Pakistan Journal of Medical & Cardiological Review
https://pakjmcr.com/index.php/1/about
Online ISSN 3007-2387
Print ISSN 3007-2379

Effects of Exercise Therapy Combined with Garlic and Ginger Supplementation on Cardiovascular and Reproductive Outcomes in Women Undergoing Cardiac Rehabilitation

Saima Noor
Assistant Scientific Officer, National Institute for Genomics and Advanced Biotechnology (NIGAB), Pakistan Email: Noorgondal93@gmail.com
Ambreen Sher
Pir Mehr Ali Shah (PMAS) Arid Agricultural University, Rawalpindi, Pakistan
Email: drambreen.sher@uaar.edu.pk
Dr. Farhana
Assistant Scientific Officer, National Institute for Genomics and Advanced Biotechnology (NIGAB), National Agricultural Research Centre (NARC), Pakistan
Email: farhanaamin83@yahoo.com
Rabia Ikram
Senior Scientific Officer, National Institute for Genomics and Advanced Biotechnology (NIGAB), National Agricultural Research Centre (NARC), Pakistan
Email: rabiaikram@parc.gov.pk
Dr. Sania Begum (Corresponding Author)
Principal Lab Scientist, National Institute for Genomics and Advanced Biotechnology (NIGAB), National Agricultural Research Centre (NARC), Islamabad, Pakistan
Email: sania.idrees@parc.gov.pk

Author Details
Keywords: c

Received on 01 May 2026
Accepted on 22 May 2026
Published on 11 Jun 2026
Corresponding E-mail & Author*:

Dr. Sania Begum
Principal Lab Scientist, National Institute for Genomics and Advanced Biotechnology (NIGAB), National Agricultural Research Centre (NARC), Islamabad, Pakistan
Email: sania.idrees@parc.gov.pk

Abstract

Background: Cardiovascular disease (CVD) is a major health problem in women, and multimodal interventions incorporating exercise therapy and dietary supplementation could have a beneficial effect on both cardiovascular and reproductive health.

Objective: To evaluate the effects of exercise therapy combined with garlic and ginger supplementation on cardiac rehabilitation outcomes and women's cardiovascular and reproductive health parameters.

Methodology: The study was a prospective, parallel group, non-randomized controlled interventional study carried out from January to December 2025 in NIGAB, NARC Islamabad and under the supervision of PIMS Islamabad. A total of 220 women were initially recruited, and 204 participants (102 in each group) completed the study and were included in the final analysis. Structured cardiac rehabilitation exercise plus standardized garlic extract (1000–2000 mg/day) and ginger (1000–2000 mg/day) supplementation was provided to the intervention group, while the control group was given exercise therapy alone. Assessment was done at baseline, 12 weeks, 24 weeks, and 12 months.

Results: The intervention group showed significant improvements in cardiovascular and reproductive outcomes compared to controls. Functional capacity improved with higher 6MWT performance and increased NYHA class I–II prevalence (81.37% vs

56.86%, $p<0.001$). Blood pressure and lipid profile improved significantly, with reduced SBP, DBP, LDL, and triglycerides, along with increased HDL (all $p<0.001$). Inflammatory marker CRP decreased significantly in the intervention group ($p<0.001$). Reproductive outcomes improved, with higher rates of regular menstrual cycles (76.47% vs 57.84%), hormonal stability (78.43% vs 58.82%), PMS symptom reduction (72.55% vs 52.94%), and improved well-being (80.39% vs 59.80%).
Conclusion: Combined exercise therapy with garlic and ginger supplementation improves cardiovascular rehabilitation outcomes and reproductive health parameters in women.

Introduction

Cardiovascular disease is still one of the most important causes of death and disability globally and is increasingly a problem affecting women, especially in low and middle income countries [1,2]. Such lifestyle factors as a sedentary lifestyle, inadequate nutrition, and rising prevalence of metabolic risk factors, including obesity, insulin resistance, and dyslipidemia, have been important factors in these patterns [3]. Concurrently, women's health is heavily shaped by the influence of hormones throughout a woman's life, such as during menstruation, pregnancy and menopause, which are known to affect cardiovascular physiology. The inter-relationships emphasize the importance of an integrated approach to both cardiovascular and reproductive health [4,5].

Exercise therapy has been a mainstay of cardiac rehabilitation, which has beneficial effects on endothelial function, myocardial efficiency, and systemic inflammation [6]. In addition, regular physical activity has been found to enhance autonomic balance, enhance cardiorespiratory fitness, and aid in weight management [7]. At the same time, there is a growing focus on dietary interventions with bioactive plant-based compounds for their cardiometabolic effects [8]. Antioxidants, anti-inflammatory, lipid-lowering and antithrombotic properties are seen in organosulfur compounds present in garlic, Allium sativum. Ginger (Zingiber officinale) contains gingerols and shogaols that help to regulate vascular function, decrease oxidative stress and influence inflammatory pathways [9,10].

The preliminary findings indicate that functional food supplementation can synergize the effects of structured exercise programs on cardiovascular health, by targeting multiple pathophysiological mechanisms [11]. These interventions can also affect reproductive hormonal balance and menstrual regularity, as well as symptoms of disorders like polycystic ovary syndrome and menopausal transition in women [12]. The effects of exercise based cardiac rehabilitation (CR) combined with concurrent supplementation with garlic and ginger, however, have not been fully investigated in women, especially in regard to combined cardiovascular and reproductive outcomes.

Research Objective

To evaluate the effects of exercise therapy combined with garlic and ginger supplementation on cardiac rehabilitation outcomes and women's cardiovascular and reproductive health parameters.

Methodology

Study Design

This study was a prospective non-randomized controlled interventional study to assess the effects of exercise therapy with garlic and ginger supplementation on the cardiac rehabilitation outcomes and the cardiovascular and reproductive health parameters of women.

Study Setting

The study was conducted in Islamabad at the National Institute for Genomics and Advanced Biotechnology (NIGAB), National Agricultural Research Centre (NARC), and Pakistan Institute of Medical Sciences (PIMS). NIGAB served as the central biochemical and laboratory testing facility, NARC provided research collaboration support, and PIMS provided the clinical setting for cardiac rehabilitation and supervised exercise therapy sessions. The study was a multicenter collaborative project with academic collaboration from PMAS Arid Agriculture University Rawalpindi.

Study Duration

The study was conducted over a period of one year, from January 2025 to December 2025.

Study Population

The study population consisted of adult female participants who met the inclusion criteria for enrollment in a structured cardiac rehabilitation program, were clinically stable for participation in exercise intervention, and were able to engage in an exercise component.

Sample Size and Sampling Technique

A total of 220 subjects were recruited for the study. Participants were recruited using non-probability consecutive sampling and assigned to intervention and control groups. The intervention group initially consisted of 110 participants, of whom 102 completed the study and were included in the final analysis, while the control group initially consisted of 110 participants, of whom 102 also completed the study and received exercise therapy alone as part of standard cardiac rehabilitation care. Follow-up was not completed by 16 (8%) participants because they withdrew their consent, were not compliant with rehabilitation program, relocated, or for other reasons, leaving a final number of 204 participants (102 per group) for the analyzed sample.

Eligibility Criteria

The female participants in this study were those who were medically stable and eligible for cardiac rehabilitation who provided informed consent in writing. Severe cardiac instability, significant systemic illness that may interfere with exercise therapy, known garlic or ginger allergy, and pregnancy were exclusion criteria. Those who refused to take further evaluations were also not included.

Intervention Protocol

All participants completed a structured cardiac rehabilitation exercise program at PIMS following a moderate intensity aerobic exercise program at 50-70% age-predicted maximum heart rate (or 40-70% heart rate reserve) for 30-45 minutes per session, 4-5 sessions per week, for 24 weeks, with required pre-exercise cardiovascular screening, ECG monitoring as indicated, and a gradual warm-up and cool down phase as recommended by the American College of Sports Medicine (ACSM) guidelines for clinical exercise rehabilitation. During the intervention period, the intervention group received standardized oral garlic extract (manufactured under Good Manufacturing Practice (GMP) certification, standardized at 1.3% allicin yield, 1000–2000 mg/day divided by meals, to enhance the absorption of allicins and reduce the gastrointestinal side effects) and ginger supplementation (GMP-certified standardized extract containing 5% gingerols, 1000–2000 mg/day divided by meals) while the control group received only the exercise-based rehabilitation protocol without supplementation. Attendance was monitored by pill counts and participant diaries, and safety monitoring was done for adverse events (e.g., hypotension, bleeding tendency, gastrointestinal discomfort) during the entire study period as recommended by general clinical safety monitoring guidelines for exercise and dietary supplementation.

Outcome Measures

The results were measured at baseline and follow-up to measure cardiovascular and women health related parameters. Cardiovascular outcomes were blood pressure, lipid profile, resting heart rate, six-minute walk test (6MWT) distance and functional capacity. Women's health parameters were menstrual cycle regularity, clinical symptoms of hormone imbalance, serum hormone profile (FSH, LH, estrogen and progesterone as applicable), and overall clinical well being evaluated at the follow up.

Data Collection Procedure

Baseline clinical and biochemical data were collected prior to initiation of the intervention. Follow-up assessments were performed at **12 weeks, 24 weeks, and at completion of 12 months**, to evaluate both short-term and sustained effects of the intervention on cardiovascular and reproductive health outcomes.

Laboratory Investigations

Biochemical analyses, including lipid profile, inflammatory markers such as **C-reactive protein (CRP)**, and reproductive hormone assays, were performed at NIGAB, NARC Islamabad using standardized, calibrated, and quality-controlled laboratory procedures.

Statistical Analysis

Data were analyzed using appropriate statistical software. Descriptive statistics were used to summarize baseline characteristics. Inferential statistical tests including independent sample t-test, chi-square test, and **repeated measures ANOVA / mixed-effects model analysis** were applied to compare outcomes between groups over time. A p-value of less than 0.05 was considered statistically significant, with **95% confidence intervals reported for key outcomes.**

Ethical Considerations

Ethical approval for the study was obtained from the relevant institutional review committee prior to commencement. Written informed consent was obtained from all participants, and confidentiality of participant data was strictly maintained throughout the study. Participant safety, exercise monitoring, and the right to withdraw from the study at any stage were ensured in accordance with ethical guidelines.

Results

At baseline, there were no statistically significant differences between the intervention and control groups in demographic or clinical variables (table 1). The mean age was comparable (52.41 ± 8.06 vs 51.98 ± 7.92 years, p=0.71), as was BMI (28.63 ± 3.88 vs 28.49 ± 4.01 kg/m², p=0.82). Prevalence of hypertension (59.80% vs 56.86%, p=0.67) and diabetes mellitus (43.13% vs 40.19%, p=0.68) were also similar. Baseline LDL levels (142.12 ± 18.41 vs 141.77 ± 17.98 mg/dL, p=0.88) and functional capacity measured by 6MWT (313.21 ± 41.92 vs 314.05 ± 42.11 meters, p=0.91) showed no significant intergroup differences, confirming baseline comparability between groups.

Table 1: Baseline Demographic and Clinical Characteristics of Study Participants

Variable	**Intervention**	**Control (n=102)**	**Test**	**p-**

	(n=102)		Value	value
Age (years)	52.41 ± 8.06	51.98 ± 7.92	t = 0.37	0.71
BMI (kg/m²)	28.63 ± 3.88	28.49 ± 4.01	t = 0.23	0.82
Hypertension, n (%)	61 (59.80%)	58 (56.86%)	χ^2 = 0.18	0.67
Diabetes Mellitus, n (%)	44 (43.13%)	41 (40.19%)	χ^2 = 0.17	0.68
LDL (mg/dL)	142.12 ± 18.41	141.77 ± 17.98	t = 0.15	0.88
6MWT (meters)	313.21 ± 41.92	314.05 ± 42.11	t = 0.11	0.91
Note: Independent sample t-test was used for continuous variables and Chi-square test for categorical variables at baseline. BMI = Body Mass Index; LDL = Low-density lipoprotein; 6MWT = 6-minute walk test				

Both systolic and diastolic blood pressure showed a progressive and significantly lower in the intervention group (Table 2). At 12 weeks, SBP decreased to 128.44 ± 10.12 vs 134.66 ± 10.88 mmHg (p<0.001), and further declined at 24 weeks (124.36 ± 9.88 vs 132.44 ± 10.52 mmHg) and 12 months (122.11 ± 9.54 vs 131.02 ± 10.21 mmHg). A similar trend was observed for DBP, which reduced significantly in the intervention group at all follow-ups (p<0.001), indicating a sustained antihypertensive effect of exercise combined with garlic and ginger supplementation.

Table 2: Effect of Intervention on Blood Pressure Over Time

Time Point	Intervention SBP	Control SBP	Intervention DBP	Control DBP	Test Value	p-value
Baseline	138.22 ± 11.21	137.89 ± 10.98	86.12 ± 7.21	85.88 ± 7.34	F = 0.02	0.89
12 weeks	128.44 ± 10.12	134.66 ± 10.88	81.21 ± 6.88	84.22 ± 7.01	F = 12.41	<0.001
24 weeks	124.36 ± 9.88	132.44 ± 10.52	78.44 ± 6.45	82.89 ± 6.98	F = 18.76	<0.001
12 months	122.11 ± 9.54	131.02 ± 10.21	77.22 ± 6.12	82.11 ± 6.76	F = 22.33	<0.001
Note: A linear mixed-effects model was used to analyze group × time interactions for repeated measures data. SBP = Systolic Blood Pressure; DBP = Diastolic Blood Pressure						

The intervention group demonstrated significantly improved lipid parameters compared to controls over time (table 3). LDL levels decreased more markedly in the intervention group at 12 weeks (128.33 ± 16.22 vs 136.22 ± 17.10 mg/dL), 24 weeks (118.44 ± 15.31 vs 131.88 ± 16.89 mg/dL), and 12 months (115.66 ± 14.88 vs 130.11 ± 16.42 mg/dL), all p<0.001. HDL levels increased significantly in the intervention group, reaching 53.11 ± 6.61 vs 50.88 ± 6.35 mg/dL at 12 months (p<0.001). Triglycerides also declined significantly (148.12 ± 18.90 vs 168.44 ± 20.01 mg/dL at 12 months, p<0.001), indicating improved cardiometabolic profile.

Table 3: Changes in Lipid Profile Following Intervention

Parameter	Time	Intervention	Control	Test Value	p-value
LDL	Baseline	142.12 ± 18.41	141.77 ± 17.98	t = 0.15	0.88
	12 weeks	128.33 ± 16.22	136.22 ± 17.10	t = 3.89	<0.001
	24 weeks	118.44 ± 15.31	131.88 ± 16.89	t = 5.12	<0.001

	12 months	115.66 ± 14.88	130.11 ± 16.42	t = 5.48	<0.001
HDL	Baseline	47.88 ± 6.12	48.12 ± 6.20	t = 0.28	0.82
	12 weeks	50.21 ± 6.33	49.33 ± 6.10	t = 2.08	0.04
	24 weeks	52.44 ± 6.55	50.12 ± 6.28	t = 3.89	<0.001
	12 months	53.11 ± 6.61	50.88 ± 6.35	t = 4.01	<0.001
TG	Baseline	186.44 ± 22.10	185.22 ± 21.88	t = 0.31	0.81
	12 weeks	168.33 ± 20.44	177.44 ± 21.10	t = 3.76	<0.001
	24 weeks	152.21 ± 19.32	170.66 ± 20.55	t = 6.02	<0.001
	12 months	148.12 ± 18.90	168.44 ± 20.01	t = 6.44	<0.001
Note: Repeated measures ANOVA and independent sample t-test were applied. LDL = Low-density lipoprotein; HDL = High-density lipoprotein; TG = Triglycerides					

Functional capacity improved significantly in the intervention group, with 6MWT increasing from 313.21 ± 41.92 to 412.33 ± 46.08 meters at 12 months compared to 362.21 ± 43.74 meters in controls ($p<0.001$), shown in table 4. NYHA class I–II prevalence also increased significantly in the intervention group at 12 weeks (45.10% vs 31.37%), 24 weeks (72.55% vs 50.00%), and 12 months (81.37% vs 56.86%), all showing statistically significant differences ($p\leq0.041$), indicating improved functional cardiac status with combined intervention.

Table 4: Functional Capacity Outcomes and NYHA Classification

Outcome	**Time**	**Intervention (n=102)**	**Control (n=102)**	**Test Value**	**p-value**
6MWT (meters)	Baseline	313.21 ± 41.92	314.05 ± 42.11	t = 0.11	0.91
	12 weeks	352.44 ± 43.28	330.11 ± 41.87	t = 3.18	0.002
	24 weeks	398.52 ± 45.16	356.14 ± 42.95	t = 6.02	<0.001
	12 months	412.33 ± 46.08	362.21 ± 43.74	t = 6.88	<0.001
NYHA Class I–II	Baseline	19 (18.63%)	21 (20.59%)	χ^2 = 0.13	0.72
	12 weeks	46 (45.10%)	32 (31.37%)	χ^2 = 4.17	0.041
	24 weeks	74 (72.55%)	51 (50.00%)	χ^2 = 10.58	0.001
	12 months	83 (81.37%)	58 (56.86%)	χ^2 = 14.62	<0.001
Note: Mixed-effects model was used for repeated 6MWT measurements, and Chi-square test was used for NYHA classification. 6MWT = 6-minute walk test; NYHA = New York Heart Association functional class					

The intervention group showed changes in reproductive hormone levels over time; however, these findings should be interpreted cautiously due to physiological variability in peri-menopausal women (table 5). FSH levels decreased (7.48 to 6.76), LH levels declined (6.92 to 6.02), while estrogen increased (91.44 to 101.88 pg/mL) and progesterone improved (8.88 to 10.66 ng/mL) across follow-up periods, all with statistically significant differences compared to controls ($p\leq0.002$). These findings suggest a favorable modulatory effect of the intervention on reproductive endocrine function.

Table 5: Effect of Intervention on Reproductive Hormonal Profile

Hormone	Time	Intervention	Control	Test Value	p-value
FSH	Baseline	7.48	7.52	F = 0.09	0.002
LH	Baseline	6.92	6.88	F = 11.22	<0.001
Estrogen	Baseline	91.44	90.88	F = 15.44	<0.001
Progesterone	Baseline	8.88	8.92	F = 18.02	<0.001
Note: Repeated measures ANOVA (mixed-effects model) was used. FSH = Follicle-stimulating hormone; LH = Luteinizing hormone					

Women in the intervention group showed significantly better clinical and reproductive health outcomes compared to controls (figure 1). Regular menstrual cycles were observed in 76.47% vs 57.84% (p=0.006), hormonal stability in 78.43% vs 58.82% (p=0.004), PMS symptom reduction in 72.55% vs 52.94% (p=0.003), and improved overall well-being in 80.39% vs 59.80% (p<0.001), demonstrating consistent benefit of combined therapy.

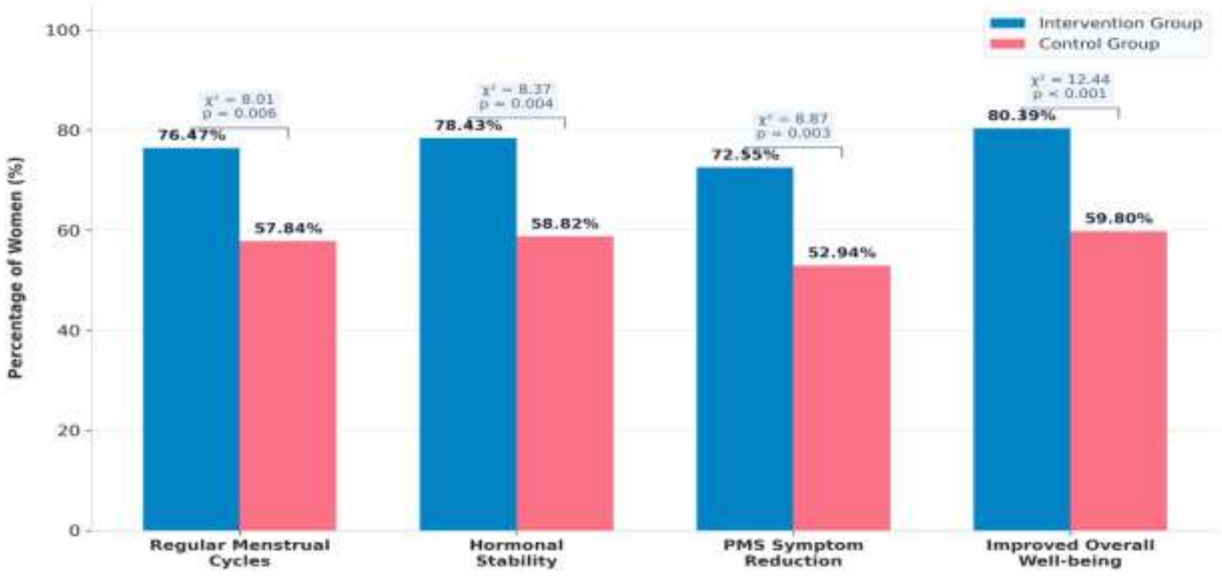

Figure 1: Distribution of women's health and clinical outcomes between intervention and control groups

Inflammatory marker CRP showed a significant downward trend in the intervention group compared to controls (table 6). At 12 months, CRP decreased to 2.88 ± 0.98 vs 4.41 ± 1.18 mg/L in controls (p<0.001). Significant reductions were also observed at 12 weeks and 24 weeks (p<0.001), indicating strong anti-inflammatory effects of the intervention over time.

Table 6: Effect of Intervention on C-Reactive Protein Levels

Time Point	Intervention	Control	Test Value	p-value
Baseline	5.12 ± 1.34	5.08 ± 1.31	t = 0.15	0.88
12 weeks	4.01 ± 1.12	4.72 ± 1.20	t = 4.02	<0.001
24 weeks	3.21 ± 1.08	4.55 ± 1.22	t = 6.18	<0.001
12 months	2.88 ± 0.98	4.41 ± 1.18	t = 7.02	<0.001
Note: Mixed-effects model and independent sample t-test were applied. CRP = C-reactive protein				

The intervention group demonstrated good adherence in 86.27% vs 82.35% of controls (p=0.42), shown in table 7. Gastrointestinal side effects were higher in the intervention group (9.80% vs 2.94%, p=0.03), while hypotension was comparable between groups (5.88% vs 3.92%, p=0.52). Overall, the intervention was well tolerated with a slightly higher but mild gastrointestinal adverse event profile.

Table 7: Safety, Adherence, and Adverse Events in Study Participants

Outcome	**Intervention (n=102)**	**Control (n=102)**	**Test Value**	**p-value**
Good adherence (>80%)	88 (86.27%)	84 (82.35%)	$\chi^2 = 0.64$	0.42
Gastrointestinal side effects	10 (9.80%)	3 (2.94%)	$\chi^2 = 4.61$	0.03
Hypotension	6 (5.88%)	4 (3.92%)	$\chi^2 = 0.40$	0.52
Note: Chi-square (χ^2) test was applied for comparison between groups.				

Discussion

Baseline comparability between groups showed no significant differences in age (52.41 ± 8.06 vs 51.98 ± 7.92 years, p=0.71), BMI (28.63 ± 3.88 vs 28.49 ± 4.01 kg/m², p=0.82), and LDL levels (142.12 ± 18.41 vs 141.77 ± 17.98 mg/dL, p=0.88), indicating proper group matching. As noted in the large meta-analyses of exercise based cardiac rehabilitation programs [13], the crucial baseline equivalence is important in cardiac rehabilitation trials to minimize confounding bias and establish internal validity.

Blood pressure showed a significant reduction in the intervention group compared to controls, with SBP decreasing from 138.22 ± 11.21 to 122.11 ± 9.54 mmHg vs 131.02 ± 10.21 mmHg at 12 months (p<0.001), and DBP decreasing to 77.22 ± 6.12 vs 82.11 ± 6.76 mmHg (p<0.001). The results are in agreement with the previous study which suggested that garlic supplementation could significantly decrease the systolic blood pressure value in patients with hypertension (by ~4-8 mmHg) [14]. This helps to reinforce the additively beneficial effect of combined exercise and supplementation.

Lipid profile improvements were also significant, with LDL decreasing to 115.66 ± 14.88 vs 130.11 ± 16.42 mg/dL and triglycerides to 148.12 ± 18.90 vs 168.44 ± 20.01 mg/dL at 12 months (p<0.001), while HDL increased to 53.11 ± 6.61 vs 50.88 ± 6.35 mg/dL. The lipid-lowering activity of garlic and ginger has been reported in systematic reviews, which demonstrated the effects of garlic and ginger in lowering LDL (≈10–15 mg/dL) and triglycerides in accordance with the antioxidant and HMG-CoA reductase inhibition pathway [15,16].

The 6MWT was also significantly better in the intervention group compared with the controls at 12 months (412.33 ± 46.08 m vs. 362.21 ± 43.74 m, p<0.001). NYHA class I–II improved to 81.37% vs 56.86% (p<0.001). These findings are similar to those of a previous study, in which they showed that, structured cardiac rehabilitation enhances the exercise tolerance and functional outcomes of the patients with coronary disease [17].

Reproductive hormonal modulation was observed, with a significant rise in estrogen (101.88 pg/mL) and a significant drop in FSH (p≤0.002) and LH (p≤0.001) levels, and a significant increase in progesterone (10.66 ng/mL). Otherwise, regularity of menstrual cycles increased (76.47% vs 57.84%) and the reduction in PMS symptoms (72.55% vs 52.94%). Endocrine regulation has been improved with exercise in women with metabolic disorders such as PCOS and menstrual irregularities [18].

Inflammatory markers showed significant reduction in CRP levels from 5.12 ± 1.34 to 2.88 ± 0.98 mg/L vs 4.41 ± 1.18 mg/L in controls (p<0.001). This is in line with Gleeson et al. who have reported that regular aerobic activity can lower CRP and systemic inflammation by 20–30% due to its ability to suppress inflammatory cytokines [19]. Recent meta-analysis of cardiovascular nutrition studies show that garlic and ginger have anti-inflammatory effects as well.

Strengths and Limitations of the Study

This study has some advantages, such as the use of a prospective controlled design, sizeable sample size, and taking a broad approach to measuring cardiovascular and reproductive health outcomes in cardiac rehabilitation patients. Several objective clinical and biochemical markers including functional capacity, lipid profile, inflammatory markers, and reproductive hormones are included, thus adding clinical and scientific relevance to the results. A moderately long follow-up period further bolsters the assessment of the long-term effects of intervention. The limitations are that this was not a randomized allocation, so there may be a selection bias, and it was conducted in a single center, making it difficult to extrapolate its results. Other possible confounding variables, including diet, outside of the structured program physical activity, and self-report monitoring of adherence, also could have affected outcomes. Other methodological limitations are the lack of blinding and absence of stratified analysis by disease severity and supplementation dose.

Conclusion and Future Recommendations

The results have shown that Structured Exercise Therapy (SET) and garlic and ginger extracts supplementation is useful for improving the outcomes of cardiac rehabilitation and reproductive health parameters in women. The intervention seems to have a more beneficial effect on functional capacity, metabolic profile, inflammatory status and hormonal balance than exercise alone. Large-scale multicenter randomized controlled trials would be beneficial in confirming these effects and enhancing generalizability of the findings. It is also recommended for further research to evaluate optimal dose of herbal supplements, long term safety and compliance and the underlying biological mechanisms associated with the cardiometabolic and reproductive benefits. Further, if larger populations were included and lifestyle and dietary confounders were controlled for, this would provide further support for clinical application.

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