The Way Exercise-Based Cardiac Rehabilitation Effect Mortality And Morbidity In Patients After Myocardial Infarction

Evgenia Trevlaki, Emmanouil Trevlakis

Abstract

Objective: The present review aims to examine the way an exercise-based cardiac rehabilitation program affects mortality, and morbidity in patients after Myocardial Infarction.

Materials and Methods: PubMed/Medline and Scopus/Elsevier electronic databases were searched for studies with no publication date limitation. A search strategy was developed based on the intersection of 3 search themes: cardiological rehabilitation program, morbidity and mortality.

Results: The articles that finally met all the inclusion criteria and were analyzed, after the screening of the title, the summary, and the whole text, were 3. A total of 33208 patients who received cardiological rehabilitation were examined in this review.

Discussion: This review demonstrated that patients' participation reduces the rates of mortality and morbidity in integrated exercise-based cardiac rehabilitation programs in-house or outpatient. Participating in a larger number of sessions or achieving greater energy expenditure are associated with a significant reduction in the risk of mortality. Excessive exercise can lead to the opposite of the desired results, increasing the risk of death from coronary heart disease and ischemic stroke. While patients with higher initial levels of cardiorespiratory resistance were found to have a lower risk of death, exercise was particularly beneficial for patients with initially low endurance, as an improvement by 1-METs after the program was associated with a 27% reduction in mortality risk.

Keywords: cardiological rehabilitation program; mortality; mobility; myocardium infrastructure

Introduction

Acute and chronic cardiovascular disease (CVD) including acute myocardial infarction (MI), causes a large proportion of all disability and death worldwide, placing a substantial burden on the healthcare systems. [1-2] There are several well-known risk factors for CVD, including increasing age, male sex, and unhealthy lifestyle habits. [3-8]

With increasing numbers of people living longer with symptomatic heart failure (HF), the effectiveness and accessibility of health services for HF patients have never been more important. [9] It is recommended that secondary prevention should be provided through comprehensive CR programs, which includes several core components, e.g. smoking cessation, physical activity as well as nutritional counselling, psychosocial management, and exercise training, generally referred to as exCR. [10] Exercise-based cardiac rehabilitation (exCR) is widely recognized to play a key role in the management of coronary heart disease (CHD) [11-13]. ExCR is an interdisciplinary, costeffective and integral component of the continuous care for patients with CVD [14], designed to improve functional capacity, psychological health and the quality of life (QoL) [15].

This role is supported by a substantive body of randomized, controlled trial (RCT) evidence that exercise training in CHD patients can result in a 25% reduction in cardiac mortality, equivalent to many cardiovascular drugs [16-17].

In recent years, questions have been raised as to whether these benefits of exercise in relation to routine care continue to exist as conventional (pharmaceutical and invasive) treatment in coronary patients has greatly improved. It is also being debated whether these benefits have been overestimated in previous randomized trials as the sample then consisted usually of low-risk middle-aged patients after uncomplicated MI. The aim of this review is to examine the way exCR at patients after MI affect mortality and morbidity risk.

Materials and methods

Search Strategy: A search strategy was developed based on the intersection of 3 search themes: cardiac rehabilitation program, mortality and morbidity. The following databases were searched: Medline databases (via PubMed), and Scopus /Elsevier. Additional relevant research was also identified by direct search in scientific journals available online. The results are presented as per the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) reporting guideline (supporting checklist/diagram). [18] A total of 3 unique studies were included in the review.

Inclusion Criteria: The review included studies designed to examine the morbidity and mortality of an exercise-based CR program with no limitation about

the publication date. Case reports and case series were excluded.

Study selection: Eligibility screening of the studies was conducted in a blinded standardized way by two independent reviewers (Ev.T.). Titles and abstracts were screened using and duplicate articles were excluded. After screening titles and abstracts, full paper copies were retrieved. Full text screening was also performed blinded by the same reviewer (Ev.T.). Disagreements between authors during any stage of the screening process were resolved by consulting a third reviewer (Em.T.).

Results

The articles that finally met all the inclusion criteria and were analyzed, after the screening of the title, the summary, and the whole text, were 7. (Table 1)

In 2010, Hammil et al. [19] published a retrospective observational study with data from Medicare, the US social security agency, which investigated whether there is a relationship between the number of exercise sessions and long-term risks of mortality and appearance of myocardial infarction. A total of 30,161 American patients participated, with coronary heart disease and other diseases that aggravated their cardiovascular condition (40% heart failure, 36% diabetes, hypertension, peripheral vascular disease, etc.) and were eligible for free CR programs from 2000 to 2005. The 65% were male and 4% were not white. All participants were over 65 years old (average 74 years old) and participated in at least 1 to> 36 exercise sessions. A 4-year monitoring after the first manifestation of coronary heart disease was conducted. After recording demographics, comorbidities, and subsequent hospitalization, patients who attended 36 sessions had a 14% lower risk of death and 12% lower risk of myocardial infarction than those who attended 24 sessions, 22% lower risk of death and 23% lower risk of myocardial infarction than those who attended 12 sessions and 47% lower risk of death and 31% lower risk of myocardial infarction than those who attended 1 session.

Williams & Thompson [20] study examined the association between higher energy exercising and a progressive reduction in mortality after a heart attack. They Cox proportional hazards or PH model were used to test the relativity of mortality to the estimated energy expended by walking or running, measured in metabolic equivalents, in 2,377 myocardial infarction survivors at 1 MET/hour/day. is the energy equivalent to running 1 km/day. Ongoing mortality was monitored through the National Death Rate from January 1991 to December 2008. A total of 526 deaths occurred during an average research follow-up of 10.4 years, 376 (71.5%), of which were related to coronary heart disease. Patients who achieved an energy expenditure of 7.2 METs/hour/day equivalent to 50km running or 75 km walking per week had a 63% lower risk of death. Patients with 3.6-5.4 METs had a 50% lower risk of cardiovascular disease than those consuming <1.07METs/hour/day. No difference was observed between those who walked or ran when the weekly energy expenditure was the same. Those who progressed to even higher levels of weekly exercise, the risk of cardiovascular death was about 2.6 times higher. This increase in the risk of cardiovascular death, for those over 50km running or 75km walking per week, was to such an extent that the mortality from cardiovascular disease in these patients was similar to those who did not exercise at all.

A retrospective cohort study by Taylor et al. [21], in June 2016, was published to examine the association between sub-maximal cardiorespiratory endurance and all-cause mortality in an exercise-based CR program. Patients were admitted between May 1993 and October 2006, and followed until November 2013 (average 14 years, range 1.2 - 19.4 years). A cohort of 534 men and 136 women, with a clinical diagnosis of coronary heart disease, aged 22-82 years, participated in a 14-week exercise-based CR program. An evaluation for correlation between baseline and maximal cardiorespiratory endurance and mortality from any cause was conducted. Patients underwent fatigue tests at the beginning and end of the program. Changes in sub-maximal cardiorespiratory endurance were expressed in METS. Initial sub-maximal cardiorespiratory resistance was a strong predictor of mortality from any cause. Compared with the low-maximal cardiorespiratory fitness group (<5 METs for women and <6 METs for men), the risk of mortality was 41% lower in the group with moderate sub-maximal cardiorespiratory fitness, and 60% lower in the group with higher levels of sub-maximal cardiorespiratory fitness (≥7 METs for women and ≥8 METs for men). The improvement in sub-maximal cardiorespiratory fitness seen from the fatigue test was not associated with a significant reduction in mortality risk for the whole cohort, but only for the group of low sub-maximal cardiorespiratory fitness (and highest mortality from any cause) at the start of the program, where improvement, by 1-METs, was associated with a 27% reduction in age-adjusted mortality risk.

Table 1. Studies included in this review

Authors (year)	Methods	Sample (n)		Intervention		Conclusion
		Size	Age	(Follow-up)	Type	
Hammil et al. 2010	Retrospective study observational (in the Medicare archives) *	Total: 30.161	Mean:74	4 years	1 to > 36 sessions	There is a dose-response relationship to the number of sessions and the reduction in mortality and recurrent myocardial infarction
Williams & Thompson 2014	Retrospective study observational	Total: 2.377	67.29 ± 13.74	Mean: 10,4 years	Running or walking <1,07 METs/h/d to > 7,2 METs/h/d	Reduce mortality by increasing exercise energy expenditure. Excessive mortality increase (> 7.2 METs)
Taylor et al. 2016	Retrospective cohort research	Total: 670	22-82	Mean: 14 years	CR & exercise 14 weeks	Higher levels of initial cardiorespiratory resistance are associated with reduced mortality. Improvement by 1 MET = 27% reduction in mortality

Discussion

A total of 33.208 patients were included in this review. Hammil et al. study [19] showed that for elderly patients (beneficiaries of Medicare CR beneficiaries) there was a strong 'dose'-response relationship between the number of exercise sessions and the long-term results. Participation in all 36 exercise sessions provided by safety was associated with a lower risk of mortality and MI and 4 years of follow-up compared to participation in fewer exercise sessions.

The results of Williams & Thomson study [20] presented that running or walking after a heart attack reduces the risk of mortality associated with CHD. The risk decreases as the level of exercise increases. On the contrary, this benefit of exercise is attenuated at the highest levels of exercise, i.e. in running over 50km. per week or on walking over 75km. the week. This excessive exercise can lead to the opposite of the desired results, increasing the risk of death from coronary and ischemic attacks.

The conclusion of the Taylor et al. research [21] showed that the highest levels of initial (Baseline) sub-maximal cardiorespiratory endurance, were associated with a reduced risk of mortality from any cause over a period of 14 years, in adults with coronary heart disease. Improving fitness through an exCR program is associated with a significant reduction in the risk of mortality in patients with low endurance.

The above results agree with the previous literature. O 'Connor et al. [22] concluded that a structured exercise program in the CR reduces mortality by 20% (total mortality, cardiovascular mortality and recurrent infarction) for at least 3 years. It also significantly reduces sudden cardiac death during at least the first year after a heart attack and possibly for 2-3 years. Whether further exercise as an independent agent in the exCR brings the above benefits needs further investigation as the research data included in this review are not sufficient to support such a conclusion. The results of Taylor et al. [23] was that with exercise mortality was reduced by 28% compared to the control group (without exercise). Half of this percentage can be attributed to the reduction of hypertension, cholesterol and smoking cessation. The Ricardo & Aruajo's review [24] confirms that exercise in the CR has favorable results compared to the usual care of the control group in overall and cardiac mortality, but also in morbidity. Regular exercise reduces the occurrence of new coronary episodes (re-infarction and vasoconstriction after angioplasty). It seems that regular exercise is the main factor responsible for the favorable results of the therapeutic intervention. Anderson et al.'s [16] results strengthened some of the data from previous research. Applying exCR leads to a 20% reduction in cardiovascular mortality and a 25% risk of re-admission to the hospital. No statistically significant difference was observed regarding total mortality, the occurrence of new myocardial infarction or new revascularization operations in relation to the subjects in the control group. Exercise patients have shown higher levels of health-related quality of life compared to non-exercise patients.

According to all systematic reviews with or without meta-analysis of many randomized trials conducted from 1960 to 2014 with a large number of samples, in which patients were followed for a long time (6 months - 6 years) it seems that in relation with patients receiving only standard (pharmaceutical) care, those participating in structured exercise programs have a 20-28% reduced risk of cardiovascular mortality and in

fact these positive results are mainly attributed to 50% of exercise.

Conclusion

This review demonstrated that the rates of mortality and morbidity are reduced by patients' participation in integrated exCR programs in-house or outpatient. In agreement to the other large retrospective observation studies, it appeared that participating in a larger number of sessions or achieving greater energy expenditure by walking or running are associated with a significant reduction in the risk of mortality. Excessive exercise can lead to the opposite of the desired results, increasing the risk of death from CHD and ischemic stroke. While patients with higher initial levels of cardiorespiratory resistance were found to have a lower risk of death, exercise was particularly beneficial for patients with initially low endurance, as improvement by 1-METs after program was associated with a 27% reduction in mortality risk.

References

1. WHO. The Top 10 Causes of Death. 2018. https://www.who.int/news-room/factsheets/detail/the-top-10-causes-of-death (12 May 2021).

2. Khan MA, Hashim MJ, Mustafa H, Baniyas MY, Al Suwaidi SKBM, AlKatheeri R, Alblooshi FMK, Almatrooshi MEAH, Alzaabi MEH, Al Darmaki RS, Lootah SNAH. Global epidemiology of ischemic heart disease: results from the global burden of disease study. Cureus 2020;12:e9349.

3. Dhingra R, Vasan RS. Age as a risk factor. Med Clin North Am 2012;96:87–91.

4. Anand SS, Islam S, Rosengren A, Franzosi MG, Steyn K, Yusufali AH, Keltai M, Diaz R, Rangarajan S, Yusuf S. Risk factors for myocardial infarction in women and men: insights from the INTERHEART study. Eur Heart J 2008; 29:932–940.

5. Pinheiro LC, Reshetnyak E, Sterling MR, Richman JS, Kern LM, Safford MM. Using health-related quality of life to predict cardiovascular disease events. Qual Life Res 2019;28:1465–1475.

6. Peterson LR, McKenzie CR, Schaffer JE. Diabetic cardiovascular disease: getting to the heart of the matter. J Cardiovasc Transl Res 2012;5:436–445.

7. Carbone S, Canada JM, Billingsley HE, Siddiqui MS, Elagizi A, Lavie CJ. Obesity paradox in cardiovascular disease: where do we stand? Vasc Health Risk Manag 2019;15:89–100.

8. Yusuf S, Hawken S, Oˆ unpuu S, Dans T, Avezum A, Lanas F, McQueen M, Budaj A, Pais P, Varigos J, Lisheng L. Effect of potentially modifiable risk factors associated with myocardial infarction in 52 countries (the INTERHEART study): casecontrol study. Lancet 2004;364:937–952.

9. Rod S. Taylor et al. Impact of exercise-based cardiac rehabilitation in patients with heart failure (ExTraMATCH II) on mortality and hospitalisation: an individual patient data meta-analysis of randomised trials. Eur J Heart Fail. 2018 December ; 20(12): 1735–1743. doi:10.1002/ejhf.1311.

10. Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. Eur J Prev Cardiol 2020;2047487320913379

11. Giannuzzi P, Mezzani A, Saner H, Bjornstad H, Fioretti P, Mendes M, et al. Working Group on Cardiac Rehabilitation and Exercise Physiology. European Society of Cardiology. Physical activity for primary and secondary prevention. Position paper of the Working Group on Cardiac Rehabilitation and Exercise Physiology of the European Society of Cardiology. Eur J Cardiovasc Prev Rehabil. 2003; 10:319–327.

12. Williams MA, Fleg JL, Ades PA, Chaitman BR, Miller NH, Mohiuddin SM, et al. American Heart Association Council on Clinical Cardiology Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention. Secondary prevention of coronary heart disease in the elderly (with emphasis on patients > or = 75 years of age): an American Heart Association scientific statement from the Council on Clinical Cardiology Subcommittee on Exercise, Cardiac Rehabilitation, and Prevention. Circulation 2002; 105:1735–1743.

13. Stone JA, Cyr C, Friesen M, Kennedy-Symonds H, Stene R, Smilovitch M. Canadian Association of Cardiac Rehabilitation. Canadian guidelines for cardiac rehabilitation and atherosclerotic heart disease prevention: a summary. Can J Cardiol. 2001; 17(suppl B):3B–30B.

14. Anderson L, Oldridge N, Thompson DR, Zwisler AD, Rees K, Martin N, et al. Exercise-Based Cardiac Rehabilitation for Coronary Heart Disease: Cochrane Systematic Review and MetaAnalysis. Journal of the American College of Cardiology. 2016; 67: 1–12.

15. Wenger NK. Current status of cardiac rehabilitation. Journal of the American College of Cardiology. 2008; 51: 1619–1631.

16. Oldridge NB, Guyatt GH, Fischer ME, Rimm AA. Cardiac rehabilitation after myocardial infarction. Combined experience of randomised clinical trials. JAMA 1988; 260:945–950.

17. O'Connor GT, Buring JE, Yusuf S, Goldhaber SZ, Olmstead EM, Paffenbarger RS Jr, Hennekens CH. An overview of randomised trials of rehabilitation with exercise after myocardial infarction. Circulation 1989; 80:234–244.

18. Ambrosetti M, Abreu A, Corra U, et al. Secondary prevention through comprehensive cardiovascular rehabilitation: from knowledge to implementation. 2020 update. A position paper from the Secondary Prevention and Rehabilitation Section of the European Association of Preventive Cardiology. Eur J Prev Cardiol 2020;2047487320913379

19. Moher d, liberati a, tetzlaff J, altmandG; prisMa Group. preferred reporting items for systematic reviews and meta-analyses: the prisMa statement. ann intern Med 2009;151:264–9, W64.

20. Hammill Bradley G., Curtis Lesley H., Schulman Kevin A., Relationship Between Cardiac Rehabilitation and Long-Term Risks of Mortality and Myocardial Infarction Among Elderly Medicare Beneficiaries , Circulation, 2010 Jan 5;121(1):63-70.

21. Williams Paul T. & Thompson Paul D., Increased Cardiovascular Disease Mortality Associated With Excessive Exercise in Heart Attack Survivors, Mayo Clinic Proceedings September 2014 Volume 89, Issue 9, Pages 1187–1194

22. Taylor Claire, Tsakirides Costas, Moxon William James, Dubfield Michael, Witte Klaus K, Ingle Lee, Carroll Sean, Submaximal fitness and mortality risk reduction in coronary heart disease: a retrospective cohort study of community-based exercise rehabilitation, BMJ Open. 2016; 6(6): e011125

23. O' Connor GT, Buring JE, Yusuf S et al. An Overview of Randomized Trials of Rehabilitation With Exercise After Myocardial Infarction, Circulation 1989, 80:234–244

24. Taylor RS, Unal B, Critchley JA, Capewell S, Mortality reductions in patients receiving exercise-based cardiac rehabilitation: how much can be attributed to cardiovascular risk factor improvements? Eur J Cardiovasc Prev Rehabil 13:369–374, 2006

25. Ricardo D.R & Araujo C.G.S, Exercise-based cardiac rehabilitation: a systematic review (English version), Rev Bras Med Esporte Vol. 12, Nº 5 – Set/Out, 2006