Observational Study

Medicine

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Cardiac rehabilitation for workers with ischemic heart disease

Benefits for cardiovascular health and quality of life

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Abstract

Cardiac rehabilitation programs (CRPs) are multifactorial interventions defined by the World Health Organization as essential strategies to improve patients' health-related quality of life (HRQoL) by enhancing their physical, psychological, social, and occupational well-being. These programs are a cornerstone in the comprehensive treatment of heart disease, facilitating the recovery of functional capacity and reintegration into the workforce through a multidisciplinary approach. The objective of this study was to assess the efficacy of CRPs in enhancing functional capacity (cardiac and psychological) and HRQoL in workers with ischemic heart disease. An observational pre-post study without a control group was conducted, focusing on actively employed individuals with ischemic heart disease. A total of 214 patients were included, selected according to specific inclusion criteria after excluding those not suitable for longitudinal follow-up. Participants were active workers aged 18 to 65 years who were prescribed a CRP between January 2020 and December 2021. Sociodemographic, occupational, cardiovascular risk, and clinical-therapeutic data were collected to evaluate changes following completion of the program. Health-related quality of life (HRQoL) was also assessed. A total of 214 patients were included, 83.9% male, with a mean age of 54.21 years. Most had a history of hypertension, dyslipidemia, smoking, low physical activity, overweight or obesity, and a family history of ischemic heart disease. Among those who started the program (94.4%), the most common diagnosis was acute myocardial infarction involving a single coronary vessel. Additionally, 77.1% underwent stent angioplasty, and 47.2% participated in a moderate-risk CRP. After completion, the SF-36 score improved significantly (46.92 vs 70.21), and depressive symptoms decreased (55.10% vs 38.22%). Significant benefits were observed in most modifiable cardiovascular risk factors, along with an increase in the proportion of patients with preserved left ventricular ejection fraction (65.4% vs 72%) and in metabolic equivalent (MET) levels. In 157 participants (73.4%), MET gain was quantified, with a mean increase of 2.67 ± 1.64 METs. These findings suggest that cardiac rehabilitation, as a secondary prevention strategy, effectively improves cardiac function and HRQoL in working-age patients with ischemic heart disease.

Abbreviations: AMI = acute myocardial infarction, CPR = cardiopulmonary resuscitation, CRPs = cardiac rehabilitation programs, CVRF = cardiovascular risk factor, EHR = exercise heart rate, EUROASPIRE V = European survey on cardiovascular disease and diabetes prevention, HRQoL = health-related quality of life, IQR = interquartile range, JACC = Journal of the American College of Cardiology, LVEF = left ventricular ejection fraction, Me = median, METs = metabolic equivalents of oxygen consumption, PTCA = percutaneous transluminal coronary angioplasty, RHR = resting heart rate, SD = standard deviation, SF-36 = Short Form 36 Health Questionnaire, SHIM = battery of questions to assess the existence and severity of sexual dysfunction in men, SORECAR = Sociedad de Rehabilitación Cardio-Respiratoria, SPSS = Statistical Package for Social Sciences, THR = training heart rate, VO_2 peak = peak oxygen consumption.

Keywords: cardiac rehabilitation, cardiovascular risk management, functional capacity, health-related quality of life, ischemic heart disease, preventive cardiology, psychosocial determinants, tertiary prevention

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

The authors have no funding and conflicts of interest to disclose.

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

This investigation was conducted in accordance with the principles outlined in the Declaration of Helsinki (1975, revised in 2013). This study received a favorable opinion from the Research Ethics Committee of the Virgen Macarena and Virgen del Rocio University Hospitals (C.P.MDC01/C.I.1968-N-22). Approval date: January 20, 2023.

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How to cite this article: Delgado-Calderón M, Jiménez-Ortega LE, Ladisa M, Camacho-Vega JC, Vilches-Arenas Á, Luque-Romero LG, Palomo-Gómez R, Martín-Pereira J, Gómez-Salgado J. Cardiac rehabilitation for workers with ischemic heart disease: Benefits for cardiovascular health and quality of life. Medicine 2025;104:36(e44019).

Received: 27 March 2025 / Received in final form: 30 July 2025 / Accepted: 31 July 2025

http://dx.doi.org/10.1097/MD.0000000000044019

1. Introduction

The World Health Organization (WHO) defines cardiac rehabilitation programs (CRPs) as multifactorial interventions aimed at improving patients' health-related quality of life (HRQoL) by enhancing their physical, psychological, social, and occupational well-being. These programs help patients regain functional capacity and reintegrate into society and the workforce. CRPs require a multidisciplinary approach, involving training plans, cardiovascular risk factor (CVRF) monitoring, health education, psychological support, and workplace motivation.[1]

CRPs are an essential part of the comprehensive treatment plan for heart disease, integrating educational strategies to improve functional capacity and promote heart-healthy lifestyles. Rather than being isolated interventions, they support patients' return to their previous bio-psycho-social context. Health education and psychosocial sessions encourage lifelong application of healthy behavioral patterns acquired during rehabilitation.[1,2] Healthcare professionals involved in CRPs must be trained in secondary prevention, cardiac rehabilitation protocols, and cardiopulmonary resuscitation (CPR) for emergency situations. According to clinical practice guidelines, an ideal cardiac rehabilitation unit should consist of a multidisciplinary team, including cardiologists, rehabilitation physicians, primary care physicians, nurses, physiotherapists, and psychologists.[1,2] Although several factors, such as unstable heart disease or the unavailability of a nearby center within 60 minutes, can prevent patient referral to a CRP,[2] patient refusal is not considered a valid reason for non-referral. It remains the professional's duty to recommend and provide access to this service.[3,4]

CRPs are known to improve cardiovascular risk factors (CVRFs), myocardial electrophysiology, endothelial function, psychosocial well-being, and reduce both morbidity and mortality rates.[2,5,6] Additionally, the relationship between psychosocial factors and ischemic heart disease is well established. Depressive phenomena, stress, poor social support, and type A behavior pattern (ambition, competitiveness and work involvement, as well as impatience and hostile attitudes) predict an increased incidence of cardiovascular disease, as well as an increased risk of infarct recurrence and ventricular arrhythmias after an ischemic cardiac event.[5,7,8] In this sense, a psychometric assessment via standardized questionnaires is encouraged to obtain information about these symptoms during the initial consultation with the cardiac rehabilitation team. One of the most commonly used questionnaires in these cases is the Goldberg anxiety and depression scale.[9]

The determination and assessment of health-related quality of life (HRQoL) is essential in public health interventions, particularly when treatment can affect a patient's quality of life without meeting their expectations. Proactive communication involving the patient in the therapeutic process ensures they can make informed decisions about their care. This is especially crucial in cases where treatment outcomes may differ from anticipated benefits. A 2016 meta-analysis published in the Journal of the American College of Cardiology (JACC) found that 65% of studies reported improved HRQoL after completing a comprehensive CRP.[10]

For patients with ischemic heart disease, HRQoL is commonly assessed using various generic instruments, with the Short Form 36 Health Questionnaire (SF-36) being the most reliable due to its validated Spanish version and strong metric properties. Although specific questionnaires are often preferred, the SF-36 has proven to be a sensitive, valid, and suitable tool for evaluating HRQoL in cardiac rehabilitation patients.[11] The SORECAR guidelines recommend measuring HRQoL scores before and after rehabilitation to assess the program's effectiveness.[1]

Previous studies using this cohort have examined the impact of cardiac rehabilitation on return-to-work outcomes following an ischemic cardiac event.[12] However, there remains a need to evaluate the program's effects on health-related quality of life and functional capacity.

The objective of the present study was to assess the efficacy of CRPs in enhancing the functional capacity (cardiac and psychological) and HRQoL of a cohort of workers who had suffered from ischemic heart disease.

2. Materials and methods

2.1. Design

This study employed a pre-post observational design without a control group, targeting working-age individuals diagnosed with ischemic heart disease. After discharge from the Coronary Care Unit and once the phase II rehabilitation plan was established, a series of validated tools were used to evaluate quality of life, emotional well-being, and sexual health. These assessments complemented the initial clinical and functional data collection. The same variables were reevaluated upon completion of the CRP to measure changes over time.

2.2. Population and sample

The study population comprised patients diagnosed with ischemic heart disease – including chronic angina, acute coronary syndrome, and related conditions classified under ICD-10 codes I20 to I25 – who had undergone percutaneous transluminal coronary angioplasty (PTCA), coronary artery bypass grafting, or conservative treatment, and who completed a CRP within the established timeframe. A total of 396 patients participated in a CRP during the study period, from which 214 individuals were selected based on predefined inclusion criteria, excluding those unsuitable for longitudinal follow-up.

It is worth noting that this same cohort was previously analyzed in a separate study focused on return-to-work outcomes[12]; however, the present investigation explores distinct research objectives and evaluates different clinical and psychosocial variables.

2.3. Study period

From January 1, 2020, to December 31, 2021, both inclusive.

2.3.1. Inclusion criteria.

- Age range between 18 and 65 years.
- Being an active worker (self-employed and/or employed and registered with social security) at the time of the ischemic cardiac event.
- Patients included in the CRP in the defined study period.
- Having completed the CRP within the specified study period.

2.3.2. Exclusion criteria.

- Being on unemployment benefit (contributory or not) at the time of the ischemic heart event. In the case of "not self-employed," exclusion criteria included being on unemployment benefit (contributory or not) or simply not actively working at the time of the cardiovascular event.
- Not actively working due to recognition of total or absolute permanent incapacity prior to the cardiovascular event (excluding students who were exclusively engaged in academic activities without being employed or self-employed).

2.4. Study variables

The independent variables (CVRFs and clinical-therapeutic factors) and changes in the dependent variables (cardiac functional capacity and HRQoL) were analyzed following completion of the CRP.

- Cardiovascular risk factors (CVRFs): Alcohol and smoking habit; personal and family history of heart disease; blood pressure; lipid and glycemic profile; physical activity; weight and abdominal circumference; and presence of anxious-depressive symptomatology.
- Clinical-therapeutic: type of heart disease; coronary vessels involved; cardiovascular risk group; and therapeutic approach.
- Cardiac functional capacity: left ventricular ejection fraction (LVEF); type of exercise test; metabolic equivalents of oxygen consumption (METs) obtained in the exercise test; training heart rate (THR); and functional class.
- Health-related quality of life (HRQoL): SF-36 questionnaire; Goldberg anxiety and depression scale; Mediterranean diet adherence questionnaire; and SHIM questionnaire (a battery of questions to assess the existence and severity of sexual dysfunction in men).

2.5. Intervention and data collection procedure

The CRP implemented by the Cardiac Rehabilitation Unit at Virgen Macarena University Hospital in Seville followed a schedule of 2 sessions per week over an 8-week period. The program combined supervised physical training with educational and psychological support activities.

The data on the CRP recorded in the patient's single digitized medical record in the Andalusian Health Service (Diraya) were used to collect these data, requiring the patients' prior informed consent to access these data and participate in the study. Therefore, the report of the first cardiac rehabilitation consultation after discharge from the Coronary Care Unit was used to record the baseline variables (CVRFs, clinical-therapeutic, and cardiac functional capacity variables) and the results of the battery of questionnaires (SF-36, Mediterranean diet, Goldberg, and SHIM) before the program, and these data were reassembled for analysis after the last cardiac rehabilitation session.

The variables in the database were collected anonymously.

2.6. Statistical analysis

The Statistical Package for Social Sciences (SPSS) version 29.0 for Windows, licensed by the University of Huelva, was used to process and analyze the data. Differences with a P-value < 0.05 were considered statistically significant.

Continuous variables with a normal distribution were expressed as mean (X) ± standard deviation (SD); when the distribution was not normal, the median (Me) ± interquartile range (IQR) was used. Categorical variables have been presented as numbers and percentages.

The Kolmogorov–Smirnov test was used to check the normal distribution of the variables, and Levene analysis was used to verify the equality of variances. When some of the samples were very small, the distribution was not normal and the Mann–Whitney U or the Kruskal–Wallis test were used. The correlation between 2 variables was measured using Spearman rho.

The chi-squared test was used to compare qualitative independent variables. For paired qualitative data, the McNemar test was used for 2×2 square (tetrachoric) tables, and the McNemar–Bowker test was used for higher order tables.

2.7. Ethical and legal aspects

The proposed study respects the fundamental principles of the Declaration of Helsinki of 1975, as revised in 2000, and complies with current legislation regarding respect for patient autonomy (Law 41/2002, of November 14, Basic Law regulating patient autonomy and rights and obligations regarding clinical information and documentation) and the protection of personal data (Organic Law 3/2018, of December 5, on the protection of personal data and the guarantee of digital rights).

The study also received a favorable opinion from the Research Ethics Committee of the Virgen Macarena and Virgen del Rocio University Hospitals (C.P.MDC01/C.I.1968-N-22) (Approval date: January 20, 2023).

The written informed consent form for participation was distributed to all participants and signed before the study begins.

2.8. Limitations

The declaration of a state of emergency in Spain due to the SARS-CoV-2 pandemic led to a significant increase in social distancing behaviors among the population, with individuals avoiding visits to healthcare centers out of concern for contracting COVID-19. Consequently, several studies have reported a decrease in the number of acute ischemic heart disease diagnoses, an increase in the time from symptom onset to reperfusion, and higher in-hospital mortality rates.[13,14]

This factor must be considered, as it has the potential to delay the inclusion of these patients in CRPs and prolong recovery time, which could negatively impact the effectiveness of such programs.

The lack of a control group constitutes a notable limitation of this study, as it limits the capacity to establish causal relationships and prevents attributing observed outcomes exclusively to the CRP. Nevertheless, withholding an intervention with well-documented benefits in a condition that significantly impacts patients' quality of life would raise ethical concerns. For this reason, future studies should consider the inclusion of historical or matched control cohorts. Although validated tools such as the SF-36 and the Goldberg anxiety and depression scale were used, these instruments remain vulnerable to certain biases, including recall bias.

It should be noted that the data used in this study originate from the same cohort previously examined in a publication focused exclusively on return-to-work outcomes following an ischemic cardiac event.[12] However, the current analysis specifically investigates the effects of the rehabilitation program on functional capacity, health-related quality of life, and psychophysical factors, providing a complementary and non-overlapping perspective.

3. Results

After meeting the selection criteria, a total sample of 214 subjects was obtained, with a mean age of 54 ± 6 years (SD), ranging from 28 to 65 years. Of the patients, 83.9% were male and 10.7% were female.

Cohabitation in a couple relationship occurred in 80.8% of the cases, more than half of the subjects (55.1%) had basic vocational training, and 25.2% had secondary or intermediate education.

Table 1 describes the frequency of CVRFs by sex, and Table 2 describes the frequency of family and personal history of ischemic heart disease and other comorbidities. Table 3 describes the frequency of clinical-therapeutic and cardiac functional capacity variables before the CRP. And, Table 4 shows the results of the questionnaires before the start of cardiac rehabilitation.

The patients' resting heart rate (RHR) and exercise heart rate (EHR) were calculated as part of the planning of the physical training sessions. The descriptive analysis of these variables showed that the patients' RHR before CRP did not follow a normal distribution, quantified by a median (Me) of 78 bpm with an interquartile range (IQR) of 17 bpm, a minimum of 46 bpm, and a maximum of 102 bpm. In the case of EHR, it followed a normal distribution with a mean (X) of 91 ± 12 bpm, a minimum of 66 bpm and a maximum of 127 bpm.

Table 5 lists the variables for which the inferential analysis showed a statistically significant benefit before and after cardiac

rehabilitation. It should also be noted that there were no statistically significant changes in alcohol consumption, weight, body mass index, adherence to the Mediterranean diet, sexual dysfunction, or anxiety symptoms following the completion of the CRP.

In relation to quality of life, a statistically significant negative correlation was found between the SF-36 questionnaire score and the time required to return to work (P-value < 0.001 and $r = -0.398$). With regard to the SHIM questionnaire score, it was found that the existence of sexual dysfunction implied a greater length of time required to return to work ($P = .004$).

Following completion of the rehabilitation program, over half of the participants demonstrated preserved LVEF and achieved more than 10 METs on the exercise test – both indicators of substantial improvement in cardiac functional capacity. Additionally, significant changes were observed in resting heart rate (RHR) and exercise heart rate (EHR), further supporting the program's positive impact on cardiovascular performance.

In 57 subjects (26.1%), the METs obtained in the exercise tests performed before and after completing the program were the same. In the rest of the subjects, METs improvement was quantified and showed an average gain mean of 2.67 ± 1.64 METs, the minimum value being 1.1 METs and the maximum being 7.8 METs; thus, offering a quantitative measure of exercise capacity improvement after rehabilitation.

Table 1

Cardiovascular risk factors by sex.

	No. patients, male (%)	No. patients, female (%)
	191 (89.3%)	23 (10.7%)
HBP	139 (72.8%)	14 (60.8%)
Treatment for HBP		
Hydrochlorothiazide		
+1 drug	57 (41%)	5 (35.7%)
2 drugs	64 (46%)	64 (46%)
>2 drugs	18 (13%)	1 (7.1%)
DM	59 (30.9%)	6 (26%)
DM type		
Type I DM	4 (6.8%)	0 (0%)
Type II DM	55 (93.2%)	6 (100%)
Treatment for DM		
Insulin	4 (6.8%)	0 (0%)
OADs	45 (76.2%)	4 (66.7%)
Insulin + OADs	10 (17%)	2 (33.3%)
Dyslipidaemia	146 (76.4%)	15 (65.2%)
Type of dyslipidemia		
Hypercholesterolemia	72 (49.3%)	10 (66.7%)
Hypertriglyceridemia	15 (10.3%)	2 (13.3%)
Combined	59 (40.4%)	3 (20%)
Treatment for dyslipidemia		
Healthy diet	49 (33.6%)	5 (33.3%)
1 drug	44 (30.1%)	3 (20%)
2 or more drugs	53 (36.3%)	7 (46.7%)
Smoking habit		
Non-smoker	35 (18.3%)	6 (26%)
Ex-smoker	56 (29.4%)	3 (13.2%)
Active smoker	100 (52.3%)	14 (60.8%)
Respiratory risk for smokers		
Mild	37 (23.7%)	6 (35.4%)
Moderate	69 (44.3%)	8 (47 %)
High	50 (32%)	3 (17.6%)
Alcohol habit		
Nondrinker	85 (44.5%)	12 (52.2%)
Regular or daily drinker	79 (41.3%)	5 (21.7%)
Occasional/weekend drinker	27 (14.2%)	6 (26.1%)
BMI		
Normal weight	17 (9%)	8 (34.8%)
Overweight	92 (48%)	10 (43.5%)
Obesity	82 (43%)	5 (21.7%)
Abdominal circumference		
Normal	13 (6.8%)	2 (8.7%)
Low CV risk	72 (37.8%)	3 (13%)
High CV risk	106 (55.4%)	18 (78.3%)
Physical activity during leisure time		
High	2 (1.1%)	0 (0%)
Moderate	27 (14.1%)	1 (4.3%)
Low	162 (84.8%)	22 (95.7%)

BMI = body mass index, CV = cardiovascular, DM = diabetes mellitus, HBP = high blood pressure, OADs = oral anti-diabetics

4. Discussion

Cardiac rehabilitation, as secondary prevention, appears to be effective in improving cardiac function, CVRFs control, and health-related quality of life.

It is widely acknowledged in the literature reviewed that a comprehensive CRP offers significant benefits for modifiable CVRFs (glycemic and lipid profile, coronary and peripheral atherosclerosis, blood pressure, abdominal circumference, sedentary lifestyle, toxic habits, etc).[1,2,15–19]

Consistent with findings from a previous analysis of this cohort,[12] a significant improvement in MET levels was observed after rehabilitation, which may positively influence patients' return to work. The program also led to notable enhancements in clinical indicators such as LVEF, functional capacity (as measured by METs), and lipid profiles. Additionally, leisure-time physical activity increased markedly, with 92.5% of participants engaging in moderate exercise post-rehabilitation. Notably, none of the patients maintained a sedentary lifestyle after completing the program.

The program was highly effective in reducing abdominal circumference in subjects with high cardiovascular risk. In fact, 58% of these subjects had their circumference reduced to 42% following the program. However, it is important to note that weight gain increased in only 30.3% of patients. The regression of atherosclerosis in different vascular beds is a well-documented benefit of rehabilitation following an acute cardiovascular event. A comprehensive CRP should address modifiable risk factors, including glycemic and lipid profiles, blood pressure, abdominal circumference, and smoking.[15,19]

Table 2

Family and pathological history of ischemic heart disease and other pathological history.

	No. patients (%)
Personal history of ischemic heart disease	
No	138 (86.79 %)
Yes	21 (13.21%)
Family history of ischemic heart disease	
No	90 (42.1%)
Yes	124 (57.9%)
Personal history of respiratory pathology	
Asthma	13 (28.9%)
COPD	10 (22.22%)
SAHS	20 (44.44%)
Neoplasm	2 (4.44%)
Family member with ischemic heart disease	
Parents	95 (76.6%)
Siblings	11 (8.9%)
Grandparents	6 (4.8%)
Uncles or aunts	12 (9.7%)
Personal history of other pathologies	
Osteo-muscular	43 (32.6%)
Digestive	22 (16.7%)
Neurological	19 (14.4%)
Mental health	19 (14.4%)
Thyroid	13 (9.8%)
Other (autoimmune, nephro-urological, etc)	16 (12.1%)

The program was also highly effective in reducing the proportion of hypertensive patients (71.5% vs 57.2%) and the proportion of active smokers (53.3% vs 12.61%). Meanwhile, the proportion of patients consuming alcohol decreased, this improvement was not significant. Likewise, neither weight nor BMI showed a significant improvement. At the "Annual Meeting of the Association for Vascular Risk and Cardiac Rehabilitation" held in May 2022, it was stated that obesity was the cardiovascular risk factor with the least room for improvement due to low disease awareness. In this line, a recent European-wide survey showed that 45% of coronary patients had no intention of losing weight. It is clear that more efforts are needed to promote body weight loss in overweight patients and improve lipid control. Therefore, educational sessions, dietary counseling, and psychological interventions should be incorporated into these programs.[20,21]

The EUROASPIRE V study (European survey on cardiovascular disease and diabetes prevention) proves that the first year after an acute cardiovascular event is the best period for patients to make lifestyle changes to avoid a new event.[22] However, with the passage of time, patients' compliance decreases. It is thus appropriate to reassess the effectiveness of CRPs 2 to 3 years after the initial event.[23,24]

Table 3

Clinical-therapeutic and functional capacity variables.

	No. patients (%)
Reason for CRP	
STEMI	86 (40.2%)
NSTEMI	80 (37.4%)
Angina	36 (16.8%)
Other (valvular dysfunction, heart failure, etc)	12 (5.6%)
Coronary vessel involvement	
No	12 (5.6%)
Yes	202 (94.4%)
Number of vessels involved	
LCT + 1 vessel	13 (6.5%)
1 vessel	96 (47.8%)
2 vessels	62 (30.8%)
3 vessels	31 (14.9%)
Therapeutic management	
PTCA + Stent	165 (77.1%)
Bypass surgery	35 (16.35%)
Conservative therapy	14 (6.55%)
Type of CRP	
Low risk	69 (32.2%)
Moderate risk	101 (47.2%)
High risk	44 (20.6%)
Initial LVEF	
>55%	140 (65.4%)
55%–45% (mild)	33 (15.4%)
44%–35% (moderate)	30 (14%)
Type of exercise test	
Clinical (–)/electrical (–)	197 (93%)
Clinical (–)/electrical (+)	11 (5.2%)
Clinical (+)/electrical (–)	3 (0.9%)
Clinical (+)/electrical (–)	3 (0.9%)
METs in initial exercise test	
<4 (low)	22 (10.3%)
4–6.9 (moderate)	50 (23.4%)
7–9.9 (high)	79 (36.9%)
>10 (very high)	63 (29.4%)
Initial functional class	
Class 1	6 (2.8%)
Class 2	131 (61.2%)
Class 3	69 (32.3%)
Class 4	8 (3.7%)

CRP = cardiac rehabilitation program, LCT = left coronary trunk, LVEF = left ventricular ejection fraction, MET = metabolic equivalent task, NSTEMI = non-ST segment elevation myocardial infarction, PTCA = percutaneous transluminal coronary angioplasty, STEMI = ST-segment elevation myocardial infarction.

In relation to smoking, EUROASPIRE V showed a smoking prevalence of 55% after myocardial infarction. In contrast, the proportion of active smokers was reduced to 12% among the subjects in the present study. This is highly relevant, as the benefits of many drugs prescribed in ischemic heart disease may be reduced in persistent smokers.[25]

Considering the mean age in this study (54 years), previous publications show that a large proportion of patients with an indication for CRP are relatively young (<55 years old) many of them with work obligations. The management of temporary incapacity processes implemented by the Mutual Societies in collaboration with Social Security, Occupational Risk Prevention Services, Primary Care Physicians, and the National Institute of Social Security have been observed to occasionally result in patients being required to return to work prematurely, despite having only partially completed their CRP. This can present a challenge to compliance with the CRP, particularly in the more active population, who may benefit from shorter, more intensive rehabilitation programs.[26]

With regard to physical functional capacity, at the conclusion of the study, the majority of patients (≥70%) exhibited an improvement of at least 1 MET on the final ergometry following the CRP. After the end of the program, there was a significant increase in the number of subjects who obtained more than 10 METs in the exercise test (29.4% vs 56.5%). This demonstrates a significant cardiac functional improvement based on 7 METS as the threshold for performing basic activities of daily living and light-moderate physical exertion without limitations.[27] The efficacy of high-intensity interval training in enhancing cardiorespiratory fitness in patients undergoing CRP, when compared to moderate-intensity continuous training, is currently under study. As previously stated, these more intense and shorter-duration programs could be beneficial for the working population by encouraging adherence to the sessions.[28,29] In some cases, the conventional exercise stress test is replaced by a cardiopulmonary exercise test, which allows for the measurement of peak oxygen consumption (VO_2 peak). This parameter provides a quantitative assessment of the patient's functional capacity and enables a more precise selection of candidates who are likely to benefit from a CRP. It also facilitates accurate monitoring of their progress, allowing for timely and appropriate adjustments.

Table 4

Results of questionnaires prior to the start of the cardiac rehabilitation program.

	No. patients (%)
Adherence to the Mediterranean diet	
Poor adherence	91 (42.5%)
Good adherence	123 (57.5%)
SHIM Questionnaire	
No dysfunction	43 (22.51%)
Mild dysfunction	69 (36.12%)
Moderate dysfunction	35 (18.33%)
Severe dysfunction	44 (23.04%)
Anxiety	
No	135 (63.1%)
Yes	79 (36.9%)
Depression	
No	96 (44.9%)
Yes	118 (55.1%)

SF-36 score (N = 214)			
Min.	**Max.**	**Median (Me)**	**Interquartile range (IQR)**
7.55	94.44	46.92	36.36

SF-36 = Short Form 36 Health Questionnaire, SHIM = battery of questions to assess the existence and severity of sexual dysfunction in men.

Table 5

Functional capacity, HRQoL, and CVRF variables before and after the CRP.

	Pre-CRP	post-CRP	*p*
Preserved LVEF (>55%)	65.4%	72%	<.001
>10 METs exercise test	29.4%	56.5%	<.001
RHR (Me) beats/min (bpm)	78 bpm	64 bpm	<.001
EHR (X) beats/min (bpm)	91 bpm	114 bpm	<.001
HBP (>140/90mmHg)	71.5%	57.2%	.011
LDL cholesterol (mg/dL)	109	58	<.001
Basal glycemia (mg/dL)	111	91	
Abdominal circumference of high cardiovascular risk	58%	42%	.005
Active smokers	53.3%	12.61%	.005
Physical act. during leisure time (moderate level)	13.1%	92.5%	<.001
Depressive symptoms (Goldberg questionnaire)	55.10%	38.22%	<.001
Questionnaire score	46.92 pts	70.21 pts	<.001
SF-36			

CRP = cardiac rehabilitation program, CVRF = cardiovascular risk factor, EHR = exercise heart rate, HBP = high blood pressure, HRQoL = health-related quality of life, LDL = low-density lipoprotein, LVEF = left ventricular ejection fraction, MET = metabolic equivalent task, RHR = resting heart rate.

Recent publications have demonstrated the role of VO_2 peak as an independent predictor of major cardiovascular events in patients at high cardiovascular risk, establishing it as a valuable tool for risk stratification and for identifying patients who may benefit from additional interventions.[30,31]

The relationship between psychosocial factors and ischemic heart disease has already been well established. The time required to return to work pressive phenomena, stress, poor social support, and type A behavior pattern (ambition, competitiveness and work involvement, as well as impatience and hostile attitudes) have been shown to define a worse prognosis by increasing the incidence of cardiovascular diseases, as well as an increased risk of recurrence of infarction and ventricular arrhythmias after an ischemic cardiac event. This suggests that an improved quality of life is associated with a faster reintegration into the workforce following a cardiac event.[7,8,32–35]

The Goldberg anxiety and depression scale indicated that the study population exhibited notable rates of anxious-depressive symptomatology. Consequently, it is imperative to implement interventions that facilitate the recovery of psychosocial functional capacity.[34,35] Indeed, the questionnaires analyzed at the end of the CRP demonstrated a statistically significant increase in the SF-36 score, with a median of 70.21 points after the program (compared to 46.92 points prior to the beginning of the program). Taking as a reference scores above or below 50 points to indicate better or worse health status, respectively, than the mean of the reference population, a significant improvement in global functionality can be observed.[11] Furthermore, there was a general decrease in the incidence of anxious-depressive symptoms, showing a statistically significant improvement in the case of depression, with 38.22% of patients presenting with depressive symptoms at the completion of the program versus 55.1% at baseline.

Despite we observed that the presence of sexual dysfunction correlates with a prolonged return-to-work period ($P = .004$), the study program demonstrated a reduction in sexual dysfunction in men, although this was not statistically significant. In the literature, erectile dysfunction is found to be a cardiovascular risk factor predictive of coronary heart disease, with a greater prevalence observed in men under the age of 60. This phenomenon can be attributed to the anxious-depressive component that can manifest in patients with coronary disease and their partners, who may be concerned that sexual intercourse may precipitate a cardiovascular event, thereby perpetuating a vicious cycle that inhibits normal sexual activity.[36] Research indicates that the energy expenditure associated with orgasm is equivalent to 5 METs, with 3.7 METs occurring during the pre- and post-orgasmic phase (similar to climbing 2 flights of stairs). This finding highlights the importance of incorporating sexual health considerations into CRPs. Consequently, educational sessions on the disease will be essential to convey to the patient that a clinically and electrically negative exertion test with a capacity of more than 5 METs ensures that no adverse events shall occur (always accounting for the patient's functional status).[37]

There exists a certain degree of controversy surrounding the optimal duration of cardiac rehabilitation. Some studies have indicated that 25 to 36 sessions may be necessary to reduce mortality, while other authors have defined 36 as the minimum number of sessions required to reduce percutaneous angioplasties.[38,39] It has become evident that the benefit of CRPs is directly related to the healthy lifestyle habits that the patient "learns" about during the program (smoking cessation, dietary changes, regular exercise). If these habits are maintained during the first years after AMI, there is a high probability that they will last in the long term. Both adherence and maintenance of the acquired healthy habits and lifestyles are conditioned by factors such as sex, level of education, personality, previous sedentary lifestyle, and family support, so it is necessary to tailor interventions during CRP as well as plan annual medical checkups after discharge.[21,23,40] Further studies would be interesting to assess the long-term benefits obtained after cardiac rehabilitation.

It should be noted that the completion of the questionnaires and the collection of CVRFs could potentially lead to a bias in patient compliance. However, the use of face-to-face follow-up in the training, educational and psychosocial intervention sessions conducted by several specialists reduced the likelihood of false data being provided.

A review of the literature revealed a dearth of studies including women. The male-to-female participant ratio was 8:1, with 83.9% of participants being male. This figure is consistent with previous studies on working-age acute myocardial infarction (AMI) patients, which report male representation ranging from 80% to 95%.[2,41–43] The underrepresentation of female participants in this study may impact its external validity and constitutes a significant limitation that hinders the drawing of meaningful conclusions. To enhance the integrity of future research, it is imperative to address the selection bias observed in this study, particularly as the ultimate goal is to identify therapeutic interventions that effectively reduce morbidity and mortality in women as well.

The predominance of male participants in the present study likely reflects the higher prevalence of ischemic heart disease among men in the working-age population; however, gender was not used as an inclusion or exclusion criterion. Several publications have reported that women's participation and adherence to CRPs is approximately 30% lower than that of men, likely due to lower referral rates, socio-economic disparities,

and psychosocial responsibilities. Nevertheless, when women do attend and complete CRPs, the survival benefit is even greater, as they tend to be older and at higher risk.[44,45]

To improve female participation and adherence in CRPs, early and proactive referral is essential, along with offering maximum flexibility in session timing and scheduling to accommodate patients' social and family obligations.[45,46]

Another important point is that the sample size required for the study to be statistically significant and externally valid could not be calculated due to the fact that the study covered the pandemic years, during which there were far fewer patients seen in the cardiac rehabilitation exercise room and many were referred to outpatient CRPs.

5. Conclusions

A multifactorial CRP with secondary prevention measures maintained over the long term has a favorable impact on the prognosis of patients with AMI. Statistically significant improvement was observed in the majority of modifiable CVRFs (with the exception of weight and alcohol consumption) and cardiac functional capacity variables following the program.

The completion of the CRP was associated with a reduction in the prevalence of anxious-depressive symptoms, although this reduction was statistically significant only in the case of depression.

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