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Narrative Review Comparing the Benefits of and Participation in Cardiac Rehabilitation in High-, Middle- and Low-Income Countries

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Abstract

Background—Cardiovascular disease is a leading cause of morbidity worldwide. Cardiac rehabilitation (CR) is a comprehensive secondary prevention approach, with established benefits in reducing morbidity in high-income countries (HICs). The objectives of this review were to summarize what is known about the benefits of CR, including consideration of cost-effectiveness, in addition to rates of CR participation and adherence in high-, as well as low- and middle-income countries (LMICs).

Methods—A literature search of Medline, Excerpta Medica Database (EMBASE), and Google Scholar was conducted for published articles from database inception to October 2013. The search was first directed to identify meta-analyses and reviews reporting on the benefits of CR. Then, the search was focused to identify articles reporting CR participation and dropout rates. Full-text versions of relevant abstracts were summarized qualitatively.

Results—Based on meta-analysis, CR significantly reduced all-cause mortality by 13%–26%, cardiac mortality by 20%–36%, myocardial re-infarction by 25%–47%, and risk factors. CR is cost-effective in HICs. In LMICs, CR is demonstrated to reduce risk factors, with no studies on mortality or cost-effectiveness. Based on available data, CR participation rates are <50% in the majority of countries, with documented dropout rates up to 56% and 82% in high- and middle-income countries, respectively.

Conclusions—CR is a beneficial intervention for heart patients in high and LMICs, but is underutilized with low participation and adherence rates worldwide. While more research is

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needed in LMICs, strategies shown to increase participation and program adherence should be implemented.

Keywords

cardiac rehabilitation; secondary prevention; myocardial infarction; participation; adherence; cost-effectiveness

Introduction

Cardiovascular disease (CVD) has emerged as the leading cause of death worldwide, accounting for 30% of global deaths [1,2]. The predominant CVDs are coronary heart disease (CHD), stroke, hypertension, and heart failure [2,3]. These disorders are responsible for more than 82% of CVD mortality [3]. According to the World Health Organization (WHO), an estimation of 17.3 million people died from CVD in 2008 [2,3]. Of these, 7.3 million deaths were due to CHD [2]. Over the next few decades, CVD will continue as the leading cause of mortality worldwide [2,3,4]. More than 23 million individuals will die annually from CVD by 2030 [4]. Further, the burden of CVD is growing disproportionately in low and middle-income countries (LMICs) [5], where 80% of CVD deaths occur [6]. This is likely due to limited resources, lack of screening and prevention, rapid urbanization and associated lifestyle changes [6].

In 2010, the estimated global cost of CVD was US$ 863 billion [3]. Almost US$ 474 billion (55%) was in direct healthcare costs, with the remaining 45% in indirect costs, including productivity loss from disability, premature death, and time lost from work [3]. This cost is estimated to increase to US$ 1,044 billion in 2030 [4]. The economic loss is exacerbated in LMICs, where a high proportion of working-age adults are affected by CVD [7]. Between 2011 and 2025, the projected economic loss from CVD is $3.76 trillion, representing >50% of the loss from non-communicable diseases in LMICs [3]. This loss could be reduced by $377 billion, in the same period, by decreasing CVD mortality by 10% [3].

Thus, in addition to the need for primary prevention, the scale of disease and the economic impact necessitate fulsome secondary and tertiary prevention in high and LMICs. A comprehensive model, such as that offered in cardiac rehabilitation (CR), is needed. CR is a multidisciplinary secondary prevention approach designed to stabilize, slow, or even promote regression of CVD [8]. The World Health Organization (WHO) defines CR as the “sum of activities required to influence favourably the underlying cause of the disease, as well as to provide the best possible physical, mental and social conditions, so that the patients may, by their own efforts, preserve or resume when lost, as normal a place as possible in the community” [9].

While much is known about CR in high-income countries (HICs), little is known about CR in LMICs. Thus, the objectives of this narrative review were to juxtapose what is known about the: (1) benefits of CR, including consideration of cost-effectiveness, and (2) rates of CR participation and adherence in HICs, with what is known in LMICs.

Methods

A literature search of Medline, Excerpta Medica Database (EMBASE), and Google Scholar was conducted for published articles from database inception to October 2013 by an information specialist. The search strategy was created in consultation with the study authors. Examples of the terms used in the search strategy included “cardiac rehabilitation”, “secondary prevention”, “physical medicine”, “physical therapy modalities”, “exercise therapy”, “participation”, “enrollment”, “adherence”, “compliance”, “dropout”, “utilization”, “benefits”, “mortality reduction”, “risk factors improvement/reduction” and relevant individual risk factors.

Countries were classified according to 2012 Gross National Income per capita, in accordance with World Bank methodology [5]. HICs were those with $12,616 per capita or greater. Countries with less were classified as LMICs. Each LMIC was included as a search term and combined with the benefits and participation searches. The search strategy identified a large number of studies in HICs and 1,417 studies in LMICs. Therefore, for HICs, we restricted the search related to CR benefits to systematic reviews and meta-analyses published since the late 1980s.

Identified citations were considered for inclusion by the first author. Full-text versions of relevant abstracts were obtained for inclusion, and summarized qualitatively. Where multiple studies were identified from a specific country reporting on participation, articles for reporting were chosen based on the following considerations: a) being the only available study from a country; b) random selection of the study population; c) large cohort of the study population; and d) being the most recent study in a country. For LMICs, 19 studies were included.

Results

Benefits of Cardiac Rehabilitation

HICs—Over the past three decades, considerable evidence of the benefits of CR for patients with CHD has mounted. Documented benefits of CR are based on findings of 8 meta-analyses of randomized clinical trials (Table 1), where outcomes among CR participants are compared with participants exposed only to usual care [10–17]. These have shown participation in CR reduces mortality and morbidity, promotes a healthy lifestyle, favourably modifies risk factors, and improves health-related quality of life. Further, a recent overview of six CR meta-analyses including 71 randomized clinical trials showed that exercise-based CR reduces all-cause mortality by a mean of 19%, cardiac mortality by a mean of 20%, re-infarction by a mean of 15%, and hospitalization by a mean of 31%, and had significant positive changes in total cholesterol, triglycerides, and systolic blood pressure among patients with CHD [18].

Mortality and morbidity: The effectiveness of CR in reducing mortality in patients with CHD has been studied widely since the late 1980s (Table 1) [10–17]. CR significantly reduced all-cause mortality by 13%–26% and cardiac mortality by 20%–36% among patients with CHD (Table 2) [10–17]. In a recent observational study of 601,099 Medicare beneficiaries enrolled in CR, five-year all-cause mortality rates were reduced by 21%–34% [19]. Cardiac mortality was also significantly reduced by 20%–36% [10–12,14,16]. With regard to fatal and/or non-fatal myocardial re-infarction, there was a significant decrease by 25%–47% with CR (Table 2) [11, 15,17].

Risk factors

Dyslipidemia: The blood lipids included as outcomes in the meta-analyses were total cholesterol, high-density lipoprotein (HDL) and low-density lipoprotein (LDL) cholesterol, and triglycerides. All these lipids, except HDL, were significantly reduced with CR(Table 3) [12–14]. Notably, triglycerides were significantly reduced with either exercise-only or comprehensive CR, while for total and LDL cholesterol results trended toward more and significant reduction with comprehensive rather than exercise-only CR [12–14]. HDL cholesterol slightly increased with CR, but not significantly [12–14].

Hypertension: With comprehensive CR, systolic blood pressure was reduced significantly by 7 to 3 mmHg [12,13], while diastolic blood pressure was significantly reduced by 2 mmHg [12]. With exercise-only CR, neither the decrease in systolic (2 mmHg) nor diastolic blood pressure (1 mmHg) was significant [13].

Smoking: This outcome has been considered in 3 meta-analyses [12–14]. Lower rates of self-reported smoking were demonstrated with CR participation compared to usual care. The proportion of smokers was non-significantly reduced by 18% with exercise-only CR [13], 24% with comprehensive CR [13], and 22%–36% with either [12,14]. However, statistically significant reductions were observed when all the trials that assessed exercise-only CR and comprehensive CR were combined, with a reduction rate of 36% (Table 3) [14].

Health-related quality of life: Health-related quality of life could not be considered in most meta-analyses to date due to variation in the instruments used across studies [13,15]. However, 7(70%) out of 10 studies separately reported that CR participants had significantly greater improvement in health-related quality of life scores when compared to non-participants [16].

LMICs—There are few RCTs and no meta-analyses of CR in LMICs [20–23]. There has been one scoping review summarizing the benefits of CR in LMICs [24]. No studies have assessed mortality or morbidity outcomes. The handful of primary studies from LMICs on CR benefits are summarized in Table 4. Results showed that participation in CR is associated with significant reduction in triglycerides [20,25,27], total cholesterol [20,25,27], LDL [20,26,27], body mass index [26–28], as well as systolic [20,26], and diastolic blood pressure [20], CR is also associated with significant increases in HDL [26,27]. Additionally, some studies revealed significant improvements in health-related quality of life [28–31], self-efficacy [28], self-regulation [28], and functional capacity [26,27,31]. The latter is strongly associated with mortality reductions [17].

Cost-Effectiveness of CR—Data on cost-effectiveness of CR stems from studies undertaken in HICs. There have been no studies that have examined cost-effectiveness of CR in LMICs. Results suggest that, as outlined above, CR programs are not only clinically-effective, but are also cost-effective in terms of saving lives and reducing healthcare consumption [32–34].

Considering a medical intervention cost-effectiveness ratios in Europe and the US of US $20,000–$100,000 per quality-adjusted life year (QALY) gained as a threshold for a cost-effective intervention [18], CR has been established as cost-effective. The earliest two full economic reviews showed a cost-effectiveness ratio of US$9200/QALY for 1991 and US $4950/life-year gained for 1995 [32,33]. Several subsequent studies have consistently shown CR as cost-effective (Table 5). More recently, an overview of 6 major meta-analyses and a systematic review have confirmed the cost-effectiveness of CR in patients with CHD [18,34].

A meta-analysis of 47 randomized controlled trials demonstrated that CR significantly reduced re-hospitalization by 31% (OR=0.69; 95% CI 0.51–0.93) among patients with CHD in the 12 months following a cardiac event [16]. A comparison of the cost-effectiveness of CR and other medical interventions available for patients with CHD is presented in Table 5. For example, an American study showed that CR was more cost-effectiveness (US$4950/year of life saved) than lipid-lowering medication (US$9630/year of life saved) or coronary artery bypass graft surgery (US$18,700/year of life saved) [33]. Similar results were demonstrated in a study in the United Kingdom [35].

CR Participation

HICs: Despite its established benefits reviewed above, CR remains underutilized. Less than half of eligible patients participate in CR programs in the majority of HICs (Table 6) [39–41]. The EUROASPIRE III Survey showed that only 36.5% of the 8,845 patients eligible for CR from 22 European countries (19 of which were high-income) attended the program [41]. The participation rates were as low as <1% in Greece and Spain and as high as 86.4% in Lithuania. Notably, participation rates >50% were reported in only 6 (19.4%) of the 31 countries with available data. Findings from the European Cardiac Rehabilitation Inventory Survey revealed that CR enrolment rates >50% were seen in only 3 (10.7%) countries while rates <30% were reported in 15 (53.6%) of the 28 countries [42]. In the United States, the largest study ever on CR utilization among 601,099 Medicare beneficiaries eligible for CR demonstrated that only 12.2% of this cohort participated [19].

LMICs: CR in middle-income countries is also under-utilized. Though its main aim was not to study CR, the international STABILITY study that included 15 countries comprises the most comprehensive data on CR participation from middle-income countries [45]. Participation rates were as low as <30% in 10 (66.6%) of the 15 included countries [45]. This rate is likely an over-estimation because CR participation was self-reported [51]. The study also demonstrated that patients living in middle-income countries had a 2-fold higher probability of decreasing their physical activity after being diagnosed with CHD when compared to those living in HICs. Other available data on CR participation are shown in Table 7, where participation rates range from 3%–89%. The self-reported 89% participation rate in China is highly inconsistent with the other values, and given the known low availability of CR there [52], this should be interpreted with caution.

No study on patient participation in CR programs in low-income countries could be found. This is likely due to the dearth of CR programs in these countries [52].

CR Adherence: Recent studies have demonstrated a dose-response association between CR attendance, in terms of number of sessions completed, with lower mortality and morbidity [19,54]. Nonetheless, studies from HICs document a dropout rate of 12–56% among enrolled patients (Table 8). Non-adherence is also demonstrated as a problem in the few available studies from middle-income countries. These studies, all from Iran, showed dropout rates as high as 82% [55–57]. No studies of CR adherence in low-income countries were identified.

Discussion

This review has encapsulated the benefits of CR participation in HICs from mortality, morbidity and cost-effectiveness through to risk factors, and in LMICs from improvement in quality of life, and CVD risk factors to functional capacity. It has also made evident the low CR participation and adherence worldwide. Participation rates of ≥50% were demonstrated in <20% of 31 HICs and in only 12.5% of 16 middle-income countries. This can be explained by the low availability of CR globally, as well as patient, provider, and system barriers in both high- and middle-income countries [52]. Most importantly, this review has summarized CR participation and adherence rates in middle-income countries for the first time.

The WHO has recommended strategic interventions known as "Best Buys" to reduce the CVD and economic burden in LMICs [65]. Specifically, WHO recommends the use of counselling and multi-drug therapy including aspirin as the "best buys" for secondary prevention. Indeed, counselling and medication management are some of the core components of CR [66]. Pending further analysis of the benefits and costs of CR delivery in LMICs, findings from this review suggest that CVD management in LMICs should be broadened to include CR implementation.

The Cochrane review on interventions to increase CR participation and adherence has recently been updated [67]. There were 8 interventions demonstrated to successfully increase participation, including motivational letters, structured nurse or therapist-led contacts via phone calls or visits, early CR appointments within 10 days after hospital-discharge, gender-specific programs, and intermediate phase programs for elderly patients. There were 3 adherence interventions demonstrated to successfully increase CR adherence namely daily self-monitoring of activity, action planning, and tailored counselling by CR staff [67]. While all these trials were undertaken in HICs, some of these strategies could be applicable in middle-income countries. For example, motivational letters in particular are a very low-cost intervention, which warrant testing in such contexts. The structured health professional-led contacts via phone calls or home visits has been practiced in MICs, particularly with the home-based CR model in Iran as well as in Brazil, where such models of CR are reported to have low cost [29,68].

To overcome barriers to CR use, there is a growing trend to test alternative delivery models to traditional hospital-based CR. Recently, electronic delivery has been introduced with the home-based CR model [69]. Though mortality as an outcome needs to be examined, a recent systematic review demonstrated that multifactorial individualized telehealth CR programs are as effective as hospital-based programs in lowering CHD risk factors and improving physical function [70]. A recent randomized controlled trial demonstrated that patients using smartphone-based CR had significant higher CR participation (80% vs. 62%), adherence (94% vs. 68%) and completion (80% vs. 47%) compared to patients in traditional hospital-based CR ($p<0.05$) [71]. Importantly, due to the wide dissemination of mobile technology in particular, including in LMICs, these models hold the potential to dramatically improve CR participation and adherence [71,72]. Health policy makers should strive to facilitate implementation of flexible alternative CR models, through payment to healthcare providers and population-based promotion of these models.

Many directions for future research have been identified. Chiefly, there is a need for randomized controlled trials in LMICs; particularly to establish whether participation is associated with reduced mortality and morbidity as seen in HICs. Moreover, there is no study on CR cost-effectiveness in LMICs. Such studies will enable forecasting and costing around the magnitude of benefit that could be achieved with regard to patients, the health system, and the economy writ large should CR be broadly implemented. Second, information on participation in CR in some regions of the world is not empirically established, and warrant investigation, namely Africa, Southeast Asia, the Eastern Mediterranean and Western Pacific regions. Research on CR adherence is needed in all regions, and requires a more standardized approach to enable cross-national comparison. Finally, randomized trials of interventions identified to successfully increase participation and adherence in HICs require rigorous testing in LMICs.

Caution is warranted when interpreting these results. First, the review was not systematic. Some articles may have been missed in the search. Only one author screened identified articles for inclusion, which invites human error and bias in the process of study selection. Article quality was not considered. Second, given the paucity of studies in LMICs, results could not be quantitatively synthesized. Third, the search was limited to English-language publications, and thus articles may have not been identified for review.

Conclusion

CR is a beneficial intervention for CVD patients, but is underutilized with low participation and adherence rates in both high-income and LMICs. CR participation rates >50% were reported in only 19.4% of HICs with available data, and in only 12.5% of LMICs. Similarly, dropout rates of 12–56% among enrolled patients were reported in HICs, and of 55–82% were reported in the few studies from LMICs. The plethora of knowledge regarding low CR participation and adherence in HICs should inform approaches to research and broader implementation of CR in LMICs.

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References

1. Gaziano TA, Pagidipati N. Scaling up chronic disease prevention interventions in lower- and middle-income countries. Annu Rev Public Health. 2013; 34:317–335. [PubMed: 23297660]
2. Mendis, S., Alwan, A., editors. Prioritized research agenda for prevention and control of noncommunicable diseases. Geneva: WHO; 2011.
3. Bloom, DE., Cafiero, ET., Jané-Llopis, E., Abrahams-Gessel, S., Bloom, LR., Fathima, S., et al. [accessed 15 April 2014] The World Economic Forum and Harvard School of Public Health. The global economic burden of non-communicable diseases. 2011. http://www3.weforum.org/docs/WEF_Harvard_HE_GlobalEconomicBurdenNonCommunicableDiseases_2011.pdf
4. Beaglehole R, Bonita R. Global public health: A scorecard. The Lancet. 2008; 372(9654):1988–96.
5. The World Bank. [accessed 29 June 2014] New country classifications. 2014. http://data.worldbank.org/news/new-country-classifications
6. Laslett LJ, Alagona P, Clark BA, Drozda JP, Saldivar F, Wilson SR, et al. The Worldwide Environment of Cardiovascular Disease: Prevalence, diagnosis, therapy, and policy issues. A report from the American College of Cardiology. JACC. 2012; 60:S1–S49. [PubMed: 23257320]
7. Gaziano TA. Reducing the growing burden of cardiovascular disease in the developing world. Health Affairs. 2007; 26:13–24. [PubMed: 17211010]
8. Balady GJ, Ades PA, Bittner VA, Franklin BA, Gordon NF, Thomas RJ, et al. Referral, enrollment, and delivery of cardiac rehabilitation/secondary prevention programs at clinical centers and beyond: a presidential advisory from the American Heart Association. Circulation. 2011; 124:2951–2960. [PubMed: 22082676]
9. WHO. Needs and Action Priorities in Cardiac Rehabilitation and Secondary Prevention in Patients with CHD. Geneva: WHO; 1993.
10. Oldridge NB, Guyatt GH, Fischer ME, Rimm AA. Cardiac rehabilitation after myocardial infarction. Combined experience of randomized clinical trials. JAMA. 1988; 260:945–950. [PubMed: 3398199]
11. O'Connor GT, Buring JE, Yusuf S, Goldhaber SZ, Olmstead EM, Paffenbarger RS, et al. An overview of randomized trials of rehabilitation with exercise after myocardial infarction. Circulation. 1989; 80:234–244. [PubMed: 2665973]
12. Jolliffe JA, Rees K, Taylor RS, Thompson D, Oldridge N, Ebrahim S. Exercise-based rehabilitation for coronary heart disease. Cochrane Database Syst Rev. 2001; 1:CD001800.
13. Brown, A., Taylor, R., Noorani, H., Stone, J., Skidmore, B. [accessed 17 November 2013] Exercise-based cardiac rehabilitation programs for coronary artery disease: A systematic clinical and economic review. 2003. http://www.cadth.ca/en/products/health-technology-assessment/publication/398
14. Taylor R, Brown A, Ebrahim S, Jolliffe J, Noorani H, Rees K, et al. Exercise-based rehabilitation for patients with coronary heart disease: systematic review and meta-analysis of randomized controlled trials. Am J Med. 2004; 116:682–692. [PubMed: 15121495]
15. Clark AM, Hartling L, Vandermeer B, McAlister FA. Meta-analysis: Secondary prevention programs for patients with coronary artery disease. Ann Intern Med. 2005; 143:659–672. [PubMed: 16263889]
16. Heran B, Chen J, Ebrahim S, Moxham T, Oldridge N, Rees K, et al. Exercise-based cardiac rehabilitation for coronary heart disease. Cochrane Database Syst Rev. 2011; 7:CD001800.

17. Lawler P, Filion K, Eisenberg M. Efficacy of exercise-based cardiac rehabilitation post-myocardial infarction: A systematic review and meta-analysis of randomized controlled trials. Am Heart J. 2011; 162:571–584. [PubMed: 21982647]
18. Oldridge N. Exercise-based cardiac rehabilitation in patients with coronary heart disease: Meta-analysis outcomes revisited. Future Cardiology. 2012; 8:729–751. [PubMed: 23013125]
19. Suaya JA, Stason WB, Ades PA, Normand S-LT, Shepard DS. Cardiac rehabilitation and survival in older coronary patients. JACC. 2009; 54:25–33. [PubMed: 19555836]
20. Jiang X, Sit JW, Wong TK. A nurse-led cardiac rehabilitation programme improves health behaviours and cardiac physiological risk parameters: Evidence from Chengdu, China. J Clin Nurs. 2007; 16:1886–1897. [PubMed: 17880478]
21. Karapolat H, Eyigor S, Zoghi M, Yagdi T, Nalbantgil S, Durmaz B, et al. Effects of cardiac rehabilitation program on exercise capacity and chronotropic variables in patients with orthotopic heart transplant. Clin Res in Cardiol. 2008; 97:449–456. [PubMed: 18317667]
22. Molazem Z, Mohebbi Z, Ostovan MA, Keshavarzi S. Effect of continuous care model on lifestyle of patients with myocardial infarction. ARYA Atheroscler. 2013; 9:186–191. [PubMed: 23766775]
23. Charoenkul P, Khuangsirikul W, Jalayondeja W, Krittayaphong R. Improvement in quality of life with phase II cardiac rehabilitation home program after coronary artery bypass surgery at Siriraj Hospital. Thai Heart J. 2007; 20:165–170.
24. Shanmugasegaram S, Perez-Terzic C, Jiang X, Grace SL. Cardiac rehabilitation services in low- and middle-income countries: A scoping review. J Cardiovasc Nurs. 2013; Epub ahead of print. doi: 10.1097/JCN.0b013e31829c1414
25. Avram A, Iurciuc S, Craciun L, Avram C, Iurciuc M, Sarau C, et al. EUROASPIRE III Romania - The need to reinforce cardiac rehabilitation in patients with coronary artery disease. TMJ. 2010; 60:299–304.
26. Sarrafzadegan N, Rabiei K, Kabir A, Sadeghi M, Khosravi A, Asgari S, et al. Gender differences in risk factors and outcomes after cardiac rehabilitation. Acta Cardiol. 2008; 63:763–770. [PubMed: 19157173]
27. Ciftçi C, Duman B, Cağatay P, Demiroğlu C, Aytekin V. The effects of phase II cardiac rehabilitation programme on patients undergone coronary bypass surgery. Anadolu Kardiyol Derg. 2005; 5:116–121. [PubMed: 15939686]
28. Intarakamhang P, Intarakamhang U. Effects of the comprehensive cardiac rehabilitation program on psychological factors and quality of life among coronary heart disease patients. Glob J Health Sci. 2013; 5:145–152.
29. Poortaghi S, Baghernia A, Golzari S, Safayian A, Atri S. The effect of home-based cardiac rehabilitation program on self-efficacy of patients referred to cardiac rehabilitation center. BMC Research Notes. 2013; 6:287.doi: 10.1186/1756-0500-6-287 [PubMed: 23880148]
30. Babu AS, Maiya AG, George MM, Padmakumar R, Guddattu V. Effects of combined early in-patient cardiac rehabilitation and structured home-based program on function among patients with congestive heart failure: A randomized controlled trial. Heart Views. 2011; 12:99–103. [PubMed: 22567195]
31. Chakraborty K, Das KM, Iswarari S, Mandal PK, Sarkar UN, Ballav A, et al. A comparative study on the effects of comprehensive rehabilitation in uncomplicated coronary artery bypass grafting patients from rural and urban India. IJPMR. 2007; 18:34–40.
32. Oldridge N, Furlong W, Feeny D, Torrance G, Guyatt G, Crowe J, Jones N. Economic evaluation of cardiac rehabilitation soon after acute myocardial infarction. Am J Cardiol. 1993; 72:154–161. [PubMed: 8328376]
33. Ades PA, Pashkow FJ, Nestor JR. Cost-effectiveness of cardiac rehabilitation after myocardial infarction. J cardiopulm rehabil. 1997; 17:222–231. [PubMed: 9271765]
34. Wong WP, Feng J, Pwee KH, Lim J. A systematic review of economic evaluations of cardiac rehabilitation. BMC Health Serv Res. 2012; 12:243.doi: 10.1186/472-6963-12-243 [PubMed: 22873828]
35. Fidan D, Unal B, Critchley J, Capewell S. Economic analysis of treatments reducing coronary heart disease mortality in England and Wales, 2000–2010. QJM. 2007; 100:277–89. [PubMed: 17449875]

36. Georgiou D, Chen Y, Appadoo S, Belardinelli R, Greene R, Parides MK, et al. Cost-effectiveness analysis of long-term moderate exercise training in chronic heart failure. Am J Cardiol. 2001; 87:984–988. [PubMed: 11305991]
37. Huang Y, Zhang R, Culler SD, Kutner NG. Costs and effectiveness of cardiac rehabilitation for dialysis patients following coronary bypass. Kidney Int. 2008; 74:1079–1084. [PubMed: 18650790]
38. Lowensteyn I, Coupal L, Zowall H, Grover SA. The cost-effectiveness of exercise training for the primary and secondary prevention of cardiovascular disease. JCRP. 2000; 20:147–155.
39. Suaya J, Shepard D, Normand S, Ades P, Prottas J, Stason W. Use of cardiac rehabilitation by Medicare beneficiaries after myocardial infarction or coronary bypass surgery. Circulation. 2007; 116:1653–62. [PubMed: 17893274]
40. Grace S, Gravely-Witte S, Kayaniyil S, Brual J, Suskin N, Stewart D. A multisite examination of sex differences in cardiac rehabilitation barriers by participation status. J Womens Health. 2009; 18:209–216.
41. Kotseva K, Wood D, Backer GD, Bacquer DD. Use and effects of cardiac rehabilitation in patients with coronary heart disease: results from the EUROASPIRE III survey. Eur J Prev Cardiol. 2013; 20:817–826. [PubMed: 22718794]
42. Bjarnason-Wehrens B, McGee H, Zwisler AD, Piepoli M, Benzer W, Schmid JP, et al. Cardiac rehabilitation in Europe: Results from the European cardiac rehabilitation inventory survey. Eur J Cardiovasc Prev Rehabil. 2010; 17:410–418. [PubMed: 20300001]
43. Beauchamp A, Worcester M, Ng A, Murphy B, Tatoulis J, Grigg L, et al. Attendance at cardiac rehabilitation is associated with lower all-cause mortality after 14 years of follow-up. Heart. 2013; 99:620–625. [PubMed: 23213175]
44. Grace SL, Shanmugasegaram S, Gravely-Witte S, Brual J, Suskin N, Stewart DE. Barriers to cardiac rehabilitation: Does age make a difference? JCRP. 2009; 29:183–187. [PubMed: 19471138]
45. Stewart R, Held C, Brown R, Vedin O, Hagstrom E, Lonn E, et al. Physical activity in patients with stable coronary heart disease: An international perspective. Eur Heart J. 2013; 34:3286–93. [PubMed: 24014220]
46. Cottin Y, Cambou J-P, Casillas JM, Ferrières J, Cantet C, Danchin N. Specific profile and referral bias of rehabilitated patients after an acute coronary syndrome. JCRP. 2004; 24:38–44.
47. Gendler Y, Geulayov G, Ziv A, Novikov I, Dankner R. A multicenter intervention study on referral to cardiac rehabilitation after coronary artery bypass graft surgery: A 1-year follow-up of rehabilitation rates among USSR-born and veteran Israeli patients. Harefuah. 2012; 151:511–517. [PubMed: 23367742]
48. Goto Y, Saito M, Iwasaka T, Daida H, Kohzuki M, Ueshima K, et al. Poor implementation of cardiac rehabilitation despite broad dissemination of coronary interventions for acute myocardial infarction in Japan. A nationwide survey. Circ J. 2007; 71:173–179. [PubMed: 17251662]
49. Parks D, Allison M, Doughty R, Cunningham L, Ellis CJ. An audit of phase II cardiac rehabilitation at Auckland Hospital. N Z Med J. 2000; 113:158–161. [PubMed: 10894341]
50. Bethell H, Lewin R, Evans J, Turner S, Allender S, Petersen S. Outpatient cardiac rehabilitation attendance in England: Variability by region and clinical characteristics. JCPR. 2008; 28:386–391.
51. Prince S, Adamo K, Hamel M, Hardt J, Gorber S, Tremblay M. A comparison of direct versus self-report measures for assessing physical activity in adults: A systematic review. Int J Behav Nutr Phys Act. 2008; 5:56.doi: 10.1186/1479-5868-5-56 [PubMed: 18990237]
52. Turk-Adawi K, Sarrafzadegan N, Grace SL. Global availability of cardiac rehabilitation. Nat Rev Cardiol. Epub ahead of print 15 July 2014.
53. Ali M, Qadir F, Hanif B, Javed S, Khan ZN, Asad S. Factors affecting outpatient cardiac rehabilitation attendance after acute myocardial infarction and coronary revascularization_ a local experience. J Pak Med Assoc. 2012; 62:347–351. [PubMed: 22755278]
54. Hammill B, Curtis L, Schulman K, Whellan D. Relationship between cardiac rehabilitation and long-term risks of death and myocardial infarction among elderly Medicare beneficiaries. Circulation. 2010; 121:63–70. [PubMed: 20026778]

55. Soleimani A, Abbasi A, Nejatian M, Salarifar M, Darabian S, Karimi A, et al. Factors predicting discontinuation of a hospital-based cardiac rehabilitation programme. Kardiol Pol. 2009; 67:140–146. [PubMed: 19288376]
56. Moradi B, Esmaeilzadeh M, Maleki M, Sari L. Factors associated with failure to complete phase II cardiac rehabilitation: Survey registry in Rajaie Cardiovascular Medical And Research Center. Int Cardiovasc Res J. 2011; 5:139–142.
57. Sarrafzadegan N, Rabiei K, Shirani S, Kabir A, Mohammadifard N, Roohafza H. Drop-out predictors in cardiac rehabilitation programmes and the impact of sex differences among coronary heart disease patients in an Iranian sample: a cohort study. Clin Rehabil. 2007; 21:362–372. [PubMed: 17613578]
58. Cannistra LB, O'Malley CJ, Balady GJ. Comparison of outcome of cardiac rehabilitation in black women and white women. Am J Cardiol. 1995; 75:890–893. [PubMed: 7732996]
59. Halm M, Penque S, Doll N, Beahrs M. Women and cardiac rehabilitation: Referral and compliance patterns. J Cardiovasc Nurs. 1999; 13:83–92. [PubMed: 10098008]
60. Turner S, Bethell H, Evans J, Goddard J, Mullee M. Patient characteristics and outcomes of cardiac rehabilitation. J Cardiopulm Rehabil. 2002; 22:253–260. [PubMed: 12202845]
61. Sanderson B, Phillips M, Gerald L, DiLillo V, Bittner V. Factors associated with the failure of patients to complete cardiac rehabilitation for medical and nonmedical reasons. J Cardiopulm Rehabil. 2003; 23:281–289. [PubMed: 12894002]
62. Yohannes A, Yalfani A, Doherty P, Bundy C. Predictors of drop-out from an outpatient cardiac rehabilitation programme. Clin Rehabil. 2007; 21:222–229. [PubMed: 17329279]
63. Kerins M, McKee G, Bennett K. Contributing factors to patient non-attendance at and non-completion of Phase III cardiac rehabilitation. Eur J Cardiovasc Nurs. 2011; 10:31–36. [PubMed: 20457543]
64. Scane K, Alter D, Oh P, Brooks D. Adherence to a cardiac rehabilitation home program model of care: a comparison to a well-established traditional on-site supervised program. Appl Physiol Nutr Metab. 2012; 37:206–213. [PubMed: 22360343]
65. World Health Organization and the World Economic Forum. From burden to "Best Buys": Reducing the economic impact of non-communicable diseases in low- and middle-income countries. Geneva: WHO; 2011.
66. Buckley JP, Furze G, Doherty P, Speck L, Connolly S, Hinton S, et al. BACPR scientific statement: British standards and core components for cardiovascular disease prevention and rehabilitation. Heart. 2013; 99:1069–1071. [PubMed: 23403407]
67. Karmali KN, Davies P, Taylor F, Beswick A, Martin NSE. Promoting patient uptake and adherence in cardiac rehabilitation. Cochrane Database Syst Rev. 2014; 6:CD007131.doi: 10.1002/14651858.CD007131.pub3
68. Salvetti XM, Oliveira JA, Servantes DM, Vincenzo de Paola AA. How much do the benefits cost? Effects of a home-based training programme on cardiovascular fitness, quality of life, programme cost and adherence for patients with coronary disease. Clini Rehabil. 2008; 22:987–996.
69. Turk-Adawi K, Grace SL. Smartphone-Based Cardiac Rehabilitation. Heart. Epub ahead of print 27 August 2014.
70. Clark RA, Conway A, Poulsen V, Keech W, Tirimacco R, Tideman P. Alternative models of cardiac rehabilitation: A systematic review. Eur J Prev Cardiol. Epub ahead of print, 13 August 2013.
71. Varnfield M, Karunanithi M, Lee C-K, Honeyman E, Arnold D, Ding H, et al. Smartphone-based home care model improved utilisation of cardiac rehabilitation in post-myocardial infarction patients: Results from a randomized controlled trial. Heart. Epub ahead of print 27 June 2014.
72. Beatty AL, Fukuoka Y, Whooley MA. Using mobile technology for cardiac rehabilitation: A review and framework for development and evaluation. J Am Heart Assoc. 2013; 2:e000568.doi: 10.1161/JAHA.113.000568 [PubMed: 24185949]

Table 1

Cardiac rehabilitation meta-analyses

Author, Year	Search dates	RCTs (N)	Patients (N)	Patient Diagnosis
Oldridge et al., 1988	Pre 1988	10	4347	MI
O'Connor et al., 1989	1960–1988	22	4,554	MI
Jolliffe et al., 2001	Pre January 1999	32	8,440	CHD
Brown et al., 2003	Pre March 2002	46	8,677	CHD
Taylor et al., 2004	1970-March 2003	48	8,940	CHD
Clark et al., 2005	Pre January 2005	40	16,142	CHD
Heran et al., 2011	Pre January 2010	47	10,794	CHD
Lawler et al., 2011	Pre July 2010	34	6,111	MI

Adapted from Oldridge[18]

Abbreviations: RCTs, randomized clinical trials; MI, myocardial infarction; CHD, coronary heart disease.

Table 2

Cardiac rehabilitation benefits: mortality and re-infarction

Outcome	OR or RR (95%CI)	*p*†
All-cause mortality		
Oldridge et al., 1988	OR: 0.76 (0.63 to 0.92)	0.004
O'Connor et al., 1989 (Comb)	OR: 0.80 (0.66 to 0.96)	< 0.05
Jolliffe et al., 2001 (Ex only)	OR: 0.74 (0.56 to 0.98)	0.040
Jolliffe et al., 2001 (Comprehensive)	OR: 0.87 (0.71 to 1.05)	0.200
Brown et al., 2003 (Ex only)	RR: 0.76 (0.59 to 0.98)	< 0.05
Brown et al., 2003 (Comprehensive)	RR: 0.88 (0.74 to 1.02)	NS
Taylor et al., 2004	OR: 0.80 (0.68 to 0.93)	0.005
Clark et al., 2005	RR: 0.83 (0.72 to 0.96)	<0.05
Heran et al., 2011 (follow up> 12 months)	RR: 0.87 (0.75 to 0.99)	0.040
Lawler et al., 2011 (Comb)	OR: 0.74 (0.58 to 0.95)	<0.05
Cardiac Mortality		
Oldridge et al., 1988	OR: 0.75 (0.62 to 0.93)	0.006
O'Connor et al., 1989 (Comb)	OR: 0.78 (0.63 to 0.96)	< 0.05
Jolliffe et al., 2001 (Ex only)	OR: 0.70 (0.51 to 0.94)	0.020
Jolliffe et al., 2001 (Comprehensive)	OR: 0.75 (0.59 to 0.97)	0.030
Brown et al., 2003 (Ex only)	RR: 0.73 (0.56 to 0.96)	< 0.05
Brown et al., 2003 (Comprehensive)	RR: 0.80 (0.65 to 0.99)	< 0.05
Taylor et al., 2004	OR: 0.74 (0.61 to 0.96)	0.002
Heran et al., 2011 >12 months	RR: 0.74 (0.63 to 0.87)	0.0002
Lawler et al., 2011 (Comb)	OR: 0.64 (0.46 to 0.88)	< 0.05
Fatal and/or non-fatal re-infarction		
O'Connor et al., 1989 (Comb)	OR: 0.75 (0.59 to 0.95)	< 0.05
Jolliffe et al., 2001 (Ex only)	OR: 0.96 (0.69 to 1.35)	0.80
Jolliffe et al., 2001 (Comprehensive)	OR: 0.88 (0.70 to 1.12)	0.30
Brown et al., 2003 (Ex only)	RR: 0.78 (0.59 to 1.35)	0.80
Brown et al., 2003 (Comprehensive)	RR: 1.07 (0.85 to 1.35)	NS
Taylor et al., 2004	OR: 0.79 (0.57 to 1.09)	0.15
Clark et al., 2005	RR: 0.73 (0.60 to 0.89)	< 0.05
Heran et al., 2011 (> 12 months)	RR: 0.97 (0.82 to 1.15)	0.73
Lawler et al., 2011 (Comb)	OR: 0.54 (0.38 to 0.76)	0.05

† p-values are presented same as they were reported in the original studies.

OR, odds ratio; RR, relative ratio; CI, confidence interval; Comb, combination of clinical trials that assessed exercise-only CR and comprehensive CR; NS, not significant.

Table 3

Cardiac rehabilitation benefits: risk factor modification

Meta-analysis, year	Effect Size (95% CI)	$p^{\dagger}$
Total cholesterol (mmol/l)		
Jolliffe et al., 2001 (Ex only)	WMD:−0.03 (−0.27 to 0.22)	0.8
Jolliffe et al., 2001 (Comprehensive)	WMD: −0.65 (−0.75 to −0.55)	< 0.00001
Brown et al., 2003 (Ex only)	WMD: −0.17 (−0.34 to 0.00)	NS
Brown et al., 2003 (Comprehensive)	WMD: −0.71 (−0.83 to −0.60)	< 0.05
Taylor et al., 2004	WMD: −0.37 (−0.63 to −0.11)	0.005
HDL cholesterol (mmol/l)		
Brown et al., 2003 (Ex only)	WMD: 0.04 (−0.01 to 0.10)	NS
Brown et al., 2003 (Comprehensive)	WMD: 0.02 (−0.01 to 0.16)	NS
Taylor et al., 2004	WMD: 0.05 (−0.03 to 0.14)	0.2
LDL cholesterol (mmol/l)		
Jolliffe et al., 2001 (Comprehensive)	WMD:−0.61 (−0.73 to −0.50)	< 0.00001
Jolliffe et al., 2001 (Ex only)	WMD: −0.02 (−0.33 to 0.30)	0.9
Brown et al., 2003 (Ex only)	WMD: −0.27 (−0.43 to 0.12)	NS
Brown et al., 2003 (Comprehensive)	WMD: −0.52 (−0.7 to −0.31)	< 0.05
Taylor et al., 2004	WMD: −0.20 (−0.53 to 0.12)	0.2
Triglycerides (mmol/l)		
Jolliffe et al., 2001 (Comprehensive)	WMD: −0.29 (−0.44 to −0.14)	< 0.05
Brown et al., 2003 (Ex only)	WMD: −0.18 (−0.31 to −0.04)	< 0.05
Brown et al., 2003 (Comprehensive)	WMD: −0.29(−0.44 to −0.14)	< 0.05
Taylor et al., 2004	WMD: −0.23 (−0.39 to −0.07)	0.005
Systolic blood pressure (mmHg)		
Jolliffe et al., 2001 (Comprehensive)	WMD: −7.6 (−10.0 to −2.70)	< 0.05
Brown et al., 2003 (Ex only)	WMD: −2.35 (−6.6 to 2.1)	NS
Brown et al., 2003 (Comprehensive)	WMD: −3.5 (−6.1 to −0.9)	< 0.05
Taylor et al., 2004	WMD: −3.19 (−5.44 to −0.95)	< 0.005
Diastolic blood pressure (mmHg)		
Jolliffe et al., 2001 (Comprehensive)	WMD: −2.24 (−3.63 to −0.85)	< 0.05
Brown et al., 2003 (Ex only)	WMD: −1.18 (−2.6 to 4.7)	NS
Brown et al., 2003 (Comprehensive)	WMD: −1.62 (−3.27 to 0.02)	NS
Taylor et al., 2004	WMD: −1.18 (−2.68 to −0.32)	< 0.12
Smoking		
Jolliffe et al., 2001 (Comb)	OR= 0.78 (0.55 to 1.11)	NS
Brown et al., 2003 (Ex only)	OR= 0.82 (0.62 to 1.18)	NS
Brown et al., 2003 (Comprehensive)	OR= 0.76 (0.58 to 1.00)	NS
Taylor et al., 2004	OR= 0.64 (0.50 to 0.83)	0.0008

† p-value is presented as it was reported in the original paper.

Smoking is self-reported.

Ex, exercise; WMD, weighted mean difference; NS, not significant; Comb, combination of clinical trials that assessed exercise-only CR and comprehensive CR.

Table 4

Benefits of cardiac rehabilitation based on studies from low- and middle-income countries

Author (country)	Study Design	Results
Ciftçi et al., 2005 (Turkey)	Pre and post 12-week CR	Significant increase in exercise capacity, oxygen consumption, anaerobic threshold, cardiac output and HDL ($p < 0.05$). Significant decrease in BMI, total cholesterol, LDL and triglycerides ($p < 0.001$).
Chakraborty et al., 2007 (India)	Exploratory study; pre-post assessment of 4-month comprehensive home-based	Significant improvements in work capacity, 6-minute walk distance, and all assessed domains of quality of life in both rural and urban patients ($p < 0.001$) compared to baseline values, but no statistical difference between the groups
Jiang et al., 2007 (China)	Randomized controlled trial; nurse-led 6 month CR versus usual care	Intervention group had a significantly better performance in walking (with a net improvement of 8.61 scores, Jenkins Activity walking score, for CR participants vs. 6.29 scores for the control group, $p < 0.01$), diet adherence ($p < 0.05$), medication adherence ($p < 0.01$); significantly greater reductions in lipids including triglyceride ($p < 0.01$), total cholesterol ($p < 0.01$), LDL ($p < 0.01$); and significantly better control of systolic and diastolic blood pressure ($p < 0.05$) at three months.
Sarrafzadegan et al., 2008 (Iran)	Retrospective, observational study; before and after 24-session CR, some patients received lipid-lowering drugs	Significant decrease in systolic blood pressure (−2.9mmHg), TG (−25.5 mg/dl), cholesterol (−18.5 mg/dl), LDL (−16.7 mg/dl), weight (−1.6kg), BMI (−0.6 kg/m^2), waist circumference (−3.05cm), and FBS (3.5 mg/dl) ($p < 0.05$). Significant increase in HDL (1.02mg/dl) and functional capacity (2.25Mets) ($p < 0.001$)
Avram et al., 2010 (Romania)	Prospective (16 months follow-up)	Significant decrease ($p < 0.05$) in TG and cholesterol
Babu et al., 2011 (India)	Randomized controlled trial of pts who attended in-patient CR followed by 8- week home- based CR compared to usual care (with the treating physician advice on staying active)	Significant increase in 6-minute walk distance in the experimental group vs. the control group (514 m vs. 429 m; $p < 0.001$) following the eight week home-based program. Significantly higher scores ($p < 0.05$) in the experimental group for mental and physical components of quality of life at the end of the 8-weeks of home-based CR, compared to controls
Intarakamhang & Intarakamhang, 2013 (Thailand)	Quasi-experimental design; pre-test and post-test single group	Significant increase ($p < 0.05$) in self-efficacy, self-regulation, quality of life, and self-care scores. Significant decrease ($p < 0.05$) in BMI
Poortaghi et al., 2013 (Iran)	Quasi-experimental before-after study	Significant improvement in quality of life domain scores of physical function, physical limitation, body pain, vitality, and general health ($p < 0.05$)

CR, cardiac rehabilitation; HDL, high-density lipoprotein; BMI, body mass index; LDL, low-density lipoprotein; TG, triglycerides; FBS, fasting blood sugar

Table 5

Cost-effectiveness of cardiac rehabilitation and other cardiac interventions

Intervention	Source (Country)	Comparator	Cost-effectiveness Ratio
Cardiac rehabilitation	Georgiou et al., 2001, (USA/Italy)	Usual care	US$3$1,773 per LYG (1999)
Cardiac rehabilitation	Ades et al., 1997 (USA)	Usual care	US$4,950 per LYG (1995)
CR (end-stage renal disease following CABG)	Huang et al., 2008 (USA)	Usual care	US$13,887 per LYG (1998)
Cardiac rehabilitation	Lowensteyn et al., 2000 (Canada)	Standard care	US$15,000 per LYG (1996)
Cardiac rehabilitation	Oldridge et al., 1993 (Canada)	Usual care	US$21,800 per LYG (1991) US$9,200 per QALY (1991)
Cardiac rehabilitation	Oldridge et al., 2008 (Canada)	Usual care	$16,580/QALY patient perspective, $60,270/QALY from society's perspective
Other cardiac interventions			
Coronary artery angioplasty (one vessel, severe angina)	Ades et al., 1997 (USA)	Medical care	US$18,700 per QALY (1993)
Smoking cessation program	Ades et al., 1997 (USA)	No therapy	US$220 per LYG (1991)
Lipid-lowering (Simvastatin) for secondary prevention	Ades et al., 1997 (USA)	No therapy	US$9,630 per LYG (1996)
PCI (one vessel, mild angina)	Ades et al., 1997 (USA)	Medical care	US$126,400 per QALY (1993)
Secondary prevention (after MI or revascularization, or angina, or heart failure)	Fidan et al., 2007 (UK)	NS	
Cardiac rehabilitation			£1957 per LYG
Aspirin			<£1000 per LYG
Beta-blockers			<£1000 per LYG
ACE inhibitors			£3398 per LYG
Statins			£4246 per LYG
CABG surgery			£3926 per LYG
Angioplasty			£4512 per LYG

LYG, life-year gained; CR, cardiac rehabilitation; CABG, coronary artery bypass grafting; QALY, quality-adjusted life year; PCI, percutaneous coronary intervention; MI, myocardial infarction; ACE inhibitors, angiotensin-converting-enzyme inhibitor.

NS, not specified but authors pointed that each treatment was based on a meta-analysis comparison with an older therapy, or with placebo if relevant.

Table 6

Participation rates among patients with coronary heart disease in high-income countries

Country[Reference]	Number of Patients	CR Participation (%)
Australia[43]	544	52
Belgium[41]	324	65.1†
Bulgaria[41]	536	22.6†
Canada[44]	1,273	43.0
Croatia[41]	454	37.4†
Cyprus[41]	426	1.9†
Czech Republic[41]	478	41.8†
Denmark[45]	102	50.0
Estonia[45]	77	30.0
Finland[41]	234	32.9†
France[46]	1394	22.0
Germany[41]	535	51.6†
Greece[41]	121	0.0†
Hong Kong[45]	117	16.0
Ireland[41]	384	75.8†
Israel[47]	489	40.4
Italy[41]	377	45.6†
Japan[48]	4,896/year	3.8–7.6
Korea[45]	503	5.0
Latvia[41]	510	34.5†
Lithuania[41]	507	86.4
Netherlands[41]	239	47.3†
New Zealand[49]	113	44.0
Norway[45]	113	36.0
Poland[41]	493	48.9†
Russia[41]	402	3.5†
Slovania[41]	295	57.3†
Spain[41]	509	0.2†
Sweeden[45]	299	47.0
UK[50]	197,405	29.0
USA[19]	601,099	12.20

†Rates computed based on values provided in original article.

CR, cardiac rehabilitation.

Table 7

Participation rates in cardiac rehabilitation among patients with coronary heart disease in middle-income countries

Country[Reference]	Number of patients	CR Participation (%)
Argentina[45]	542	16
Brazil[45]	384	20
Bulgaria[45]	222	22
Chile[45]	195	12
China[45]	369	89
Hungary[41]	452	51.8†
India[45]	398	13
Mexico[45]	141	20
Pakistan[53]	416	36.2
Peru[45]	78	37
Philippines[45]	219	20
Romania[25]	566	14
South Africa[45]	386	8
Thailand[45]	207	14
Turkey[41]	329	3.3†
Ukraine[45]	353	41

†Rates computed based on data provided in primary article.

Table 8

Dropout rates from cardiac rehabilitation

First Author	Publication year	Country	CR program duration	Dropout rate
High-income countries				
Cannistra[58]	1995	USA	3 months	40% - females
Halm[59]	1999	USA	6–8 weeks	25% - females 12% - males
Parks[49]	2000	New Zealand	6 weeks	56%
Turner[60]	2002	UK	2–6 months	15% - females 12% - males
Sanderson[61]	2003	USA	2–3 months	42%
Yohannes[62]	2007	UK	6 weeks	55% - females†
Kerins[63]	2011	Ireland	6–8 weeks	19%††
Scane[64]	2012	Canada	TP:12 months HP:6 months	36% 28% 45% - males†
Middle-income countries				
Sarrafzadegan[57]	2007	Iran	2 months	55%
Soleimani[55]	2009	Iran	8 weeks	82%
Moradi[56]	2011	Iran	3 months	69%

† Dropout rate in the first 2 weeks.

†† Non-completer defined as attended less than 60% of the program. TP, traditional program; HP, home program; USA, United States of America; UK, United Kingdom.