, Nieuwland, Buunk, Sanderman, and Rispens (1999) have argued convincingly that self-efficacy beliefs may stimulate changes in beneficial recovery and rehabilitation behaviors and thus should be considered as an important outcome of CR. Indeed, the AACVPR (2004) has acknowledged self-efficacy beliefs in its guidelines in relation to the promotion of behavior change. Furthermore, Maddux and Gosselin (2003) have emphasized that one of the most important consequences of the development of self-efficacy beliefs is the development of capacity for self-regulation. Self-efficacy beliefs encourage self-regulation by influencing goal-setting, activity choice, persistence, effort expenditure, and problem-solving—necessary skills to foster behavior change. While the notion of developing self-regulatory efficacy may intuitively appear to be part of CR programs, and would seem related to CRP outcomes, there is a need to determine if this has been demonstrated in the extant literature (cf. Brawley, Rejeski, & King, 2003).

Whereas the nature of the CR program and related outcomes provide justification for examining self-efficacy, further impetus is derived from a consideration of the characteristics of the older adult population that constitute a large proportion of the participants engaged in CR.

Advanced age is often associated with declines in physical function and concomitant reductions in task efficacy (McAuley & Katula, 1998). However, attendant disease conditions such as coronary heart disease are likely to dramatically and rapidly decrease self-efficacy beliefs. Participation in the physically active lifestyle advocated by CR does much to attenuate further decline in physical function. On the other hand, the maintenance of older adults' lifestyle change is complex and challenging when considered in the face of the chronic nature of CVD combined with other age-related comorbidities (Brawley et al., 2003). It would be useful to understand the factors that promote or inhibit older adults' self-efficacy beliefs and their relationship to CR adherence behavior, given the complexity of exercise rehabilitation and the challenge of maintaining lifestyle change.

Although Ewart (1995) has provided a selective narrative review of limited studies drawn from the CR and self-efficacy literature, no *systematic* attention has been paid to the relationship between self-efficacy and exercise among individuals involved in CR. This is surprising given that McAuley and colleagues (1998; McAuley & Blissmer, 2000; McAuley et al., 2001) have reviewed a substantial body of research on self-efficacy and exercise that mainly concerns *asymptomatic* individuals. While the aforementioned reviews draw attention to examples of studies that concern self-efficacy and exercise among individuals with chronic disease (e.g. chronic obstructive pulmonary disease; heart disease), a review of the symptomatic population studies was not their main purpose. Thus, it is the overall purpose of this article to focus on one of these populations. We review the observational, experimental, and intervention research on exercise and self-efficacy as related to the CR context. In doing so, we will determine whether CR results (a) support the propositions of self-efficacy theory, (b) are consistent with the findings in the general exercise literature and consider (c) the extent to which the CR findings should be qualified based upon the quality of the research. Relative to these conclusions we will (d) make recommendations for the next generation of research.

Method

A comprehensive, computerized search of the published English-language literature on self-efficacy and cardiac rehabilitation exercise was conducted. First, three relevant databases—PsycINFO, PubMed, and SPORTDiscus—were systematically searched for all previous years up to and including March 2005. The search terms utilized a combination of the keywords *cardiac*, *coronary*, *rehabilitation*, *exercise*, *physical activity*, and *self-efficacy*. Second, previous selected narrative reviews on self-efficacy and CR were hand searched for additional citations (Ewart, 1995; Lemanski, 1990). Finally, two reviewers were involved in data extraction and quality assessment.

Inclusion criteria

The first criterion for inclusion in this review was that self-efficacy was assessed relative to physical activity. In other words, self-efficacy was operationalized as either task self-efficacy to perform specific physical activities (e.g. walking, jogging) or self-regulatory efficacy to perform actions that facilitate exercise adherence (e.g. overcome barriers, schedule). The second inclusion criterion was that the study focused on exercise as either a treatment, antecedent or outcome variable. Specifically, physical activity was operationalized as planned, structured bodily movement done to improve or maintain one or more components of physical function (i.e. acute bouts, structured exercise, lifestyle participation). The final inclusion criterion was that a study was empirical and conducted using individuals engaged in CR.

Based on our inclusion criteria, the literature search resulted in the detection of 41 English-language articles that specifically considered self-efficacy and exercise rehabilitation for cardiac patients. These articles were drawn from a range of journals in diverse areas including nursing, cardiology, rehabilitation, and exercise. The articles spanned a 22-year time frame (i.e. 1983 to 2005).

Each of the 41 studies was subsequently examined on the basis of: (a) participant characteristics (e.g. gender, age); (b) research design; (c) conceptualization of self-efficacy (i.e. task versus self-regulatory); (d) direction of the self-efficacy and physical activity relationship (i.e. self-efficacy as an antecedent or outcome); (e) timing of self-efficacy measurement; (f) intervention characteristics (e.g. physical activity versus psychosocial); and (g) nature and type of physical activity (e.g. frequency, intensity). These details are summarized in Tables 1 and 2. Criteria for evaluation of the self-efficacy concept and related measures followed tenets of self-efficacy theory (Bandura, 1997) and reviews of self-efficacy measurement in the general physical activity literature (McAuley & Mihalko, 1998; McAuley et al., 2001).

Results

Participant characteristics and research design

As shown in Table 1, the sample sizes ranged from 21 to 472 participants with a mean of 92. The mean age of participants ranged from 52 to 76, with a mean of 60 years. However, five studies either did not report descriptive statistics for age of participants (e.g. Allison & Keller, 1992) or only reported age range descriptions (e.g. 72% between 45–64 years: Vidmar & Rubison, 1994).

The vast majority of study participants was men (*M* = 80%). Thirty-two studies examined both men and women, while seven studies examined solely male participants and one study examined solely female participants (Moore et al., 2003). In addition, two studies did not report the gender of their study participants.

The majority of study samples was comprised of individuals with heterogeneous cardiovascular complications (e.g. myocardial infarction: MI; coronary artery bypass graft: CABG). However, four studies examined *only* CABG patients (Brown et al., 1992; Carroll, 1995; Gilliss et al., 1993; Parent & Fortin, 2000) and two studies consisted of *only* MI patients (Bennett et al., 1999; Ewart et al., 1983). An additional study examined a combination of individuals with CVD and those at high-risk for developing CVD (Rejeski et al., 2003).

Operationalization of self-efficacy

Task self-efficacy In this literature, the majority of studies operationalized self-efficacy as task efficacy (i.e. confidence to perform the elemental aspects of a task such as walking for 20 minutes at moderate intensity). Thirty-nine studies in the present review assessed participants' confidence to perform specific physical activities (e.g. climbing, jogging, walking, cycling). In addition, one recent study (Bray & Cowan, 2004) assessed participants' confidence in the skills and abilities of their exercise consultant (i.e. proxy efficacy).

Self-regulatory-efficacy Only nine studies measured self-regulatory efficacy for actions that facilitate exercise adherence (see Table 1). Specifically, Woodgate and colleagues (2005) assessed self-efficacy to schedule exercise sessions, while five studies examined self-efficacy to overcome barriers to attendance (Blanchard et al., 2002; Bock et al., 1997; Maddison & Prapavessis, 2004; Rejeski et al., 2003; Vidmar & Rubison, 1994). In addition, although one study labelled a scale as 'maintenance efficacy', inspection of the scale items revealed that it assessed self-efficacy to overcome barriers (Scholz et al., 2005). Finally, self-efficacy was also measured as confidence to control symptoms and maintain function (Berkhuysen et al., 1999).

Table 1. Characteristics of self-efficacy and exercise studies

	Participants							
Citation	*N*	*M age*	*% men*	*Design*	*Self-efficacy*	*Exercise behavior*	*Findings*	*Result*
Antecedent studies (N=16)								
Bennett, Mayfield, Norman, Lowe, & Morgan (1999)	37	62	73	Prospective	Task	Exercise frequency	SE did not predict frequency of light exercise	–
Blanchard, Rodgers, Courneya, Daub, & Knapik (2002)	81	60	70	Prospective	Self-regulatory	CR attendance	Men reported higher SE and exercise attendance. SE related to attendance	+
Carroll (1995)	133	72	76	Prospective	Task	Jenkins Activity Checklist	SE predicted activity at 6 weeks	+
Ewart et al. (1986b)	40	55	100	Prospective	Task	Heart rate	Jogging SE related to minutes of exercise above prescribed heart rate	+
Ewart, Taylor, Reese, & DeBusk (1983)	40	52	100	Prospective	Task	Heart rate Activity monitor	Change in SE score correlated with heart rate and leg work at home	+
Jeng & Braun (1997)	33	50% >65	76	Prospective	Task	Compliance rate Exercise Intensity	No relationship between SE and compliance rate or exercise intensity	0
Jenkins & Gortner (1998)	199	76	76	Prospective	Task	Jenkins Activity Checklist	SE correlated with activity	+
Maddison & Prapavessis (2004)	41	64	71	Prospective	Task Self-regulatory	CR attendance Energy expenditure	SRSE predicted attendance but not energy expenditureTask SE predicted energy expenditure but not attendance	+, 0
Moore, Dolansky, Ruland, Pashkow, & Blackburn (2003)	60	54	0	Prospective	Task	Total number of exercise minutes; exercise intensity; number of exercise sessions attended	At 3 months, SE correlated with total number of exercise minutes, but not exercise intensity or number of sessions	+, 0
* Oka, Gortner, Stotts, & Haskell (1996)	43	60	81	Cross-sectional	Task	Duke Activity Status IndexJenkins Activity Checklist	SE correlated with the Duke Activity Status Index, but not the Jenkins Activity Checklist	+, 0
* Robertson & Keller (1992)	51	61	–	Cross-sectional	Task	Jenkins Walking Activity Checklist	Model significant; SE effect unclear	+

(continued)

Table 1. (continued)

	Participants							
Citation	*N*	*M age*	*% men*	*Design*	*Self-efficacy*	*Exercise behavior*	*Findings*	*Result*
Ruiz, Dibble, Gilliss, & Gortner (1992)	156	60	80	Prospective	Task	Jenkins Checklist for General Activities	SE predicted general activities	+
Scholz, Sniehotta, & Schwarzer (2005)	211	59	79	Longitudinal	Task Self-regulatory	Self-report exercise	SRSE but not task SE was a significant predictor of 4-month exercise	+, 0
* Schuster & Waldron (1991)	101	59	80	Cross-sectional	Task	CR attendance	SE related to attendance for most of sample, but negative relationship for male bypass patients	+
* Vidmar & Rubison (1994)	138	72% 45–64	86	Cross-sectional	Task Self-regulatory	Self-report exercise compliance	Both types of SE predicted self-reported exercise	+
* Yates, Price-Fowlkes, & Agrawal (2003)	64	65	78	Cross-sectional	Task	Self-report physical activity	SE was a significant predictor of physical activity	+
Outcome studies (N=16)								
* Allison & Keller (1992)	31	>65	–	Cross-sectional	Task	Self-report physical activity	Current SE correlated with physical activity	+
Beniamini, Rubenstein, Zaichkowsky, & Crim (1997)	38	59	76	RCT	Task	Strength training vs Flexibility training	Strength training increased SE compared to flexibility training Increases in strength and treadmill time correlated with enhanced SE	+
Berkhuysen et al. (1999)	111	52	85	Quasi -experimental	Self-regulatory	High vs Low frequency exercise	Low frequency exercise enhanced SE more than high frequency exercise	+
Bock et al. (1997)	46	65	67	Prospective	Self-regulatory	CR physical activity	SE increased significantly from baseline to end of CRP	+
* Brown, Laschinger, Hains, & Parry (1992)	21	56	100	Cross-sectional	Task	Heart rateTreadmill test (i.e. METS)	First 4 items of walking SE subscale significantly correlated with heart rate, but SE was not correlated with METS	+, 0

(continued)

Table 1. (continued)

Citation	Participants N	M age	% men	Design	Self-efficacy	Exercise behavior	Findings	Result
* Burns, Camaione, Froman, & Clark (1998)	213	58	86	Cross-sectional	Task	Self-report leisure physical activity (LPA)	LPA predicted SE	+
Ewart, Stewart, Gillilan & Kelemen (1986a)	40	55	100	RCT	Task	Weight training vs Volleyball Arm and leg strength testing	Weight training group increased SE compared to volleyball group Arm and leg SE increased following respective strength testing	+
Foster et al. (1995)	26	57	73	Prospective	Task	Cycle ergometer	SE increased from baseline	+
Gardner et al. (2003)	472	63	76	Prospective	Task	CR exercise program Caloric expenditure	SE increased from baseline. Caloric expenditure predicted SE	
Gilliss et al. (1993)	156	59	81	RCT	Task	Treatment (exercise + SE enhancement) vs usual care	Treatment group increased SE	+
Gulanick (1991)	40	58	70	RCT	Task	Routine care vs Testing + teaching vs Exercise training	All 3 groups increased SE	+
King, Humen, Smith, Phan, & Flo (2001)	195	69% <70	76	Prospective	Task	CR attendance	At 6 months, those who had attended CR reported higher SE	+
Oldridge & Rogowski (1990)	51	57	75	RCT	Task	Ward ambulation vs Exercise center CR program	Exercise center had higher SE after program completion compared to ward ambulation	+ +
Parent & Fortin (2000)	56	57	100	RCT	Task	Treatment (3 social support visits) vs control	Treatment group reported higher SE than the control group at discharge	+
Stewart, Kelemen, & Ewart (1994)	51	–	100	RCT	Task	Exercise training program	Exercise training increased arm SE and leg SE	+
Stewart, Mason, & Kelemen (1988)	25	58	100	Prospective	Task	Weight training vs Aerobics	Weight training group increased arm SE and leg SE. Aerobics group decreased arm SE and leg SE	+, –

(continued)

Table 1. (continued)

Citation	Participants N	M age	% men	Design	Self-efficacy	Exercise behavior	Findings	Result
Antecedent + Outcome(N = 9)								
Bray & Cowan (2004)	29	57	83	Prospective	Task	CR attendance	Task SE did not predict attendance Task SE plus attendance predicted subsequent task SE	+, 0
Carlson et al. (2001)	80	59	82	RCT	Task	Exercise frequency Traditional vs Modified program	SE correlated with 3- and 6-month exercise frequency Modified program had higher SE for exercising without ECG monitor compared to traditional program	+
Cheng & Boey (2002)	43	64	77	Prospective	Task	Exercise tolerance CR program	Initial SE correlated with exercise tolerance on a treadmill test SE increased following CR program	+
Evon & Burns (2004)	80	61	100	Prospective	Task	Duke Activity Status Index	Changes in SE predicted physical activity Changes in activity did not predict SE	+, 0
Gortner & Jenkins (1990)	149	59	84	RCT	Task	Jenkins Activity ChecklistTreatment (in-patient education and telephone monitoring) vs Usual care	SE at 8 weeks significantly predicted activity at 12 weeks Treatment group increased SE	+
* Jeng & Braun (1995)	23	–	78	Cross -sectional	Task	Exercise training intensity Self-report prior activity level	SE correlated with exercise intensity No differences in SE by prior activity	+, 0
Rejeski et al. (2003)	147	65	52	RCT	Task Self-regulatory	Change in physical activity (PAR), fitness (METS)Treatment (group-mediated	Change in SRSE was significantly related to change in physical activity and fitness Treatment group had significantly	+

(continued)

Table 1. (continued)

	Participants							
Citation	*N*	*M age*	*% men*	*Design*	*Self-efficacy*	*Exercise behavior*	*Findings*	*Result*
						cognitive behavioral intervention) vs Standard care (exercise therapy)	greater SE than standard care	
Taylor, Bandura, Ewart, Miller, & DeBusk (1985)	30	52	100	RCT	Task	Spouse observation of exercise vs ParticipationTreadmill performance	Spouse participation resulted in greater SE. SE related to treadmill performance	+
Woodgate, Brawley, & Weston (2005)	64	65	92	Prospective	Task Self-regulatory	CR attendance Perceived exercise intensity	Task and self-regulatory SE predicted CR attendance. Task SE predicted perceived exercise intensity. Past CR attendance predicted both types of SE	+

Note: SE = self-efficacy; + = positive finding; – = negative finding; 0 = no relationship observed

* Denotes a cross-sectional study where the study authors have classified self-efficacy as either an antecedent or outcome. However, the readers should view this classification with caution and read the study to draw their own interpretation

Table 2. Characteristics of cardiac rehabilitation intervention programs

Citation	*Duration*	*SE determinant*	*Type of SE*	*Conditions*	*Result*
Exercise					
Beniamini et al. (1997)	12 weeks	Mastery experiences	Task	2 conditions: (a) strength-training; (b) flexibility-training	+
Berkhuysen et al. (1999)	6 weeks	Mastery experiences	Self-regulatory	2 conditions: (a) high-frequency exercise (10 sessions/wk); (b) low-frequency exercise (2 sessions/wk)	+
Ewart et al. (1986)	10 weeks	Mastery experiences	Task	2 conditions: (a) strength-training; (b) volleyball	+
Stewart et al. (1988)	3 years	Mastery experiences	Task	2 conditions: (a) aerobic-training; (b) aerobic plus strength-training	+
Taylor et al. (1985)	Acute	Mastery experiences, vicarious experience	Task	3 conditions: (a) wives who do not observe treadmill test; (b) wives who observe test; (c) wives who observed and participated in test	+
Psychosocial					
Gilliss et al. (1993)	12 weeks	Vicarious experience, verbal persuasion	Task	2 conditions: (a) information control; (b) efficacy enhancement intervention	+
Gortner & Jenkins (1990)	8 weeks	Vicarious experience, verbal persuasion	Task	2 conditions: (a) information control; (b) efficacy enhancement intervention	+
Parent & Fortin (2000)	3 visits	Vicarious experience	Task	2 conditions: (a) information control; (b) vicarious experience intervention	+
Exercise + Psychosocial					
Carlson et al. (2001)	24 weeks	Mastery experiences, verbal persuasion, vicarious experience, physiological arousal	Task	2 conditions: (a) traditional supervised program; (b) modified independent program (exercise plus efficacy enhancement intervention)	+

(Continued)

Table 2. (Continued)

Citation	Duration	SE determinant	Type of SE	Conditions	Result
Gulanick (1991)	5 weeks	Mastery experiences, vicarious experience, verbal persuasion, emotional arousal	Task	3 conditions: (a) routine care; (b) exercise testing and teaching; (c) exercise testing, teaching, and exercise training	+
Rejeski et al. (2003)	3 mos + 6 mos home-based + 3 mos follow-up	Mastery experiences, verbal persuasion for both types of efficacy	Task, self-regulatory	2 conditions: (a) standard care; (b) standard care plus group-mediated cognitive behavioral therapy that included systematically applied learning of behavior modification and self-regulatory skills	+

Note: SE = self-efficacy; + = positive finding; – = negative finding; 0 = no relationship observed

Direction of the self-efficacy and physical activity relationship

The self-efficacy and cardiac rehabilitation exercise studies are diverse, ranging from the examination of self-efficacy as an antecedent (n = 16, Table 1), as well as an outcome (n = 16, Tables 1 and 2) of physical activity. In addition, nine studies investigated self-efficacy as *both* an antecedent and outcome.

In a number of cross-sectional studies, the classification of a study as providing evidence of self-efficacy as an antecedent or an outcome became challenging (n = 9). Difficulties in classification arise when the study design and statistical test selection are not necessarily concordant with the relationship identified. For example, an observational study that utilizes concurrent measurement procedures and correlational analyses may draw conclusions about self-efficacy as a determinant. Obviously, no causal determination can be inferred from a correlational study using a one-time assessment design. Thus, we classified the study as reflecting an antecedent (e.g. efficacy leading to some outcome) on the basis of the designation by the investigators of the specific study. However, we suggest that the reader interpret the theoretical and practical conclusions that can be drawn from this cross-sectional evidence about self-efficacy as an 'antecedent' with caution. Fortunately, these studies constituted a minority of the observational reports.

Self-efficacy as an antecedent of exercise behaviour In the studies that have examined self-efficacy as an antecedent of exercise behavior, the findings are mainly supportive of self-efficacy theory (Table 1). The majority of studies was prospective (n = 12) and reported a significant and positive relationship between self-efficacy and exercise behavior. However, in one study, a negative relationship was reported for a subset of a sample (Schuster & Waldron, 1991). Specifically, among male non-bypass surgery patients, greater task self-efficacy was related to poorer CR program attendance.

Moreover, three antecedent studies only found a significant relationship between self-efficacy and certain forms of exercise behavior (Maddison & Prapavessis, 2004; Moore et al., 2003; Oka et al., 1996), while three studies found no relationship between self-efficacy and exercise behavior. For example, no relationship was found between task self-efficacy (i.e. confidence to walk or bike various distances) and CR adherence or objective exercise intensity (i.e. speed and elevation during a treadmill test: Jeng & Braun, 1997). Furthermore, general self-efficacy for lifestyle behaviors (e.g. exercise regularly, not smoking, eat a healthy diet) did not predict frequency of light exercises (Bennett et al., 1999). Finally, proxy self-efficacy did not predict CR participants' exercise attendance (Bray & Cowan, 2004). It is possible that some of the non-significant findings are due to a lack of correspondence between the independent (i.e. efficacy) and dependent (i.e. type of physical activity) variable. More will be said about this issue in a subsequent section on the measurement of self-efficacy.

Self-efficacy as an outcome of exercise behaviour The details of the prospective and cross-sectional studies where we have classified efficacy as an outcome are summarized in Table 1. While intervention studies can also be considered from an efficacy as an outcome perspective, we discuss these separately given their different objectives and designs (see Table 2, $n = 11$ interventions).

In the *cross-sectional* outcome studies ($n = 4$), the findings are mixed. Two studies do not support a relationship between exercise and the outcome of self-efficacy (Brown et al., 1992; Jeng & Braun, 1995). These studies exhibit many of the same measurement and correspondence problems as the antecedent studies that failed to support a relationship between self-efficacy and exercise (e.g. poor correspondence; mismatch between outcomes and efficacy ratings). The remaining two studies reflect concurrently assessed relationships where past physical activity or CR program participation is related to self-efficacy.

In general, for the *prospective* outcome studies ($n = 7$), changes in efficacy occurred after exposure to both acute bouts of exercise and after CR exercise programs (e.g. 8 to 12 weeks of 2 + exercise sessions per week). Evidence for asymptomatic samples suggests that relative mastery experience with exercise improves efficacy beliefs (e.g. Bandura, 1997; McAuley & Mihalko, 1998). Using this evidence to generate a hypothesis, it can be suggested that enhanced CR exercise efficacy is due to mastery experiences occurring over time within a CR program. These prospective studies may encourage us to draw such a conclusion. However, investigations that compare individuals randomized to either a CR exercise therapy or non-exercising comparison condition with the specific objective of altering efficacy beliefs as a function of mastery experience are needed.

The characteristics of the 11 *intervention* outcome studies are summarized in Table 2. Five of the intervention studies were exercise-only interventions, three were solely psychosocial interventions, and three interventions examined conditions where exercise was coupled with psychosocial interventions. Whereas all interventions supported a relationship between self-efficacy and exercise, an important issue to be considered within these interventions relates to the development and measurement of self-efficacy beliefs about different types of performance accomplishments (cf. Maddux & Gosselin, 2003).

Nine interventions reported results only for task self-efficacy (e.g. confidence in abilities to perform increasingly challenging durations of walking). Surprisingly, self-regulatory efficacy was assessed in only two psychosocial intervention studies (Berkhuysen et al., 1999; Rejeski et al., 2003). Although many of the remaining interventions with psychosocial conditions may have included the teaching of self-regulatory skills, that form of efficacy was not assessed. Instead, task efficacy was measured as an intervention outcome. As mentioned earlier, this mismatch between the determinant manipulated and the efficacy measured raises the possibility of a lack of correspondence between independent and dependent variable and the potential for underestimating the size of a physical activity—efficacy relationship.

Timing of self-efficacy measurement

In this section, we review theoretical and methodological issues pertaining to the timing of efficacy measurement. CR studies have generally been limited to: (a) the correlation between baseline self-efficacy and one endpoint; (b) short or no follow-up assessment of self-efficacy; and (c) one assessment of self-efficacy *during* CR exercise interventions. These limitations constrain the conclusions that we can draw about self-efficacy in CR.

Most CR studies assess efficacy at baseline immediately prior to an acute exercise bout (e.g. symptom limited treadmill test) or initiation of an exercise intervention. However, McAuley and Mihalko (1998) suggest waiting for subjects to gain some initial exercise experience prior to assessment of baseline efficacy, otherwise participants can overestimate their efficacy and a true study baseline cannot be obtained. Their rationale is that it is not uncommon for pre-investigation efficacy levels to *decrease* slightly as participants engage in the first few exercise sessions. Participants subsequently gain mastery-type experiences as a function of these initial attempts and commonly lower their initial estimates of their abilities. While initial efficacy beliefs may be an interesting target for study themselves, they can be unreliable relative to participants' physical activity during the study and thus may be unrelated to future adherence. Consequently, McAuley and Mihalko recommend that prior to assessing participants' initial efficacy levels, sufficient participation time must elapse (e.g. two weeks of experience) for participants to understand their exercise experience.

In prospective studies, the primary trial design dictates when efficacy will be assessed over time. These assessment points are frequently dictated by the primary outcomes of physical function associated with the trial. For example, efficacy is often measured at the end of discrete phases of an exercise intervention along with fitness outcomes (e.g. end of an intensive center-based phase). However, the dynamic change in efficacy beliefs may not be captured by conveniently assessing all measures at the same time. For example, intermediary assessments of efficacy during the trial might provide information regarding the development of efficacy beliefs. These assessments of efficacy may be more correspondent to changes in exercise adherence over time (cf. Brawley, Rejeski, Angove, & Fox, 2003).

In a few interventions, efficacy was also measured at a follow-up period, which allowed for an examination of efficacy beyond the intensive phase of the CR program (e.g. two or three months: Bock et al., 1997; Moore et al., 2003; Scholz et al., 2005). Although these findings provide valuable post-program information, the duration of follow-up periods is relatively short. Without measures of efficacy during some lengthier follow-up period, it is difficult to determine, for example, whether higher efficacy is related to sustained adherence to independent post-program exercise.

Nature and type of physical activity

We would be remiss if we only focused on self-efficacy without examining the nature and type of physical activity to which self-efficacy is related. Although we have identified relationships between self-efficacy and exercise behavior in previous studies, a broad definition of 'physical activity' has been used. In a number of cases, the relationships observed concern self-efficacy's relationship with three very different aspects of physical activity: (a) frequency; (b) intensity; and (c) physical fitness.

Exercise frequency Fifteen studies focused on self-reported exercise frequency. Some of these reports are problematic in that they correlate efficacy in general or efficacy for future behavior with retrospective recall of previous exercise. Not only is the direction of this relationship questionable, it is also limited by the inherent problems of memory error in longer-term recall (cf. Sallis & Saelens, 2000). In addition, six studies assessed objectively measured CR program attendance. It is surprising that the research addressing frequency of CR attendance and efficacy is so under-investigated given the emphasis placed on improving adherence to CR programs (Mullinax, 1995) and the known relationship of efficacy to increased adherence in asymptomatic exercisers (McAuley & Mihalko, 1998).

Exercise intensity Self-efficacy perceptions are postulated to influence both an individual's persistence (e.g. exercise frequency, duration) and effort expenditure (e.g. exercise intensity; Bandura, 1997). Given that exercise *intensity* is also an important part of the dose-response prescription that is taught to cardiac rehabilitation participants during exercise therapy, it is surprising that only seven studies have examined this aspect of the efficacy as antecedent to behavior relationship. In three studies, task self-efficacy has been associated with heart rate during the initial phase of cardiac rehabilitation. An additional study examined exercise intensity during intensive CR, but failed to detect a significant relationship between task efficacy and objective exercise intensity (i.e. speed and elevation during treadmill test: Jeng & Braun, 1997). Finally, task efficacy has also been shown to predict perceived exercise intensity among CR *maintainers* (Woodgate et al., 2005). While these studies represent promising initial examinations of the efficacy–intensity relationship, correspondence between the measures of task efficacy (e.g. walking ability, biking ability) and the assessed outcomes (e.g. perceived exertion, heart rate) could be improved.

Physical fitness In contrast to the preceding studies, four of the reviewed studies focused upon the relationship between self-efficacy and post-exercise therapy outcomes of treatment (i.e. physical functioning). Specifically, task self-efficacy was positively related to physical fitness (i.e. METS: Brown et al., 1992; Maddison & Prapavessis, 2004; Rejeski et al., 2003), and exercise tolerance on a treadmill test (Cheng & Boey, 2001).

In summary, although the findings appear generally robust in that positive relationships are observed between self-efficacy and physical activity, it is important to remember that the research frequently concerns different aspects of behavior. From a rehabilitation perspective, the frequency or intensity of participants' behavior reflects different manifestations of activity, each of which could be varied as they attempt to adhere to physical activity. Thus, the specificity of the efficacy measure and its correspondence to the aspect of behavior that is the focus of adherence becomes important in both detecting and interpreting effects. Having the efficacy to adhere to one behavioral aspect of an exercise CR prescription may not necessarily generalize to other aspects that also require adherence to generate a physical function outcome (e.g. improved fitness or work capacity).

Discussion

Adherence to the lifestyle behavior change associated with cardiac rehabilitation involves both physical and self-regulatory skills training (Brawley et al., 2003; Rejeski et al., 2003). A variable that is clearly linked to exercise adherence and adjustment in asymptomatic and CR populations is self-efficacy (cf. Ewart, 1995; McAuley et al., 2001). Both conceptual and methodological issues related to self-efficacy will be discussed with reference to self-efficacy theory (Bandura, 1997) and compared to asymptomatic research. We also offer qualifications about the quality of the reviewed studies. Finally, we will suggest directions for future research.

Task and self-regulatory efficacy

Theory and past research We have reviewed numerous studies assessing self-efficacy and exercise within the context of CR. The most commonly employed measures of self-efficacy are those assessing task efficacy. This is consistent with the extant literature on asymptomatic exercisers (McAuley et al., 2001). While it is expected that investigators would assess participants' efficaciousness toward exercise tasks, it is surprising that other actions that make attendance and daily lifestyle activity possible (e.g. self-regulatory-efficacy for scheduling; coping with perceptions of pain or fatigue: Brawley et al., 2003; Maddux & Gosselin, 2003; McAuley & Mihalko, 1998) are infrequently examined. According to theory, self-regulatory efficacy beliefs about self-regulatory performance accomplishments affect behavior and have been identified as the more crucial efficacy beliefs to measure (Bandura, 2001, 2004; Maddux, 1995).

Qualifications about the studies While CR programs provide education about changing physical activity after the participant leaves the CR program, self-regulatory efficacy for this physical activity behavior change appears to be under-investigated in this population. However, self-regulatory efficacy may be especially important in the management of this independent exercise (cf. Bandura, 2004; Brawley et al., 2003; Clark, 2003). Indeed, traditional CR programs have been criticized for providing limited instruction and practice in developing *self-regulatory* skills for behavior change toward an *independent* exercise regimen (Rejeski et al., 2003; Scholz et al., 2005). One promising study focused CR participants in an exercise plus group-mediated cognitive behavioral intervention (GMCB) on learning and using self-regulatory strategies for independent exercise. GMCB participants had superior adherence after they left the context of formal training compared to their standard care CR counterparts (Rejeski et al., 2003). Specifically, GMCB intervention participants engaged in group counseling and direct experience with relevant self-regulatory skills (e.g. self-monitoring, setting goals, preventing relapse) as an adjunct to their weekly exercise therapy sessions. Within the GMCB group, improvements in barriers efficacy were related to improvements in physical fitness.

In the few CR self-regulatory efficacy studies that were reviewed, barriers efficacy was the primary self-regulatory belief examined (e.g. Blanchard et al., 2002; Maddison & Prapavessis, 2004). Conceptually and methodologically, barriers efficacy encompasses confidence to overcome obstacles. To date, however, it has provided little information about what behaviors and processes to target for change and how to accomplish this change (i.e. exercisers are confident that they can overcome incidental or unexpected barriers, but *how* do they do this?). Researchers seem to draw the implicit conclusion from the extant relationship-based evidence that if exercisers are efficacious and adherent, they possess the self-regulatory skills to facilitate adherence in the face of barriers. However, the efficacy beliefs about the skills used to offset the limitations posed by real or perceived barriers have not been examined in any systematic way. A research need is a study that: (a) actually varies the barriers to which participants are exposed to determine if those who express high barriers efficacy actually manage to cope with these barriers; and (b) to examine the actual coping methods of these participants. Fulfilling this need may shed light upon whether measures of barriers efficacy are sufficiently representative of the self-regulatory abilities of CR participants or if other conceptually representative self-regulatory efficacy measures are also needed.

Only two studies examined self-regulatory efficacy beliefs about other skills and abilities (symptom control: Berkhuysen et al., 1999; scheduling: Woodgate et al., 2005). However, multiple aspects of self-regulation are necessary to sustain the progress made in center-based and/or staff-supported CR such as self-monitoring, goal-setting, and relapse prevention (Brawley et al., 2003; Meichenbaum & Turk, 1987). Thus, we suggest that a systematic assessment of CR participants' self-regulatory efficacy should extend beyond a measure of overcoming unpredictable barriers to encompass other self-regulatory skills used to change and maintain regular physical activity.

Antecedent or outcome?

Theory and past research Self-efficacy theory suggests that self-efficacy can act as both an antecedent (i.e. determinant) and outcome of exercise participation. Exercise research on asymptomatic individuals supports this premise (Bandura, 1997; McAuley & Blissmer, 2000). In general, the CR literature also supports self-efficacy theory. This literature provides consistent evidence that self-efficacy is an outcome of exercise participation. Specifically, both acute and chronic bouts of exercise influence CR participants' self-efficacy cognitions. Many of these outcome studies have been cross-sectional and report the correlational nature of the exercise–efficacy outcome relationship.

Qualifications about the studies However, there have also been studies of exercise-training interventions where efficacy has been a secondary outcome. In many of the interventions, the outcome of increased efficacy followed a treatment manipulation that consisted of graded physical activity *within* the intensive phase of CR. Although the mastery of exercise can enhance task self-efficacy via systematic exercise training (cf. McAuley & Mihalko, 1998), an exercise-only intervention may focus on developing cardiovascular fitness without the specific purpose of systematically enhancing self-efficacy. As such, improvement of task self-efficacy in these interventions is often an unplanned outcome of successful fitness improvement following participation in graded exercise therapy. While the examination of self-efficacy in these studies was secondary to developing physical function outcomes, structured exercise training appears to have increased participants' post-intervention task efficacy. However, these interventions did not conduct planned, systematic manipulations of the determinants of efficacy with the a priori goal of changing efficacy beliefs.

By contrast, psychosocial interventions that systematically alter sources of efficacy belief information (e.g. mastery, verbal persuasion, vicarious experience) to develop self-efficacy, assess efficacy as a *direct* outcome of a manipulation. All of the interventions with psychosocial conditions attempted to increase participants' self-efficacy perceptions by altering or manipulating one or more of the sources of information that Bandura (1997) suggests as efficacy determinants. In fact, those interventions that were conducted with the primary goal of increasing self-efficacy have demonstrated promising results (e.g. Carlson et al., 2001; Rejeski et al., 2003). For example, within the intensive phase of CR, Rejeski and colleagues (2003) demonstrated that the use of a group-mediated cognitive behavioral intervention that focused on developing self-regulatory skills led to superior adherence among older adults as compared to traditional CR exercise therapy alone. Furthermore, within the GMCB treatment group, improvements in barriers efficacy were related to positive change in both MET capacity and self-reported frequency of physical activity (Rejeski et al., 2003). The systematic development of CR participants' self-efficacy according to theoretical determinants is an area ripe for future investigation.

Measurement of efficacy

Theory and past research A number of studies have examined self-efficacy as an antecedent of both adherence and physical function. However, several of these investigations have been cross-sectional in nature, and the exact direction of the efficacy–exercise relationship could not be effectively delineated. These studies have produced mixed findings and are instructive as they highlight common measurement and assessment issues and problems (cf. Bandura, 1997; McAuley & Mihalko, 1998) that are central to testing the relationship between efficacy and exercise. Inconsistency in measurement and assessment may provide a possible explanation for the non-significant findings.

With respect to theory, Bandura (1997) has placed a strong emphasis on the correspondence of efficacy measures with behavioral outcomes. In several of the studies where no relationship was observed, poor correspondence was evident between self-efficacy and exercise (Jeng & Braun, 1997). It has been noted in the asymptomatic exercise literature that specific measures of self-efficacy are superior to the omnibus assessments of global self-efficacy (McAuley & Mihalko, 1998). However, in some of the reviewed studies, general efficacy perceptions were correlated with specific frequency of physical activity (e.g. Bennett et al., 1999).

Qualifications about the studies In some cases, both correspondence and specificity problems were evident. For example, an attempt was made to correlate participants' self-efficacy beliefs about exercise frequency with exercise outcomes such as METS (Brown et al., 1992). However, this outcome is a function of persistent training behavior. Thus, the frequency of that training behavior, and not the physical function outcome itself, is the more correspondent behavioral measure. This does not negate the possibility of a relationship. However, it may underestimate the relationship because of less direct correspondence.

An additional methodological issue to consider is intervention design. We would be remiss if we did not caution that many of the interventions that have examined self-efficacy have employed single-group designs using a selective sample. Neither random assignment nor standard care or comparison control conditions were used. For the few interventions that were well designed (i.e. control group with randomization to treatment), greater self-efficacy increases for the treatment group have been evident compared to either a control or comparison group. The results of these well-designed studies provide strong evidence that exercise participation develops self-efficacy among CR participants. For example, one study that randomized CR participants to either a traditional exercise program or an independent exercise program demonstrated greater task efficacy among participants in the independent exercise program (Carlson et al., 2001).

The next generation of research

It is apparent that there are a number of gaps in the CR exercise self-efficacy research, which if filled, could extend and advance the literature. These issues (e.g. small number of studies in various categories, methodological shortcomings) also represent significant barriers to conducting other types of literature reviews (i.e. meta-analytic). Once these issues have been remedied in future literature, the complementary use of narrative and meta-analytic reviews could be the research synthesis goal. Accordingly, we suggest two areas as logical starting points to fill these gaps.

First, consider that self-regulatory self-efficacy is related to the self-management of CVD in that it reflects individuals' beliefs about effectively managing their disease in the face of the challenges that it presents (cf. Clark, 2003). For example, exercising to cope with disease involves a continual process of adjustment in order to deal with symptomatology and progressive disability. Thus, self-efficacy to perform recommended exercise may be influenced by the challenge of adjusting to disease-related parameters (e.g. angina, shortness of breath). Accordingly, self-regulatory efficacy to perform exercise in the face of CVD symptoms should be a focus of future research attention.

A second starting point to direct future research would be the use of theory to purposefully guide intervention and investigation with a view to determining causality. In order to assist CR participants to learn to self-manage their physical activity, self-efficacy needs to be studied as a main outcome of CR interventions designed to systematically improve physical function, self-regulatory and task efficacy (cf. Berkhuysen et al., 1999). Thus, it is crucial to use self-efficacy theory as part of the basis for guiding the systematic development of interventions (cf. Baranowski, Anderson, & Carmack, 1998; Brawley et al., 2003; Rejeski, Brawley, McAuley, & Rapp, 2000). To illustrate, the final section of this review concerns the use of theory to address several key issues and gaps in the exercise self-efficacy and CR literature.

Theory-driven studies

Intervention processes and mediation Baranowski and colleagues (1998) have suggested that more theoretically driven research is necessary to examine the current gap in our understanding of the intervention–mediator–outcome relationship in physical activity intervention studies. This suggestion is considered a priority for the physical activity research on older adults with chronic disease (Brawley et al., 2003). It is essential to advance CR–exercise self-efficacy research to a level beyond mere description (i.e. expand research to the investigation of mediators, moderators). While the identification and assessment of process variables has been deemed critical to the fidelity of behavior change interventions (Rejeski et al., 2000), studies of self-efficacy as part of the process evoking behavioral change have received relatively little attention in the CR exercise research. We found only one intervention that attempted a preliminary examination of the relation between systematically developed self-regulatory efficacy and sustained change in physical function outcomes after completion of formal CR (cf. Brawley et al., 2003; Rejeski et al., 2003).

Unexplored manifestations of efficacy-influenced behavior

Although exercise intensity is an important part of the behavioral dose-response prescription that is taught to CR participants, little CR research exists in which efficacy is examined with respect to *exercise intensity*. From a theoretical perspective, self-efficacy is thought to influence effort. In exercise therapy, intensity is an example of effort (i.e. mild, moderate, vigorous). We found only three studies that considered the association of task self-efficacy with manifestations of exercise intensity (e.g. overexertion, peak heart rate) during the initial, intensive phase of CR (Ewart et al., 1983; Ewart et al., 1986; Jeng & Braun, 1995).

Inasmuch as CR participants must self-regulate the intensity of their exertion in accordance with their exercise prescription, their self-regulatory efficacy about their actions may also influence future attempts to manage exercise intensity. While CR participants are asked to vary the exercise prescription in order to produce favorable physiological outcomes (AACVPR; 1999), it is unclear whether they possess the requisite confidence to monitor and independently adapt their exertion without the consultation of their CR program interventionist. One recent study suggested that *maintenance* CR participants appear to make the link between exertion and exercise because their task self-efficacy was a significant predictor of their perceived exertion (Woodgate et al., 2005). Given that exertion level is one central aspect of self-managing the exercise prescription in order to improve cardiovascular fitness, the examination of the efficacy–intensity relationship is another aspect of adherence that warrants future research.

Moderators of the efficacy–exercise relationship

Although there were an insufficient number of studies to examine moderators of the efficacy–exercise relationship, it is important to acknowledge that the positive relationship we observed in this review may not be consistent across all CR participants. There are findings in the literature that suggest that gender, age, initial level of function, and disease characteristics may be potential moderators to investigate in future.

For example, reviews and studies of CR have reported that *women* exhibit poorer psychosocial profiles at entry into CR, and have lower rates of attendance than men when completing CR (Brezinka & Kittel, 1995; Moore et al., 2003). Some reports indicate that female CR participants appear to have lower exercise self-efficacy at program entry compared to men (Blanchard et al., 2002; Gardner et al., 2003; Jenkins & Gortner, 1998; Schuster & Waldron, 1991) while others suggest that women who successfully complete CR may experience self-efficacy improvements similar to those observed in male CR participants (e.g. Gardner et al., 2003). Disparities in the findings may be attributable to the fact that women have lower rates of entry into CR programs and results may be based upon selective sampling (Ades, Waldmann, Polk, & Coflesky, 1992). Recently, Rejeski and colleagues (2003) remedied these problems by employing a randomized control trial stratified by gender. In addition to favorable intervention effects, they also detected gender differences among older adults where women had lower post-intervention physical fitness, activity levels, and task self-efficacy than men. More research is clearly required to detect and understand such gender effects.

Advancing *age* may also influence CR participants' self-efficacy appraisals. While the number of elderly patients undergoing cardiac surgery continues to rise (Jenkins & Gortner, 1998), only two of the reviewed studies employed participant samples with a mean age greater than 70 years (i.e. 72 years: Carroll, 1995; 76 years: Jenkins & Gortner, 1998). In fact, a recent overview of physical activity interventions and behavior change among older adults stressed that age may alter the complexity of both the initial attempts to change behavior and the subsequent attempts to maintain regular physical activity among individuals who live with chronic disease and disablement (Brawley et al., 2003). The possibility that age may differentially impact the CR self-efficacy of older adults with CVD aged 70+ requires examination. If differential impact is observed, physical activity behavior change interventions may need to be tailored for age differences. At present, we have minimal information to inform such interventions.

Beyond the CR program: long-term maintenance

Most of the research on self-efficacy in CR involves the initiation and intensive phase of activity. However, long-term CR maintenance represents both a research and public health challenge (Rothman, 2000; Wing, 2000). The need for this research is important when the behavioral challenges confronted by participants for their long-term maintenance of CR exercise are considered (e.g. scheduling, overcoming barriers, self-monitoring). For CR participants to meet the challenge of being consistently active, conditions that engage social cognitions such as efficacy beliefs will be required (e.g. ongoing conscious forethought, self-regulation: Bandura, 1997; Brawley et al., 2003; McAuley & Katula, 1998).

There is some promise of successful maintenance in either interventions of longer duration (e.g. three-year CR exercise; Stewart et al., 1988) or follow-up studies of interventions (e.g. Moore et al., 2003; Rejeski et al., 2003), but these CR studies are still modest in number. However, the understanding of maintenance is partly confounded by varying operational definitions of maintenance duration. For example, in asymptomatic exercise research, successful maintenance has been defined as engaging in regular physical activity for at least six months (Marcus et al., 2000). However, in order to understand which psychosocial factors characterize successful maintenance, it may be more informative to study individuals who have managed change and then maintained their physical activity for several years (Bandura, 2004; Strachan, Woodgate, Brawley, & Tse, 2005; Wing, 2000). Only one study that we reviewed examined successful, multiple-year maintainers from a self-efficacy perspective (Woodgate et al., 2005). These investigators found that self-regulatory efficacy was predictive of attendance to a center-based CR program and emphasized the importance of such beliefs for maintenance behavior. Maddux (1997) has argued that these behaviors are under our volitional control and even if they become customary routines, they require mindful forethought and planning for their maintenance as lifestyle behaviors. Thus, self-regulatory efficacy about skills that sustain maintenance of physical activity is clearly a target for research. How we conceptualize and represent these skills in our measures may need to be different than the measures used to assess CR participants who are initiating rehabilitation and behaviour change.

Conclusion

The development of task and self-regulatory skills for managing rehabilitative exercise is a central part of CR participants' rehabilitation. The successful acquisition of these skills as well as the development and preservation of self-efficacy beliefs may influence the maintenance of the adherence necessary to produce favorable short- and long-term CR outcomes (Bandura, 2004; Schneiderman, Antoni, Saab, & Ironson, 2001). In order to meaningfully advance our knowledge of exercise self-efficacy in CR, it is critical that we move beyond the examination of efficacy as a secondary research question (cf. Berkhuysen et al., 1999).

In agreement with others who have commented on adherence to physical activity specifically and chronic disease generally, we recommend the pursuit of theory-driven interventions and research with respect to CR and self-efficacy for physical activity (cf. Baranowski et al., 1998; Brawley et al., 2003; Clark, 2003; Marks, Allegrante, & Lorig, 2005; Rejeski et al., 2000; Schneiderman et al., 2001). Given the importance of being able to self-manage the maintenance of improved physical function for individuals who are rehabilitating, it is critical that we use a theory-based approach to examine the efficacy and exercise adherence relationship as a *primary study outcome*.

We also recommend that research in this area should target an understanding of the *process of adjustment* experienced by individuals as they attempt to alter their lives (Newman, Steed, & Mulligan, 2004). If the goal of CR interventionists is to use exercise therapy to promote improved physical function, we can also systematically help to improve participants' self-efficacy by encouraging the belief that the participant can both cause and sustain their function. Recent CR evidence offers promise that behavior change can both enhance the effectiveness of traditional CR and sustain the maintenance of its effects (Rejeski et al., 2002, 2003). The investigation of self-regulatory efficacy is one route to understanding these improvements.

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