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Role of Cardiac Rehabilitation in Blood Pressure and Glycaemic Control: An Integrated Approach to Cardiovascular Risk Management

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Abstract

Cardiovascular diseases remain a leading cause of global morbidity and mortality, with hypertension and diabetes mellitus acting as major modifiable risk factors that frequently coexist. Cardiac rehabilitation (CR) is a multidisciplinary secondary prevention programme combining supervised exercise training, nutritional counselling, weight management, patient education, psychological support, and medication adherence. The role of CR in blood pressure regulation and glycemic control is discussed in this review, focusing on interventions based on exercise, lifestyle modification and integrated risk factor management. There is evidence to indicate that both aerobic and resistance training improve endothelial function, insulin sensitivity and metabolic health with subsequent reductions in blood pressure, fasting glucose and HbA1c. But the benefits to exercise capacity may be smaller and less sustained in patients with diabetes. Barriers including limited participation, cost, and poor adherence restrict long-term benefit. Individualised, comprehensive CR strategies, integrated with optimal pharmacological therapy, are essential to optimise long-term cardiovascular outcomes.

Keywords: *Cardiac Rehabilitation; Hypertension; Diabetes Mellitus; Glycaemic Control; Cardiovascular Risk Management.*

INTRODUCTION

Cardiovascular diseases (CVDs) are among the leading causes of morbidity and mortality worldwide, representing a major public health concern. Several modifiable risk factors, especially hypertension, diabetes mellitus, obesity, physical inactivity and unhealthy dietary habits are highly associated with the development and progression of them. Among these factors, hypertension and diabetes are the main contributors to cardiovascular risk by inducing vascular damage, endothelial dysfunction, atherosclerosis, and impaired cardiac function [1]. Hypertension increases the heart's workload and results in structural changes in blood vessels, and diabetes accelerates cardiovascular complications through persistent hyperglycaemia, insulin resistance and metabolic abnormalities. Additionally, the combination of these conditions increases the likelihood of individuals developing coronary artery disease, heart failure, stroke, and other blood vessel and heart-related issues [2].

Cardiac rehabilitation (CR) is an essential component of secondary cardiovascular prevention, especially for patients who have suffered from myocardial infarction, coronary revascularization or have chronic cardiovascular diseases. The program is a comprehensive multidisciplinary initiative that is designed to improve the quality of life, physical function, and cardiovascular health [3]. It includes supervised exercise training, nutrition counseling, patient education, psychological support, smoking cessation, and appropriate medication management. The underlying risk factors associated with cardiovascular diseases are addressed by these interventions, which assist patients in adopting healthier lifestyles [4].

Sustainable improvements in cardiovascular health depend on managing all risk factors. Cardiac rehabilitation can help control blood pressure and assist in glycemic control through regular physical activity, changes in diet, weight management and ongoing surveillance. Moreover, integration of lifestyle interventions along with appropriate medical treatment can help in slowing down the progression of the cardiovascular complications and improve long-term health outcomes [5].

This review aims to summarize the effect of cardiac rehabilitation on blood pressure and diabetes control, with a focus on exercise-based interventions, lifestyle changes and integrated risk factor management. Moreover, it underlines the necessity of developing extensive rehabilitation programs aimed at improving cardiovascular results and promoting long-term disease prevention.

CARDIAC REHABILITATION AND ITS ROLE IN CARDIOVASCULAR RISK FACTOR MANAGEMENT

Cardiac rehabilitation (CR) is a multidisciplinary, medically supervised program designed to improve cardiovascular health, restore physical functioning, and reduce the risk of recurrent cardiovascular events in individuals with established heart diseases [6]. The main goals are to improve exercise capacity, control of modifiable cardiovascular risk factors, promotion of healthy lifestyle behaviors, and overall quality of life of patients. It is an important element of secondary prevention and deals with the medical, physical and behavioral aspects of cardiovascular disease.

The main elements of cardiac rehabilitation are supervised aerobic and resistance exercise training, nutritional counseling, patient education, weight control, psychological support and medication adherence. Exercise on a regular basis improves the cardiovascular system and changes in diet help to control blood pressure, glucose and lipids. Patient education is a process that helps patients to understand their health conditions, follow through prescribed therapies, and make lasting lifestyle changes. Medication adherence also helps in the effective management of hypertension, diabetes and other cardiovascular risk factors [7].

CR is provided by a team of specialists from several disciplines, including cardiologists, nurses, physiotherapists, exercise specialists, dietitians, and other health care professionals. Through collaboration, they are able to continually assess the patient, prescribe appropriate exercise, and individually manage risk factors [8]. Rehabilitation programs should be individualized according to the patient's clinical conditions, physical capabilities and associated comorbidities, particularly in patients with hypertension and diabetes. The combined lifestyle and medical interventions offered in cardiac rehabilitation lead to improved cardiovascular risk profiles, fewer hospital readmissions, and improved long-term health outcomes [9].

Table 1: Role of Cardiac Rehabilitation in Cardiovascular Risk Factor Management

Cardiovascular risk factor	Cardiac rehabilitation intervention	Expected benefits
Hypertension	Aerobic exercise, resistance training, sodium restriction, and regular blood pressure monitoring.	Improved blood pressure regulation and reduced cardiovascular workload.
Diabetes mellitus	Structured physical activity, dietary counselling, weight management, and glucose monitoring.	Improved insulin sensitivity, glycaemic control, and metabolic health.
Obesity	Exercise training, calorie-controlled diet, and behavioural counselling.	Weight reduction and improved cardiovascular fitness.
Dyslipidaemia	Regular exercise, heart-healthy diet, and medication adherence.	Improved lipid profile and reduced atherosclerotic cardiovascular risk.
Physical inactivity	Supervised exercise programmes and physical activity education.	Increased exercise capacity, muscle strength, and functional independence.
Smoking	Smoking cessation counselling and behavioural support.	Reduced vascular damage and risk of recurrent cardiovascular events.
Psychological stress	Psychological counselling, stress management, and relaxation techniques.	Improved emotional well-being and adherence to rehabilitation.
Poor medication adherence	Patient education, medication counselling, and regular clinical follow-up.	Better control of cardiovascular risk factors and treatment outcomes.

Impact of Cardiac Rehabilitation on Blood Pressure Regulation and Hypertension Management

Cardiac rehabilitation has an important role in control of hypertension through structured exercise training and lifestyle modification. Walking, cycling and treadmill exercise are aerobic exercises that can lower both systolic and diastolic blood pressure. Resistance training improves cardiovascular fitness and vascular function. Regular physical activity helps keep the endothelium healthy, increases the amount of nitric oxide available, lowers peripheral vascular resistance and makes arteries more flexible, all of which help to regulate blood pressure more effectively [10].

Cardiac rehabilitation also includes weight management and dietary changes, as well as exercise, to help manage hypertension. Eating a diet high in fruits, vegetables, whole grains, and low-fat foods and low in sodium helps keep blood pressure healthy. If individual is overweight or obese, losing weight reduces the workload on heart and helps to control blood pressure. These lifestyle interventions also help to reduce other cardiovascular risk factors associated with obesity [11].

Blood pressure monitoring during cardiac rehabilitation is important for health care professionals to monitor the response to treatment, adapt the exercise intensity and identify abnormal cardiovascular responses during physical activity. Monitoring prior to and after exercise sessions is also useful to ensure patient safety and to assess improvement in blood pressure regulation. Overall integration of supervised exercise, dietary counseling, weight management and continuous blood pressure monitoring provides an integrated approach to hypertension management and reduces risk of associated cardiovascular complications [12].

Table 2: Role of Cardiac Rehabilitation in Blood Pressure Regulation and Hypertension Management

Intervention	Mechanism / role	Expected benefits
Aerobic exercise training	Improves endothelial function, nitric oxide availability, and blood circulation.	Helps reduce systolic and diastolic blood pressure.
Resistance exercise training	Improves muscular strength and vascular function.	Supports blood pressure regulation and cardiovascular fitness.
Weight management	Reduces excess body weight and cardiac workload.	Supports hypertension control.
Dietary modifications	Encourages fruits, vegetables, whole grains, and low-fat foods.	Promotes healthy blood pressure levels.
Sodium restriction	Helps regulate fluid balance and reduce sodium-related blood pressure elevation.	Supports blood pressure reduction.
Regular blood pressure monitoring	Evaluates blood pressure before and after exercise sessions.	Helps assess treatment response and maintain exercise safety.

INFLUENCE OF CARDIAC REHABILITATION ON DIABETES MANAGEMENT AND GLYCAEMIC CONTROL

Diabetes mellitus is a major risk factor for cardiovascular disease and is characterized by insulin resistance, chronic hyperglycaemia and metabolic derangements. Poor glycemic control can cause damage of blood vessels, endothelial dysfunction, accelerate atherosclerosis and increase the risk of coronary artery disease and other cardiovascular complications [13]. Therefore, effective management of diabetes is an important component of cardiac rehabilitation especially in patients with coexisting cardiovascular disease.

Regular physical activity as a part of cardiac rehabilitation enhances glucose uptake in the skeletal muscles, improves the sensitivity of insulin and the metabolism of glucose, and reduces insulin resistance. Structured aerobic and resistance exercise programs improve glycemic control. These have been associated with reduction in fasting blood glucose and glycated hemoglobin (HbA1c) levels [14]. In addition, exercise increases energy expenditure and improves body composition and metabolic health, which helps with long-term diabetes management.

Also important are nutrition counseling on balanced diets, appropriate carbohydrate intake, portion control and reducing the intake of added sugars and unhealthy fats. Weight management also further improves insulin sensitivity, particularly in the overweight/obese. Also make sure patient continue taking any prescribed antidiabetic and cardiovascular meds to keep glucose levels steady and reduce risk of related complications. Abnormal glycemic responses are also found with regular monitoring of blood glucose pre- and post-exercise sessions. Appropriate timing and adjustment of exercise intensity, meal timing and medication when clinically advised can reduce the risk of exercise-related hypoglycaemia [15]. Thus, exercise, dietary management, medication adherence and glucose monitoring in cardiac rehabilitation should be integrated to promote better glycemic control and cardiovascular health.

Table 3: Role of Cardiac Rehabilitation in Diabetes Management and Glycaemic Control

Intervention	Mechanism / role	Expected benefits
Aerobic exercise training	Increases muscular glucose uptake and improves insulin sensitivity.	Helps reduce blood glucose levels and improve glycaemic control.

Resistance exercise training	Improves muscle mass and glucose utilization.	Supports insulin sensitivity and metabolic health.
Nutritional counselling	Promotes balanced diets, carbohydrate control, and healthy food choices.	Helps maintain stable blood glucose levels.
Weight management	Reduces excess body fat and insulin resistance.	Improves metabolic function and diabetes management.
Medication adherence	Supports consistent management of blood glucose and associated cardiovascular conditions.	Helps maintain glycaemic stability and reduce complications.
Blood glucose monitoring	Evaluates glucose responses before and after physical activity.	Helps identify abnormal glucose levels and prevent exercise-related hypoglycaemia.

COMPREHENSIVE RISK FACTOR MANAGEMENT AND LONG-TERM CARDIOVASCULAR OUTCOMES

Cardiac rehabilitation is an important component of comprehensive risk factor management since it addresses the simultaneous management of multiple conditions associated with cardiovascular diseases. The cardiovascular strain is reduced and the progression of atherosclerosis and other cardiovascular complications is prevented through the integrated management of hypertension, diabetes, obesity, and dyslipidemia. Healthy dietary practices, weight management, smoking cessation, and appropriate medication adherence, in conjunction with supervised exercise training, contribute to the promotion of heart health and the better management of these risk factors [16].

In order to achieve sustainable health improvements, it is equally crucial to implement patient education and behavioral modifications. Patients who are enrolled in cardiac rehabilitation need to be educated about a healthy lifestyle and compliance with medicines, physical activity, dietary habits and the need for regular medical check-ups. Health care providers are able to regularly monitor blood pressure, blood glucose, body weight, and lipids to see how well treatment is working and to detect changes that require further action. These factors may be effectively managed to prevent disease-related complications, minimize hospital readmissions, reduce recurrent cardiovascular events, and enhance the quality of life and physical functioning [17].

Nevertheless, cardiac rehabilitation may be hindered by a variety of obstacles, such as inadequate patient engagement, financial constraints, inadequate knowledge, inadequate healthcare access, and inadequate adherence to prescribed lifestyle modifications. Some people also struggle to maintain a regular physical activity and diet routine once supervised rehabilitation is over. Long-term participation and maintenance of cardiovascular health requires ongoing patient education, family support, regular follow-up and individualized lifestyle guidance [18].

LITERATURE REVIEW

(Gadager et al., 2026) [19] Cardiac rehabilitation (CR) after coronary heart disease is known to benefit cardiovascular health and quality of life, but it remains unclear whether people with diabetes gain as much exercise capacity from it as those without the condition. To look into this, we followed a cohort of patients who were discharged from hospital after a cardiac event between February 2019 and December 2022 and went on to finish a 12-week CR program at 18 community health centers. Each patient's exercise capacity was measured with a symptom-limited bicycle ergometer test, recording peak oxygen uptake (VO_2peak) in both absolute terms (mL O_2/min) and relative to body weight (mL O_2/kg/min). We used multiple regression to compare how much each group improved, and binary logistic regression to estimate the chance of reaching a minimal clinically important difference (MCID) of 3.5 mL O_2/kg/min. Patients with diabetes did get better after rehabilitation, yet their gains were smaller than those of patients without diabetes, and they were less likely to reach a clinically meaningful improvement. These findings point to the need for CR approaches tailored to this higher-risk group so that they can benefit more fully from the program.

(Zhang et al., 2026) [20] Cardiac rehabilitation (CR) is known to lower both mortality and morbidity in people with coronary heart disease (CHD), and this review set out to examine how well exercise-based cardiac rehabilitation (ExCR) works for patients who have diabetes mellitus (DM) alongside CHD. We searched eight databases from their inception up to December 13, 2025: PubMed, Embase, the Cochrane Library, Web of Science, China National Knowledge Infrastructure (CNKI), Wanfang, VIP, and the Chinese Biomedical Database (CBM). Results were pooled with both fixed-effect and random-effects models, and where heterogeneity was substantial ($I^2 \geq 50\%$), the random-effects model served as the primary analysis, with I^2 used to gauge the degree of statistical heterogeneity. To check how stable the main findings were, we ran sensitivity analyses, and we used subgroup analyses and meta-regression to look for

possible sources of the variation between studies. Overall, the evidence suggests that ExCR may benefit patients with both CHD and DM, with improvements seen in glycolipid metabolism, the 6-minute walk test (6-MWT), and left ventricular ejection fraction (LVEF). The effect on peak oxygen uptake (VO_2peak), however, remains unclear, and the conclusions are constrained by the quality of the included studies. Further high-quality research is therefore needed to confirm how effective ExCR really is in this population.

(Peter et al., 2026) [21] carried out a systematic review and meta-analysis of randomized, placebo-controlled cardiovascular outcome trials that looked at GLP-1 receptor agonists (GLP-1RAs) in adults at high cardiovascular risk. Major adverse cardiovascular events (MACE) was the primary outcome, and the secondary ones were cardiovascular mortality, all-cause mortality, non-fatal myocardial infarction, non-fatal stroke, hospitalisation for heart failure and adverse events. When the trials were pooled, each of those cardiovascular outcomes dropped significantly too, not just MACE. On the safety side, GLP-1RAs did not really raise the risk of severe hypoglycaemia or acute pancreatitis, though gastrointestinal side effects showed up more often, and this was consistent across trials. So in high-risk people these drugs seem to cut major cardiovascular events and deaths, and their long term safety looks good. The benefit goes beyond glycaemic control alone, which backs up bringing GLP-1RAs further into cardiovascular risk reduction strategies.

(Adam et al., 2025) [22] A higher risk of coronary artery disease, stroke, aortic disease, heart failure, atrial fibrillation, and peripheral arterial disease is associated with diabetes mellitus. Increasing the risk of future cardiovascular (CV) events exacerbates the condition's prognosis. A comprehensive and personalized assessment and identification of the cardiovascular risk profile are necessary for patients with type 2 diabetes mellitus. Special considerations are needed in individuals at very high risk because of the high risk of adverse events even with adequate management and treatment. Key interventions to reduce this risk include CV prevention and cardiac rehabilitation. Traditional and non-traditional CV risk factor management, dietary modifications, regular physical activity, aerobic and resistance exercise training, psychosocial and frailty management, optimal pharmacological therapy, and investigation of comorbidities are recommended to reduce the development of CV disease and mortality. Therefore, our manuscript provides updated and critical evidence on the comprehensive management of patients with type 2 diabetes mellitus in clinical practice from the perspective of CV prevention and cardiac rehabilitation, with a focus on individuals at very high risk. Further, practical guidance on individualizing exercise prescriptions based on patient-specific risk profiles and comorbid conditions is provided.

(Paz et al., 2024) [23] A mobile health application was used to examine changes in cardiovascular risk factors and app engagement. The app was used in a workplace setting to conduct a self-management program for cardiovascular risk from January 2018 to December 2022, open to people with hypertension with or without dyslipidemia. The association of the amount of app usage by participants and change in blood pressure (BP), total cholesterol (TC), low-density lipoprotein cholesterol (LDL-C) and weight was assessed retrospectively. We ran multiple regression analyzes to evaluate the effect of the nonpharmacological digital coaching based on guideline-based lifestyle advice on these outcomes, controlling for confounders. Reductions in BP, TC, LDL-C and weight were all seen with the program, which was good result overall. These findings suggest the technology could be a useful tool for controlling cardiovascular risk factors more broadly.

(Senesael et al., 2023) [24] analysed the patient data from our cardiac rehabilitation center over the last 3 years to assess the evolution in exercise capacity and blood pressure before and after the rehabilitation program. Patients diagnosed with coronary artery disease (acute coronary syndrome, elective percutaneous coronary intervention or coronary artery bypass graft) between October 2019 and September 2022 were retrospectively included if they followed at least 50% of the total training sessions. Mean blood pressure at the beginning and end of the cardiac revalidation was derived from the mean values of the first 5 sessions and of the last 5 sessions. A change in 5 mmHg was investigated. Following cardiac rehabilitation in patients with coronary artery disease, a decrease in blood pressure was seen in 41% of the participants. This decrease was mainly seen in males that stopped smoking and had no acute coronary disease. A trend towards a significant relation between improved exercise capacity (in METS) and improved blood pressure was observed.

(Eser et al., 2020) [25] aimed to compare the effectiveness of current cardiac rehabilitation (CR) programs across seven European countries between elderly cardiac patients with and without DM. 1633 acute and chronic coronary artery disease (CAD) patients and patients after valve intervention with an age 65 or above who participated in comprehensive CR (3 weeks to 3 months, depending on centre) were included. Peak oxygen uptake (VO2 peak), body mass index, resting systolic blood pressure, low-density lipoprotein-cholesterol (LDL-C), and glycated haemoglobin (HbA1c) were assessed before start of CR, at termination of CR (variable time point), and 12 months after start of CR, with no intervention after CR. Baseline values and changes from baseline to 12-

month follow-up were compared between patients with and without DM using mixed models, and mortality and hospitalisation rates using logistic regression. While immediate improvements in VO2 peak after CR in elderly patients with and without DM were similar, 12-month maintenance of this improvement was inferior in patients with DM, possibly related to disease progression. Glycemic control was less favourable in diabetic patients needing insulin in the short- and long-term. Since glycemic control was only related to weight loss but not to increase in exercise capacity, this highlights the importance of weight loss in obese DM patients during CR.

DISCUSSION

The reviewed evidence supports cardiac rehabilitation as an effective, integrated strategy for managing hypertension and diabetes in patients with cardiovascular disease. Exercise-based CR improves endothelial function, insulin sensitivity, and body composition, and Senesael et al. (2023) observed reduced blood pressure in 41% of coronary patients, particularly men who quit smoking. For glycaemic control, Zhang et al. (2026) reported improved glycolipid metabolism, walking capacity, and ejection fraction, though effects on VO_2peak remain unclear. Importantly, response is not uniform: Gadager et al. (2026) and Eser et al. (2020) found that patients with diabetes achieved smaller, less clinically meaningful, and less sustained gains in exercise capacity, with weight loss emerging as the key correlate of glycaemic control. Complementary approaches, including digital coaching (Paz et al., 2024) and GLP-1 receptor agonists (Peter et al., 2026), may further reduce cardiovascular risk. Nevertheless, limited participation, cost, and poor post-programme adherence constrain long-term benefit, underscoring the need for tailored, multidisciplinary programmes.

CONCLUSION

Cardiac rehabilitation is a cornerstone of secondary cardiovascular prevention, offering an integrated approach to managing hypertension, diabetes, and related risk factors. Supervised aerobic and resistance exercise, dietary counselling, weight management, patient education, and regular monitoring collectively improve blood pressure regulation, insulin sensitivity, and glycaemic control, while reducing cardiovascular strain and the risk of recurrent events. Nonetheless, patients with diabetes may derive smaller and less durable functional gains, indicating that rehabilitation should be individualised according to clinical status, comorbidities, and physical capacity, with particular emphasis on weight loss. Pharmacological advances and digital health tools may complement conventional programmes. Barriers such as limited participation, financial constraints, and poor long-term adherence must be addressed through family support, continued education, and regular follow-up. Future high-quality, long-term studies are needed to confirm the clinical effects of exercise-based rehabilitation on glycaemic and blood pressure outcomes and to define optimal individualised strategies for sustained cardiovascular risk management.

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