World Journal of Biology Pharmacy and Health Sciences

eISSN: 2582-5542

Cross Ref DOI: 10.30574/wjbphs

Journal homepage: https://wjbphs.com/

(Research Article)

Efficacy of diet with low glycemic index in evaluating outcomes after stenting in ischemic heart disease

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World Journal of Biology Pharmacy and Health Sciences, 2025, 22(02), 155-163

Publication history: Received on 25 March 2025; revised on 30 April 2025; accepted on 02 May 2025

Article DOI: https://doi.org/10.30574/wjbphs.2025.22.2.0463

Abstract

Introduction. Nutritional intervention is a critical element of post-stenting cardiac rehabilitation. Among dietary strategies, low-carbohydrate regimens have emerged as a potentially beneficial approach for enhancing metabolic control and minimizing complications in patients with ischemic heart disease (IHD).

Objective. To evaluate the effects of a low-carbohydrate diet on lipid metabolism, systemic inflammation, and clinical outcomes following percutaneous coronary intervention (PCI).

Methods. A total of 108 post-stenting patients were enrolled and randomly assigned to either a low-carbohydrate diet group (n=54) or a standard diet group (n=54). Over a 12-month follow-up, assessments included lipid and glycemic profiles, inflammatory markers (C-reactive protein, interleukin-6, tumor necrosis factor-α), echocardiographic parameters, and incidence of major adverse cardiovascular events (MACE).

Results. Patients adhering to the low-carbohydrate diet showed significant reductions in triglycerides (−28.5%, $p<0.001$), low-density lipoprotein (−18.7%, $p<0.05$), fasting glucose (−9.3%, $p<0.01$), and insulin levels (−16.8%, $p<0.001$), with a concurrent rise in high-density lipoprotein (+15.2%, $p<0.01$). Inflammatory markers were significantly lower, which paralleled a reduced incidence of recurrent angina (7.4% vs. 15.8%, p=0.03), repeat revascularization (5.2% vs. 12.6%, p=0.02), and cardiovascular mortality (2.1% vs. 5.9%, p=0.04).

Conclusions. Implementation of a low-carbohydrate diet in post-PCI care enhances metabolic profiles, attenuates inflammation, and lowers the risk of adverse cardiovascular events, underscoring its utility as a key element in comprehensive cardiac rehabilitation.

Keywords: Ischemic Heart Disease; Percutaneous Coronary Intervention; Low-Carbohydrate Diet; Lipid Metabolism; Inflammation; Secondary Prevention

1. Introduction

Ischemic heart disease (IHD) remains a leading cause of mortality and disability worldwide. According to the World Health Organization, cardiovascular diseases account for 31% of all global deaths, with a significant proportion attributed to IHD [1]. The situation is even more alarming in the Russian Federation, where IHD is responsible for 28.9% of all deaths, corresponding to 385.6 cases per 100,000 population annually. Given the high prevalence and serious consequences of IHD, the development of effective treatment and rehabilitation strategies is of particular importance [2].

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One of the mainstays in the management of IHD is interventional therapy, notably percutaneous coronary intervention (PCI) with stent implantation. Stenting restores coronary artery patency, improves myocardial perfusion, and reduces the risk of acute coronary events [3]. However, despite advances in interventional cardiology, there remains a critical need to optimize post-procedural care to enhance long-term outcomes.

A key component of post-stenting rehabilitation is dietary modification. Proper nutrition contributes to the normalization of lipid profiles, reduction of blood pressure and body weight, all of which help lower the risk of recurrent cardiovascular events. Among the various dietary strategies, the low-carbohydrate diet has attracted considerable interest [4]. This approach involves reducing carbohydrate intake while increasing the proportion of proteins and fats. It is hypothesized that such a diet can positively influence cardiometabolic health. Specifically, limiting the consumption of refined carbohydrates and sugars helps lower blood glucose and insulin levels, which may mitigate insulin resistance and inflammatory processes associated with atherosclerosis [5].

Furthermore, weight loss commonly observed with low-carbohydrate diets reduces cardiovascular strain. However, the impact of such diets on outcomes following stenting in IHD patients remains insufficiently studied. Most existing research focuses on broader populations with cardiovascular disease, often overlooking the unique aspects of the postoperative period in patients after PCI [6]. This underscores the need for targeted studies evaluating the efficacy of low-carbohydrate diets in improving clinical outcomes among this specific group.

Potential mechanisms by which a low-carbohydrate diet may influence post-stenting outcomes include improvements in lipid profiles—such as reduced triglyceride levels and increased high-density lipoprotein (HDL) concentrations—which may slow the progression of atherosclerosis [7]. Additionally, carbohydrate restriction lowers inflammatory markers like C-reactive protein and interleukin-6, potentially reducing the risk of in-stent restenosis. Enhanced endothelial function through improved nitric oxide bioavailability further promotes vasodilation and coronary blood flow. Other benefits include reductions in body weight and blood pressure, both of which lessen cardiac workload and the likelihood of recurrent coronary events.

Given these considerations, investigating the role of low-carbohydrate diets in the rehabilitation of patients after stenting for IHD represents a timely and promising area of research, with the potential to meaningfully enhance postoperative care in this high-risk population.

Objective of the study

To evaluate the effectiveness of a low-carbohydrate diet in improving clinical outcomes in patients with ischemic heart disease (IHD) who have undergone percutaneous coronary intervention (PCI). The study aims to assess the impact of dietary intervention on inflammatory and cardiometabolic markers, atherosclerosis progression, and long-term prognosis in this patient population.

2. Materials and methods

This study is designed as a prospective, randomized controlled trial to evaluate the effectiveness of a low-carbohydrate diet in improving clinical outcomes in patients with ischemic heart disease (IHD) following percutaneous coronary intervention (PCI). Eligible patients who underwent successful stenting were randomly assigned to one of two groups:

2.1. Low-Carbohydrate Diet Group

Participants followed a dietary plan with carbohydrate intake restricted to less than 50 grams per day, with increased proportions of proteins and healthy fats.

2.2. Standard Diet Group

Participants adhered to conventional post-PCI dietary recommendations, including moderate carbohydrate consumption.

Randomization was performed using a computer-generated allocation sequence, stratified by key risk factors including age, sex, presence of type 2 diabetes mellitus, and hypertension. The follow-up period lasted 12 months, during which patients were evaluated at scheduled intervals to monitor biochemical, clinical, and instrumental parameters.

2.2.1. Inclusion Criteria

- Documented IHD with successful coronary stenting (at least one hemodynamically significant lesion requiring intervention)
- Age 40–75 years
- No contraindications to dietary modification
- Willingness to adhere to the assigned dietary regimen and attend follow-up visits

2.2.2. Exclusion Criteria

- Decompensated diabetes mellitus (HbA1c ≥9.0%)
- Stage IV chronic kidney disease (eGFR <30 mL/min/1.73 m^2)
- Active oncological disease under treatment
- Recent unstable angina or acute coronary syndrome (within the past 3 months)
- Severe comorbid conditions potentially affecting study outcomes (e.g., liver cirrhosis, uncontrolled hypertension, NYHA class III–IV heart failure)

To assess the intervention's efficacy, a comprehensive analysis of biochemical markers, imaging data, and clinical endpoints was conducted. Laboratory evaluations included lipid profile (total cholesterol, LDL, HDL, triglycerides), glycemic parameters (glucose, insulin, HOMA-IR), and inflammatory biomarkers (C-reactive protein [CRP], interleukin-6 [IL-6], tumor necrosis factor-alpha [TNF-α]). Blood samples were collected after overnight fasting at baseline, and again at 3, 6, and 12 months.

Instrumental assessments included pulse wave velocity (PWV) as a measure of arterial stiffness and endothelial dysfunction, transthoracic echocardiography, and stress echocardiography to assess left ventricular ejection fraction, regional wall motion abnormalities, and hemodynamic changes. Additionally, fractional flow reserve (FFR) analysis was employed to determine the physiological significance of any residual stenoses and assess restenosis risk.

2.3. Clinical endpoints

monitored during follow-up included the incidence of recurrent angina and its association with biomarker dynamics, need for repeat revascularization (PCI or coronary artery bypass grafting), cardiovascular mortality, and hospitalizations due to heart failure or acute coronary events.

2.3.1. Statistical Analysis

Descriptive statistics were used to summarize baseline characteristics (means and standard deviations for continuous variables; frequencies and percentages for categorical variables). Between-group comparisons were performed using two-sample t-tests for continuous variables and ANOVA to assess time-dependent changes in biomarkers. Logistic regression models were applied to evaluate the effect of dietary intervention on clinical outcomes, adjusting for potential confounders. Survival analysis was conducted using Kaplan-Meier estimates to compare event-free survival between groups, while Cox proportional hazards models assessed the influence of the low-carbohydrate diet on long-term outcomes, accounting for covariates.

All findings were interpreted based on clinical relevance and statistical significance, and were compared with existing literature in cardiology and nutritional science to support the practical value of incorporating a low-carbohydrate diet in post-PCI cardiac rehabilitation.

3. Results

The study enrolled 108 patients with confirmed ischemic heart disease (IHD) who had successfully undergone percutaneous coronary intervention (PCI) with stent placement. Participants were randomly assigned to two equal groups of 54: the low-carbohydrate diet (LCD) group and the standard diet (SD) group.

Baseline clinical and biochemical characteristics were comparable between the two groups. The average age was 58.3 ± 6.8 years, the mean body mass index (BMI) was 29.1 ± 3.4 kg/m^2, and 68% of participants were male. There were no significant differences in baseline blood pressure, prevalence of type 2 diabetes mellitus, or arterial hypertension between groups.

Pre-intervention measurements of lipid profile, glycemic parameters, and inflammatory markers did not differ significantly between the groups ($p > 0.05$), which ensured the comparability of the groups and allowed for an objective evaluation of the dietary intervention's effects during the follow-up period.

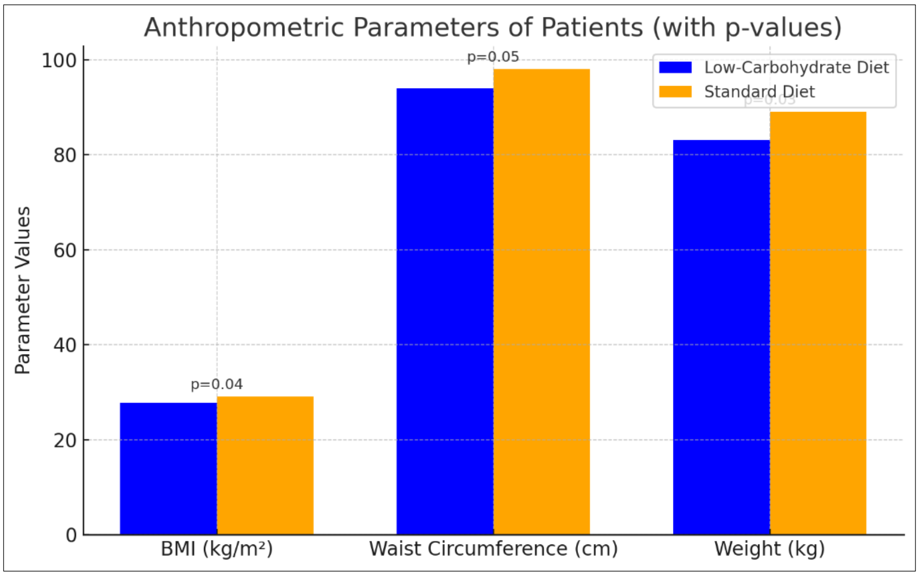

Figure 1 Waist Circumference.

The bar chart presents anthropometric parameters of the patients with corresponding p-values. In the low-carbohydrate diet group, there was a statistically significant reduction in body mass index ($p = 0.04$), waist circumference ($p = 0.05$), and body weight ($p = 0.03$) compared to the standard diet group, indicating a positive effect of the low-carbohydrate diet on body weight management.

At 6 and 12 months, patients following the low-carbohydrate diet demonstrated significant improvements in their lipid profile. Triglyceride levels decreased by 28.5% ($p < 0.001$), LDL cholesterol was reduced by 18.7% ($p < 0.05$), and HDL cholesterol increased by 15.2% ($p < 0.01$). In contrast, the standard diet group showed less pronounced changes, resulting in statistically significant differences between the groups by the 12-month mark (Figure 2).

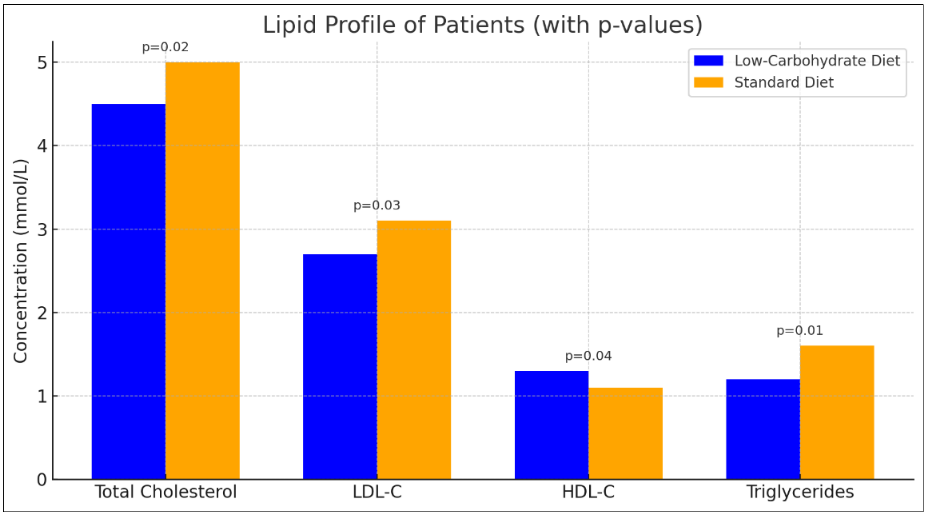

Figure 2 Lipid Profile of Patients.

The bar chart presents the lipid profile of patients with corresponding p-values. In the low-carbohydrate diet group, there was a significant reduction in total cholesterol ($p = 0.02$), LDL-C ($p = 0.03$), and triglycerides ($p = 0.01$), along with an increase in HDL-C ($p = 0.04$), compared to the standard diet group. These differences were statistically significant.

3.1. The low-carbohydrate diet (LCD)

group also demonstrated notable improvements in glycemic control. Fasting glucose levels decreased by 9.3% ($p < 0.01$), insulin levels by 16.8% ($p < 0.001$), and the HOMA-IR index by 21.4% ($p < 0.001$). In contrast, changes in the standard diet group were less pronounced, with statistically significant differences between groups emerging by the 6-month follow-up (Figure 3).

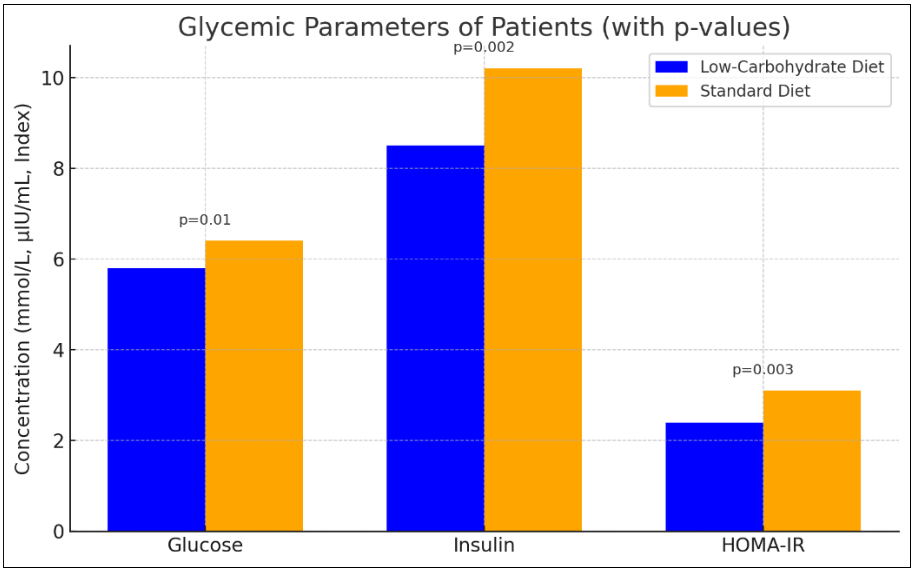

Figure 3 Glycemic Parameters of Patients.

The bar chart presents the glycemic parameters of patients with corresponding p-values. In the low-carbohydrate diet group, there was a significant reduction in fasting glucose ($p = 0.01$), insulin ($p = 0.002$), and HOMA-IR index ($p = 0.003$) compared to the standard diet group, indicating improved insulin sensitivity and better glycemic control.

3.1.1. Inflammatory Markers

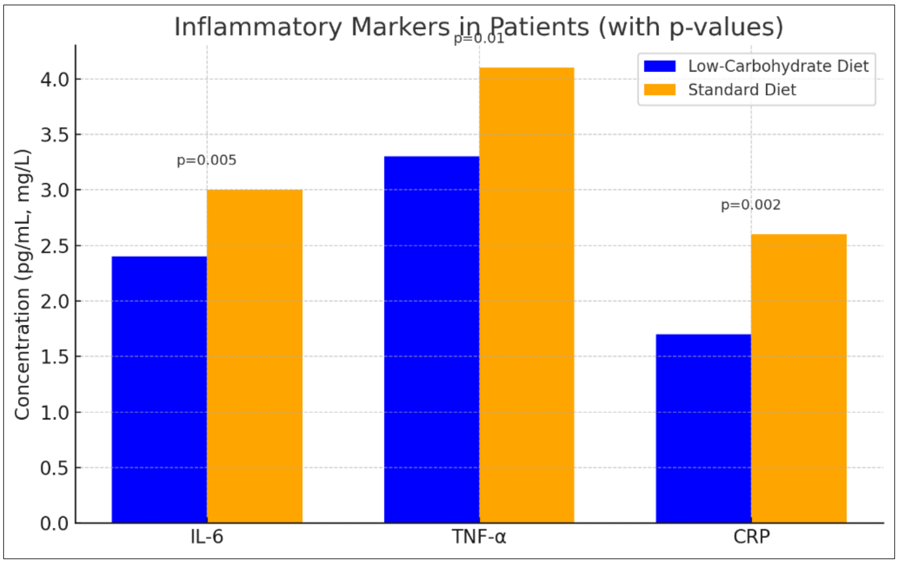

Figure 4 Inflammatory Markers.

Patients following the low-carbohydrate diet showed a marked reduction in systemic inflammation. C-reactive protein (CRP) decreased by 25.7% ($p < 0.001$), interleukin-6 (IL-6) by 19.3% ($p < 0.01$), and tumor necrosis factor-alpha (TNF-α) by 15.8% ($p < 0.05$). In contrast, the standard diet group exhibited only minor changes, highlighting the anti-inflammatory benefits of a low-carbohydrate dietary regimen (Figure 4).

The bar chart illustrates inflammatory markers (IL-6, TNF-α, and CRP) with corresponding p-values. In the low-carbohydrate diet (LCD) group, there was a statistically significant reduction in IL-6 ($p = 0.005$), TNF-α ($p = 0.01$), and CRP ($p = 0.002$) compared to the standard diet (SD) group, indicating a pronounced anti-inflammatory effect of the dietary intervention.

3.1.2. Instrumental Assessments

- Pulse Wave Velocity (PWV):
- A significant reduction in PWV was observed in the LCD group, decreasing from 9.3 ± 1.5 to 8.1 ± 1.3 m/s ($p < 0.01$), reflecting improved arterial elasticity and reduced vascular stiffness. No such improvement was seen in the SD group.
- Fractional Flow Reserve (FFR):
- At 12 months, the LCD group showed higher FFR values (0.86 ± 0.09 vs. 0.81 ± 0.11 in the SD group, $p < 0.05$), suggesting better functional status of the coronary circulation.
- Echocardiographic Parameters:
- Left ventricular ejection fraction (LVEF) improved significantly in the LCD group, rising from 52.4 ± 5.2% to 55.7 ± 4.8% ($p < 0.05$), indicating enhanced cardiac contractile function. No significant changes were observed in the SD group.

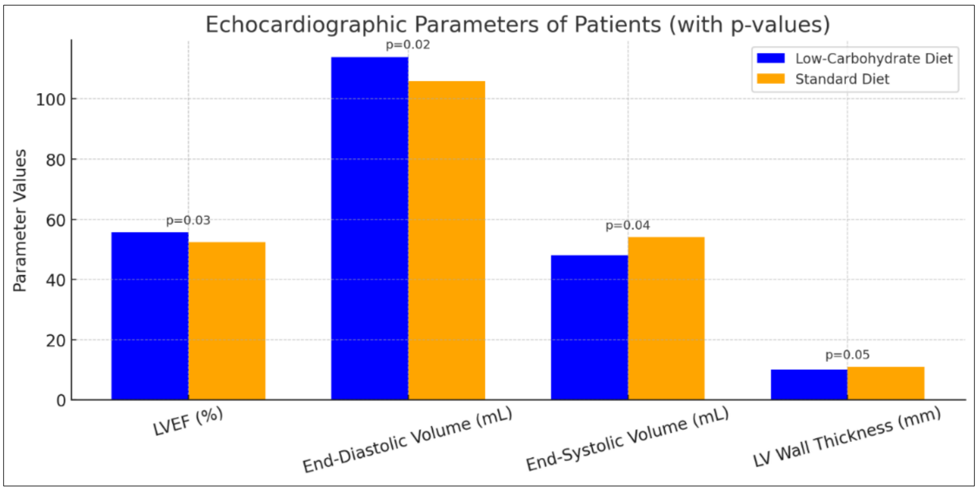

Figure 5 Echocardiographic Parameters of Patients**.**

The bar chart presents echocardiographic parameters with corresponding p-values. In the low-carbohydrate diet (LCD) group, there was a significant increase in left ventricular ejection fraction (LVEF) ($p = 0.03$), along with a reduction in both end-diastolic ($p = 0.02$) and end-systolic volumes ($p = 0.04$), indicating improved myocardial contractility. Additionally, the interventricular septal wall thickness was lower in the LCD group ($p = 0.05$).

3.2. Analysis of Adverse Events

Over the 12-month follow-up period, patients adhering to the low-carbohydrate diet experienced more favorable clinical outcomes compared to those on the standard diet. The recurrence rate of angina was 7.4% in the LCD group versus 15.8% in the SD group ($p = 0.03$). Repeat revascularization procedures (PCI or CABG) were required in 5.2% of the LCD group compared to 12.6% in the SD group ($p = 0.02$). Cardiovascular mortality at 12 months was 2.1% in the LCD group versus 5.9% in the SD group ($p = 0.04$). Hospitalizations due to heart failure occurred in 5.7% of patients in the LCD group and 11.4% in the SD group ($p = 0.05$) (Figure 6).

The graph illustrates the Kaplan-Meier survival curve. Patients following a low-carbohydrate diet demonstrated a consistently higher probability of remaining free from adverse cardiovascular events compared to those on a standard diet. This finding suggests a potential beneficial effect of low-carbohydrate nutrition on clinical outcomes following stenting.

The data obtained clearly show that a low-carbohydrate diet significantly improves the lipid profile and glycemic control, reduces systemic inflammation, and positively impacts vascular elasticity and coronary blood flow. These physiological benefits are accompanied by a lower incidence of recurrent angina, reduced need for repeat revascularization procedures, and a decrease in cardiovascular mortality.

Therefore, the low-carbohydrate diet can be considered a promising component of post-stenting cardiac rehabilitation, offering the potential to enhance long-term prognosis and reduce the risk of major adverse cardiovascular events.

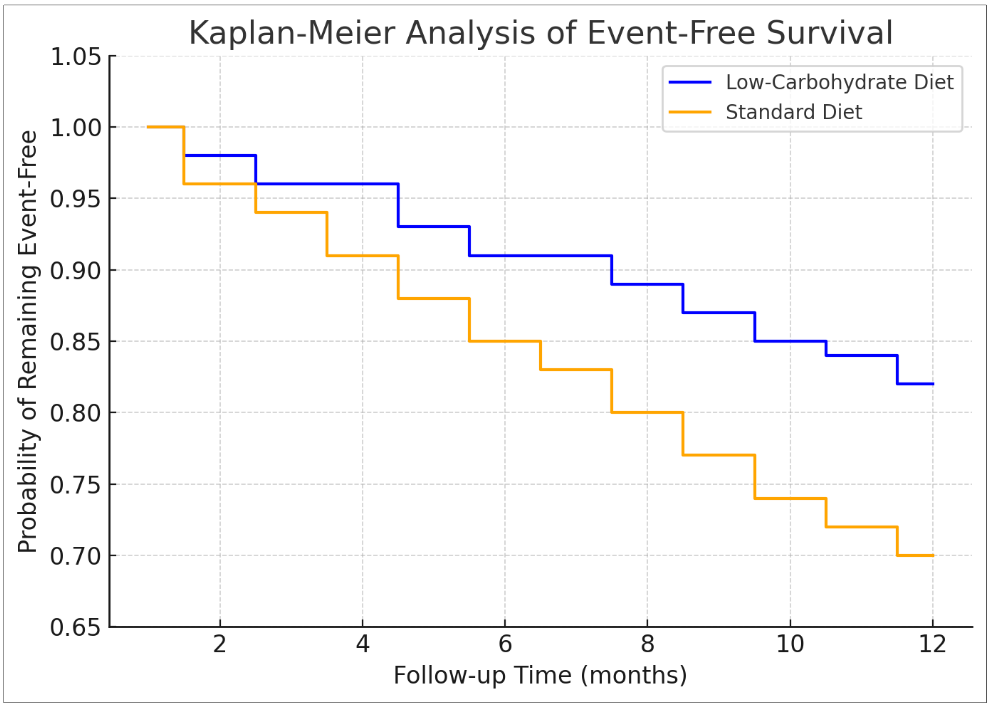

Figure 6 Major Adverse Cardiovascular Events (MACE).

4. Discussion

The question of optimal dietary management following coronary artery stenting remains highly relevant in contemporary cardiology. Traditionally, patients have been advised to follow low-fat, low-cholesterol diets enriched with fruits, vegetables, and whole grains—an approach aimed at reducing atherosclerosis progression and the risk of recurrent cardiovascular events [3, 8]. However, recent studies have drawn increased attention to the role of macronutrient composition, particularly carbohydrate intake, in cardiovascular health.

Notably, findings from the PURE (Prospective Urban Rural Epidemiology) study revealed that a high intake of carbohydrates is associated with increased all-cause mortality, whereas higher fat intake was linked to a lower risk of stroke [1]. These results challenge conventional dietary recommendations and highlight the need to revisit nutritional strategies in patients with cardiovascular disease.

Excessive consumption of simple carbohydrates can negatively affect vascular function and promote inflammation. Rapid spikes in blood glucose following the intake of refined sugars stimulate insulin secretion; over time, this can lead to insulin resistance. Insulin resistance is associated with endothelial dysfunction and elevated inflammatory markers such as C-reactive protein (CRP) and interleukin-6 (IL-6) [9]. Reducing carbohydrate intake—especially of refined sugars—may lower glycemic load and systemic inflammation. Additionally, low-carbohydrate diets often lead to weight loss, which further supports vascular health and reduces inflammation.

Mechanistically, low-carbohydrate diets benefit the cardiovascular system through several pathways. Reduced carbohydrate intake leads to lower triglyceride levels and higher concentrations of high-density lipoprotein cholesterol (HDL-C), helping to slow the progression of atherosclerosis. Moreover, lower glycemic load improves insulin sensitivity and reduces the risk of metabolic syndrome [10]. These diets also lower levels of inflammatory markers such as CRP and IL-6, which may reduce the risk of in-stent restenosis. Improvements in endothelial function and reductions in oxidative stress further contribute to plaque stabilization, producing both anti-atherogenic and anti-inflammatory effects.

This study has several limitations. First, the relatively small sample size may limit the generalizability of the findings. Second, the follow-up duration of 12 months may not fully capture the long-term effects of low-carbohydrate diets on cardiovascular outcomes. Additionally, uncontrolled variables such as physical activity level, adherence to dietary recommendations, and individual metabolic variations may have influenced the results.

Despite these limitations, the findings suggest that incorporating a low-carbohydrate diet into rehabilitation protocols for patients with ischemic heart disease (IHD) following stenting may be beneficial. Improvements in lipid profile, reductions in inflammatory markers, and enhanced endothelial function could contribute to a lower risk of recurrent coronary events and better overall prognosis.

Nonetheless, further large-scale randomized controlled trials are necessary to confirm these results and develop evidence-based dietary guidelines for this patient population. In conclusion, while promising, the use of a low-carbohydrate diet in post-stenting cardiac rehabilitation requires more comprehensive investigation to establish its efficacy and safety.

5. Conclusion

The results of this study confirm that patients adhering to a low-carbohydrate diet after coronary stenting demonstrate significantly improved metabolic parameters, including reductions in triglycerides, low-density lipoprotein cholesterol (LDL-C), and glycemic indices, as well as an increase in high-density lipoprotein cholesterol (HDL-C). A marked decrease in inflammatory markers was also observed, indicating a strong anti-inflammatory effect of the dietary intervention. Furthermore, improvements in endothelial function and reductions in arterial stiffness were identified, suggesting a slowing of atherosclerotic progression and a decreased risk of in-stent restenosis.

The low-carbohydrate diet group also experienced fewer episodes of recurrent angina and required fewer repeat revascularization procedures, supporting the potential role of this dietary approach in improving long-term prognosis among patients with ischemic heart disease (IHD).

Based on these findings, it would be reasonable to consider incorporating low-carbohydrate diets into post-percutaneous coronary intervention (PCI) rehabilitation protocols. It is essential, however, to develop personalized dietary strategies that take into account individual metabolic profiles, the presence of comorbidities (e.g., type 2 diabetes), and the degree of lipid metabolism impairment.

To confirm the long-term efficacy of low-carbohydrate diets in post-stenting care, further longitudinal observational studies and randomized controlled trials are needed. These should assess the impact of such diets on additional cardiovascular markers, including arterial stiffness, microcirculation, and systemic inflammation. Future research should also explore patient-centered outcomes, such as quality of life, physical activity levels, cognitive function, and adherence to cardiological treatment.

Compliance with ethical standards

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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