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Efficacy of Structured Exercise Protocol on Patient-Related Outcome Measures, Blood Pressure, And Waist-Hip Ratio in Post Myocardial Infarction Subjects with Hypertension

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ABSTRACT

Hypertension, commonly known as high blood pressure, is a chronic condition where the force of blood against artery walls remains consistently high. Hypertension is a widespread global health concern, affecting over 1.2 billion people worldwide. Its prevalence is increasing due to factors like aging populations, unhealthy lifestyles, and rising obesity rates. It is a major risk factor for heart disease, stroke, and other serious health complications. The study was conducted to find the efficacy of structured exercise protocol training in post-angioplasty subjects with hypertension. A total of 168 subjects were selected, met the inclusion and exclusion criteria, and were randomly divided into two groups. Group A (n= 84) received conventional physiotherapy with lifestyle modifications and Group B (n= 84) received structured exercise training for 6 months. Subjects were evaluated based on pre and post assessment by patient related outcome measures, blood pressure and waist hip ratio. Both the groups showed significant improvement but Group B showed much substantial improvement as compared to Group A. Group B (**anxiety $p < 0.000$, depression $p < 0.000$, sleep disturbance $p < 0.000$, QOL - physical functioning $p < 0.000$, emotional $p < 0.001$, social $p < 0.029$and social function $p < 0.389$), blood pressure - systolic $p < 0.000$, diastolic $p < 0.485$ and waist-hip ratio $p < 0.70$**, indicating the rejection of null hypothesis and acceptance of structured exercise protocol. Given the robust evidence supporting the benefits of cardiac rehabilitation, it should be incorporated into standard post-MI care protocols to improve long-term cardiovascular outcomes.

Keywords: *Post myocardial infarction, Hypertension, Patient related outcome measures, Blood Pressure, Waist hip ratio*

1. INTRODUCTION

Currently, Hypertension is the most common risk factor for numerous cardiovascular diseases, stroke, and kidney disease also the biggest public health challenge. According to a Global report created by the World Health Organization (WHO) on hypertension in the year 2023 stated that in the age group of 30-79 years of age, almost 1.28 billion adults are globally diagnosed as hypertensive. And out of those 1.28 billion adults, almost 46% of the adults are not aware of it [1]**.** The prevalence of hypertension differs from area to area. Low and middle-income countries (LMICs) show a prevalence of 67%, which is due to poor screening as well as poor quality of treatment. Almost two-thirds of the total hypertension cases noted in the entire world are from low and middle-income countries (LMICs). High-income countries have comparatively higher treatment strategies than low and middle-income countries and therefore, control rates in the high-income countries have almost more than 50% of hypertensive individuals taking the necessary treatment for the same. While on the other hand, only 37% of the individuals in LMICs are undergoing any treatment. In 2023, WHO generated a report which elaborated that in the year 2021**,** 10.8 million deaths were reported worldwide and it was solely due to hypertension**.** Uncontrolled hypertension led to nearly half of the deaths due to cardiovascular issues [1].

In the year 2021, a systematic review was done by NCD Risk Factor Collaboration stated that the global age-standardized prevalence of hypertension is different in men and women. It is 31% and 29% in men and women respectively. The highest prevalence was seen in Central and Eastern Europe which was almost 35-40% followed by Sub-Saharan Africa which showed a prevalence of almost 38%. On the other hand, the Asia-Pacific region considered as one of the highest income region enlightened the lowest prevalence which was between 20-25%[2].

There are various reasons such as urbanization, dietary changes, sedentary lifestyles, and an aging population which contribute in India experiencing a higher number of cases of hypertension. In the year 2019-2021, a National Family Health Survey (NFHS-5) was conducted to highlight the prevalence of hypertension among Indian adults in the age group 15 years and above in men and women to be 24% and 21% respectively. The prevalence calculated may not be true as there are many undiagnosed cases [3]. According to a survey conducted by the Indian Council of Medical Research (ICMR)-India Hypertension Control Initiative (IHCI) in the year 2023, only 12% of the entire population have their blood pressure levels under control and the remaining population which encompasses about 220 million adults are hypertensive [4].

Due to various lifestyle-related risk factors, the prevalence of hypertension in urban areas and rural areas is 30-35% and 20-25% respectively. The southern and northern states of India including Kerela, Punjab, and Tamil Nadu have a prevalence of more than 30% which is comparatively high. On the other hand, a relatively lower prevalence is seen in the central and northeastern states of India [5]. An increase in the prevalence is seen with increase in the age of the individual stating that almost 50% of the adults with age 60 years and above are affected. Also, although it is poorly controllable in women due to post-menopausal scenarios, yet they are at lower risk as compared to men [6].

A significant impairment in the production of nitric oxide was seen along with hypertension promoting vascular damage resulting in endothelial dysfunction. Nitric oxide is an important vasodilator. The impairment in the production of nitric oxide results in enhancement in the vascular resistance and the arterial stiffness which leads to a reduction of the ability of the coronary artery to supply blood to the walls of heart [7]. In a study performed on the same stated a significant increase in foam cell formation was seen due to the oxidation of low-density lipoprotein leading to plaque formation [8]. According to a study in the year 2022, the stabilization of the atherosclerotic plaques weakens due to chronic inflammation along with the rise in the cytokines level **(**IL-6, TNF-α, CRP**),** which ultimately increases the chances of rupture [10].

The hypertrophy of the left ventricle is also seen as a result of prolonged exposure to high afterload created by persistent hypertension [11]. Although hypertrophy of the left ventricle is a compensatory response, it holds a significant potential to promote an episode of MI because of an increase in myocardial oxygen demand along with impaired coronary perfusion leading to ischemia. A decrease in coronary reserve results in hypertrophy of the myocardium making it more prone to ischemic injury [12].

The plaque instability is seen due to a rise in the shear stress experienced by the walls of the arteries [13]. Also, increase in platelet aggregation leading to hypercoagulability results in rapid thrombus formation and coronary occlusion [14]**.** Also, a decrease in fibrinolysis results in a delay in clot dissolution which further increases the severity of the infarct [15].

Individuals with hypertension have a 2-3 times greater risk of developing MI compared to normotensive individuals. According to a study, any individual diagnosed with hypertension faces 2-3 times higher risk of developing MI while on the other hand, normotensive individuals are not that susceptible to the same. Hypertension is responsible for 25% of MI cases globally, followed by dyslipidemia as another major risk factor for the occurrence of MI [16]. According to a study, with

every 10mmHg rise in systolic blood pressure level, the risk of developing MI is also raised by almost 25%. This promotes the importance of maintaining good control over blood pressure levels [17]. A meta-analysis performed in 2022, implemented antihypertensive therapy in the treatment of hypertension proved itself to help to decrease the risk of MI by almost 20-30% [18].

According to the study performed in the year 2021, hypertensive people often face anxiety issues which are the ultimate cause of avoidance of physical activity resulted from a state of continuous fear about cardiovascular reaction towards the activity [19]. It is proved that hypertension has an impact on autonomic nervous system dysfunction which results in an increasing incidence of generalized anxiety disorder (GAD) and depression [7]**.** According to a study performed in the year 2021, an increase in stress and depressive symptoms can be seen in post-MI and hypertensive patients due to long-term treatment, and drastic lifestyle modifications A meta-analysis performed on the same noted that almost 30-40% of post-MI hypertensive patients predominantly experienced depression**,** which is accompanied with a 2-fold increased risk of mortality [20]**.**

Hypertension has also proved itself to have a negative impact on the sleeping pattern resulting in insomnia and weakened sleep efficiency [15]. According to a study performed in the year 2021 showed increased incidences of nocturnal apnea, as most of the post-MI hypertensive patients have undiagnosed obstructive sleep apnea which further worsens the condition [21A significant disturbance in melanin production is seen due to certain cardiovascular drugs which creats disturbance in sleeping patterns [22].

Poor sleep quality was the common complaint received from 50% of the post-MI hypertensive patients while on the other hand, only 30% of the post-MI normotensive patients complained about the same. Mindfulness-based stress reduction (MBSR) and structured exercise programs significantly improve sleep patterns and reduce nighttime BP fluctuations [23]. A study elaborated that there is a positive influence of Mindfulness-based stress reduction (MBSR) along with tailored exercise programs in improving the sleeping pattern and dropping nocturnal blood pressure levels [12]**.**

The patient imposes activity restrictions on himself/ herself because of the fear of reoccurrence of cardiac events which results in decreasing the mobility and independence of the patient [24].

According to a study, patients generally have the feeling of frustration, fatigue, and emotional instability which is responsible for deteriorating mental health related quality of life (HRQOL) [25]. Antihypertensive medications can lead to fatigue, dizziness, and erectile dysfunction**,** further impacting the well-being of an individual [26]. In a study performed in the year 2022, the scoring of SF-36 (Short Form-36 Health Survey) and WHOQOL-BREF (World Health Organization Quality of Life) assessments in comparatively low in post-MI hypertensive patients while it is not the same in normotensive counterparts [18]. Implementation of psychological intervention along with cardiac rehabilitation will showcase a significant positive impact on the physical and mental health [27].

Fear of physical exertion and dietary restrictions limit participation in family and social gatherings, patients are unable to participate in family functions and social gatherings due to agitation of physical exertion and limitations in diet [28]. The economic stress a patient experiences due to the cost of managing hypertension and post MI care required also showcases a negative influence on the social engagement [29]. The sense of loneliness and insufficient social support given to the patient also contribute in it [30]. More than 40% of patients reported social withdrawal which had a negative effect on the patient's general recovery [18]. There was a significant improvement seen in the social re-integration and enhancement in the mental well being in the patients with the help of social support networks, group therapy, and lifestyle modification programs [31].

According to a research, exercise is the most important aspect in the cardiac rehabilitation and simultaneously plays a crucial role in enhancing the overall health and the wellbeing in patients with post MI having hypertension as [32]. The study also stated that encompassing resistance training and aerobic training in the exercise protocol has a positive impact on the functional capacity, sleep quality, quality of life and social interactions and also, there is a drastic drop in the anxiety and depression levels. Post MI recovery can be because of strain over cardiovascular health and its functioning due to hypertension. It is crucial to include tailored exercise protocol in rehabilitation program as it is crucial in optimizing long term prognosis [17].

The decrease in stress levels and enhancement of the mood can be seen due to the positive influence of exercise on the levels of certain hormones such as endorphin and serotonin [20]**.** A study was performed in the year 2020 which showed a deterioration in the overactivity of the sympathetic nervous system, assisting in reducing stress hormone levels or cortisol levels [33]**.** A rise in greater heart rate variability (HRV) along with decrease in other symptoms such as panic attacks is seen due to the enhancement in the autonomic functioning [7]. Implementation of a 12 week tailored exercise protocol in the rehabilitation of post MI hypertensive patients helped the anxiety and depression levels to decrease by 25% and 30% respectively [34]. Anxiety levels were assessed by GAD-7 scores and the depression levels were assessed by PHQ-9 scores. **I**mplementation of the cognitive-behavioral therapy (CBT) along with the exercise protocol would showcase enhancement in mood by decreasing the depression levels due to synergistic effect [20].

It is determined that hypertensive patients undergoing post MI recovery generally encompasses a disturbed sleep

quality, rise in nocturnal blood pressure and also experiences insomnia [15]. By proper regulation and monitoring of circadian rhythms and alteration in nocturnal hypertension, a in significant enhancement in the sleep efficiency can be seen [35]. Cardiovascular recovery and autonomic regulation it is very important to improve the slow wave sleep which is also known as deep sleep [24].

Pittsburgh Sleep Quality Index (PSQI) was used to assess the sleep quality which illustrated that by exercise-based rehabilitation enhanced the scores by 30-40% illustrating the improvement in the sleep quality [37]. aerobic type of exercise for approximately 150 minutes a week can show significant alteration in night time awakenings and sleep latency [38].

Enhanced physical health can provide a considerable freedom and a drop in the everyday fatigue levels. Improvement in the emotional status of the individual can be seen with reduction in the sense of helplessness and fear [16]. Promoting more involvement in social as well as in recreational activities will stimulate the adaptation of normalcy [10]. The scales used to assess the health progression among the participants were SF-36 and WHOQOL-BREF.

Implementation of cardiac rehabilitation in group contributes to various aspects such as social support, encouraging peer interactions as well as motivation [12]. Also, enhancement of self-confidence and emotional stability was seem more among those who attended social participation [20]. Overall wellbeing is improved with decrease in fatigue and pain symptoms which ultimately results in increased social outings [26]. The post MI patients who are involved in exercise protocols are more likely to return back to their social and community activities as compared to the patients who are not involved in exercise protocol [18].

Exercise plays a very vital role among post myocardial infarction patients having hypertension in lowering the blood pressure levels and also enhancing the body composition. Waist-Hip ratio is an efficient marker for cardiovascular morbidity and for mortality, it is also proven that patients having hypertension have a higher chance of recurrent cardiovascular events [12]. Post MI patients with hypertension who undergo regular aerobic training along with resistance training have shown a positive influence on lowering blood pressure levels (BP), decreasing the central adiposity and also enhancement in cardiovascular health [30]**.** Post MI hypertensive patients experience a positive influence of exercise on systolic and diastolic blood pressure by reducing it by 8-12 mmhg and 4-8 mmhg respectively [33]. A combination of resistance training and aerobic exercises resulted in a 10-15% of drop in the blood pressure along with that some positive influence noted in patients with higher baseline BP [30]. High- intensity interval training had greater impact on reducing the blood pressure levels and enhancing vascular efficiency as well as cardiac efficiency as compared to moderate intensity exercise [15].

The most important component of the central obesity and cardiovascular risk is Waist-Hip ratio. With the rise in WHR there is a rise in the danger of recurrency in MI and heart failure [26]. Exercising results in mobilizing the visceral fat which leads to decrease the WHR and also enhances the metabolic function. Implementation of both aerobic exercises and resistance training for more than 12-16 weeks helps to decrease almost 3-5% of WHR [13]**.**

HIIT has proven itself to be more effective than the moderate intensity exercise. Implementation of HIIT resulted in rapid visceral fat loss and have shown significant metabolic enhancement.

Continuation of exercise on regular basis by post MI patients usually have WHR of about 0.02-0.05 units which is comparatively improved than those who are having sedentary lifestyle [20].

AIM

- To study the efficacy of structured exercise protocol on patient related outcome measures , blood pressure and waist hip ratio in post myocardial infarction subjects **with hypertension**

OBJECTIVES

- To determine the efficacy of structured exercise protocol on patient related outcome measures , blood pressure and waist hip ratio in post myocardial infarction subjects **with hypertension**
- To determine the efficacy of structured exercise protocol on patient related outcome measures , blood pressure and waist hip ratio in post myocardial infarction subjects **with hypertension**

HYPOTHESIS

- **Null hypothesis:** There will be no significant difference between structured exercise protocol and conventional physiotherapy on patient related outcome measures, blood pressure and waist hip ratio in post myocardial infarction subjects **with hypertension**
- **Alternate hypothesis:** There will be no significant difference between structured exercise protocol and conventional physiotherapyon patient related outcome measures, blood pressure and waist hip ratio in post myocardial infarction subjects **with hypertension**

2. METHODS

Study Design and Setting

This study was a randomized controlled trial (RCT) conducted at Krishna Hospital and Medical Research Center (KH&MRC), Karad, India. The study was carried out between August 2018 and May 2020 after obtaining ethical approval from the Institutional Ethics Committee of Krishna Vishwa Vidyapeeth, Krishna Institute of Medical Sciences (Deemed to be University), Karad (Ethical Approval Number: XXXX). The trial adhered to the Consolidated Standards of Reporting Trials (CONSORT) guidelines.

Participants and Eligibility Criteria

Inclusion Criteria : 1.Adults aged 40–75 years.2. Clinically diagnosed with myocardial infarction (MI) within the past months.3. blood pressure less than 180/110 mmhg 4. Medically stable and cleared by a cardiologist for exercise participation.

Exclusion Criteria : 1. Unstable angina or a recent cardiac event within the last month.2. Severe heart failure (NYHA Class III–IV).3. Uncontrolled hypertension (BP > 180/110 mmHg).4. Orthopedic or neurological conditions limiting exercise participation.5. Refusal to provide informed consent.

Randomization and Group Allocation

A computer-generated randomization sequence was used to allocate participants into one of two groups, ensuring allocation concealment:

1. Intervention Group (IG): Participants underwent a structured exercise protocol and lifestyle modification counseling..
2. Control Group (CG): Participants received standard care, including conventional physiotherapy and lifestyle modification counseling.

Intervention

The structured exercise protocol was based on cardiac rehabilitation guidelines and tailored to individual fitness levels.

Exercise Prescription for the Intervention Group

- Intensity: Determined by VO_2 max calculation. Frequency: 5 sessions per week. Duration: 60 minutes per session. Setting: Cardiorespiratory Physiotherapy Department, KH&MRC.

Exercise Prescription for the Control Group

- Type: Brisk walking. Frequency: 5 sessions per week. Duration: 30–45 minutes per session.

Outcome Measures

Assessments were conducted at **baseline (Week 0), Week 12, and Week 24**.

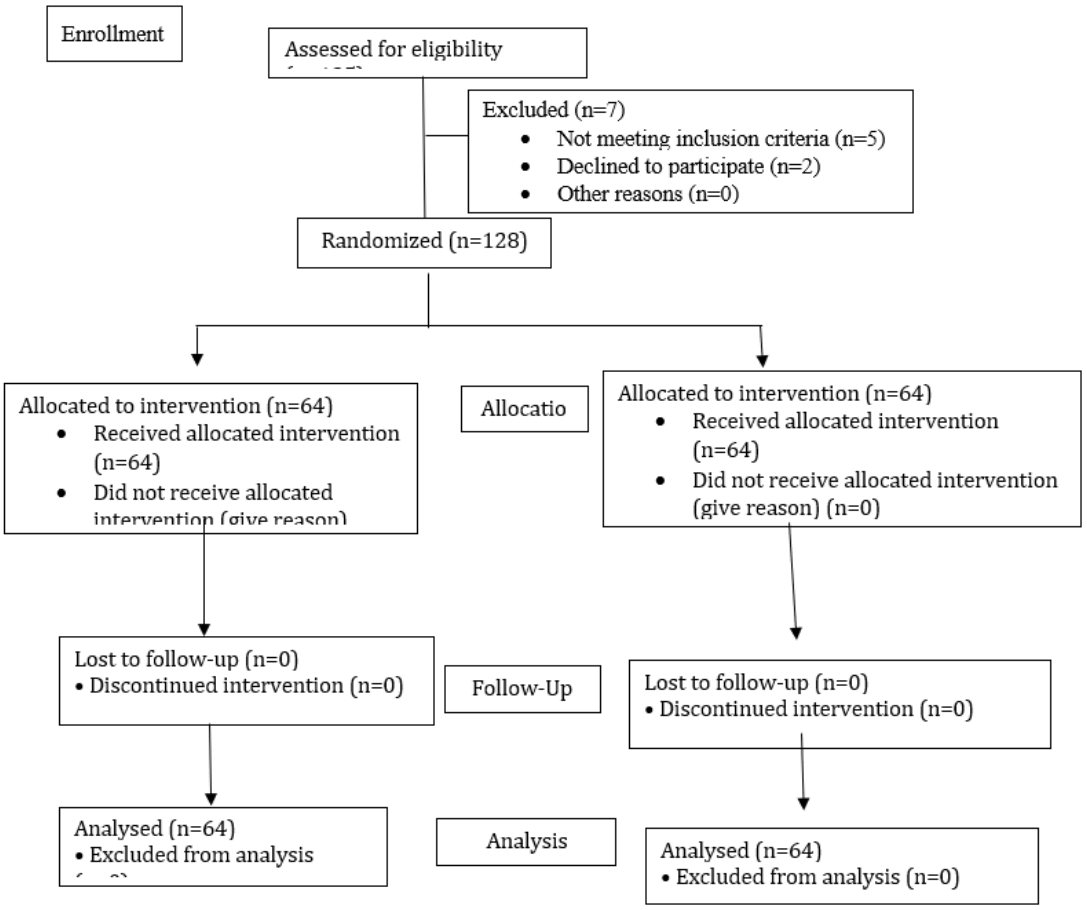
Primary Outcome Measures

1. Patient related outcome measures : Zung Anxiety Scale, becks depression inventory , Pittsburgh Sleep Quality Index,Macnew quality of life after myocardial infarction questionnaire ,Social life (ENRICHD Social Support Instrument
2. Bloop pressure : systolic and diastolic pressure measure by spygmomanometer
3. Waist-Hip Ratio (WHR): Measured using a standard inch tape.
4. Adherence and Compliance: Monitored through daily exercise logs and session attendance records.

Procedure

Before enrollment, all patients underwent a thorough functional assessment to establish baseline measures. Functional capacity was evaluated using standardized tools such as the Duke Activity Status Index (DASI) and the Shuttle Walk Test (SWT) to assess exercise tolerance and daily activity levels. Additionally, patient-related outcome measures, including anxiety, depression, and sleep quality, were assessed using validated scales like the Zung Anxiety Scale, Beck's Depression Inventory, and the Pittsburgh Sleep Quality Index. These assessments provided insight into the patients' physical and psychological status before the intervention. Evaluating these parameters helped determine individualized exercise prescriptions and monitor progress throughout the study. Establishing a comprehensive baseline ensured that any improvements could be accurately attributed to the intervention. Post intervention all the pre tested parameters were tested again and statistically analyzed .

CONSORT 2010 FLOW DIAGRAM



Data Collection and Statistical Analysis

- Blinded assessors collected data at three time points: baseline (Week 0), mid-intervention (Week 12), and post-intervention (Week 24).Continuous variables were analyzed using paired t-tests . Categorical variables were analyzed using Chi-square tests.Intention-to-treat (ITT) analysis was performed to handle missing data. Statistical significance was set at $p < 0.05$, and analyses were conducted using SPSS v.26 (IBM Corp., Armonk, NY, USA).

OVERALL DESCRIPTIVE STATISTICS

Table no 01. Baseline characteristics of overall participants of the study (n = 168)

Variables	**Frequency**	**Percentage %**
Sex		
Male	84	50.0
Female	84	50.0
Smoking		
Yes	105	62.5
No	63	37.5
ALCOHOLIC		
Yes	104	61.9
No	64	38.1

FAMILY		
Yes	103	61.3
No	65	38.7
Diseased vessel		
1	51	30.4
2	77	45.8
3	40	23.8
OBESITY		
YES	103	61.3
NO	65	38.7

OVERALL STATISTICS OF CONTINUOUS VARIABLES

Table no -02. Descriptive statistics of continuous variables (Age) expressed as mean and SD for the overall participants in this study

Variable	**Mean (95% CI)**	**SD**	**Min - Max**	**IQR**
Age	54.10(53.19-55.01)	5.962	45-65	10

Table no - 03. Descriptive statistics of Patient reported outcome measures expressed as mean and SD for the overall participants in this study

Variables	**Mean (95% CI)**	**SD**	**Min - Max**	**IQR**
Pre_Anxiety	49.43 (48.40-50.57)	6.823	35-63	7
Pre_Depression	16.10 (15.39-16.82)	4.689	9- 25	6
Pre_Sleep quality	8.74 (8.42-9.07)	2.130	5- 14	3
Pre_PF_QOL	51.53 (50.65-52.41)	5.792	41- 59	9
Pre_EW_QOL	44.36 (43.52-45.21)	5.552	30- 69	9
Pre_SF_QOL	30.49 (29.46-31.52)	6.760	16- 41	11
Pre_SES	20.89 (20.27-21.51)	4.081	11- 29	5

BIOMARKERS

Table no - 04. Descriptive statistics of investigated biomarkers expressed as mean and SD for the overall participants in this study

Variables	Mean (95% CI)	SD	Min - Max	IQR
Pre systole BP	190.13 (188.54-191.72)	10.425	175 - 220	5
Pre Daistolic BP	83.90 (82.79-85.00)	7.248	74 - 100	5
Pre -WHR	0.9801(0.9559-1.0043)	0.15885	0.81 - 1.50	0.11

Table no - 05. Baseline comparison of categorical variables (age) between groups and statistical analysis of similarity using Chi-Square test.(Categorical data)

Variables	Control Group, n(%)	Treatment group, n(%)	Chi-Square	P value
Age				
50 & less	37(44)	37(44)	O.000	1.000
Above 50	47(56)	47(56)		
sex				
Male	42(50.0%)	42(50.0%)	0..000	1.000
Female	42(50.0%)	42(50.0%)		
Smoking				
Yes	53(63.1)	52(61.9)	O.25	1.000
No	31(36.9%)	32(38.1)		
Alcoholism				
Yes	32(38.1)	52(84)	.000	1.000
No	32(38.1)	32(38.1)		
Family				
Yes	52(61.9)	51(61.7)	.025	1.000
No	32(38.1))	33(39.3)		
Diseased vessel				
1	26(31.0%)	25(29.8%)	.033	1.000

2	38(45.2%)	39(46.4%)		
3	20(23.8%)	20(23.8)		
Obesity				
Yes	52(61.9%)	51(60.7%)	0.025	1.000
No	32(38.1%)	33(39.3%)		

Baseline comparison of age between group expressed as mean (SD) and statistical analysis of similarity between the groups using independent t test.

Table no -06. Baseline between the groups (Continuous data) Age

Variable	Control Group Mean (SD)	Treatment Mean (SD)	t-value	p value
Age	54.14n(5.982)	54.06 (5.977)	0.90	0.928

Table no -07. Comparison of patient-reported outcome measures at baseline between the control and intervention groups, expressed as mean (SD) with level of significance at 0.05

Variables	Control group Mean (SD)	Treatment Mean (SD)	t-value	p value
Pre_Anxiety	50.05 (6.538)	48.82 (7.082)	1.116	0.245
Pre_Depression	16.36 (4.728)	15.85 (4.728)	0.706	0.481
Pre_Sleep quality	9.51(1.587)	7.98 (2.238)	0.4995	0.000
Pre_PF_QOL	50.15(5.299)	52.90 (5.965)	-3.159	0.02
Pre_EW_QOL	44.51(5.900)	44.21(5.211)	0.347	0.729
Pre_SF_QOL	30.51(5.211)	30.48 (5.859)	0.034	0.973
Pre_SES	21.04 (3.678)	20.74 (4.464)	0.472	0.638

Table no -8. Comparison of biomarkers value at baseline between the control and intervention groups, expressed as mean (SD) with level of significance at 0.05

Variables	Control group Mean (SD)	Treatment Mean (SD)	t-value	p value

Pre_Systole_BP	190.17(10.431)	190.10b (10.481)	0.044	0.965
Pre_Diastole_BP	83.93(7.256)	83.87(7.284)	0.053	0.958
PreWHR	.9839(0.15797)	.9762 (0.16058)	0.315	0.753

Table no -9. Within the group comparison of pre-test and post-test values of patient-reported outcome measures for control (n =84) and intervention (n =84) groups using paired t test

Groups	**Mean (SD)**		**Mean Diff (95% CI)**	**t value**	**p value**
Groups	**Pre**	**Post**			
Anxiety					
Control	50.05	40.90	8.261=10.025	20.623	0.000
Experimental	48.82	33.15	14.739-16.594	33.590	0.000
Depression					
Control	**16.63**	**10.39**	**5.561-6.368**	**29.402**	**0.000**
Experimental	**15.85**	**7.12**	**8.348 - 9.105**	**45.835**	**0.000**
Sleep quality					
Control	9.51	7.21	2.144-2.451	29.759	0.000
Experimental	7.98	4.55	3.231-3.626	34.572	0.000
PF_QOL					
Control	50.15	67.82	-18.749 - -16.584	-32.464	0.000
Experimental	52.90	80.26	-28.966 --24.749	-33.830	0.000
EW_QOL					
Control	44.51	75.29	-31.980 - 29.568	-50.759	0.000
Experimental	44.21	85.01	-42.122- -39.474	-61.287	0.000
_SF_QOL					

Control	30.51	73.77	-44.526 - -41.998	-68.093	0.000
Experimental	30.48	76.70	-47.712-44.740	-61.880	0.000
SES					
Control	21.04	28.42	-8.212 - -6.110	-17.660	0.000
Experimental	20.74	28.95	-8.867	-25.042	0.000

Table no -10. Within the group comparison of pre-test and post-test values of biomarkers value for control (n =84) and intervention (n =84) groups using paired t test

Groups	**Mean (SD)** **Pre** **post**		**Mean Diff (95% CI)**	**t value**	**p value**
Systole_BP					
Control	190.17(10.431)	148.12(16.858)	40.146-43.949	43.990	.000
Experimental	190.10(10.431)	126.18(16.858)	61.909-65.925	63.309	000
Diastole_BP					
Control	83.93(7.256)	80.77(5.863)	2.182-4.128	6.448	.000
Experimental	83.87(.16058)	80.27(2.922)	2.428 - 4.763	6.125	000
WHR					
Control	.9839(.15797)	.9292(.10013)	.03988-0.0696	7.319	.000
Experimental	.9762(.16058)	.8951(.8951)	2.428-4.763	6.621	000

Table no - 11. Comparison of post-test patient-reported outcome measures between the groups, control group versus experimental group using independent t test, the findings are expressed as mean difference (95% CI) and p value.

Variables	**Control** **Mean (SD)**	**Intervention** **Mean (SD)**	**Mean diff (95% CI)**	**t value**	**P value**
Post_Anxiety	40.90 (8.334)	33.15 (7.940)	5.270-10.230	6.170	0.000
Post_Depression	10.39 (3.415)	7.12 (4.760)	5.2705.270-4.536	5.122	0.000

Post_Sleep quality	7.21 (1.757)	4.55 (2.289)	2.045-3.288	8.471	0.000
PostPF_QOL	67.82 (8.339)	80.26 (12.304)	-15.642--9.239	-7.671	0.000
Post_EW_QOL	75.29 (9.248)	85.01 (6.899)	-12.212- -7.241	-7.726	0.000
Post_SF_QOL	73.77 (8.029)	76.70 (9.165)	-5.554-- -.303	-2.202	0.029
Post_SES	28.42 (4.294)	28.95 (3.719)	-1.760-0.688	-0.864	0.389

FIGURE NO. 1 Post-intervention Depression Scale by Group

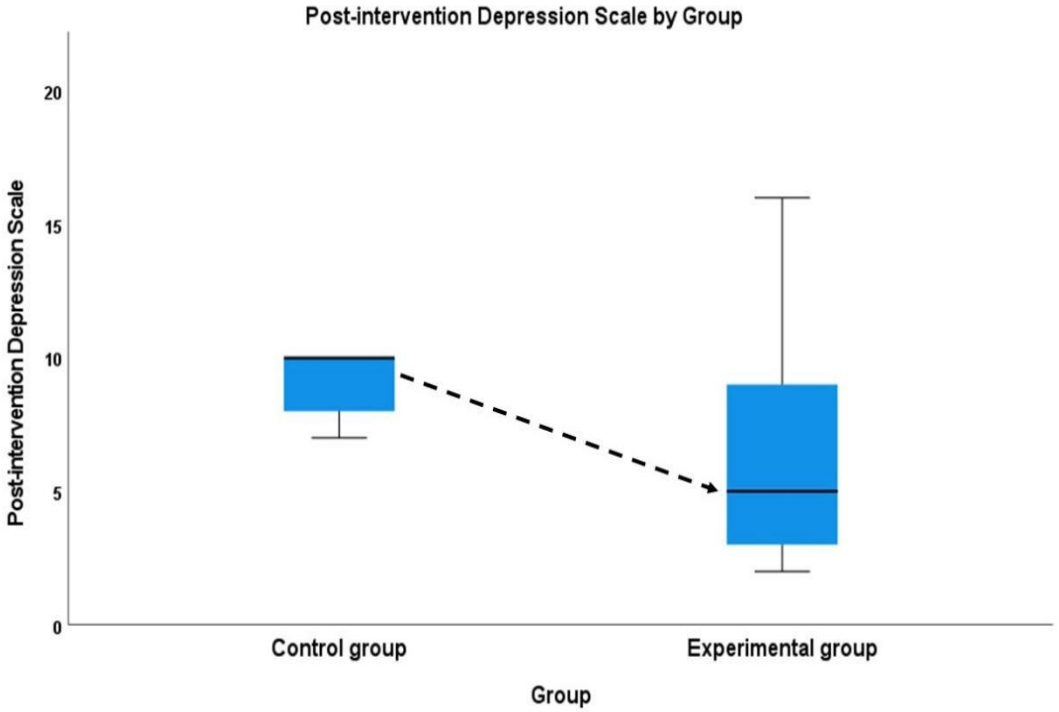


FIGURE NO. 2 Post-intervention Anxiety Scale by Group

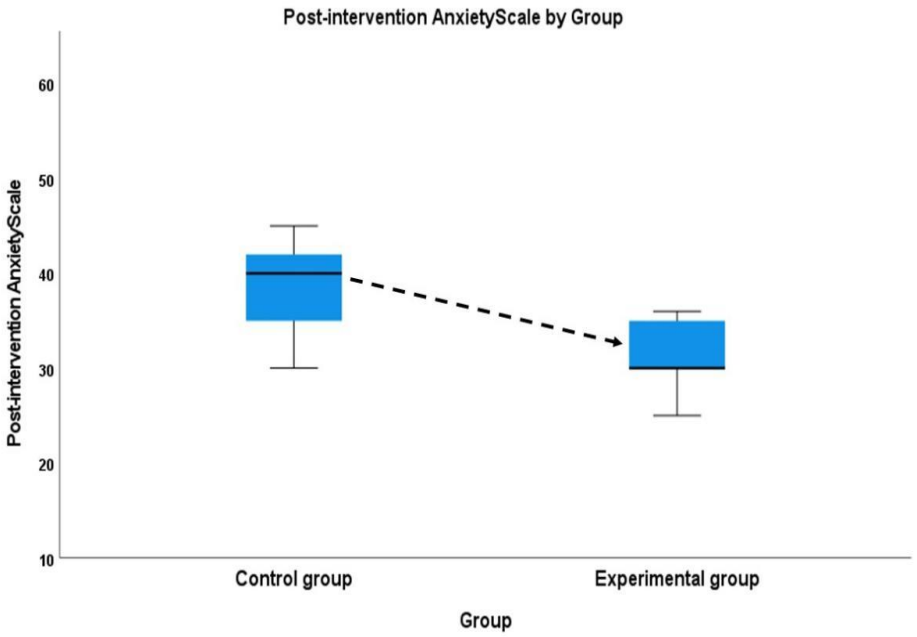


FIGURE NO. 3 Post-intervention Sleep Apnoea by Group

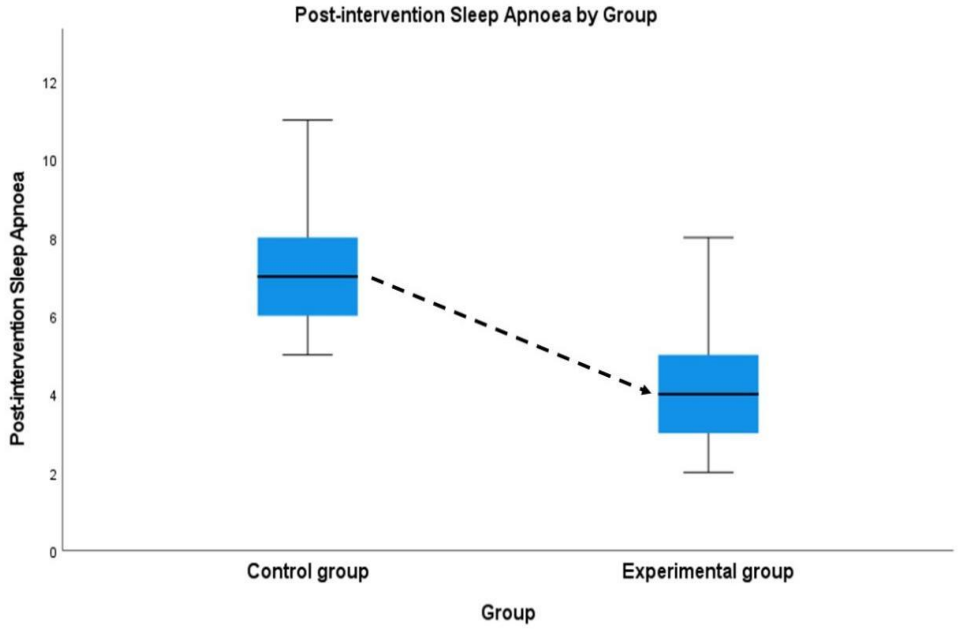


FIGURE NO. 4 Post-intervention PF Qol by Group

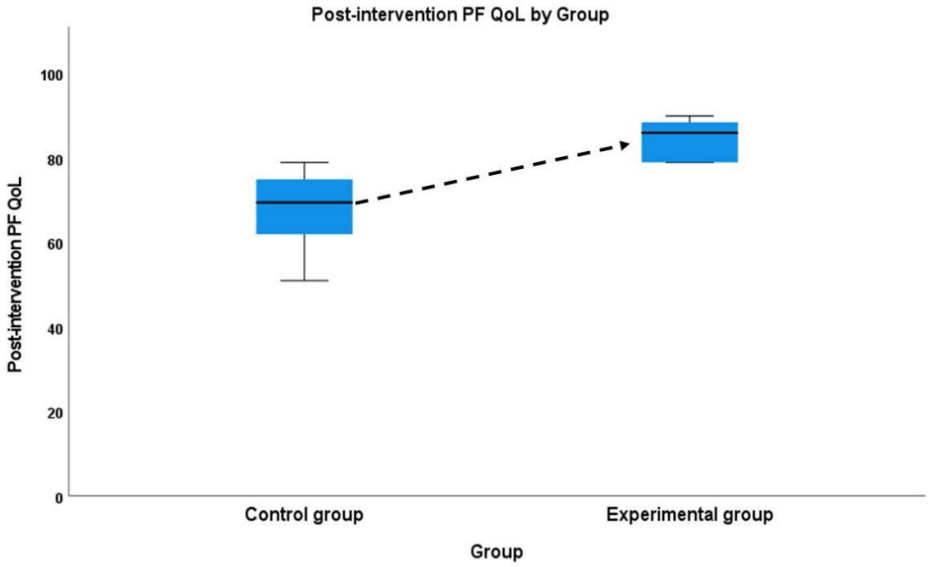


FIGURE NO. 5 Post-intervention EW QoL by Group

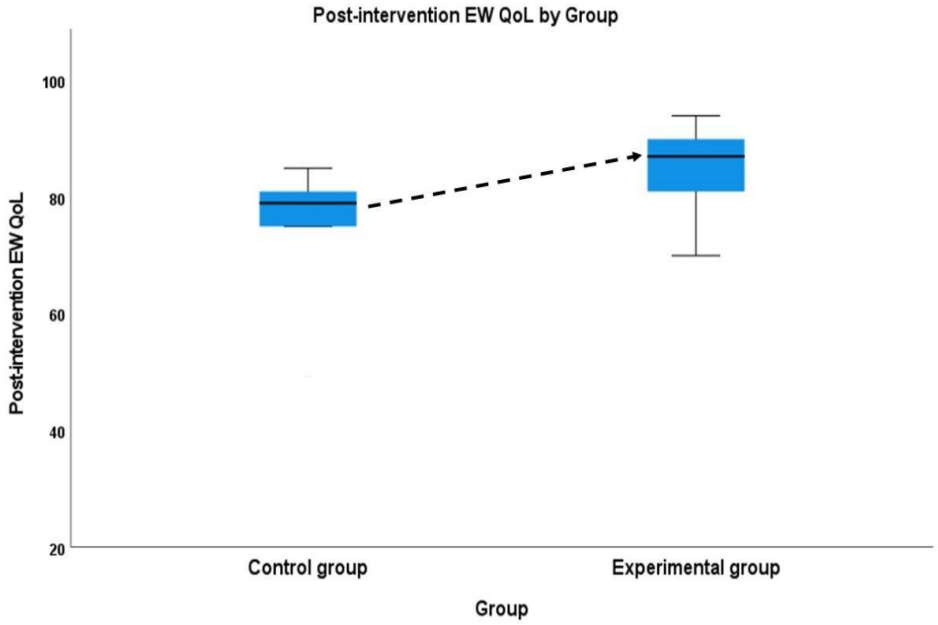


FIGURE NO. 6 Post-intervention SF QoL by Group

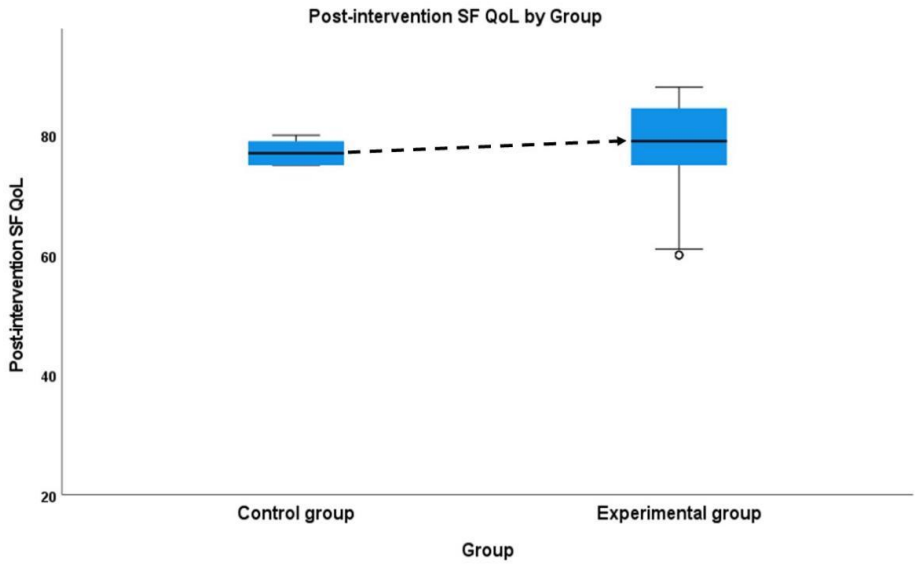


FIGURE NO. 7 Post-intervention activity status by Group

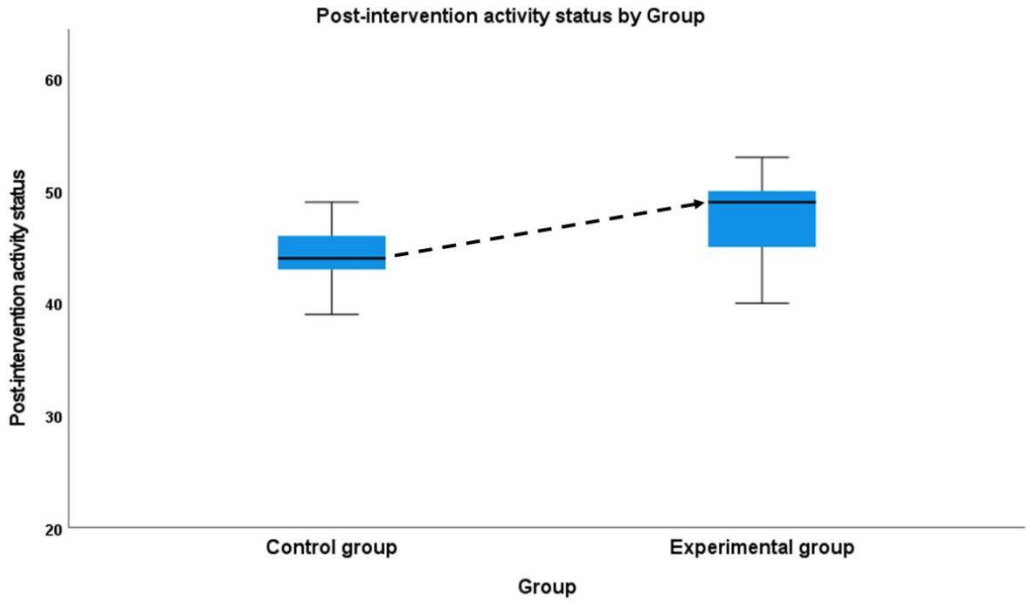


Table no - 12. Comparison of post-test biomarkers value between the groups, control group versus experimental group using independent t test, the findings are expressed as mean difference (95% CI) and p value.

Study Findings and Statistical Analysis	Control Mean (SD)	Intervention Mean (SD)	Mean diff (95% CI)	t value	P value
Post_Systole_BP	148.12(16.858)	126.18(9.223)	17.801-26.080	10.465	0.000

Post_Diastole_BP	80.77(5.863)	80.27 (2.922)	-.911-1.911	0.700	0.485
post_WHR	.9292(.100. 13	.8951(.06552)	.00827-0.5983	2.608	0.70

FIGURE NO. 8 Post-intervention Systolic BP by Group

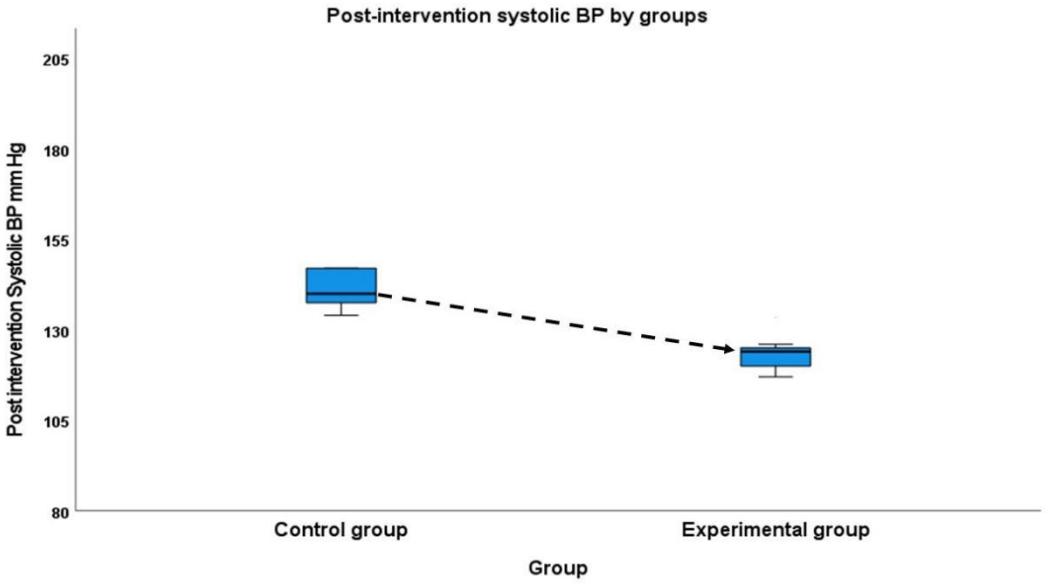


FIGURE NO. 9 Post-intervention Diastolic BP by Group

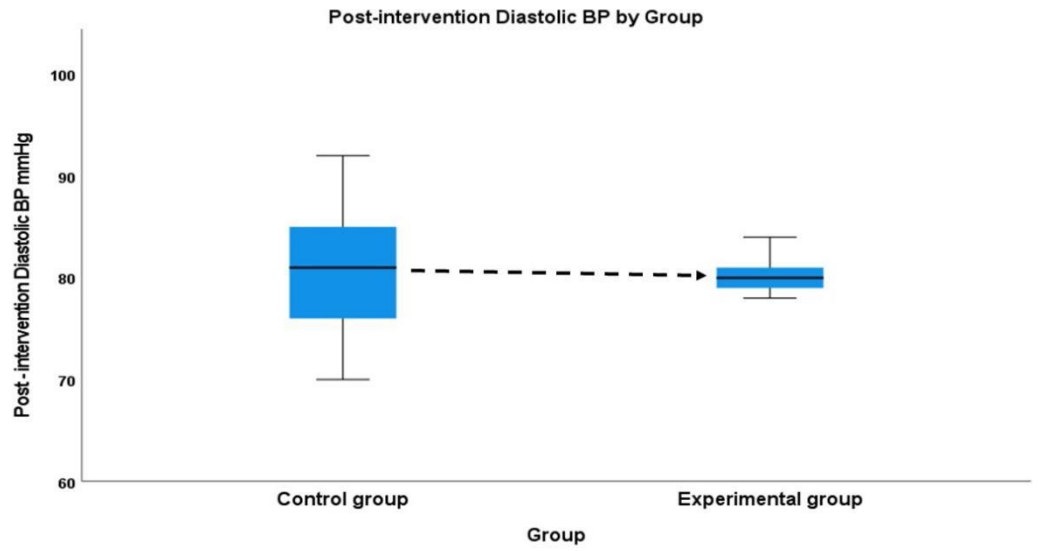
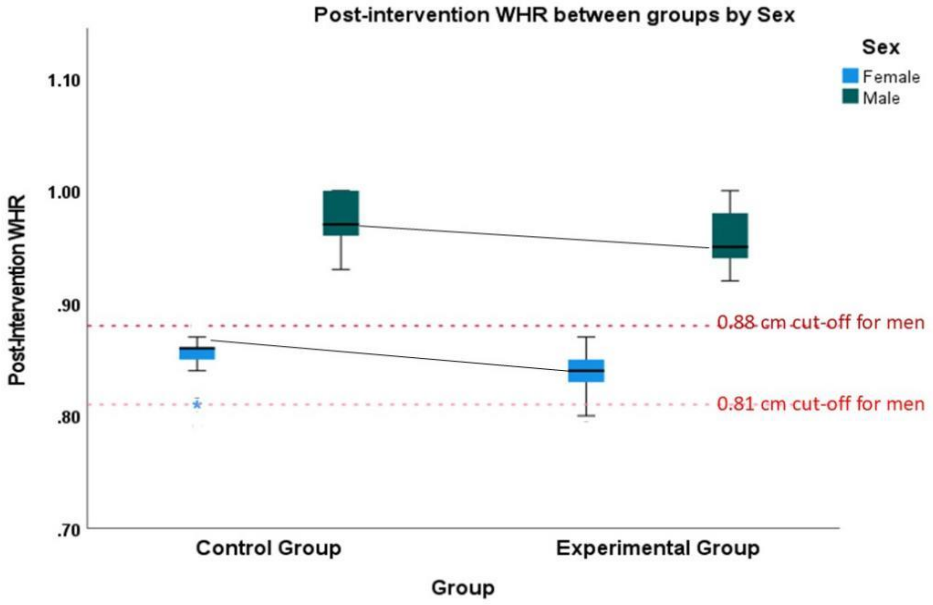


FIGURE NO. 10 Post-intervention WHR between Groups by Sex



3. DISCUSSION

The prevalence of a study of smoking and alcohol consumption was 62.5% and 61.9% respectively was comparatively very high and showcased that sedentary lifestyle habits predominantly contribute to the increase in cardiovascular risk (Li, et al. 2022) [39]. A study performed highlighted a significant connection between obesity with metabolic syndromes and cardiovascular diseases (Lavie, C. J., et al. (2020)) [40].

The prerequisites among the interventional group and the controlled group showed a difference of $p > 0.05$, not highlighting any major difference, estimating that potential confounders were effectively well managed and balanced by randomization. By this, the outcomes of post-intervention highly influenced internal validity by strengthening and reducing the biases. Before implementing the intervention, the anxiety and depression scores were notably very high. The mean pre-anxiety and pre-depression score were calculated which was 49.43% and 16.10% respectively. After implementing the interventions, both the interventions highlighted a drastic drop. But the experimental group on the other hand showed a phenomenal improvement in post- anxiety and post-depression scores which was $\Delta=14.739$, $p<0.001$ and $\Delta=8.348$, $p<0.001$ respectively.

Exercise showed a positive influence on anxiety and depression by the means of the various pathways which consists of neurochemical regulation by experiencing a rise in serotonin and endorphins, automatic modulation as well as social interaction benefits. This results also enlightened those studies who practiced tailored exercise protocols in post-myocardial infarction patients, helping in managing and reducing the psychological distress (Lobello et al, 2017) [41]. Also, in another systematic review performed among CVD patients, it ensures that aerobic exercises along with the resistance training showed a positive influence on reducing depressive symptoms by rising the neuroplasticity and the inflammatory marker levels (Schuch et al, 2021) [42].

Before implementing the intervention, the mean was calculated to check the severity of sleep apnea which was 9.51, comparatively very high in the controlled group than in the experimental group which was 7.98. But post-intervention the experimental group had a positive influence on its result which was $\Delta=3.231$, $p<0.001$. Post MI patients generally have very poor sleep quality which further have some negative influence on the autonomic function, sympathetic activity as well as on the respiratory functioning. Application of the tailored exercise helps to reduce the negative effects on various systems by improving vagal tone and by enhancing the in general cardiovascular health and its functioning.

In a similar study, the groups were assessed on the basis of Physical Functioning (PF-QOL), Emotional Well-being (EW-QOL), and Social Functioning (SF-QOL) and both the groups highlighted positive influence. Also, huge positive influence was noted in the experimental group. In some studies, cardiac rehabilitation showed a significant rise in the quality of life. Here, it signifies that more physical activity results in more improvement of the self-efficacy along with the drop in fatigue levels and improvement in the psychological resilience (Anderson L, et al. 2016) [43].

Implementation of the interventions in both groups resulted in a drastic drop in the systolic blood pressure levels as well as in the diastolic blood pressure levels. But the experimental group comparatively showed more decline in the systolic blood

pressure levels and the diastolic blood pressure level which was Δ=63.309 mmHg, p<0.001 and Δ=40.146 mmHg, p<0.001 respectively. This study suggests that according to a meta-analysis, tailored exercise protocols help in lowering the blood pressure levels by enhancing various activities such as endothelial function, reducing arterial stiffness and also improving the nitric oxide availability (Cornelissen, et. al. 2013) [44].

This study also indicates that the tailored interventions had a positive effect on the systolic blood pressure levels as it had an impact on the arterial compliance and the peripheral resistance while the diastolic level did not show a major drop which was Δ=2.428, p=0.485.

Implementing the intervention in both the groups resulted in a drastic drop in the WHR which was p<0.001 as an effect of the tailored exercise specially seen on the adiposity reduction. Also, the study stated that reduced WHR has a clear relation with the enhanced metabolic health and simultaneous reduction in the cardiovascular risk. To achieve certain required body composition, more specifically for visceral fat reduction, resistance training and aerobic exercises are practiced. This suggests that there is a direct correlation between metabolic health and the cardiovascular health (Després, J. P. et. al. 2021). [45].

A study introduced the Biopsychological model that enumerated the effect of the tailored exercises on various factors including biological factors such as BP and WHR, psychological factors such as anxiety and depression as well as on the social factors such as quality of life. This enumerated the need and significance of the holistic rehabilitation programs (Egan, B. M., et al. 2022) [46].

Also, a study performed on Self-Efficacy Theory, in the year 1997, stated that significant improvement is seen in the self-efficacy after exercise, inspiring patients to practice healthier behaviors, continuing the rehabilitation program along with acknowledging the improvement in their health status (Schuch, F. B, et. al. 2019) [47].

According to the Anti-inflammatory Hypothesis suggested in a study, in the year 2011, implementation of the exercise in day-to-day life has shown a reduction in inflammatory markers such as CRP, TNF- α, reducing the chronic low-grade inflammation usually highlighted in the cardiovascular disease as well as in depression (Miller, et al. 2021) [48].

According to a systematic review performed in the year 2020, the mortality risk in the post-MI patients reduced by 26% after the implementation of the exercise-based rehabilitation. This highlights the significance of tailored exercise programs in secondary prevention [49].

Also, a study conducted in the year 2016, concluded that there is a positive influence on the QOL as well as on the psychological well-being due to cardiac rehabilitation which shows a good congruency with the current study (Anderson L, Thompson DR, Oldridge N, et al.) [43].

In the year 2019, a study performed stated that physical activity showcased a positive influence on the severity of the depression by the means of neurogenesis as well as by stress regulation. The above statement supports the positive influence on the depression scores (Schuch, F. B, et. al. 2019) [47].

Also, the improvement in the sleep apnea scores was observed in the current study after implementation of the intervention which is also supported by the results of a study performed in the year 2021 which stated that tailored exercise protocol significantly helped in the enhancement of sleep quality (Miller, et al. 2021). [48].

4. LIMITATIONS AND FUTURE DIRECTIONS

Although there are remarkable results, yet the study has some limitations. In order to assess the sustainability of the improvements the longitudinal studies proves itself to be necessary. Additionally, to enlighten the physiological mechanisms, future research should concentrate more on including inflammatory and metabolic markers as well. Although groups were well-matched at baseline, larger multi-center trials would enhance generalizability.

5. CONCLUSION

The results enumerated in this study enlightens that post MI patients show a positive impact on various aspects of health such as enhancement of functional capacity, maintaining psychological wellbeing as well as on the cardiovascular health after undergoing a tailored exercise protocol. The interventions implemented resulted in remarkable drop in anxiety, depression, blood pressure as well as on the sleep disturbances. This supports the effectiveness of the tailored exercise in cardiac rehabilitation programs. Future research should concentrate more on recognizing strategies to promote long-term adherence and reveling the underlying mechanisms that contribute to the above health benefits

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