Systematic Review of Interventions Designed to Maintain or Increase Physical Activity Post-Cardiac Rehabilitation Phase II

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ABSTRACT

BACKGROUND: Cardiovascular disease (CVD) continues to be the No. 1 cause of death in the United States and globally, and individuals with a history of a cardiac event are at increased risk for a repeat event. Physical inactivity creates health problems for individuals with chronic heart disease. Evidence shows that physical activity (PA), as a central component of cardiac rehabilitation phase II (CRII), decreases hospital readmission and mortality. Yet, individual adherence to PA tends to decline several months following CRII completion.

OBJECTIVE: The purpose of this review was to evaluate current literature for interventions designed to assist individuals diagnosed with myocardial infarction (MI), coronary artery bypass graft (CABG), coronary artery disease (CAD), and percutaneous coronary intervention (PCI) to maintain or increase PA post-CRII.

METHODS: A systematic search of 5 electronic databases including hand-searched articles between 2000 and 2019. Key Medical Subject Headings (MeSH) search terms included cardiac rehabilitation, intervention, exercise or PA, outcomes, compliance, adherence, or maintenance. Only interventions implemented following CRII program completion were included for review.

RESULTS: Based on the inclusion criteria, the search yielded 19 randomized control trials retained for descriptive analysis. Interventions were categorized into 3 domains. The intervention designs varied widely in terms of duration of the intervention and the length of time to outcome measurement. Most interventions were short-term with only 2 studies offering a long-term intervention of greater than 1 year. Interventions using a theoretical approach most often included a cognitive-behavioral model.

CONCLUSIONS: Interventions offered shortly after completion of CRII may help cardiac patients maintain PA and reduce the risk of experiencing additional cardiac events; however, more quality research is needed. Additional research to examine PA maintenance in older adults (70 years and older) would be valuable based on the increase in average lifespan. Studies with larger and more diverse samples, and less variation in methods and outcomes would greatly increase the ability to conduct a high-quality meta-analysis.

KEYWORDS: Exercise, physical activity, intervention, adherence, cardiac rehabilitation

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Despite significant advances over the past 50 years in diagnosing and treating cardiovascular disease (CVD), it remains the No. 1 cause of death globally and in the United States.[1] According to the World Health Organization,[1] annually 17.9 million people die as a result of CVD, accounting for 1 in 3 deaths globally. Coronary artery disease (CAD), also known as coronary atherosclerosis, is a form of CVD which involves narrowing of the coronary arteries.[2] Individuals with a prior history of CAD are at increased risk for a future heart event.[3] Cardiac rehabilitation phase II (CRII) is a secondary prevention program designed to restore health following a cardiac event and decrease the risk of mortality and future cardiac events.[3-12] There is substantial evidence that participation in CRII decreases hospital readmission and mortality.[4,9,13-17] Cardiac rehabilitation programs include a multidisciplinary staff to supervise exercise and educate patients about CAD risk factors and disease management.[8] A referral to CRII following an acute cardiac event is a Class 1A recommendation[11,18,19] and is the standard of care in the United States.[8,20]

Adhering to long-term physical activity (PA) has been historically problematic for adults with a cardiac history.[21,22] Following the completion of a CRII program, individuals, especially the elderly, encounter physical and psychological obstacles in daily living which eventually disrupt daily routines including exercise and PA.[23-25] Potential barriers to PA should be recognized early in the rehabilitation process and thoughtfully managed.[20] During CRII patients with CAD are taught various exercises with the intention of adopting a long-term PA routine; however, maintaining such a routine is a challenge.[21,22,26-28] Circumstances arise which interrupt exercise plans.[20,21] Some patients report having a difficult time remembering discharge instructions[25] while others no longer engage in the prescribed exercise routine for reasons including poor health, time, cost, and other factors.[29] It has been reported that 1-year post-CRII as few as 25% to 40% of patients remain physically active.[29,30] As a result, the health benefits gained during CRII often are not sustained. Without the regular supervision and encouragement from CRII staff, individuals simply lack motivation necessary to continue exercising on their own.[25,27] Fletcher et al[20] stressed the importance of identifying personal barriers and emphasized setting PA goals. Successful interventions and plans for maintaining PA need to be addressed with patients prior to CRII completion to decrease the risk of adverse health events and possibility of a repeat cardiac event.

Interventions designed to maintain and, in some cases, increase PA post-CRII have demonstrated positive physical and psychological outcomes.[31] Chase[32] and Martinello et al,[33] in 2 prior reviews, found evidence to support the effectiveness of interventions designed to maintain PA and exercise following CR. Currently, intervention designs for cardiac patients to maintain or increase PA vary from mobile applications to low-cost home-based interventions,[20,34,35] and the use of technology such as web-based health education, accelerometers, and other monitoring devices.[36-38] Evidence shows that interventions designed according to a theoretical framework provide a greater likelihood for successful program outcomes in supporting individuals to meet PA goals.[30-32] To date, Social Cognitive Theory[39] and the Transtheoretical Model[40,41] have been cited most often in the literature pertaining to PA program design.[32] The purpose of this article is to review the literature for existing studies that have examined interventions used to help patients with CAD maintain or increase PA post-CRII. Original papers were identified and closely evaluated for quality of design and for identifying theoretical models used in PA interventional studies.

Methods

This review, with the assistance of the medical librarian, included a comprehensive systematic literature search for randomized control trials (RCTs) published between January 2000 and January 2019 in the following 5 databases: PubMed, PsycInfo, CINAHL, Medline, and Scopus. The review was conducted using the Preferred Reporting Items for Systematic and Meta-analyses (PRISMA) statement.[42] Bibliographies of publications retrieved from the primary search were reviewed by the authors for related articles. Authors were interested in identifying interventions effective in maintaining or increasing PA compared to standard care that patients receive following CRII. Exercise and PA are used interchangeably in the literature,[43] but the concepts are different. According to Caspersen et al[43] by definition, exercise is a subset of PA, and PA is bodily movement which involves the expenditure of energy using muscle.[43] For the purpose of this article, PA when used includes exercise. Maintenance and adherence are 2 terms also used interchangeably. Maintenance when used in this review refers to activity adherence of 3 months or greater following participation in an intervention. Adherence refers to behavior in accordance with medical recommendation.[44] Key Medical Subject Headings (MeSH) search terms used included cardiac rehabilitation, exercise or PA, compliance or adherence or maintenance, intervention, and outcomes.

Inclusion criteria for retaining resulting publications for review included only original research studies published in the English language, which reported interventions to increase and/or maintain PA as either a primary or secondary outcome. Studies with participants, age 18 years and older, irrespective of gender, who completed a structured CRII program and were diagnosed with CAD myocardial infarction (MI), cardiac revascularization procedure, including coronary artery bypass grafting (CABG), or percutaneous coronary intervention (PCI) were included. Due to differences in pathophysiology, studies with participants diagnosed with heart failure, cardiac transplantation, or dysrhythmias were excluded. If CRII program completion was undetermined or if a cardiac rehabilitation program was not clearly distinguished as a CRII program, authors were contacted by email for confirmation.[45-47] Inclusion and exclusion criteria are found in Table 1.

All search results were initially reviewed independently by 2 researchers. A third researcher provided additional review if consensus was not reached between the first 2 researchers followed by a research team discussion. The primary components of each included study were synthesized by one researcher and verified by a second researcher. Data extraction was entered by 2 reviewers into a spreadsheet identifying the following parameters: authors, country of origin, year of publication, theoretical framework (if applicable), sample characteristics (sample size, mean age, and gender) details of intervention design, measures/tools, results (significant and non-significant), and limitations.

Quality assessment

The methodological quality of the studies was assessed for bias and quality by referencing the Downs and Black checklist;[49] however, checklist items specific to a meta-analysis were not assessed.[49] Properties assessed using the checklist included the following items: the aim(s), sample, outcomes, inclusion and exclusion criteria, clear description of intervention and main findings, attrition, appropriate statistical test, statistic (p-value and power), randomization to intervention groups, and if randomization concealed to subject and health care provider.[49] Two reviewers independently reviewed and rated the studies for quality. A third researcher provided an additional review when agreement was not reached between the 2 reviewers.

Results

The initial search produced 1375 publications. Titles and abstracts were reviewed to eliminate studies not meeting the basic inclusion criteria. Of these, 307 full-text publications

Table 1. Selection criteria for systematic review.

INCLUSION CRITERIA	EXCLUSION CRITERIA
• Diagnosis of CAD, MI, CABG, and PCI • Study design: randomized control trial • Language: English • Participants: 18 years and older; had completed CR Phase II • Intervention: any intervention designed to maintain or increase exercise adherence or physical activity following CR Phase II completion	• Systematic reviews or meta-analyses • Participants were in CR Phase I, did not participate in CR, or were in CR Phase III • Participants were enrolled for heart failure patients, heart valve surgery, or arrythmias • Participants with noncardiac conditions (cancer, stroke, diabetes, etc.)

Abbreviations: CABG, coronary artery bypass grafting; CAD, coronary artery disease; CR, cardiac rehabilitation; MI, myocardial infarction; PCI, percutaneous coronary intervention.

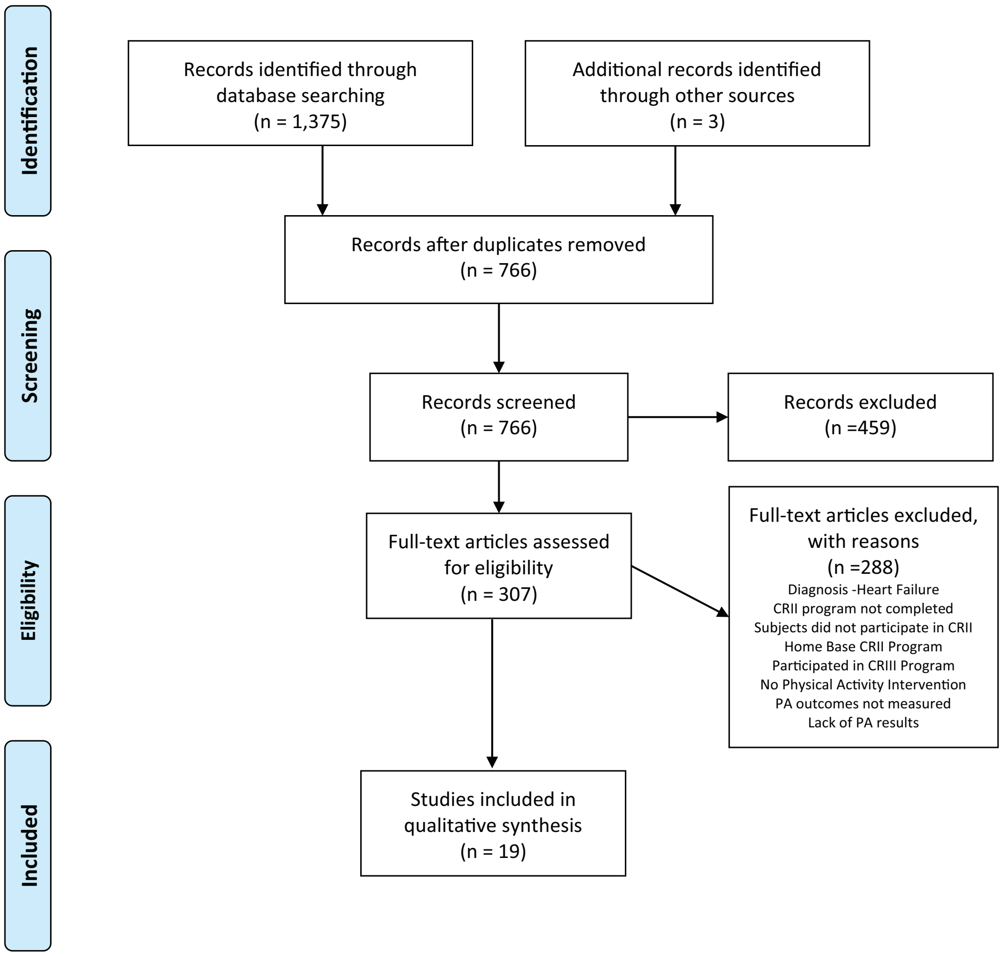

Figure 1. PRISMA flow diagram for systematic review. CRII indicates cardiac rehabilitation phase II; CRIII, cardiac rehabilitation phase III; PRISMA, Preferred Reporting Items for Systematic and Meta-analyses.
Source.[50] For more information, visit www.prisma-statement.org.

were reviewed, 3 publications were added through back-referencing, and 19 RCTs were retained for final analysis. A PRISMA flow chart of the search and review process can be seen in Figure 1.

The 19 full-text articles meeting the criteria were reviewed according to pre-established guidelines as shown in Table 1. The earliest publication identified was from 2003 and the most recent was from 2017. Six studies were conducted in the United States, while the rest were from Netherlands, Australia, Canada, France, Germany, Iran, Norway, Italy, and Switzerland. Sample sizes varied from 29 to 3241 participants with mean ages ranging from 57 to 68 years. Most studies included more male participants with the exception of one Australian study which only included female participants.[28] The number of CRII sessions participants had attended prior to trial enrollment varied from 1 session[51,52] to 36 sessions.[30,53-55] In some studies, participants in the control group only received usual care, while in other studies, they received a limited part of the intervention which could have impacted the results and conclusions.[45,56] A summary of

Table 2. Quality assessment.

AUTHOR/YEAR	REPORTING ASSESSMENT	EXTERNAL VALIDITY ASSESSMENT	BIAS ASSESSMENT	CONFOUNDING ASSESSMENT	POWER ASSESSMENT
Aliabad et al[48]	*	*		*	*
Antypas and Wangberg[45]	*	*	*	*	*
Arrigo et al[30]	*	*		*	*
Butler et al[51]	*	*		*	*
Clark et al[56]	*	*		*	*
Giallauria et al[57]	*	*	*	*	*
Giannuzzi et al[47]	*	*	*	*	*
Guiraud et al[37]	*	*		*	*
Janssenet al[53]	*	*		*	*
Janssen et al[58]	*	*	*	*	*
Johnson et al[28]	*	*		*	*
Lear et al[54]	*	*		*	*
Madssen et al[55]	*	*		*	*
Millen and Bray[52]	*	*		*	*
Moore et al[22]	*	*	*	*	*
Pinto et al[59]	*	*		*	*
Pinto et al[60]	*	*		*	
Sniehotta et al[61]	*	*		*	*
Yates et al[62]	*	*		*	

* = met assessment criteria.

the methodological quality can be seen in the Table 2. Overall quality concerns related to attrition,[22,28,45,51,59,61] power,[28,45,52,56,59] and of the 19 studies, only 3 studies were double blinded.[22,45,58]

Twelve of the 19 studies (63%) reported a significant improvement in PA following implementation of the intervention (See Table 3). Intervention designs varied considerably as did methodology, outcome measures, and the use (or absence) of theoretical framework. Intervention length ranged from 1.5 months to 3 years. All studies were RCTs using a 2-group design except for 2 3-group design studies by Sniehotta et al[61] and Yates et al.[62] Outcome variables were measured at time points ranging from 3 to 36 months after interventions were implemented. Direct and indirect measures of PA included self-report questionnaires, pedometer or accelerometer, active energy expenditure/metabolic equivalent of tasks, peak oxygen update, and 6-minute walk test.[28,37,52,55,56,59,60] While participants may have overestimated their PA using self-report,[63] exercise capacity or maximal oxygen consumption testing, considered the gold standard for measuring exercise capacity, were used often.[30,48,55,59] After closely examining the individual studies, the interventions offered were categorized into 1 of 3 domains: (1) cognitive-behavioral intervention (n = 3),[53,56,58] (2) PA intervention (n = 5),[28,30,37,52,55] or (3) combined cognitive and PA intervention (n = 11).[22,45,47,48,51,54,57,59-62]

Cognitive-behavioral interventions

Three studies compared a cognitive-behavioral approach intervention to standard care.[53,56,58] A cognitive-behavioral intervention included a combination of counseling, coaching, diary logs, behavioral assignments, family support, face-to-face meetings used to change PA behavior mediated by cognitive processes. Cognitive-behavioral interventions often resulted in better self-regulation and increased PA behavior.

Clark et al[56] examined the effects of the participants' selection of music on achieving recommended PA activity levels using Self-Efficacy as the theoretical framework. The choice of music was not reported to be effective on increasing the individual's PA level. Two studies by Janssen et al[53,58] used a motivational interviewing technique led by a health psychologist with home assignments for the participants. Both studies

Table 3. Summary of interventions designed to maintain or increase physical activity.

AUTHOR	THEORETICAL BASIS	SAMPLE	INTERVENTION	MEASURES FOR PA/RESULTS	LIMITATIONS
Aliabad et al[48]/ Iran	HAPA model	N = 96 Age = 57.5 Male = 84.4%	HAPA-based training (3-PA & planning sessions) and HAPA booklet; family support. Control: usual care. *M*: 147.39 PA Length of intervention: 4 mo *M*: 182.6 PA	Pre/post HAPA Questionnaire; Diary sheets; Modified Godin Leisure-Time Exercise Questionnaire; pre/post maximal oxygen uptake (Bruce Protocol). Follow-up: 4 mo after intervention PA score and exercise capacity sig higher in the IG. Statistical significance: **	Small sample; small percentage of women; self-reporting techniques used
Antypas and Wangberg[45]/ Norway	HAPA Model; Self-Efficacy; TTM	N = 69 Age = 59 Male = 77%	Tailored Internet questions and mobile-based intervention text messages. Control: basic Internet-based nontailored intervention. *M*: 1356.0 IPAQ Length of intervention: 3 mo *M*: 5613.0 IPAQ	IPAQ; URICA-E2: PC-EX Follow-up: 1 and 3 mo after CR Significantly higher overall total PA maintained. Statistical significance: *	Small sample; at completion attrition rate 72%; small percentage of women; inclusion criteria broad including the range of co-morbidities; self-reporting
Arrigo et al[30]/ Switzerland	Unstated	N = 228 Age = 61 Male = 79%	Quarterly physician-supervised group exercise Control: usual care *M*: 154.0 PA Watts Length of intervention: 3 mo *M*: 163.0 PA Watts	Self-report daily PA minutes; diary log; exercise capacity test Follow-up: 1 year following CR Significantly greater self-report for PA in minutes. 73% of intervention group reported regular PA versus 40% of control group. No difference in exercise capacity Statistical significance: **	No socioeconomic variables available; description of intervention lacked details; self-reporting; unvalidated tools for measuring PA
Butler et al[51]/ Australia	Self-efficacy	N = 110 Age = 64 Male = 75%	Pedometer; behavioral counseling telephone calls; face-to-face meetings Control: usual care; received 2 generic PA brochures *M*: 8.0 sessions Length of intervention: 6 mo. *M*: 9.6 sessions	Pedometer; step calendar; active Australian survey; Self-Efficacy for Exercise Scale; Modified PA Scale; METS by submax cardiorespiratory testing. Follow-up: 6 wks and 6 mo Significant improvements at 6 mo. in minutes of PA and number of activity session. No significant difference in cardiorespiratory fitness Statistical significance: *	Sample bias—high proportion of eligible patients chose not to participate; possible under-representation of CR population
Clark et al[56]/ Australia	Self-efficacy	N = 56 Age = 68 Male = 79%	Participant selected music with guidance from a music therapist Control: phone calls without exercise support *M*: 7029 daily steps Length of intervention: 6 mo *M*: 8136 daily steps	Accelerometer (ActivPAL); 6 minute walk test; Exercise Self-Efficacy Scale Follow-up: 6 wks and 26 wks NS: no significant differences in daily minutes walked, nor achieving recommended PA levels nor for recommended amount of PA. No difference in 6-minute walk test	Small sample size; more participants in the IG. Younger adults excluded. Lacked power. Used calculated cut-off points for calculating METS

(Continued)

Table 3. (Continued)

AUTHOR	THEORETICAL BASIS	SAMPLE	INTERVENTION	MEASURES FOR PA/RESULTS	LIMITATIONS
Giallauria et al[57]/Italy	Unstated	N=52 Age=58 Male=80%	Multifactorial, educational and behavioral intervention Control: usual care *M*: 154 Peak V02 Length of intervention: 6 mo *M*: 216 Peak V02	Symptom limited cardiopulmonary exercise test. Leisure time symptom limited questionnaire (LTPA). Follow-up: 12 mo and 24 mo Significant improvement in cardiopulmonary functional capacity Statistical significance: *	Small sample size; younger age group (mean age=58); elderly under-represented; predominantly male; single-center trial; decreased heterogeneity; no social-economic variable
Giannuzzi et al[47]/Italy	Unstated	N=3241 Age=58; Male=86%	Multifactorial, educational, and behavioral intervention Control: usual care, 1 site visit at 6 mo and 1 visit at 12 mo X 2 *M*: 71.1 questionnaire Length of intervention: 3 years. *M*: 7.5 questionnaire	Symptom limited exercise test and brief questionnaire for PA and other risk factors Follow-up: 6 mo, 12 mo, 24 mo, and 36 mo Significant improvement in the level of physical activity at all f/u appointments Results for symptom limited exercise test not given Statistical significance: *	Excluded participants older than 75 years; low-risk population PA data limited to self-report; no validity for questionnaire reported
Guiraud et al [37]/France	Unstated	N=29 Age=58 Male=79%	Accelerometer worn X 8 wks and telephone call with feedback and counseling from kinesiologist Control: usual care; wore accelerometer one time in wk 8 *M*: 266.7 PA minutes Length of intervention: 8 wks *M*: 543.7 PA minutes	METs (EE) (kcal/week.) Follow-up: 8 wks Significantly higher moderate-intensity PA between week 1-8. Significant energy expenditure (kcal) at wk 8 Statistical significance: *	Sample size small. Short-term results. Effect of telephone calls versus accelerometers not measured
Janssenet al[53]/Netherlands	Self-regulation theory	N=210 Age=58 Male=81%	Self-regulation lifestyle maintenance program with motivational interview, group sessions, and home assignments. Control: usual care, 1 hour individual interview with psychologist. No motivational counseling and no follow-up *M*: 7634 steps/day Length of intervention: 4 mo *M*: 9235 steps/day	Pedometers (Yamax) Follow-up: 6 mo Significant effect of exercise behavior (steps/day) Statistical significance: **	Small sample size; self-reporting; self-selection bias; and attrition 17%
Janssen et al[58]/Netherlands	Self-regulation theory	N=210 Age=58 Male=81%	Self-regulation lifestyle maintenance program with motivational interview; group sessions and home assignments Control: usual care, 1 hour individual interview with psychologist. No motivational counseling and no follow-up *M*: 7663 steps/day Length of intervention: 4 mo *M*: 9096 steps/day	Pedometers (Yamax) Follow-up: 6 mo and 15 mo Significant increase in PA and a reduction in PA in control group Statistical significance: **	Small sample size; self-reporting: selection bias; attrition 17%

(Continued)

Table 3. (Continued)

AUTHOR	THEORETICAL BASIS	SAMPLE	INTERVENTION	MEASURES—TOOLS/RESULTS	LIMITATIONS
Johnson et al[28]/Australia	TTM	N = 153 Age = 63 Male = 0%	Progressive 12-week Endurance Walking Program 3 times per week Control: usual care *M*: 6.31 MacNew score Length of intervention: 3 mo *M*: 6.38 MacNew score	HRQL (MacNew); self-report activity; Daily active log. Stages of Change Follow-up: 3 mo, 6 mo, and 12 mo after CR NS: PA declined over time in both groups with significant decline in the control group	Insufficient power; selection bias; usual care not defined; self- reporting; nonvalidated PA questionnaire; significant difference in baseline characteristics not reported; Attrition 26%
Lear et al[54]/ Canada	Self-efficacy	N = 302 Age = 65 Male = 82.5%	ELMI: exercise sessions, telephone follow-up; risk factor counseling Control: usual care *M*: 10.0 METS Length of intervention: 12 mo *M*: 10.0 METS	Modified Minnesota Leisure Time PA (LTPA) questionnaire; log book; symptom limited exercise stress test (METS) Follow-up: 12 mo NS: no significant difference in lifestyle behaviors and risk factor between ELMI and control group	Lifestyle behavior definition lacking; baseline differences include diagnosis, BMI and waist circumference, and family history; self-selection bias; use of global risk scores instead of secondary prevention global risk scores; details lacking for Case Management Model; participants not blinded study; stress test results not reported and attrition
Madssen et al[55]/Norway	Unstated	N = 49 Age = 61 Male = 70%	Monthly supervised HIIT sessions; written home exercise program (HIIT) 3X/wk Control: usual care *M*: Peak V02 32.8 Length of Intervention: 12 mo *M*: Peak V02 28.8	Change in peak VO2 (Oxycon Pro); cardiopulmonary max exercise test; PA-level questionnaire; Diary sheets; sub-group of patients wore activity monitor (Sensewear) Follow-up: 12 mo NS: no significant between group difference in peak VO2; neither group deteriorated in exercise capacity; no sig. difference in exercise adherence	Selection bias; control group significantly younger; self-report; PA questionnaire not identified nor validated
Millen and Bray[52]/Canada	SCT	N = 40 Age = 61 Male = 59%	Social cognitive theory-based resistance-training manual-elastic thera-band with instructions Control: orientation to resistance training and logbook to track resistance training. *M*: 1.47 Training days/wk *M*: 2.47 Exercises/session *M*: 14.53 Exercise sets/wk Length of Intervention: 3 mo *M*: 2.65 Training days/wk *M*: 4.05 Exercises/session *M*: 24.20 Exercise sets/wk	Questionnaires (4)—(Self-Efficacy for Training Technique; Self-Efficacy for Adherence; Outcome Expectations; telephone f/u for PASE Questionnaire); Resistance Training Behavior Log Follow-up: 3 mo Significantly greater amounts (sets) and days of resistance training and greater self-efficacy and outcome expectations Statistical significance: *	Sample bias including small number; homogeneous sample; mediated effects were underpowered; self-reporting; study limited to low-risk patients; generalizability limited to those without contraindications to resistance training

(Continued)

Table 3. (Continued)

AUTHOR	THEORETICAL BASIS	SAMPLE	INTERVENTION	MEASURES—TOOLS/RESULTS	LIMITATIONS
Moore et al[22]/ USA	Social problem-solving model; self-efficacy, expectancy-value theory, relapse prevention theory	N=250 Age=62.5 Male=62%	"Change Habits by Applying New Goals & Experiences" (CHANGE) introduced at 1 to 2 mo after CR Included 5-small group counseling sessions over 12 mo Control: usual care *M*: 6.4 PA/hr Length of Intervention: 2 mo *M*: 7.0 PA/hr	6-Minute Walk Test; Portable wristwatch heart rate monitors (Polar Vantage); exercise diary; number of months exercising after CR; exercise maintenance (frequency, amount, and intensity compliance) Exercise Benefits/Barrier Scale; Exercise Barrier and Adherence Self-Efficacy Scale; Problem Solving Inventory; Self-Regulation Short Version Scale; Social Support for Exercise Scale; Charlson Scale; NYHA Classification Scale; and Depression/Dejection Scale of Profile Moods; telephone calls to collect data on mediating measures Follow-up: 12 mo NS: no significant differences in exercise amount, frequency, or intensity; Downward trend for frequency and amount of exercise both groups and adjusting for covariates usual care group 76% more likely to stop exercising 1-year after cardiac event	Selection bias; self-monitoring techniques not measured; attrition 19.4%
Pinto et al[59]/ USA	SCT; TTM	N=130 Age=64 Male=79.2%	Telephone-based exercise counseling session on maintenance of exercise "Maintenance Counseling Group (MCG)"; pedometer for exercise activities Control: telephone calls, tip sheets on cardiovascular health *M*: 199 min/wk Length of Intervention: 6 mo *M*: 233 min/wk	7-Day PA Recall (7-Day PAR); Accelerometer (Biotrainer-Pro); Graded maximal exercise stress test (Quinton & Bruce Protocol (Peak VO2); Stage of Motivational Readiness for Exercise; Home logs; Medical Outcomes Study 36-Short Form Health Survey (SF-36). Follow-up: 6 mo and 12 mo At 6 mo increased PA maintenance nonsignificant IG but significant for the intervention group at 12 mo; stronger likelihood of achieving PA guidelines and not regressing at 6 and 12 mo. No differences in fitness at 6 mo; Odds for IG being at Action/ Maintenance level were twice as high as for controls Statistical significance: *	No exclusion criteria; selection bias and homogenous sample; attrition 26%; attrition greater in intervention group at 6 mo and double attrition rates for females; Study not powered to identify significant moderators of treatment effects
Pinto et al[60]/ USA	SCT; TTM	N=130 Age=64 Male=79.2%	Telephone-based exercise counseling session on maintenance of exercise "Maintenance Counseling Group (MCG)"; pedometer for exercise activities Control: Telephone calls, tip sheets on cardiovascular health *M*: 1.20 SS Friends Length of Intervention: 12 mo *M*: 1.24 SS Friends	7-Day PA Recall (7-Day PAR); Home logs; Self-Efficacy for Exercise; Processes of Exercise; Decisional Balance; Social Support for Exercise Survey; Physical Activity Enjoyment Scale Follow-up: 6 mo and 12 mo Significant positive effects only on social support only at 6 mo and decreasing support from friends mediated greater exercise participation at 12-mo Statistical significance: *	No exclusion criteria; selection bias and homogenous sample; low percentage of women; use of self-efficacy scale did not include barriers; significance of baseline differences not given; lacking a multidimensional approach to studying self-efficacy

(Continued)

Table 3. (Continued)

AUTHOR	THEORETICAL BASIS	SAMPLE	INTERVENTION	MEASURES—TOOLS/RESULTS	LIMITATIONS
Sniehotta et al[61]/ Germany	SCT	N = 240 Age 58 Male = 81.5%	3-group design with 2-intervention groups: (I) a planning group with planning booklet and sheets and (II) planning group with planning booklet and sheets plus diary with personal plans Control: usual care *M*: 121.26 mins/wk Length of Intervention: 1.5 mo Mean (group I): 182.92 mins/wk Mean (group II): 150.72 mins/wk	Modified Exercise Self Efficacy Scale; Sniehotta Action and Coping Planning Subscales; Kaiser Physical Activity Survey Scale; Diary sheets Follow-up: 2 mo and 4 mo Time 2 general physical exercise significantly higher for Group I. Group II significantly higher for strenuous exercise, self-efficacy, and Action Control; Groups I and II significantly higher in behavioral intentions and coping planning. T 3 intervention groups significantly higher in strenuous exercise than control No significant difference for general physical exercise. Group II significant difference in cardiac training group attendance Statistical significance: *	Homogeneous sample; details for control group lacking; small percentage of women; self-reporting; differences in exercise and PA not defined; attrition 17%; Loss of participants not discussed
Yates et al[62]/ USA	Self-efficacy	N = 64 Age = 67 Male = 69%	3-group design with 2-intervention groups: (I) structured education counseling booster sessions with individual goal setting and motivation by telephone or (II) In-person at clinic visits Control: One phone call to assess program satisfaction and risk reduction behaviors *M*: 65.50 PF *M*: 4.03 EF *M*: 33.80 duration Length of Intervention: 9 wks Mean (telephone): 72.08 PF Mean (clinic): 75,50 PF Mean (telephone): 4.58 EF Mean (clinic): 4.78 EF Mean (telephone): 29.71 duration Mean (clinic): 33.00 duration	SF-36 v1 subscale (Medical Outcomes Scale, and Ware); Behavioral outcomes 3-item nonpublished survey; PA Questionnaire (3-questions); Clinical outcomes—10 min monitored exercise session on a treadmill Follow-up: 3 mo and 6 mo Effects of the booster interventions were not significant. Overall decline in exercise adherence and frequency noted at 6 mo. At 3 mo increase in physical functioning only for participants in group with low baseline scores NS: in relation to the outcomes (frequency and duration of exercise) there were no significant differences between the booster intervention group versus usual care group	Nonvalidated measurement questionnaires; sample size small; limited power

Abbreviations: Ave., average; BMI, body mass index; CR, cardiac rehabilitation; EE, energy expenditure; EF, exercise frequency; ELMI, Extensive Lifestyle Management Intervention; HAPA, Health Action Process Approach; HIIT, high-intensity interval training; HRQL, health related quality of life; IG, intervention group; IPAQ, International Physical Activity Questionnaire; Mo, month/months; METS, metabolic equivalents; NYHA, New York Heart Association; PA, physical activity; PASE, Physical Activity Scale for the Elderly; PC-EX, perceived competence for regular physical exercise; PF, physical functioning; SCT, Social Cognitive Theory; SS, social support; TTM, Transtheoretical Model; URICA-E2, University of Rhode Island Change Assessment.

$^{*}P \leq .05$; $^{**}P \leq .01$.

included physiological measurements, health behavior measures, functional capacity, symptom checklist (SCL-90), and PA measures to determine if a self-regulation lifestyle program was capable of changing health behaviors. Janssen et al[53] reported a significant effect on exercise behavior at 6 months, and Janssen et al[58] later reported significant results with exercise behavior at 15 months postintervention. Although weaknesses of the study included sample bias and low percentage of women, PA improved significantly indicating the use of cognitive-behavioral intervention based on self-regulation principles, motivational interviewing, groups sessions, and home assignments demonstrate promising potential to improve PA behavior.

PA interventions

Five studies focused on PA interventions versus standard care for the control group.[28,30,37,52,55] A PA intervention included a walking program, physician-supervised exercise, time spent at moderate-intensity exercise, resistance exercise, or high-intensity interval training used to change PA behavior through exercise.[28,37,52,55,56,59,60] Guiraud et al[37] measured light, moderate, and vigorous intensity exercise among 29 subjects participating in a physician-supervised exercise group. Participants wore an accelerometer and received feedback and support via telephone. The intervention group had significantly greater moderate-intensity-PA duration and significantly greater total energy expenditure. In an all-female study by Johnson et al,[28] a 12-week walking program was implemented for continuing aerobic exercise. Using self-report, a decline in PA was noted over 12 months post-CRII, with the intervention group having a higher attrition rate. The PA decline over time for both groups indicated that walking as a sole intervention may not be as effective as using multiple intervention strategies. Millen and Bray[52] took a different approach and studied the effect of resistance training as the sole PA intervention for low-risk cardiac patients (N = 40). Thera-band and resistance bands provided various degrees of resistance and were used following American Association of Cardiopulmonary Rehabilitation (ACVPR)[8] recommendations on resistance-training modality for cardiac patients. Using self-report, researchers reported that resistance-training levels defined as how much resistance they could move in a 10-repetition maximum task, were higher in the intervention group at 4-week follow-up and adherence differences were sustained at 3-month follow-up. Aside from limiting this study to low-risk individuals, the results indicate that the use of resistance training appears to have a place in post-CRII. In another study, Madssen et al[55] measured peak oxygen uptake and PA among 49 subjects who participated in a monthly supervised high-intensity interval exercise session, along with an at-home exercise program and exercise diary to be performed and recorded 3 times per week. The study, a 12-month maintenance exercise program, with a focus on high-intensity exercise identified no change in peak oxygen uptake or self-reported PA levels for both the intervention and usual care group.

Combined cognitive-behavioral and PA interventions

Eleven studies used a combination of cognitive-behavioral and PA interventions, [22,45,47,48,51,54,57,59-62] There was considerable variability in the intervention designs used for evaluating PA success post-CRII. Studies explored self-monitoring,[22,59] behavioral counseling,[51] Extensive Lifestyle Management Intervention (ELMI),[54] and structured telephone counseling and education booster.[62] Not all studies indicated significant impact on PA-related measures. For example, Yates et al[62] implemented booster sessions on health, behavioral, and PA status guided by the concept of self-efficacy at 3 and 6 months post-CRII. These interventions were administered person-to-person or by phone. Follow-up evaluation showed no significant differences in frequency and duration of PA in terms of sessions per week between the control group and the groups receiving the booster sessions by phone or in person.

Aliabad et al[48] examined 96 subjects who received family support as the main construct from the Health Action Process Approach (HAPA) intervention. Family support was assessed using a questionnaire and maximum oxygen uptake via treadmill. Results of the HAPA trial were significantly higher for the intervention group. Similarly, Moore et al[22] tested the effectiveness of the CHANGE (Change Habits by Applying New Goals and Experiences) Program, a lifestyle modification program designed to increase exercise maintenance in the year following CRII. While the amount, frequency, and intensity of exercise between groups were not significant, participants in the usual care group were 76% more likely to stop exercising than the intervention group.

Self-monitoring using an exercise log or activity diary were mostly successful in promoting PA maintenance post-CRII. The logs or diaries typically included descriptions of activities, exercise, and PA, including documentation of progress toward meeting individual goals, action plans, and mental strategies.[61] Consistent encouragement appeared to impact the results as the counseling group reported significantly higher exercise participation than the control group at 12 months.[59,60] Some researchers incorporated multifactorial educational interventions.[47,57] Giallauria et al[57] reported functional capacity and leisure time PA was significantly greater for the intervention group. Giannuzzi et al[47] reported significantly greater improvement for PA in the intervention group.

Lifestyle modification[22] and innovative psychological interventions including detailed action plans and barrier-focused mental strategies[61] were effective. Continued contact with patient and family[48] by Internet group discussions or mobile text,[45] or consistent encouragement using home logs and pedometers was especially effective.[59,60] Giallauria et al[57] and Giannuzzi et al[47] also demonstrated improvement in PA using a multifactorial educational intervention, motivational readiness, and telephone support. Findings from a few studies however were not consistent with the abovementioned studies. Lear et al[54] after examining the effectiveness of an extensive lifestyle management program did not find significant improvement in PA behaviors. Likewise, Yates et al[62] found that an intervention using counseling by either by phone call or clinic visit was not effective in significantly increasing PA.

Technology was used in 9 (47%) of the studies reviewed and primarily used to measure outcomes rather than as part of the PA intervention.[22,37,45,51,53,55,58-60] Clark et al[56] researched the effects of music as an intervention giving accelerometers to measure PA outcomes in the usual care and intervention groups. In another study, participants in the intervention and control groups wore an accelerometer to collect PA outcome data; however, the intervention group wore the activity monitoring device for 8 weeks versus 1 week for the control group.[37] How much wearing the accelerometer, a wearable PA tracking device created a Hawthorne effect, motivating participants in the control group to exercise is unknown. Three studies however, did use PA tracking devices given only to participants in the intervention group and found significant improvements in exercise outcomes.[51,59,60] Butler et al[51] also found combining pedometers and telephone calls increased the total number of walking sessions and time at the 6-month follow-up. Technology in combination with direct and/or indirect staff supervision was especially effective.[51,59,60]

Discussion

This systematic review identified studies examining the effectiveness of interventions designed to help cardiac patients maintain PA post-CRII. Physical activity outcomes were measured either as the primary or secondary outcome. Overall, most studies reviewed found patients enrolling in an intervention soon after CRII completion had better PA outcomes than those receiving usual care. Four new studies were identified since an earlier review/meta-analysis published by Martinello et al,[33] Clark et al,[56] Janssen et al,[53] Johnson et al,[28] and Pinto et al.[60] Although, the purpose of the Martinello et al[33] review/meta-analysis is similar to this review, there are distinctions. For example, 60% of the electronic databases searched and the inclusion criteria differed. Unlike the earlier review,[33] which included studies of individuals diagnosed with heart failure, individuals with heart failure and other heart disease were excluded in the current review due to differences in disease process, exercise progression and outcomes.[12] Martinello et al[33] does not identify which phase (e.g. Phase I, Phase II, or Phase III) of the CR program individuals had completed prior to enrollment in an intervention study, whereas this review was specific to studying post-CRII only. The current review includes only studies published since 2000 while Martinello et al[33] includes studies dating from 1980 to 2015. Even considering these distinctions, it is clear that the findings of both papers complemented each other and further strengthens the reviews.

In this review, variations were identified between study design, interventions offered, and the services individuals received in their prior CRII program (e.g. length of program, type of services offered, etc.). For example, the length of time over which an intervention was delivered and the amount of time between intervention completion to the time of follow-up varied considerably. According to Room et al[23] the length of a health care intervention is an important factor to consider when planning to measure PA outcomes.[64] Yet, of the 19 studies reviewed, only 2 included interventions that extended beyond 12 months.[47,57] To better understand maintenance of PA, more longitudinal studies are needed.[65] Of note, Martinello et al[33] found the length of the intervention significantly affected PA outcomes but the length of the preceding CRII program did not.[33] In the studies we reviewed, there remains lack of insight as to the interrelationship of CRII services offered, duration of program participation, and post-CRII intervention on PA. The absence of these facts, variations between study design and methodologies weighs strongly against a constructive meta-analysis.

Irrespective of which of the 3 domains studies were categorized into, the results were not consistent. Studies that included PA intervention techniques alone, reported fewer positive outcomes but a greater number of studies that included cognitive techniques combined with PA techniques reported significant results.[45,47,48,53] According to Slovinec D'Angelo et al[66] successful maintenance of exercise for patients with coronary heart disease is largely dependent on autonomous motivation.[66] Using a comprehensive lifestyle maintenance program based on self-regulatory theory combined with PA interventions has been reported to reduce CAD risk factors and improve levels of PA.[53,58] According to Nigg et al,[64] when studies lack a theoretical framework the chances of changing people's health behaviors are limited and our understanding PA maintenance is reduced.[23] Interventions with a combined cognitive-behavioral and PA approach grounded with a health behavior theory or model, appear to have been more effective in motivating patients to maintain PA. Additional future research is needed to determine the advantages and disadvantages between these approaches.

Continued social support and communications with health care providers in a rehabilitation setting beyond CRII is important.[25,67] The success of an intervention may be related to the quality of the relationship formed between provider and patient.[68] Several factors affect the relationship building process between a patient and provider, including the age of the clinician, number of years of experience, and organizational and environmental factors which act either as facilitators or barriers to forming a therapeutic relationship. Aliabad et al[48] trialed a comprehensive health model which included maintaining communications with patients. One-on-one planned discussions were scheduled between therapist and patient with family involvement encouraged. As a result, exercise maintenance and capacity increased.[48,69] In another study, the intervention included quarterly supervised sessions with discussions at individual and group levels. One year following the intervention, more patients in the intervention than control group maintained regular PA.[30] Although patient support and direct communication delivered face-to-face, on-line, or by direct messaging was not a primary focus of this review, establishing a positive patient-centered relationship is a critical factor that emerged from our analysis and ought to be considered for future PA interventions targeting post-CRII patients.

The accessibility and affordability of health and fitness technologies such as eHealth, telemedicine, PA tracking devices (e.g. FitBit), and smart phone-based health apps have significantly improved since many of these studies were published.[20] Regrettably, PA tracking devices were only used as an intervention in few of the studies.[51,59,60] The use of telehealth for follow-up can be helpful as demonstrated by Barnason et al,[70] whom reported significantly more weight loss over 6 months in cardiac patients when telehealth was used. Telehealth, generally not reimbursed by third-party payers, may eventually become be a first-rate option to increasing PA, particularly for cardiac patients with transportation issues and who live in remote areas. When pedometers or accelerometers are issued to participants in both the intervention and control groups for the purpose of collecting PA data, the presence of a Hawthorne effect or the tracker serving as a behavioral cue to action should be considered and accounted for.[29,56] Strategies using various forms of technology may support PA maintenance for some. Although not currently reflected in the research,[51,71] mobile devices may be another beneficial delivery source of support, accountability, and communication,[72] especially since such devices have gained popularity and become more reasonably priced over the past 10 years.[51,71]

Strengths and limitations

This review has strength in the quality assessment and that all studies included were RCTs. The review was limited to studies published in English, and it is possible that worthwhile studies were overlooked. Similar to many cardiac studies including the 2 systematic reviews for PA maintenance,[32,33] women and older adults were poorly represented. Most studies did not give demographic details related to prior history of cardiac events, timing of cardiac event(s), disease severity, disease progression, and co-morbidities; data which would have been useful and informative for future intervention development. The findings may not represent the typical cardiac population based on several factors; self-selection, homogeneous characteristics, and only cardiac patients participating in CRII were recruited. Finally, it is difficult to determine if the exercise and education participants received previously from their CRII programs[37,51,56] acted as confounding factors and obscured the results leading to incorrect conclusions.

Conclusion

This review suggests PA interventions offered shortly after completion of CRII may help cardiac patients successfully maintain PA in the long-term; however, additional quality intervention research is needed. Research to examine PA maintenance in adults older than 70 years of age would be valuable as the average lifespan continues to increase and cardiac disease remains a primary cause of death globally. Studies with larger and more diverse samples and more consistent methods and outcome measures would greatly increase the possibility for doing a high-quality meta-analysis of successful PA maintenance interventions post-CRII. Future intervention research to increase and maintain PA in post-CRII patients should be designed from the outset using a health behavior theory framework and include both PA and cognitive-behavioral components to optimize the likelihood of participants' long-term PA adherence.

Author Contributions

Graham H, Prue-Owens K, Kirby J, and Ramesh M substantially contributed to the manuscript. All authors were involved in the research process, drafting the manuscript and making revisions throughout the process of writing the paper. All authors reviewed the final draft/copy of the paper.

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