

Physical Function Assessment in Cardiac Rehabilitation

SELF-REPORT, PROXY-REPORT AND PERFORMANCE-BASED MEASURES

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INTRODUCTION

Older patients (≥ 65 years old) account for two thirds of all myocardial infarctions and for more than half of all revascularization procedures done in the United States.¹ The number of older patients with coronary heart disease (CHD) is expected to continue rising over the next several decades; thus, assessing the effectiveness of cardiac rehabilitation (CR) services for older coronary patients represents a serious public health issue.¹ The literature supporting the effectiveness of CR services for older patients is mounting, but still relatively limited when compared to what has been accumulated in younger patients.^{2,3}

What seems clear is that CR is safe for coronary patients aged 65 years and older,^{2,4} with no fatalities reported among participants involved in the elderly-specific studies completed to date.² In addition, the exercise component of CR programs appears to be effective at improving exercise tolerance in older patients.^{2,4} In fact, when compared to younger coronary patients who participated in similar CR programs, older coronary female and male patients have demonstrated exercise trainability levels similar to those observed in their younger counterparts.⁴

Yet, several questions remain regarding the effectiveness of CR for older patients. Of these, the effect of CR services on outcomes such as physical function, functional impairment, and disability needs to be clarified.³ Patients with CHD in general have higher rates of disability than those without CHD,¹ but the burden of disability is especially heavy for older CHD patients because disability rates increase with advanced age.⁵ Compared with their younger counterparts, older CHD patients

have longer hospitalizations after a cardiac event and greater subsequent disability and mobility limitations.^{1,3,6} Thus, preventing or delaying the onset of physical disabilities is a major goal of CR in older patients.⁷

The key to preventing or delaying physical disabilities for many patients is early detection of physical limitations and appropriate physical activity intervention.⁸ Proper assessment of physical function (PF) plays a central role in early detection of physical limitations and, consequently, in disability prevention.⁸ Traditionally in CR, exercise tolerance has been used as an indicator of overall PF.⁹ However, exercise tolerance has been shown to poorly predict a person's ability to perform activities of daily living.^{9,10} Exercise tolerance is not a comprehensive measure of PF, but rather a measure of cardiovascular fitness, only one of the several parameters of PF.

Comprehensive measures of PF are available and the value of using such measures in CR has been recognized.¹¹ Unfortunately, however, guidelines for PF assessment in older CR patients generally have been brief and incomplete. Thus, the purpose of this article is to provide a thorough review of the different means that are currently available to assess PF in older CR

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Table 1 • OVERVIEW OF SELF-REPORT MEASURES OF PHYSICAL FUNCTION

Reference	Measure	Construct	No. of Questions	Validity	Reliability	Method
Jette et al, 2002 ¹⁶ Haley et al, 2002 ¹⁷	Late Life FDI	Physical function	32	Construct	Test-retest: .96	Interview or self-administered
Tarlov et al, 1989 ¹⁸ McHorney et al, 1994 ¹⁹	SF-36	Physical function	10	Content Construct	Cronbach's alpha: .93	Interview or self-administered
Bergner et al, 1981 ²⁰ Nanda et al, 2003 ²¹	SIP136 SIP68	Physical function	SIP136 = 45 SIP68 = 29	Content Construct	Cronbach's alpha: .94 Test-retest: .50	Interview or self-administered
Ferrans and Powers, 1992 ²³	Ferrans and Powers QLI – Cardiac Version III	Health and functioning	14	Content Construct Concurrent*	Cronbach's alpha: .93 Test-retest: .87	Self-administered

SF-36, Short Form-36 of the Medical Outcomes Study; SIP, Sickness Impact Profile; FDI, Function and Disability Instrument; QLI, Quality of Life Index; PFQ, Physical Functioning Questionnaire.

*Concurrent validity was established based on comparison to a single-item life satisfaction assessment.

patients, to present a review of the literature that has addressed PF in CR patients, and to discuss how these findings apply to daily CR practice.

PHYSICAL FUNCTION ASSESSMENT

Information regarding a patient's PF can be obtained from various sources. These sources include the patient himself (self-report), a family member or health care provider (proxy-report), and direct observation of the patient's PF by an examiner using a performance-based measure.¹² No one method has been identified as the best way to measure PF; likewise, no one instrument has been identified as the "gold standard."^{13,14} Thus, clinicians and researchers in search of a PF measure need to consider the advantages and disadvantages of each method as well as the psychometric properties of the different instruments that are currently available.

Self-report Measures

Self-report measures of PF usually require the patient to report whether he/she is able to perform a given task or whether he/she performs the task on a daily basis.¹² Several self-report instruments are available to measure PF, but few apply to community-dwelling older adults such as older CR patients.¹⁵ One self-report measure of PF, the Late Life Function and Disability Instrument (FDI),^{16,17} was recently developed specifically to capture a wide range of individual levels of functioning. In addition, several quality-of-life questionnaires have a PF subscale that can serve as a measure of self-reported PF. These include, but are not limited to, the Medical Outcome Study Short-Form Health Survey (SF-36),¹⁸ the Sickness Impact Profile (SIP),^{20,21} and the Ferrans and Powers Quality of Life Index (QLI).^{22,23} Table 1 provides an overview of these measures, with information per-

taining to the evidence of validity and reliability established to date for each instrument.

Self-report instruments have the advantage of being relatively inexpensive and easy to administer.²⁴ Although generally valid and reliable, they may provide inaccurate information when discrepancies exist between the patient's perception of his/her PF and his/her actual ability to perform certain tasks.^{12,24} Thus, when used alone, self-report measures may paint a biased picture of the patient's PF. In addition, they provide little information regarding the type of impairment affecting an individual, and seem to lack sensitivity to subtle, but clinically relevant, changes.¹⁴ These two limitations may be particularly problematic in a CR setting if the objective is to design and evaluate an intervention aimed at improving specific aspects of PF.

Proxy-report measures

Proxy-report measures are similar to self-report instruments, but are designed for a proxy to rate the patient's PF.¹² Proxy raters usually consist of a significant other, a family member who lives with the patient, or a health care provider.¹² Instruments that provide a standardized proxy-adapted version include the SF-36 and the Sickness Impact Profile.²⁵

Proxy-report has been suggested as an alternative to self-report for situations in which the patient's ability to complete a survey is compromised, for example in patients with cognitive limitations.²⁵ The accuracy of proxy-report as an alternative to self-report has been questioned in the past, but a recent review of the literature comparing proxy and patient ratings for health-related quality-of-life demonstrated moderate to good levels of agreement between the two sources.²⁵ Moreover, level of agreement between both sources (proxy and patient) was found to be higher for physical functioning than for any other domain of health-related quality-of-

life.²⁵ On the other hand, a recent study by Phillips and colleagues²⁶ indicated that proxy raters tended to underestimate patients' PF. Further research will be needed to clarify the level of agreement between self- and proxy-reported PF. Regardless, one fact will hold: the limitations that apply to self-report measures will also apply to proxy-report measures. Thus, if PF is measured through proxy-report, the actual ability of the patient to perform certain tasks will remain unknown, the type of impairment affecting the patient will be unidentified, and responsiveness to change will likely be limited.

Performance-based measures

Concerns about the limitations of self- and proxy-report measures led to the development of several performance-based measures of PF over the last decade.¹³ Direct observation of PF using performance-based measures differs substantially from self-report and proxy-report in two ways: first, it requires the patient to actually perform certain tasks; and, second, the patient's score on each task is determined by an examiner based on previously established scoring criteria.¹²

Performance-based measures of PF that are currently available include the American Alliance of Health, Physical Education, Recreation and Dance (AAHPERD) Functional Fitness Assessment for Adults Over 60 Years,²⁷ the Physical Performance Test (PPT),¹² the Established Populations for the Epidemiologic Study of the Elderly (EPESE)/MacArthur Successful Aging studies tests,²⁸ the Functional Fitness Test (FFT),²⁹ the Continuous-Scale Physical Functional Performance (CS-PFP),¹⁴ and the Senior Fitness Test (SFT).⁸ An overview of each of these measures, along with validity and reliability data, is provided in Table 2.

Measurement of performance-based physical function requires the presence of a trained examiner, which translates into more time and effort for staff members, and less convenience for patients.¹² In addition, many performance-based measures require additional space and equipment.¹² From a theoretical perspective, direct observation, unless performed repeatedly, reflects a patient's PF at one point in time and may not accurately reflect his or her performance in daily life.^{12,24} Underestimation or overestimation of the patient's true daily function also may occur as a result of abnormally low or high motivation, respectively, because performance on PF test batteries is known to be influenced by the patient's motivation to perform.^{12,24}

On the other hand, direct observation of PF using performance-based measures has the advantage of providing patients, clinicians, and researchers with an objective measure of the patient's performance, and is thereby robust to discrepancies between patient or proxy report and patient performance.¹² In that regard, this method may provide more accurate information than self-report

or proxy report.¹² In addition, unlike self-report, direct observation allows clinicians and researchers to evaluate individuals with cognitive limitations.²⁴ Finally, scores obtained on performance-based measures seem to be more responsive to change than those obtained from self-report or proxy-report.^{12,24}

Relationship Between Self-report and Performance-based Measures

Few studies have examined the relationship between self-reported PF and performance on PF test batteries. Evidence available to date suggests that both types of measures are significantly associated, but that the relationships are inconsistent and generally weak to moderate.^{13,24,30} Thus, based on the current evidence, it appears that both methods do not measure the exact same construct, suggesting perhaps that using a combination of both methods would be optimal.^{13,24} However, given that time, money, and space are often limited in CR settings, adding several PF measures to an already extensive evaluation process may seem unrealistic.

In our opinion, proper PF assessment should be a priority with older CR patients. With regards to the methods, self-report is certainly appealing, with its capacity to provide generally valid and reliable information in an inexpensive, time-efficient, and relatively "user friendly" manner. However, its subjective nature and the lack of responsiveness to change of most PF scales limit the use of self-report as sole method to evaluate PF. Performance-based measures, on the other hand, provide an objective assessment of PF and are sensitive to change. They require more time, effort, space, and equipment than self-reported measures, but considerable variations exist from one battery to the next. Certain performance-based measures—for instance the Senior Fitness Test³¹—use inexpensive equipment (standard-height chair, dumbbells, stopwatch, measuring tape, etc.), are easy to administer, and can be completed in less than 45 minutes.

Thus, we believe that the use of a performance-based measure—one that meets the program's needs and resources in terms of time, money, space, and staffing—should be strongly considered. Given that quality-of-life scales are already widely used in CR, information about self-reported PF is likely to be already available in most programs. In settings where this is not the case, a quality-of-life scale that includes a PF subscale should be integrated into the evaluation process. Finally, proxy-report should be considered as an alternative to self-report when the patient is unable or unwilling to complete a survey.

PHYSICAL FUNCTION IN CR

Relatively few investigations have specifically examined PF in CR patients. However, information related to PF can

Table 2 • OVERVIEW OF PERFORMANCE-BASED MEASURES OF PHYSICAL FUNCTION

Reference	Measure	Parameters	No. of items	Validity	Reliability	Time to Administer
Osness et al, 1990 ²⁷	AAHPERD	Aerobic endurance Agility/dynamic balance Coordination Lower-body flexibility Upper body strength	6	Content	Unknown	30-45 min
Reuben and Siu, 1990 ¹²	PPT	Aerobic endurance Balance Coordination Mobility Upper coarse motor function Upper fine motor function	7 or 9	Content Construct Concurrent*	Cronbach alpha: 7 items: .79 9 items: .87 Interrater: 7 items: .93 9 items: .99	5-10 min
Guralnik et al, 1994 ²⁸	EPESE/ MacArthur	Balance Gait Hand performance Lower-body strength Lower-body coordination Upper-body strength	7	Content Construct	Cronbach alpha: .56	Unknown
Netz and Argov, 1997 ²⁹	FFT	Agility Balance Coordination Lower-body flexibility Lower-body strength Upper-body flexibility Upper-body strength Walking ability	8	Content Construct Concurrent*	Cronbach alpha: .91 Test-retest: .82 to .90	3 hours for 50 people
Cress et al 1996 ¹⁴	CS-PFP	Aerobic endurance Balance and coordination Lower-body strength Upper-body flexibility Upper-body strength	15	Content Construct Concurrent†	Cronbach alpha: .74 to .97 Test-retest: .84 to .97 Interrater: .92 to .99	45-75 min
Rikli and Jones, 1999 ⁸	SFT	Aerobic endurance Agility/dynamic balance Lower-body flexibility Lower-body strength Upper-body flexibility Upper-body strength	6	Content Construct Concurrent†	Test-retest: .80 to .98	30-45 min

AAHPERD, American Alliance of Health, Physical Education, Recreation and Dance Functional Fitness Assessment for Adults Over 60 Years; PPT, Physical Performance Test; EPESE/MacArthur, Established Populations for the Epidemiologic Study of the Elderly/MacArthur Successful Aging studies tests; FFT, Functional Fitness Test; CS-PFP, Continuous-Scale Physical Functional Performance; SFT, Senior Fitness Test.

*Concurrent validity was established based on comparison to self-report measures.

†Concurrent validity was established based on comparison to criterion performance measures.

be obtained from several quality-of-life studies conducted among CR populations. Studies can be generally categorized as either descriptive studies or clinical trials. Descriptive studies have either described CR patients' PF at a specific point in time^{32,33}, or identified determinants of PF in CR patients.^{7,34} Conversely, clinical trials have examined change in PF from baseline to completion of CR using either an observational study design (no comparison group), a nonrandomized controlled study design

(with a comparison group, but no random assignment), or a randomized controlled study design (with random assignment to either CR or to the comparison group).

Descriptive Studies

Overall, patients recovering from an acute cardiac event have been shown to have lower levels of both self-reported and directly observed PF upon entry into a CR

program as compared to the general population.^{32,35} In contrast, patients already enrolled in CR (for at least 1 month) have been found to report satisfactory levels of PF.³³

In both stable coronary patients and those recovering from an acute cardiac event, self-reported PF has been shown to be lower in patients with a diagnosis of MI as compared to patients with other cardiac diagnoses.^{7,34} Exercise capacity, strength measures, depression score, and comorbidity score also have been identified as strong predictors of self-reported PF, unlike body mass index, time since cardiac event, presence of angina or ischemia, and left ventricular ejection fraction.^{7,34}

Women have been shown to report lower PF levels than men despite similar ages, diagnoses, depression scores, and comorbidity scores.^{7,34} Finally, self-efficacy to maintain function and to control symptoms has been found to be predictive of self-reported PF, after accounting for coronary disease severity, anxiety, and depression.³⁶

Clinical Trials

All clinical trials providing PF data in CR patients published before January 2004 were reviewed. Details about these trials, including information pertaining to study design, participants, interventions under study, PF measure(s), and main findings are presented in Table 3.

With the exception of one investigation,³⁷ observational studies have consistently obtained significant increases in self-reported PF in CHD patients after a 3-month or 12-week CR program.^{34,38-42} Morrin and colleagues⁴¹ found no additional improvements when program duration was extended to 6 months, suggesting that gains in PF occur early into the program. Improvements in self-reported PF following CR were shown to be of equal or greater magnitude in patients aged 65 years and above than in their younger counterparts^{38,39}, indicating that CR benefits older patients as much as, or perhaps even more, than it benefits younger patients with regards to PF.

Results from nonrandomized trials have also provided support for the effectiveness of CR at improving PF, with CR participants achieving greater gains in self-reported PF than non-participants on three separate trials.⁴³⁻⁴⁵ Interestingly, nonparticipants from these studies showed lesser, but sometimes significant, improvements, which could suggest that some PF gains occur simply as a result of the natural course of recovery following a cardiac event. In addition, Savage and colleagues⁴⁶ demonstrated that overweight patients enrolled in an enhanced program, consisting of traditional CR enhanced by a nurse-coordinated weight loss intervention, were able to achieve significantly larger improvements in self-reported PF than those enrolled in the traditional CR regimen alone. This finding indicates possible room for further PF gains than those currently generated by the traditional CR program.

In general, randomized trials have yielded inconsistent results. First, Stahle and colleagues⁴⁷ were unable to detect significant short-term and long-term differences in self-reported PF between CHD patients assigned to a 3-month CR program and those assigned to the control group. In contrast, Belardinelli and colleagues⁴⁸ obtained greater gains in self-reported PF from post-angioplasty patients randomized to 6 months of CR than from those assigned to the control group. In a third trial, patients randomized to an enhanced program, consisting of CR and group-mediated cognitive behavioral therapy, achieved significantly larger improvements in self-reported PF than those assigned to traditional CR,⁴⁹ suggesting once again that CR programs could generate larger gains in PF than they currently do. Increasing frequency of CR sessions was shown to be ineffective in that regard on two separate occasions, in which patients assigned to low-frequency CR obtained similar improvements in self-reported PF than those assigned to high-frequency CR.^{50,51}

To date, direct observation of PF using performance-based measures has been reported in only one clinical trial conducted with CHD patients.^{52,53} The investigation was designed to compare the effects of a 6-month resistance training program to those of a flexibility-control intervention in disabled older women with stable CHD (i.e. not recovering from an acute cardiac event). It was found that women assigned to the resistance training program achieved gains in directly observed PF, without any change in self-reported PF. Meanwhile, women from the flexibility-control group showed no improvement in either type of PF measure (self-reported or directly observed). These findings provide support for the use of resistance training to improve PF in CHD patients, and offer additional evidence that performance-based measures are more sensitive to PF change than self-reported measures. The generalizability of these results to patients recovering from an acute cardiac event undergoing traditional CR is limited because the investigation was conducted in disabled women with stable CHD undergoing resistance training alone. Nonetheless, these findings, reported by Brochu et al.⁵² and by Ades et al.⁵³ propose yet another way by which program effectiveness could be increased.

DISCUSSION

The literature published to date suggests that self-reported PF improves over time as patients recover from an acute cardiac event, even when those patients do not participate in any form of CR.⁴³⁻⁴⁵ This highlights the importance of including a comparison group and may explain, in part, why observational studies have consistently provided support for the effectiveness of CR at improving self-reported PF.

Nevertheless, results from nonrandomized and randomized trials suggest that CR programs typically allow

Table 3 • CLINICAL TRIALS OF CARDIAC REHABILITATION AND PHYSICAL FUNCTION

Reference	Design	Study Population	CR Intervention	Comparison Intervention	PF Measure	PF scores			P within	P between
						Pre-CR	Post-CR	Change		
Lavie and Milani, 1995 ³⁸	Observational: young vs older	N = 151 (66 young, 85 older)	36 sessions, 3-4 months	None	SF-36 (PF-10)	Young: 37.5 ± 8.1 Older: 35.8 ± 7.7	Young: 42.6 ± 6.1 Older: 41.7 ± 6.5	—	Young: < .0001 Older: < .0001	Δ Pre-post: NS
Lavie and Milani, 2000 ³⁹	Observational: young vs older	N = 182 (125 young, 57 older)	3 sessions per week, 12 weeks	None	SF-36 (PF-10)	Young: 35 ± 8 Older: 31 ± 9	Young: 42 ± 7 Older: 39 ± 7	Young: + 20% Older: + 27%	Young: < .0001 Older: < .0001	Pre-CR: < .01 Δ Pre-post: = .02
Ades et al, 1999 ³⁴	Observational: pre-post CR	N = 218	3 sessions per week, 12 weeks	None	SF-36 (PF-10)	65.6 ± 22.8	80.2 ± 20.4	—	< .001	—
Cohen et al, 1999 ³⁷	Observational: pre-post CR	N = 35 (21 men, 14 women)	12 weeks	None	SF-36 (PF-10)	68.3 ± 21.7	—	7.4 ± 25.0	NS	—
Jungbauer et al, 1999 ⁴⁰	Observational: pre-post CR multicenter	N = 928 (622 men, 306 women)	12 to 36 sessions, 4 to 12 weeks	None for PF	SF-36 (PF-10)	50 ± 24	70 ± 23	—	< .05	—
Morrin et al, 2000 ⁴¹	Observational: pre-post CR	N = 126 (93 men, 33 women)	2 sessions per week, 6 months	None	SF-36 (PF-10)	62.7 ± 19.9	3 months: 78.7 ± 17.5 6 months: 80.1 ± 16.7	—	3 months: < .025 6 months: < .025 3-6 months: NS	—
Verrill et al, 2001 ⁴²	Observational: pre-post CR	N = 420 285 men, 135 women)	12 weeks	None	Ferrans & Powers QLI- Cardiac Version III (Health and Functioning subscale)	21.1 ± 5.2	23.5 ± 4.7	+ 10.2%	< .001	—
Lindsay et al, 2003 ⁴³	Nonrandomized: CR vs control	Post-CABG N = 164 (119 CR, 45 Controls)	12 weeks	No CR	SF-36 (PF-10)	CR: 36.9 ± 23.7 Control: 32.9 ± 24.4	CR: 63.9 ± 27.2 Control: 46.9 ± 28.1	—	CR: < .0001 Control: = .0189	Pre-CR: NS Post-CR: = .0015
Hawkes et al, 2003 ⁴⁴	Nonrandomized: CR vs control	Post-CABG N = 149 (38 CR, 111 Controls)	1 session per week, 6 to 8 weeks	No CR	SF-36 (PF-10)	—	—	CR: 33 ± 25 Controls: 22 ± 27	—	Δ Pre-post: = .02
Pasquali et al, 2003 ⁴⁵	Nonrandomized: CR vs control	Post-CABG Post-PTCA N = 700 (172 CR, 558 Controls)	Participation to supervised CR for ≥ 30 days in the first or second month after CABG/PTCA	No CR	SF-36 (PF-10)	CR: 62.5 ± 27.3 Controls: 52.5 ± 28.7	—	CR: 7.3 ± 26.2 Controls: 5.9 ± 28.2	—	Pre-CR: < .0001 Δ Pre-post: < .005

(continues)

Table 3 • CLINICAL TRIALS OF CARDIAC REHABILITATION AND PHYSICAL FUNCTION (Continued)

Reference	Design	Study Population	CR Intervention	Comparison Intervention	PF Measure	PF scores			P within	P between
						Pre-CR	Post-CR	Change		
Savage et al, 2002 ⁴⁶	Nonrandomized: CR vs enhanced CR (ECR)	<i>Overweight</i> N = 82 (55 CR, 27 ECR)	36 sessions, 12 weeks	CR + structured, nurse-coordinated, weight loss intervention	SF-36 (PF-10)	CR: 64.7 ± 22.6 ECR: 60.0 ± 19.8	CR: 77.8 ± 20.4 ECR: 84.4 ± 17.9	CR: + 20.2% ECR: + 24%	CR: = .0001 ECR: = .0001	Δ Pre-post: = .05
Stahle et al, 1999 ⁴⁷	Randomized: CR vs control	N = 101 (50 CR, 51 Controls)	3 sessions per week, 3 months or 12 weeks	No CR	Karolinska Questionnaire (Physical Ability subscale)	—	—	3 months: CR: 0.2 ± 0.7 Controls: 0.0 ± 0.4 12 months: CR: 0.2 ± 0.7 Controls: 0.1 ± 0.4	3 months: CR: < .05 Controls: NS 12 months: CR: < .05 Controls: NS	Δ Pre-post: 3 months: NS 12 months: NS
Belardinelli et al, 2001 ⁴⁸	Randomized: CR vs control	<i>Post-PTCA</i> <i>Post-CS</i> N = 118 (59 CR, 59 Controls)	3 sessions per week, 6 months	No CR	SF-36 (PF-10)	CR: 50 ± 21 Controls: 48 ± 18	CR: 78 ± 19 Controls: 55 ± 20	—	—	Post CR: = .001
Rejeski et al, 2002 ⁴⁹	Randomized: CR vs enhanced CR (ECR)	N = 129 (67 CR, 62 ECR)	3 sessions per week, 3 months	Group-mediated cognitive behavioral intervention	PFQ (Perceived Difficulty subscale)	Total sample: 77.6 ± 18.4	Total sample: 81.4 ± 16.9	Total sample: 4.03 ± 12.6	Total sample: < .001	Δ Pre-post: < .05
Berkhuysen et al, 1999 ⁵⁰	Randomized: high-frequency (HF) vs low-frequency (LF) CR	N = 116 (58 HF, 58 LF)	2 sessions per day, 5 days per week, 6 weeks	1 session per day, 2 days per week, 6 weeks	SF-36 (PF-10)	HF: 70.7 ± 19.3 LF: 77.8 ± 18.8	HF: 80.3 ± 19.9 LF: 83.5 ± 17.0	HF: + 9.6% LF: + 5.7%	HF: < .001 LF: < .01	Δ Pre-post: NS
Nieuwland et al, 2000 ⁵¹	Randomized: HF vs LF CR	N = 130 (63 HF, 67 LF)	2 sessions per day, 5 days per week, 6 weeks	1 session per day, 2 days per week, 6 weeks	SF-36 (PF-10)	HF: 71.3 ± 19.5 LF: 77.2 ± 18.9	HF: 80.4 ± 19.7 LF: 83.4 ± 16.9	HF: + 13% LF: + 8%	HF: < .001 LF: < .001	Δ Pre-post: NS
Ades et al, 2003 ⁵³	Randomized: resistance training vs control	<i>Disabled women with stable CHD</i> N = 33 (19 RT, 14 Controls)	Resistance training, 3 sessions per week, 6 months	Flexibility/relaxation program, 3 sessions per week, 6 months	SF-36 (PF-10) CS-PFP (total score)	RT: 59 ± 20 Controls: 69 ± 15 RT: 43.6 ± 13.2 Controls: 47.9 ± 19.1	RT: 65 ± 21 Controls: 76 ± 17 RT: 55.7 ± 13.5 Controls: 49.0 ± 18.2	RT: + 10% Controls: + 10% RT: + 28% Controls: + 2%	RT: NS Controls: NS RT: < .0001 Controls: NS	Δ Pre-post: NS = .0001

CR, cardiac rehabilitation; PF, physical function; SF-36, Short-Form 36-Item Questionnaire from the Medical Outcomes Study; PF-10, 10-item Physical Function subscale; NS, not significant; QLI, Quality-Of-Life Index; CABG, coronary artery bypass graft; PTCA, percutaneous transluminal coronary angioplasty; CS, coronary stenting; PFQ, Physical Functioning Questionnaire.

patients to achieve greater gains in self-reported PF than those generated by the natural course of recovery.⁴³⁻⁴⁵ However, the evidence also indicates that certain modifications to the current CR program could increase its effectiveness with regards to PF.^{46,49} Enhancing the traditional CR regimen with a structured, nurse-coordinated weight loss intervention may improve program effectiveness in overweight patients.⁴⁶ Likewise, adding a group-mediated cognitive-behavioral intervention and/or a thorough resistance training component to the current approach may generate larger gains in PF.^{49,52,53} On the other hand, extending program duration from 3 to 6 months or increasing frequency of sessions from twice a week to five times a week does not seem to produce any larger PF gains.^{41,50,51} These findings will need to be confirmed in the future. In addition, more studies comparing traditional CR versus other forms of enhanced interventions are needed.

Results from the clinical trial reported by Brochu et al⁵² and Ades et al⁵³ clearly indicate that gains in directly observed PF (with performance-based measures) do not always translate into gains in self-reported PF in CR patients. These findings offer additional support to the theory that self-report and performance-based measures of PF do not measure the exact same construct and that performance-based measures are more sensitive to change than self-report measures. Alternatively, these results could suggest that, although patients increased their measured physical function through resistance training, they chose to maintain their established routines despite having an improved capacity to perform.⁵³ In that case, these findings would highlight the importance of physical activity counseling to translate increases in strength into increases in true daily physical activity.⁵³ More data will be needed to confirm which of these two hypotheses is correct.

As mentioned previously, the PF gains obtained by Brochu et al⁵² and Ades et al⁵³ cannot be generalized to the broader CR population since the trial was conducted in patients with stable CHD undergoing resistance training alone. Nevertheless, these authors were the first to report the use of performance-based measures of PF with CHD patients, and the first to demonstrate that older disabled women with CHD can sustain a resistance-training intensity that is high enough to generate PF gains. In the future, similarly well-designed studies will need to be conducted to evaluate the impact of traditional CR on directly observed PF in CHD patients recovering from an acute cardiac event.

SUMMARY AND APPLICATION TO PRACTICE

The purpose of this article was to present the main methods and instruments that are available to assess PF and to review the literature that has addressed PF in CR patients.

The concepts and findings that were presented in this article have implications for both CR clinicians and researchers. The information provided on the advantages and disadvantages of self-report, proxy-report, and performance-based measures of PF, together with the overview of several instruments, should substantially help clinicians choose a PF measure that is both scientifically sound and clinically applicable, given their program's needs and resources.

The literature review of the relatively few descriptive studies and clinical trials completed to date highlights the need for additional research addressing PF in CR patients. Several areas for future inquiries were suggested, including the nature and the strength of the relationship between self-report and performance-based measures of PF, the impact of traditional CR on directly observed PF, and the effectiveness of various enhanced CR interventions at improving self-reported or performance-based measured PF.

One of the main goals of CR in older patients is to prevent or delay the onset of physical disabilities and to promote functional independence.⁷ As the CR population gets older, this goal is likely to be given increased consideration when the value of CR programs continues to be evaluated by decision-makers. It is our belief that PF should be routinely evaluated in older CR patients, using proper methods, to monitor whether this goal is being achieved through current practice.

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