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CARDIAC REHABILITATION FOR CORONARY ARTERY DISEASE PATIENTS - A LITERATURE REVIEW

MUBASHSHIRAH FIRDAUS ANSARI, NABAM MANIA, SHIVPRIYA SHARMA
Department of Physiotherapy, Sharda University, Greater Noida 201306, India

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Corresponding Author: Ms. Shivpriya Sharma, Assistant Professor, Department of Physiotherapy, Sharda University, Greater Noida 201306, India.
ORCID ID: 0000-0003-4668-3102

Email: shivpriya.sharma@sharda.ac.in

ABSTRACT

Background and purpose: This literature review objective is to appraise the outcome of Cardiac Rehabilitation for (CAD) patients.

Methods: This literature review constitutes the articles which were published in 2017-2022. The evidence search was performed on Google Scholar, PubMed database and Web of science.

Results: According to 34 studies incorporated in our literature review shows that cardiac rehabilitation has led to enhancing the well-being of patients suffering from (CAD). We performed a literature review of different articles, including seven studies that were randomised control trials and seven studies that were systematic reviews, and three studies that were meta-analyses providing evidence on the benefits of cardiac rehabilitation and its recent advances in (CAD) patients.

Discussion: This literature review, according to selective studies, demonstrates that routine exercise habits act as a precautionary regimen in patients suffering from (CAD). It has led to enhancement in cardiovascular strength and decreasing fatness in a healthy population. Exercise Based (CR) has also shown remarkable outcomes in enhancing the well-being of patients suffering from (CAD).

Keywords: Coronary artery disease, cardiac rehabilitation, home-based cardiac telerehabilitation, exercise-based cardiac rehabilitation.

INTRODUCTION

Coronary Artery Disease (CAD) is an inflammatory disease which occurs due to the formation of atherosclerotic plaque, and the deposition of lipids leads to blockage of the coronary artery, which causes ischemia and decreases the oxygen to the myocardium. An abnormal sequence such as angina, myocardial infarction, arrhythmias, heart failure and at last sudden cardiac arrest is common in CAD.[1] According to the global burden of diseases, widespread coronary artery disease all over the world has 154 million overall diseases related to cardiovascular health.[2] One survey was held constituting the population of 24-64 years in India which shows that 9.7% were people belonging to urban areas and 2.7% were people belonging to rural areas having coronary artery disease.[3] The complication of pharmacological and surgical treatment is higher in these patients; thus, alternative treatment, such as cardiac rehabilitation, can introduce in the treatment protocol.

According to the American Association of Cardiovascular and Pulmonary Rehabilitation (AACVPR), "cardiac rehabilitation (CR) is defined as a comprehensive and coordinated long-term plan, including medical evaluation, exercise prescriptions, interventions for cardiac risk factors, health education, counselling, behavioural interventions, and so on".[4] AACVPR divides cardiac rehabilitation into 4 phases: Phase 1- Inpatient programme - It takes a time period from 1-14 days. It focuses on advice-giving to the patients by lowering the predisposing factors and drug tolerance and by creating awareness through the engagement of family and patient to restart the activity of daily living.[5] Phase 2 - Sub-Acute-It starts from the eighth day to 6 weeks prior to the outpatient phase. The exercise and making the patient in-

dependent is educated to the patient, which comprises of checking the vitals, regulation of clinical manifestations and VO_2 max with the help of a workmate. Phase 3- Outpatient based programme or hospital-based programme-It takes a time period from 6 weeks to 12 weeks, and the patient can visit two times a week while it also fulfils the need of larger patients by providing the facilities through domiciliary care, advanced technology like mobiles, digital services and electronic services. Phase 4 Maintenance phase or Community-based programme: In the maintenance phase, the workout performed by the patient can be one time in a week. The patients are made capable of self-inspection while making as a daily routine in their life. It plays a very crucial role in enhancing cardiorespiratory fitness, haemodynamic and muscle physiology. So, the objective of the literature review is to appraise the outcome of CR for CAD patients.[6]

METHODS

Search Strategy

In this literature review, we performed a literature review of different articles, including seven studies that were randomised control trials and seven studies that were systematic reviews and three studies that were meta-analysis providing evidence on the benefits of cardiac rehabilitation and its recent advances in CAD patients. The articles were looked out from Google Scholar and PubMed. Moreover, Scopus indexing was also checked.

Table 1: Recent articles showing the effect of Cardiac rehabilitation for coronary artery disease

Author name	Study design	Methodology	Result and conclusion
Kubacka et al., 2017	Systematic review	Thirty men aged above 50 years and 30 women whose age was above 60 years suffering from CAD underwent an 8-week training programme which consisted of 24 interval training on a cycle ergometer performed a week thrice. Interval exercise training was done in reference to the guidelines for CAD patients. The total time for training was 40 minutes which consisted of a 2-minute warm-up, 4-minute exercise bouts six times, along with 2 minutes of rest given to the patients while increasing the intensity of exercise simultaneously to maintain the range of heart rate.	Exercise training has benefitted in decreasing depression and anxiety after CAD. The outcomes of exercise training on physical strength and autonomic balance were improved in both men and women.[7]
Popovic et al., 2018	Peer reviewed	The enhancement in cardiorespiratory fitness in the patients was seen in the rehabilitation given after the surgery. Cardiopulmonary Exercise Testing was performed to analyse the variables like oxygen intake and ventilatory efficiency other than cardiac rehabilitation by 142 patients for a time duration of 3 to 6 months.	There was a remarkable enhancement in Cardio Pulmonary Exercise Testing parameters, mainly ventilatory efficiency, Oxygen Uptake Efficiency, VO_2 / Work Rate slope, and peak O_2 pulse due to exercise-based CR, which was performed by patients suffering from CAD.[8]
Xia et al., 2018	Randomised control trial	Exercise-based CR included tele-based, Home based, centre based while performing CR. It included strength training exercises and aerobic exercises, which were performed by 1449 patients in the group for a time duration of twenty minutes to two hours.	Patients with CAD can benefit from Center-based CR. [9]
Badrov et al., 2019	Systematic review	Exercise-Training-Based Cardiac Rehabilitation (CR) was conducted for six months which included Aerobic and Resistance Training for clinical examination in 22 CAD patients. It was performed under the observation consisting of community-based CRand in addition to the home-based programme. Aerobic exercises comprise running, walking, and cycling exercise. The time period and range of physical activity rise according to the capacity of each patient during 6-month training. Resistance exercises comprise a circuit training of full body including 8 to 12 exercises, and resistance has been raised according to 12 -15 repetitions through the upper limb and is finished smoothly.	6-month exercise-based (CR) has resulted in a major improvement in baseline autonomic function, decreased the significant rise in baseline arterial BP and has decreased the mortality, increased discharge rates and enhanced the life expectancy of CAD patients.[10]

Author name	Study design	Methodology	Result and conclusion
Lee et al., 2019	Randomised control trials	In Cardiac Rehabilitation, the category of Moderate Intensity Continuous Exercise comprises jogging and walking on a treadmill with a time duration of thirty to forty minutes with a threshold of sixty to eighty per cent of VO_2 peak, which must be incorporated with warm up and cool down exercise. The category of Aerobic Interval Training started from a sixth-week run-in for 4 minutes intervals with a threshold of ninety to ninety-five per cent, and the persons suffering from 31 post-menopausal CAD carried out the present routine safekeeping in CR.	Aerobic Interval Training has shown remarkable benefits in enhancing VO_2 peak up to 0.95 mL kg/min in contrast to Moderate Intensity Continuous Exercise.[11]
Schopfer et al., 2020	Systematic review	Two hundred thirty-seven patients of CAD were selected for a practical trial, and they were registered in 6 min walk test; there was an increment in the distance over three months. Both the 116 patients registered in Facility-Based CR and 121 in Home Based CR characteristics were the same. Mean 6Minute Walk Test distances at baseline were 346 m in the 121 patients of Home-Based CR versus 349 m and 116 patients in Facility-Based CR. Home Based CR program consists of daily living performed by individuals, like swimming and bicycling. Three-month gains in six-minute walk test distance were far better in Home Based CR in comparison with Facility Based CR.	Mean 6-Minute Walk Test distances at baseline were 346 m in the 121 patients in Home Based (CR) versus 349 m in the 116 patients in facility Based (CR) programs consisting of daily living performed by individuals like swimming and bicycling .Home Based CR was better in comparison with Facility Based CR.[12]
Bellmann et al., 2020	Randomised control trials	Twenty-six patients with CAD aged above seventy years were distributed in control groups. It was performed for a time period of 12 weeks. Examination of balance was done according to Timed Up and Go test and the Functional reach test.	Balance and flexibility exercises proved to be essential for increasing balance and performing fine movements efficiently in CR. [13]
Mendelson et al., 2020	Randomised control trials	The CR program was conducted for six months which comprised 90 minutes under observation and was performed once a week by the 15 patients, and the Home-Based program is to be performed four days a week. In CR program, both Aerobic Exercise and Resistance Exercise were performed simultaneously. Individuals were given priority according to their balance and ambulation activity and were judged on the basis of baseline, graded exercise test, which was performed using a cycle ergometer or treadmill under the supervision of a cardiologist technician.	There was a remarkable decrease in high-risk sleep apnea.[14]
Winnige et al., 2021	Systematic review	The Cardiac Rehabilitation model for6 months program in secondary prevention is a viable strategy for lowering death and disability. CR has various benefits for 1772 patients individuals, such as increased self-sufficiency and enhanced quality of life, and it also has systemic effects.	Information found could be leveraged to design even more effective CR tactics as well as customised options. CR has led to decrease hospitalizations and lowering overall healthcare expenditures. [15]
Dibben et al., 2021	Randomised control trials	Psychological counselling along with exercise training was performed by 23430 people in groups or individually, and the comparison was made with the people performing no exercise meanwhile suffering from CAD within 12 months.	Exercise – base [CR] has significant benefits for people with coronary heart disease [CHD], including a lower risk of Myocardial Infarction [MI)], a likely small reduction in all cause mortality, a large reduction in all cause hospitalisation ,along with associated health care costs, and improved health related quality of life after 12 months.[16]

Table 2: Recent articles showing the effect of Postoperative cardiac rehabilitation in coronary artery disease

Author name	Study design	Methodology	Result and conclusion
Beatty et al., 2017	Systematic review	The clinical outcomes assessment of 23972 patients in the program, a quality improvement registry, took four sessions in an outpatient CR programme that covers all non-federal institutions in Washington State that do cardiac revascularisation or valve surgeries, was used to conduct the analysis.	Both Percutaneous intervention and cardiac surgery patients benefit from CR; it is well documented that patients are less inclined to participate after Percutaneous coronary intervention than after cardiac surgery. [17]
Duijndam et al., 2017	Cohort study	Emotional stress was assessed in 384patients. The perceived concentration was measured in post-surgical patients. The Patient Health Questionnaire (PHQ-9) was taken for psychological health in post-surgical patients. The assessment for well-being was done through a questionnaire according to World Health Organisation the patients suffering from CAD.	The results of the general liners mixed modelling analysis revealed that, over time, perceived concentration issues were linked to well-being in all categories, regardless of clinical or demographic factors.[18]
Winzer et al., 2018	Meta analysis	A meta-analysis of 8940 patients who had undergone coronary revascularisation had CAD. Exercise training intervention includes exercises like endurance exercises. Ultra-marathon was followed in daily routine habits helped in the reduction of mortality rate in CAD patients. The patients involved in Exercise Training interventions have resulted a lower number of hospital admissions and higher life expectancy.	The Recreational exercises have been very helpful in the primary prevention of heart disease and increased the life span for five years, simultaneously decreasing the death rate due to coronary heart disease. [19]
Haybar et al., 2018	Descriptive epidemiological study	Fifty-four patients after angioplasty were engaged in the cardiac rehabilitation program for the duration of 2 months. Patients were split up into two different groups, depressed and non-depressed groups, and the functional capacity and depression scores were judged in two groups before and after the cardiac rehabilitation program. For 2 months of CR, individuals engaged in 24 sessions weekly for three days which consisted of 1 hour of training and 1 hour of exercise. Individuals took part in dynamic exercise programs after training, where they performed on treadmills and fixed bikes, as well as walking and warm-up. Each session of the exercise program consists of a 5-minute warm-up, 20-45 minutes of aerobic exercise, along 10 minutes of cooling.	The outcomes after cardiac rehabilitation were a remarkable decrease in the percentage of depression in depressed patients lower mortality rate of patients with myocardial infarction, and Coronary artery bypass grafting.[20]
Fu et al.,2019	Systematic review and meta-analysis	Benefits from Rehabilitation Exercise of 6 months on their coronary artery in 229 patients suffering from (CAD) Post Percutaneous Coronary Intervention was estimated. The team were divided into two hundred twenty-nine patients in the control category and two hundred twelve patients in the Rehabilitation Exercise category while dealing with coronary restenosis till six months.	The level of coronary restenosis in patients who are performing rehabilitation exercises depends on the threshold of physical activity and fuel utilised. [21]
Arnov et al., 2019	Case-control study	36 patient was constituted in the study who were doing physical activity for the time duration of 60 minutes for four months; meanwhile, physical activity example, the static bicycle was advised to some patients to be done, which was of light intensity for a duration of 12 months.	This randomised clinical trial found that an early integrated stage 3 CR programme after coronary bypass surgery that includes both an educational course and controlled physical exercise (a 4-month course of Physical systematic therapy) had a positive effect on the patient's psychological status and quality of life.[22]

Author name	Study design	Methodology	Result and conclusion
Zhang & Chang, 2019	Meta-analysis	Sixty-three randomised trials which included (6- minute walk test)found an absolute reduction in the risk of cardiovascular mortality from 10.4 per cent to 7.6 per cent in patients who had a myocardial infarction or had undergone surgical procedures. Exercising after post-surgery may benefit patients with CAD by improving left ventricular ejection fraction, and slowing the progression of cardiac mortality, myocardial infarction, coronary angioplasty, angina pectoris, and restenosis, according to this retrospective study and contextual. After Percutaneous coronary intervention treatment, exercise had no effect after coronary artery bypass surgery in individuals with CAD.	Exercising after Percutaneous coronary intervention may benefit patients with CADby improving left ventricular ejection fraction and slowing the progression of cardiac mortality, myocardial infarction, coronary angioplasty, angina pectoris, and restenosis.[23]
Origuch et al., 2020	Peer reviewed	Active involvement in Outpatient CR, bicycle ergometry Post Coronary Artery Bypass Grafting started around the second or third week and was followed for three to five months. It comprises of cycle ergometer, walking and callisthenics which was performed in a hospital under observation once or thrice a week. Tutoring and separate advising in addition to Home-based physical activity like brisk walking for thirty to sixty minutes with two to four repetitions every week with instructed heart rate. In Cardio Pulmonary Exercise Testing with the use of bicycle ergometry, the heart rate was calculated on the basis of an anaerobic threshold. The individuals were divided into Active and Non- Active teams in Cardiac Rehabilitation for 3.5 years.	Active involvement of patients who have undergone surgical procedures has shown remarkable enhancement in Exercise Capacity.[24]
Ying Li et al., 2021	Retrospective analysis	Two hundred thirty patients suffering from CAD who had undergone surgical procedures were judged for Cardiac Rehabilitation centre. A gradual Cardio Pulmonary Exercise Test while using a cycle ergometer was assigned to the patients. To execute the statistical analysis, chi-square test and Mann Whitney U test was used. 223 patients out of 230 patients showed a decrease in physical activities tolerance.	The final result depicts that anxiety has been reduced while exercising and has increased exercise capacity in the patients who underwent percutaneous coronary intervention.[25]
Missiri et al., 2021	Prospective study	One hundred twenty patients suffering from stable coronary artery disease post-Coronary angioplasty were registered in a phase 2 CR program for the duration of 2 weeks, and the exercise protocol was conducted through a treadmill. With respect to patients' body mass index, they were divided into two groups: non-obese and obese. Non-obese are those patients who have BMI<30 $Kg/m^{2,}$ and obese are those who have BMI≥30 Kg/m^2.The total time for each session was 45 minutes which consisted of 5 to 10 minutes of warm-up, 20 minutes of aerobic training, along with 5 to 10 minutes of rest given to the patients. CR programs give a remarkable depletion in cardiovascular death related to enhancement in body weight and exercise.	On completion of CR program, obese patients showed further depletion of Body mass index and blood pressure at the time of ventricle contraction, and relaxation has resulted in a further rise in left ventricular ejection fraction in contrast to non-obese patients.[26]

Table 3: Recent advances in medical health related to coronary artery disease

Nanotechnology, Biodegradable Stents, Home Based Tele rehabilitation, Tissue Engineering and Behavioural Medicine Intervention in Physiotherapy have shown remarkable effects on CAD patients.

Author name	Study design	Methodology	Result and conclusion
Zuo & Kandaswamy, 2017	Randomised control trials	The current therapy for coronary artery disease is medical, surgical, or either amalgamation of medical or surgical, relying on the degree, intensity and signs of CAD. The cooperation of biotechnology and tissue engineering results in the advancement of novel therapeutic schemes example, stem cells and nanotechnology handling CAD patients exhibited wonderful results.	Nanotechnology has been considered for potentiality and encourages to relieve along with decrease restenosis. They cause endothelialisation of the stent to encourage healing. CAD therapeutics' future appears to be very differently hopeful with the constant endeavour.[27]
Li et al., 2018	Literature review	Nanotechnology helps in detecting the composition, infiltration, and amplification of macrophages which can be used to assess the evolution and instability of atherosclerotic lesions in the treatment of CAD.	The use of intravascular ultrasonography and photoacoustic imaging in conjunction with gold nanoparticles as compounds to co-localise with circulating macrophages in plaques. As a result, detecting the composition, infiltration, and amplification of macrophages can be used to assess the evolution and instability of atherosclerotic lesions.[28]
Alam et al., 2019	Peer review	In-stent restenosis, a biodegradable stent improved to the extent that the permanent stent is unneeded. The eco -friendly substance such as abrasive metals, polycarbonates, polyesters and bacteria obtain polymers for stent advancement.	Coronary angioplasty is operated on by using coronary artery stenting. The stent platform pattern has been considerably spontaneous, which has decreased In-Stent Restenosis despite Bare Metal Stent.[29]
Borg.et al., 2020	Randomised control trials	The patients who were suffering from CAD were categorised randomly into Routine (ECRA) for the time duration of 4 months and Behavioural Medicine Intervention in the Physiotherapy group for the time duration of 12 months. Behavioural Medicine Intervention in Physiotherapy included face-to-face interaction, face to face follow-ups through video calls to activate the imaged reaction. Aerobic exercises were included in the Routine (ECRA). Post (ECRA) results were analysed, which has shown a remarkable increase in Physical Fitness and has resulted in secondary prevention from CAD along with a decrease in the death rate occurring from CAD.	Patients have prolonged beneficial outcomes of submaximal aerobic exercise and were having more adherence to physical activity in contrast to Routine (ECRA).[30]
Ramachandran et al., 2022	Systematic review	Home Based Cardiac Tele rehabilitation was performed by acquiring the technology in the patients who were suffering from CAD. Home Based Cardiac Tele rehabilitation was done through smartphones, websites, video calls, phone calls, texting, emails, and short message delivery in addition to tele monitoring services. The self-inspection was also done by the patients through heart rate monitors, accelerometers and pedometers.	The contrast was done between the Home Based Cardiac Telerehabilitation and Center Based CR among the patients who were suffering from CAD, and it was seen that both showed the similar result on Cardiac admission, vital capacity, anxiety, enriched life and reduction in smoking following a healthy lifestyle.[31]

DISCUSSION

Recent studies, according to “American Heart Association” denotes that Exercise Based Cardiac Rehabilitation which comprises Aerobic and Resistance Based Exercise Training, decreases the rise in baseline arterial blood pressure and action of sympathetic nerves to sudden exertion in patients suffering from CAD. Exercise Based CR has shown remarkable outcomes on autonomic function in addition to enhanced baroreflex control on maintaining sympathetic neural control in patients suffering from CAD.[10] The existing reviews, according to "The Journal of Cardiopulmonary Rehabilitation and Prevention”, depicts that remarkable enhancement in Cardiopulmonary Exercise Testing variables in relation to cardiovascular, endothelial, metabolic and autonomic systems was seen in patients suffering from CAD and those who were enrolled for Exercise-Based CR. The favourable outcomes have resulted in enhanced activity of the heart and cardiorespiratory fitness in patients suffering from CAD.[8] The multiple studies, according to “American Heart Association”, demonstrates that routine exercise habits act as a precautionary regimen in patients suffering from CAD. It has led to enhancement in Cardiovascular strength and decreasing fatness in a healthy population. Technology-Based telerehabilitation has resulted in beneficial outcomes in aerobic competency and longevity in patients suffering from CAD.[19] The narrative review, according to “Disability and Rehabilitation”, reveals that Rehabilitation Exercise performed daily has resulted in a remarkable decrease in the narrowing of coronary artery and late luminal loss post (PCI) in patients suffering from (CAD). Rehabilitation exercise started earlier after the (PCI) led to enhanced reserve volume, the functioning of cardiac health and perfusion in the coronary artery along with rapid return in power and decreased prevalence of CAD.[21] According to archives of medical research goal of this research is to judge the cardiac rehabilitation program effectiveness for CAD patients following CABG comprised of controlled medical centre-based physical therapy for four months. The acquired outcomes exhibit the enhancement of the patient's physical activity in the CE test, along with cardiac productivity.[22] According to the journal of the "American Heart Association, "this study was done on patients with recent ischemic heart disease who were registered in Home-based cardiac rehabilitation and facility-based cardiac rehabilitation. The results were changed in the 6-minute walk distance along with the measure of the quality of life as well enhanced regularly between the HBCR patient.[12] According to “Journal Sports and Medicine”, this study was done on a meta-analysis of 10 RCTs consisting of 1274 patients. The results exhibit that the exercise and (PCI) together work in decreasing the possibility of cardiac death, MI, coronary angioplasty, angina pectoris and restenosis comparative to (PCI) only, along with there was a remarkable enhancement in left ventricular ejection fraction among individuals with exercise compared to those individuals without exercise. The level of hypersensitive C-reactive protein and inflammatory cytokines can decrease in patients suffering from coronary heart disease following PCI by exercise rehabilitation.[23] In the following study, according to “British Medical Journal Open Sport & Exercise Medicine” in mostly female patients suffering from CAD referred for a 24-week outpatient CR program, effects of AIT versus standard care MICE the main conclusion was that this prospective study design was unfeasible in this female CAD patient population, and difficulties encountered.[11] Around the world, according to the "World journal of clinical cases, "CR is underutilised. Inconsistent delivery, inadequate reimbursement, and other CR involvement hurdles in individuals are all issues, according to recent studies.[15] Our findings imply, according to "The International Journal of Behavioral Medicine", that getting older is linked to improved general well-being, as well as mental health and a suitable atmosphere. Moreover, no effect on the association of cognition and well-being, as poorer perceived cognition was still related to poorer (HRQL).[18]

STUDYSTRENGTHS AND LIMITATIONS

The literature review comprises the articles which were published from 2017 to 2022. The strength of the literature review is that it comprises the highest-graded articles like Randomised Control Trials and Systematic Reviews regarding the rehabilitation of patients suffering from (CAD). Moreover, the limita-

tions of this article were that it had no effect on the link between perceived cognition and health-related quality of life. Further studies are still examining that Home Based Cardiac Telerehabilitation as a holistic approach in secondary precaution for CAD.

CONCLUSION

This literature review concluded that the effectiveness of multifaceted rehabilitation services has enhanced the well-being and accentuated follow-up protocol, ultimately leading to a decrease in the death rate of people suffering from CAD. Exercise Training based CR is significant in decreasing the susceptibility to CAD and in providing a longer life expectancy. Cardiopulmonary Exercise Testing (CPET) is used as a valuable and accepted tool in clinical assessment in providing information about medicinal adequacy in those patients suffering from CAD. It is a comprehensive test which has shown a significant increase in cardiopulmonary capacity in post-surgical patients. Outpatient CR has contributed to enhancing physical activity tolerance, decrease in high-risk sleep apnea in patients and greater viability is seen in patients. Further studies examine that Home Based Cardiac Telerehabilitation is a holistic approach in secondary precaution for CAD. Finally, CAD therapeutics' future with CR appears to be very differently hopeful with the constant endeavour.

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