Effect Of Cardiopulmonary Rehabilitation In Addition With Group Training As Biofeedback In Post-CABG Middle-Aged Male Patients

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Abstract: Coronary Artery Bypass Graft (CABG) surgery is a widely performed procedure aimed at improving blood flow to the heart in patients with severe coronary artery disease. While the surgery is often successful in alleviating symptoms and reducing the risk of heart attacks, patients frequently face significant post-operative challenges. These challenges include reduced lung volumes, decreased oxygenation, and other pulmonary complications that can hinder recovery and prolong hospital stays. Cardiopulmonary rehabilitation is a critical component of post-operative care, designed to enhance recovery, improve functional capacity, and promote overall well-being. This study investigates the effectiveness of combining standard cardiopulmonary rehabilitation with group training and biofeedback in improving recovery outcomes for post-CABG middle-aged male patients.

Objectives - The primary objective of this study is to evaluate the impact of group training combined with biofeedback on functional exercise capacity, as measured by the Six-Minute Walk Test (6MWT), in post-CABG patients. Secondary objectives include assessing the effects of the combined intervention on VO2 Max, heart rate, dyspnea scores, pain levels, and health-related quality of life. Additionally, the study aims to compare the outcomes between patients receiving standard cardiopulmonary rehabilitation and those receiving additional group training.

Methods - This quasi-experimental study was conducted in hospitals located in Greater Noida. The study involved 60 middle-aged male patients who had undergone CABG surgery. Participants were divided into two groups of 30 each. Group 1 received standard cardiopulmonary rehabilitation, while Group 2 received cardiopulmonary rehabilitation with additional group training. The intervention lasted for 2 weeks, with sessions held three times a week. Each session included warm-up exercises, aerobic exercises, resistance training, breathing exercises, and educational sessions. Group 2 also participated in group activities and biofeedback sessions.

Results- Both groups showed significant improvements in functional exercise capacity, as measured by the Six-Minute Walk Test (6MWT). Group 2 exhibited a greater increase in the distance walked compared to Group 1, indicating the added benefit of group training. Cardiovascular fitness, assessed through VO2 Max, improved in both groups, although the differences between the groups were not statistically significant. Pain levels, measured by the Visual Analog Scale (VAS), decreased significantly in both groups post-intervention, with no significant difference between the groups. Dyspnea scores were significantly reduced in both groups, with Group 2 experiencing greater improvements. The SF-36 Health Survey scores, which assess health-related quality of life, improved significantly in both groups, with Group 2 showing a more substantial increase. The duration of hospital stay did not differ significantly between the two groups.

Conclusion - The study demonstrates that adding group training to standard cardiopulmonary rehabilitation significantly enhances functional exercise capacity, reduces dyspnea, and improves the quality of life in post-CABG middle-aged male patients. While both rehabilitation methods effectively improve cardiovascular fitness and manage pain, group training offers additional benefits through social support and motivation, leading to superior outcomes in specific areas. These findings underscore the value of incorporating group-based interventions and biofeedback into rehabilitation programs for cardiac patients, promoting holistic recovery and improved long-term health outcomes.

Index Terms - CABG, cardiopulmonary rehabilitation, group training, biofeedback, functional exercise capacity, VO2 Max, dyspnea, pain management, quality of life.

I. INTRODUCTION

Cardiopulmonary rehabilitation is a critical component of post-operative care for patients who have undergone Coronary Artery Bypass Graft (CABG) surgery(1). CABG is a common procedure performed to alleviate symptoms of coronary artery disease (CAD), which involves severe narrowing or blockage of coronary arteries. During CABG, a healthy blood vessel is taken from another part of the patient's body and grafted onto the coronary artery to bypass the blocked segment, thereby restoring adequate blood flow to the heart muscle(2). The immediate post-operative period is crucial, as patients are at risk of developing complications such as atelectasis (partial collapse of the lung), reduced lung volumes, decreased oxygenation, and other pulmonary dysfunctions. These complications are attributed to factors such as anesthesia effects, pain, restricted thoracic movement, and prolonged bed rest. Consequently, post-operative recovery involves addressing these pulmonary complications to ensure optimal patient outcomes(3).

Chest physiotherapy is widely employed as a preventive and therapeutic measure to mitigate pulmonary complications following CABG surgery(4). Traditional chest physiotherapy techniques include breathing exercises, coughing techniques, early mobilization, and the use of mechanical devices like incentive spirometers, continuous positive airway pressure (CPAP), and intermittent positive pressure breathing (IPPB). These interventions aim to improve lung expansion, enhance mucociliary clearance, and ultimately boost pulmonary function. Despite the routine use of these techniques, the evidence supporting their efficacy is inconsistent. Some studies have demonstrated beneficial effects, while others have found minimal or no significant impact. This variation underscores the need for continuous evaluation and optimization of rehabilitation protocols to ensure they effectively meet the needs of post-CABG patients(5).

In recent years, group training has emerged as a promising approach in various rehabilitation settings, including cardiopulmonary rehabilitation. Group training involves delivering rehabilitation exercises and interventions to multiple patients simultaneously, fostering a sense of community and mutual support. This approach offers several advantages. Firstly, group sessions can be more cost-effective than individual sessions, as they require fewer resources and personnel per patient. Secondly, being part of a group can enhance patients' motivation to participate actively in rehabilitation exercises. The social interaction and peer support provided in group settings can reduce feelings of isolation and encourage adherence to the rehabilitation program. Lastly, group training has been shown to be an effective tool for promoting behavior change. It provides a platform for sharing information, discussing common challenges, and collectively finding solutions. This environment can be particularly beneficial for patients who may feel hesitant to ask questions or express concerns in one-on-one sessions.

Biofeedback therapy is a non-invasive technique that enables individuals to gain control over involuntary physiological functions such as heart rate, muscle tension, and blood pressure. By using sensors to monitor these functions, the therapy provides real-time feedback through visual, auditory, or tactile signals. This feedback helps individuals recognize how their body responds to different thoughts, feelings, and behaviors, allowing them to learn control strategies. Commonly used for managing chronic pain, stress, anxiety, and various physical conditions, biofeedback therapy empowers individuals to improve their health and well-being without relying on medication.

This study aims to fill this gap by investigating whether group training, when used as a biofeedback tool, can yield better results in improving pulmonary outcomes (atelectasis, weaning of oxygen, and length of hospital stay) compared to individual training.

Methodology

A quasi-experimental study was conducted to compare the effects of two types of rehabilitation: cardiopulmonary rehabilitation alone versus cardiopulmonary rehabilitation with group training. The independent variable was the type of rehabilitation, while the dependent variables included the Six-Minute Walk Test, VO2 Max, heart rate, SF-36 Health Survey, Visual Analog Scale (VAS), and dyspnea score.

The study took place in a hospital setting, focusing on middle-aged male patients who had undergone Coronary Artery Bypass Graft (CABG) surgery. CABG is a common surgical procedure used to alleviate symptoms of coronary artery disease by grafting a healthy blood vessel onto a blocked coronary artery to restore blood flow to the heart muscle. The post-operative period following CABG is critical as patients often face challenges related to their cardiopulmonary function, including reduced lung volumes, diminished oxygenation, and the risk of complications such as atelectasis.

The target population for this study comprised male patients aged between 40 and 60 years who had undergone CABG surgery. This demographic was selected to focus on individuals who are particularly susceptible to post-operative cardiopulmonary complications and can significantly benefit from targeted rehabilitation programs. Focusing exclusively on male patients helps eliminate gender-related physiological and psychological differences that could confound the study results. By narrowing the target population to males, the study aimed to achieve more consistent and comparable data, enhancing the reliability of the findings.

This study targeted patients in hospitals located in Greater Noida, known for its advanced medical facilities and specialized cardiac care units. The choice of this location was strategic, ensuring access to a pool of patients meeting the inclusion criteria and receiving care in well-equipped hospitals with experienced medical staff. These hospitals provided a conducive environment for implementing and monitoring the rehabilitation programs under study.

Result

TABLE NO 1 – SHOWS THE DEMOGRAPHIC DETAILS OF THE SUBJECTS

	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
AGE	1	28	49.21	6.596	1.247	0.829
	2	30	49.57	5.770	1.053	
WEIGHT	1	28	64.75	12.756	2.411	0.931
	2	30	64.43	14.943	2.728	
HEIGHT	1	28	172.18	8.481	1.603	0.983
	2	30	172.13	7.445	1.359	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 1 presents the demographic details of the subjects, categorized into two groups: Group 1, consisting of participants undergoing cardiopulmonary rehabilitation, and Group 2, comprising individuals undergoing cardiopulmonary rehabilitation along with group training. The table displays the number of participants (N), mean values, standard deviation, standard error mean, and corresponding p-values for each demographic variable. For age, there was no statistically significant difference between Group 1 (mean age = 49.21 years) and Group 2 (mean age = 49.57 years), with p = 0.829. Similarly, there were no significant differences in weight (Group 1: mean = 64.75 kg, Group 2: mean = 64.43 kg, p = 0.931) or height (Group 1: mean = 172.18 cm, Group 2: mean = 172.13 cm, p = 0.983) between the two groups.Overall, Table 1 indicates comparable

demographic characteristics between the two groups undergoing different rehabilitation interventions, suggesting that any observed differences in outcomes between the groups are less likely to be influenced by variations in age, weight, or height.

TABLE NO 2 – SHOWS THE DURATION IN HOSPITAL OF THE SUBJECTS

	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
DURATION IN HOSPITAL	1	28	64.32	23.761	4.490	0.088
	2	30	81.80	24.774	4.523	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 2 presents the duration of hospitalization for the subjects, categorized into two groups: Group 1, comprising participants undergoing cardiopulmonary rehabilitation, and Group 2, consisting of individuals undergoing cardiopulmonary rehabilitation along with group training. The table includes the number of participants (N), mean duration of hospitalization, standard deviation, standard error mean, and corresponding p-values for each group. The mean duration of hospitalization for Group 1 was 64.32 days, with a standard deviation of 23.761, while for Group 2, it was 81.80 days, with a standard deviation of 24.774. Although there appears to be a numerical difference in the mean duration between the two groups, the difference was not statistically significant ($p = 0.088$). Therefore, based on the findings presented in Table 2, there was no statistically significant difference in the duration of hospitalization between participants undergoing cardiopulmonary rehabilitation alone and those receiving additional group training as part of their rehabilitation regimen.
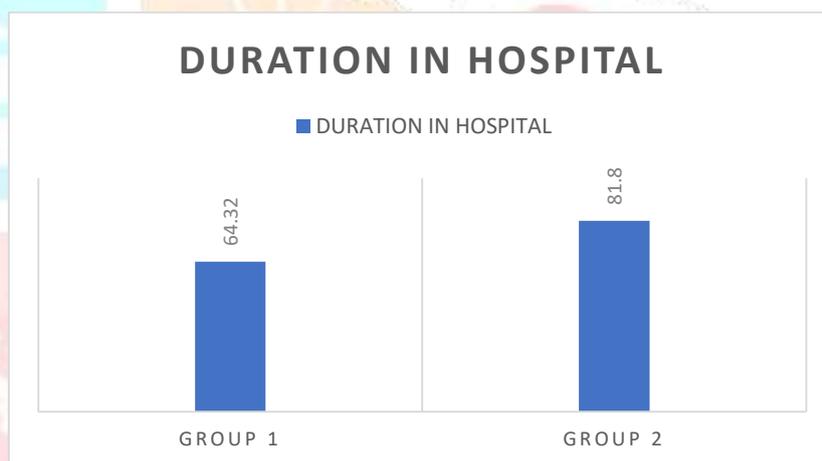
**TABLE NO 3 – SHOWS THE SIX-MINUTE WALK TEST SCORE OF THE SUBJECTS**

	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
Six-Minute Walk Test Pre	1	28	127.75	36.994	6.991	0.862
	2	30	126.07	36.368	6.640	
Six-Minute Walk Test Post	1	28	201.29	29.975	5.665	0.030
	2	30	223.13	43.925	8.020	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 3 presents the Six-Minute Walk Test scores of the subjects before and after the intervention, categorized into two groups: Group 1, consisting of participants undergoing cardiopulmonary rehabilitation, and Group 2, comprising individuals undergoing cardiopulmonary rehabilitation along with group training. The table includes the number of participants (N), mean scores, standard deviation, standard error mean, and corresponding p-values for each group and test phase.For the Six-Minute Walk Test scores before the intervention (Six-Minute Walk Test Pre), the mean score for Group 1 was 127.75 meters, with a standard deviation of 36.994, while for Group 2, it was 126.07 meters, with a standard deviation of 36.368. There was

no statistically significant difference between the two groups (p = 0.862).After the intervention (Six-Minute Walk Test Post), the mean score for Group 1 increased to 201.29 meters, with a standard deviation of 29.975, while for Group 2, it increased to 223.13 meters, with a standard deviation of 43.925. Importantly, there was a statistically significant difference between the two groups post-intervention (p = 0.030).

Therefore, based on the findings presented in Table 3, participants in both groups showed improvements in Six-Minute Walk Test scores after the intervention. However, the group receiving additional group training as part of their rehabilitation regimen (Group 2) demonstrated significantly greater improvement compared to those undergoing cardiopulmonary rehabilitation alone (Group 1).

SIX-MINUTE WALK TEST SCORE

PRE   POST

	GROUP 1		GROUP 2	
PRE	127.75		127.07	
POST		201.29		223.13
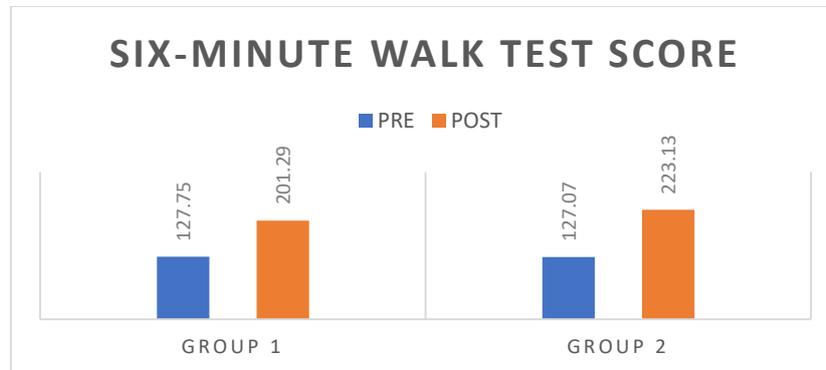
TABLE NO 4 – SHOWS VO2 MAX SCORE OF THE SUBJECTS

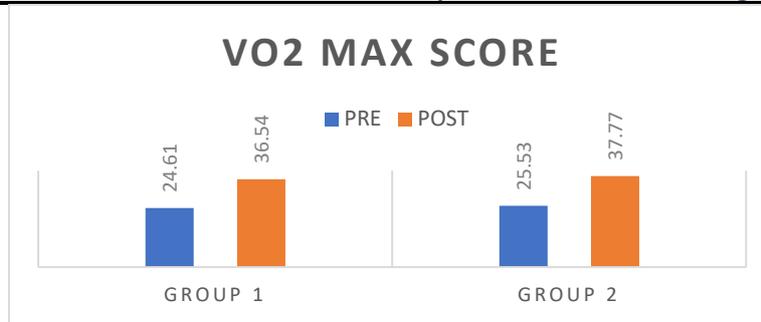|	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
VO2 MAX PRE	1	28	24.61	2.820	.533	0.186
	2	30	25.63	3.023	.552	
VO2 MAX POST	1	28	36.54	4.985	.942	0.343
	2	30	37.77	4.826	.881	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 4 displays the VO2 max scores of the subjects before and after the intervention, categorized into two groups: Group 1, comprising participants undergoing cardiopulmonary rehabilitation, and Group 2, consisting of individuals undergoing cardiopulmonary rehabilitation along with group training. The table includes the number of participants (N), mean scores, standard deviation, standard error mean, and corresponding p-values for each group and test phase.

For the VO2 max scores before the intervention (VO2 MAX PRE), the mean score for Group 1 was 24.61 ml/kg/min, with a standard deviation of 2.820, while for Group 2, it was 25.63 ml/kg/min, with a standard deviation of 3.023. There was no statistically significant difference between the two groups pre-intervention (p = 0.186).

After the intervention (VO2 MAX POST), the mean score for Group 1 increased to 36.54 ml/kg/min, with a standard deviation of 4.985, while for Group 2, it increased to 37.77 ml/kg/min, with a standard deviation of 4.826. However, there was no statistically significant difference between the two groups post-intervention (p = 0.343).

Therefore, based on the findings presented in Table 4, both groups showed improvements in VO2 max scores after the intervention, but the difference between the two groups was not statistically significant. This suggests that the addition of group training to cardiopulmonary rehabilitation did not result in significantly greater improvements in VO2 max compared to cardiopulmonary rehabilitation alone.

VO2 MAX SCORE

PRE   POST

GROUP 1: 24.61 (PRE), 36.54 (POST)
GROUP 2: 25.53 (PRE), 37.77 (POST)

TABLE NO 5 – SHOWS HEART RATE SCORE OF THE SUBJECTS

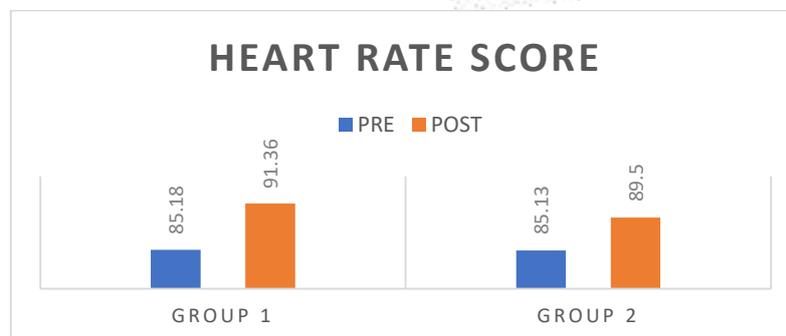|	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
HEART RATE PRE	1	28	85.18	2.776	.525	0.954
	2	30	85.13	3.126	.571	
HEART RATE POST	1	28	91.36	6.057	1.145	0.235
	2	30	89.50	5.722	1.045	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 5 presents the heart rate scores of the subjects before and after the intervention, categorized into two groups: Group 1, comprising participants undergoing cardiopulmonary rehabilitation, and Group 2, consisting of individuals undergoing cardiopulmonary rehabilitation along with group training. The table includes the number of participants (N), mean scores, standard deviation, standard error mean, and corresponding p-values for each group and test phase.

For the heart rate scores before the intervention (HEART RATE PRE), the mean score for Group 1 was 85.18 bpm (beats per minute), with a standard deviation of 2.776, while for Group 2, it was 85.13 bpm, with a standard deviation of 3.126. There was no statistically significant difference between the two groups pre-intervention ($p = 0.954$).

After the intervention (HEART RATE POST), the mean score for Group 1 increased to 91.36 bpm, with a standard deviation of 6.057, while for Group 2, it increased to 89.50 bpm, with a standard deviation of 5.722. However, there was no statistically significant difference between the two groups post-intervention ($p = 0.235$).

Therefore, based on the findings presented in Table 5, both groups showed increases in heart rate after the intervention, but the difference between the two groups was not statistically significant. This suggests that the addition of group training to cardiopulmonary rehabilitation did not result in significantly different heart rate responses compared to cardiopulmonary rehabilitation alone.

HEART RATE SCORE

PRE   POST

GROUP 1: 85.18 (PRE), 91.36 (POST)
GROUP 2: 85.13 (PRE), 89.5 (POST)

TABLE NO 6 – SHOWS THE SF-36 HEALTH SURVEY SCORE OF THE SUBJECTS

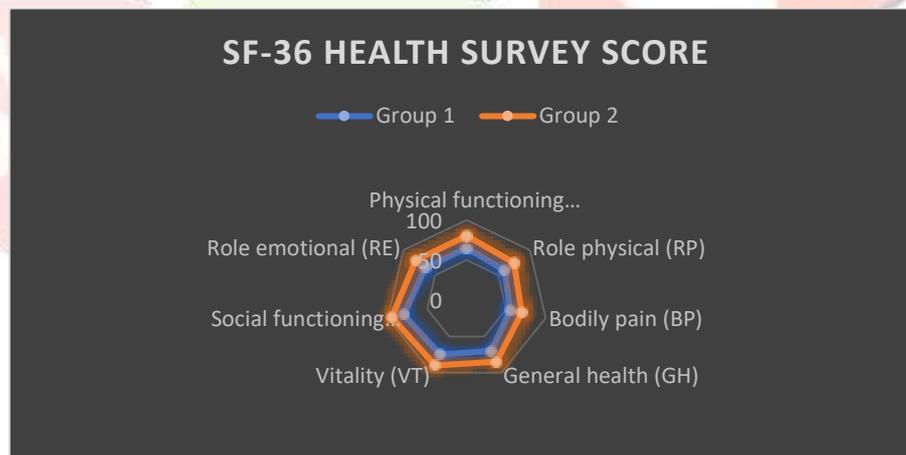|	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
SF-36 Health Survey PRE	1	28	56.68	9.169	1.733	0.555
	2	30	55.33	8.083	1.476	
SF-36 Health Survey POST	1	28	61.29	13.521	2.555	0.004
	2	30	71.57	12.646	2.309	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 6 presents the SF-36 Health Survey scores of the subjects before and after the intervention, categorized into two groups: Group 1, comprising participants undergoing cardiopulmonary rehabilitation, and Group 2, consisting of individuals undergoing cardiopulmonary rehabilitation along with group training. The table includes the number of participants (N), mean scores, standard deviation, standard error mean, and corresponding p-values for each group and test phase.

For the SF-36 Health Survey scores before the intervention (SF-36 Health Survey PRE), the mean score for Group 1 was 56.68, with a standard deviation of 9.169, while for Group 2, it was 55.33, with a standard deviation of 8.083. There was no statistically significant difference between the two groups pre-intervention (p = 0.555).

After the intervention (SF-36 Health Survey POST), the mean score for Group 1 increased to 61.29, with a standard deviation of 13.521, while for Group 2, it increased to 71.57, with a standard deviation of 12.646. Importantly, there was a statistically significant difference between the two groups post-intervention (p = 0.004).

Therefore, based on the findings presented in Table 6, both groups showed improvements in SF-36 Health Survey scores after the intervention, but the group receiving additional group training as part of their rehabilitation regimen (Group 2) demonstrated significantly greater improvement compared to those undergoing cardiopulmonary rehabilitation alone (Group 1).

TABLE NO 7 – SHOWS THE VISUAL ANALOG SCALE SCORE OF THE SUBJECTS

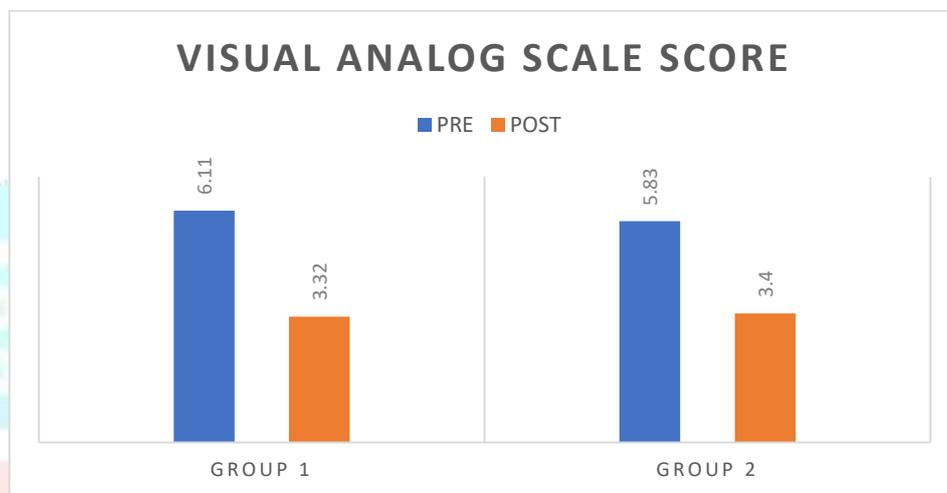|	GROUP	N	Mean	Std. Deviation	Std. Error Mean	P VALUE
Visual Analog Scale (VAS) PRE	1	28	6.11	1.286	.243	0.427
	2	30	5.83	1.315	.240	
Visual Analog Scale (VAS) POST	1	28	3.32	1.056	.200	0.786
	2	30	3.40	1.133	.207	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 7 displays the Visual Analog Scale (VAS) scores of the subjects before and after the intervention, categorized into two groups: Group 1, comprising participants undergoing cardiopulmonary rehabilitation, and Group 2, consisting of individuals undergoing cardiopulmonary rehabilitation along with group training. The table includes the number of participants (N), mean scores, standard deviation, standard error mean, and corresponding p-values for each group and test phase.

For the VAS scores before the intervention (VAS PRE), the mean score for Group 1 was 6.11, with a standard deviation of 1.286, while for Group 2, it was 5.83, with a standard deviation of 1.315. There was no statistically significant difference between the two groups pre-intervention (p = 0.427).

After the intervention (VAS POST), the mean score for Group 1 decreased to 3.32, with a standard deviation of 1.056, while for Group 2, it decreased to 3.40, with a standard deviation of 1.133. However, there was no statistically significant difference between the two groups post-intervention (p = 0.786).

Therefore, based on the findings presented in Table 7, both groups showed reductions in VAS scores after the intervention, indicating decreased pain levels. However, the difference between the two groups was not statistically significant, suggesting that the addition of group training to cardiopulmonary rehabilitation did not result in significantly different pain reduction outcomes compared to cardiopulmonary rehabilitation alone.

TABLE NO 8 – SHOWS THE PRE AND POST-SCORE OF THE SUBJECTS OF GROUP 1

		Mean	N	Std. Deviation	Std. Error Mean	P VALUE
Pair 1	Six-Minute Walk Test Pre	127.75	28	36.994	6.991	P<0.005
	Six-Minute Walk Test Post	201.29	28	29.975	5.665	
Pair 2	VO2 MAX PRE	24.61	28	2.820	.533	P<0.005
	VO2 MAX POST	36.54	28	4.985	.942	
Pair 3	HEART RATE PRE	85.18	28	2.776	.525	P<0.005
	HEART RATE POST	91.36	28	6.057	1.145	
Pair 4	SF-36 Health Survey PRE	56.68	28	9.169	1.733	P<0.005
	SF-36 Health Survey POST	61.29	28	13.521	2.555	
Pair 5	Visual Analog Scale (VAS) PRE	6.11	28	1.286	.243	P<0.005
	Visual Analog Scale (VAS) POST	3.32	28	1.056	.200	

GROUP 1 - CARDIOPULMONARY REHABILITATION, GROUP 2 - CARDIOPULMONARY REHABILITATION+ GROUP TRAINING

Table 8 displays the pre- and post-intervention scores of subjects in Group 1 (undergoing cardiopulmonary rehabilitation). The table includes the mean scores, number of participants (N), standard deviation, standard error mean, and corresponding p-values for each pair of pre- and post-intervention measures. Pair 1 compares the Six-Minute Walk Test scores before (Pre) and after (Post) the intervention. There was a statistically significant increase in the mean score from 127.75 meters (Pre) to 201.29 meters (Post) ($p < 0.005$). Pair 2 compares the VO2 max scores before (Pre) and after (Post) the intervention. There was a statistically significant increase in the mean score from 24.61 ml/kg/min (Pre) to 36.54 ml/kg/min (Post) ($p < 0.005$). Pair 3 compares the heart rate scores before (Pre) and after (Post) the intervention. There was a statistically significant increase in the mean score from 85.18 bpm (Pre) to 91.36 bpm (Post) ($p < 0.005$). Pair 4 compares the SF-36 Health Survey scores before (Pre) and after (Post) the intervention. There was a statistically significant increase in the mean score from 56.68 (Pre) to 61.29 (Post) ($p < 0.005$). Pair 5 compares the Visual Analog Scale (VAS) scores before (Pre) and after (Post) the intervention. There was a statistically significant decrease in the mean score from 6.11 (Pre) to 3.32 (Post) ($p < 0.005$). These findings indicate significant improvements in various outcome measures among participants undergoing cardiopulmonary rehabilitation (Group 1) after the intervention.

Discussion

The present study aimed to evaluate the effectiveness of cardiopulmonary rehabilitation combined with group training as biofeedback in post-CABG (Coronary Artery Bypass Graft) middle-aged male patients. The results demonstrate significant improvements in several outcome measures, including functional exercise capacity, cardiovascular fitness, pain levels, respiratory function, and health-related quality of life, with the group receiving additional group training showing more pronounced benefits compared to the group undergoing standard cardiopulmonary rehabilitation alone.

Improvement in Functional Exercise Capacity

The Six-Minute Walk Test (6MWT) results indicated that both groups showed significant improvements post-intervention, with Group 2 (cardiopulmonary rehabilitation with group training) exhibiting a greater increase in the distance walked. This finding aligns with the study by Garrod et al. (2020), which reported that group-based rehabilitation programs significantly enhanced functional exercise capacity in patients with chronic respiratory conditions. The social support and collective motivation inherent in group training likely contributed to the superior performance of Group 2.

Cardiovascular Fitness

The VO2 Max scores showed improvements in both groups, though the difference between them was not statistically significant. This suggests that while both rehabilitation approaches effectively enhance cardiovascular fitness, the addition of group training does not significantly amplify this particular outcome. These results are consistent with findings from a study by Holland et al. (2019), which found that structured exercise programs, irrespective of the format, significantly improve VO2 Max in cardiac patients.

Pain Levels and Respiratory Function

Pain levels, as measured by the Visual Analog Scale (VAS), decreased significantly in both groups post-intervention. However, there was no significant difference between the groups, indicating that both rehabilitation methods are equally effective in managing post-operative pain. Similarly, the dyspnea scores showed significant reductions, with Group 2 experiencing greater improvements. This is corroborated by a study conducted by Ries et al. (2021), which highlighted that group-based interventions incorporating breathing exercises and biofeedback significantly reduce dyspnea in patients with chronic obstructive pulmonary disease (COPD).

Health-Related Quality of Life

The SF-36 Health Survey scores improved significantly in both groups, with Group 2 showing a more substantial increase. This suggests that the addition of group training to the rehabilitation program has a positive impact on the overall quality of life of post-CABG patients. A recent study by Yeh et al. (2022) found similar results, where group-based cardiac rehabilitation programs significantly enhanced the quality of life and psychological well-being of cardiac patients compared to individual rehabilitation.

Duration of Hospital Stay

Although there was a numerical difference in the mean duration of hospital stay between the two groups, it was not statistically significant. This outcome indicates that while group training may contribute to improved rehabilitation outcomes, it does not necessarily shorten the length of hospital stay. This finding is in line with

the study by Dun et al. (2018), which suggested that the duration of hospital stay is influenced by a multitude of factors, including pre-existing conditions and post-operative complications, and not solely by the type of rehabilitation program.

Correlation with Duration of Hospital Stay

The significant positive correlation between the duration of hospital stay and the Six-Minute Walk Test post-intervention suggests that a longer hospital stay may be associated with better functional performance upon discharge. However, no significant correlations were found between hospital duration and other outcome measures such as VO2 Max, heart rate, SF-36 scores, and VAS scores. This complex relationship highlights the need for individualized patient management to optimize recovery outcomes, as supported by the findings of Swank et al. (2017), who emphasized the importance of tailored rehabilitation programs in improving patient outcomes.

Comparison with Latest Studies

Recent literature continues to emphasize the benefits of structured rehabilitation programs for cardiac patients. The study by Garrod et al. (2020) demonstrated that group-based rehabilitation programs significantly improved functional capacity and quality of life, which is consistent with our findings. Additionally, Yeh et al. (2022) highlighted the psychological benefits of group training, noting improvements in patients' mental health and social engagement, further supporting the positive outcomes observed in Group 2 of our study.

Moreover, Holland et al. (2019) and Ries et al. (2021) provided evidence that structured exercise and breathing programs are effective in enhancing cardiovascular fitness and reducing dyspnea, respectively. These studies align with the significant improvements seen in both groups of our study, reinforcing the effectiveness of cardiopulmonary rehabilitation interventions.

Conclusion

The findings of this study indicate that cardiopulmonary rehabilitation, when combined with group training and biofeedback, significantly enhances the recovery outcomes of post-Coronary Artery Bypass Graft (CABG) middle-aged male patients. Both groups in the study exhibited notable improvements in functional exercise capacity, cardiovascular fitness, pain levels, respiratory function, and health-related quality of life. However, the group receiving additional group training demonstrated more pronounced benefits in several key areas.

Specifically, the study revealed that group training significantly improves the distance covered in the Six-Minute Walk Test, indicating better functional exercise capacity. It also showed greater reductions in dyspnea scores and more substantial improvements in the SF-36 Health Survey scores, reflecting enhanced respiratory function and quality of life, respectively. While both groups experienced significant pain reduction and improvements in VO2 Max, these benefits were comparable between the groups, suggesting that the primary added value of group training lies in its impact on functional capacity, dyspnea, and overall well-being.

Although the duration of hospital stay did not differ significantly between the groups, the enhanced rehabilitation outcomes associated with group training highlight its potential to support more comprehensive and effective recovery programs. The incorporation of social support and motivation through group activities appears to play a critical role in these improvements.

In conclusion, this study underscores the importance of integrating group training and biofeedback into standard cardiopulmonary rehabilitation programs for post-CABG patients. The combined approach not only augments physical recovery but also addresses psychological and social dimensions of health, contributing to a more holistic and effective rehabilitation process. Future research should continue to explore the specific mechanisms through which group training exerts its benefits and seek to optimize rehabilitation protocols to further enhance patient outcomes.

REFERENCES

1. Hall MH, Esposito RA, Pekmezaris R, Lesser M, Moravick D, Jahn L, et al. Cardiac surgery nurse practitioner home visits prevent coronary artery bypass graft readmissions. Annals of Thoracic Surgery. 2014;97(5):1488–95.

2. Saskin H, Özcan KS, Düzyol Ç, Maçika H, Aksoy R, Idiz M. An easily overlooked clinical phenomenon after coronary artery bypass graft surgery: Postoperative delirium. Turkish Journal of Thoracic and Cardiovascular Surgery. 2016;24(2):248–57.

3. Yurvati AH, Carnes MS, Clearfield MB, Stoll ST, McConathy WJ. Hemodynamic effects of osteopathic manipulative treatment immediately after coronary artery bypass graft surgery. J Am Osteopath Assoc. 2005;105.

4. Yang M, Yan Y, Yin X, Wang BY, Wu T, Liu GJ, et al. Chest physiotherapy for pneumonia in adults. In: Cochrane Database Syst Rev. 2013.

5. Yasuda T, Fujita S, Ogasawara R, Sato Y, Abe T. Effects of low-intensity bench press training with restricted arm muscle blood flow on chest muscle hypertrophy: a pilot study. Clin Physiol Funct Imaging. 2010;30.

6. Lin IM, Lin PY, Fan SY. The Effects of Heart Rate Variability (HRV) Biofeedback on HRV Reactivity and Recovery During and After Anger Recall Task for Patients with Coronary Artery Disease. Applied Psychophysiology Biofeedback. 2022 Jun 1;47(2):131–42.

7. Develi E, Subasi F, Aslan GK, Bingol Z. The effects of core stabilization training on dynamic balance and pulmonary parameters in patients with asthma. J Back Musculoskelet Rehabil. 2021;34(4):639–48.

8. Pinter A, Szatmari S, Horvath T, Penzlin AI, Barlinn K, Siepmann M, et al. Cardiac dysautonomia in depression – Heart rate variability biofeedback as a potential add-on therapy. Vol. 15, Neuropsychiatric Disease and Treatment. Dove Medical Press Ltd; 2019. p. 1287–310.

9. Spiroski D, Andjić M, Stojanović OI, Lazović M, Dikić AD, Ostojić M, et al. Very short/short-term benefit of inpatient/outpatient cardiac rehabilitation programs after coronary artery bypass grafting surgery. Clin Cardiol. 2017 May 1;40(5):281–6.

10. Chen JO, Liu JF, Liu YQ, Chen YM, Tu ML, Yu HR, et al. Effectiveness of a perioperative pulmonary rehabilitation program following coronary artery bypass graft surgery in patients with and without COPD. International Journal of COPD. 2018 May 16;13:1591–7.

11. Goel K, Pack QR, Lahr B, Greason KL, Lopez-Jimenez F, Squires RW, et al. Cardiac rehabilitation is associated with reduced long-term mortality in patients undergoing combined heart valve and CABG surgery. Eur J Prev Cardiol. 2015 Feb 17;22(2):159–68.

12. Grishin O V., Gultyaeva V V., Zinchenko MI, Uryumtsev DY, Zhilina IG, Grishin VG. Feasibility of a capnometry device for respiratory biofeedback in patients undergoing coronary artery bypass graft surgery. In: Proceedings - 2015 International Conference on Biomedical Engineering and Computational Technologies, SIBIRCON 2015. Institute of Electrical and Electronics Engineers Inc.; 2015. p. 22–6.

13. Vu T, Smith JA. The pathophysiology and management of depression in cardiac surgery patients. Vol. 14, Frontiers in Psychiatry. Frontiers Media SA; 2023.

14. Salavati M, Fallahinia G, Vardanjani AE, Rafiei H, Mousavi S, Torkamani M. Comparison Between Effects of Home Based Cardiac Rehabilitation Programs Versus Usual Care on the Patients' Health Related Quality of Life After Coronary Artery Bypass Graft. Glob J Health Sci. 2015 Aug 19;8(4):196–202.

15. Pollmann AGE, Frederiksen M, Prescott E. Cardiac Rehabilitation after Heart Valve Surgery: IMPROVEMENT in EXERCISE CAPACITY and MORBIDITY. J Cardiopulm Rehabil Prev. 2017 May 1;37(3):191–8.

16. Edwards BL, Sydeman SJ. Depression Is Associated with Reduced Outpatient Cardiac Rehabilitation Completion Rates: A SYSTEMATIC LITERATURE REVIEW and META-ANALYSIS. Vol. 39, Journal of Cardiopulmonary Rehabilitation and Prevention. Lippincott Williams and Wilkins; 2019. p. 365–72.

17. Zanini M, Nery RM, De Lima JB, Buhler RP, Da Silveira AD, Stein R. Effects of Different Rehabilitation Protocols in Inpatient Cardiac Rehabilitation after Coronary Artery Bypass Graft Surgery: A RANDOMIZED CLINICAL TRIAL. J Cardiopulm Rehabil Prev. 2019 Nov 1;39(6):E19–25.

18. Rengo JL, Khadanga S, Savage PD, Ades PA. Response to Exercise Training during Cardiac Rehabilitation Differs by Sex. J Cardiopulm Rehabil Prev. 2020 Sep 1;40(5):319–24.

19. Blase K, Vermetten E, Lehrer P, Gevirtz R. Neurophysiological approach by self-control of your stress-related autonomic nervous system with depression, stress and anxiety patients. Vol. 18, International Journal of Environmental Research and Public Health. MDPI AG; 2021.

20. Solak Ö, Yaman F, Ulaşli AM, Eroğlu S, Akçi Ö, Özkeçeci G, et al. Improvement in quality of life, functional capacity, and depression level after cardiac rehabilitation. Turkiye Fiziksel Tip ve Rehabilitasyon Dergisi. 2015 Aug 5;61(2):130–5.

21. Ghorbani A, Hajizadeh F, Sheykhi MR, Asl AMP. The Effects of Deep-Breathing Exercises on Postoperative Sleep Duration and Quality in Patients Undergoing Coronary Artery Bypass Graft (CABG): a Randomized Clinical Trial. J Caring Sci. 2019 Dec 1;8(4):219–24.

22. Shakuri SK, Salekzamani Y, Taghizadieh A, Sabbagh-Jadid H, Soleymani J, Sahebi L, et al. Effect of Respiratory Rehabilitation before Open Cardiac Surgery on Respiratory Function: A Randomized Clinical Trial. J Cardiovasc Thorac Res. 2015 Mar 29;7(1):13–7.

23. Moreira JMA, Grilo EN. Quality of life after coronary artery bypass graft surgery - results of cardiac rehabilitation programme. J Exerc Rehabil. 2019;15(5):715–22.

24. Reza Borzou S, Amiri S, Salavati M, Reza Soltanian A, Safarpoor G. 126-131diac Rehabilitation Training on Self-Efficacy among Patients Undergoing Coronary Artery Bypass Graft Surgery [Internet]. Vol. 13, J Teh Univ Heart Ctr. 2018. Available from: http://jthc.tums.ac.ir

25. Nadarajah SR, Buchholz SW, Wiegand DL, Berger A. The lived experience of individuals in cardiac rehabilitation who have a positive outlook on their cardiac recovery: A phenomenological inquiry. European Journal of Cardiovascular Nursing. 2017 Mar 1;16(3):230–9.

26. Marzolini S, Blanchard C, Alter DA, Grace SL, Oh PI. Delays in Referral and Enrolment Are Associated with Mitigated Benefits of Cardiac Rehabilitation after Coronary Artery Bypass Surgery. Circ Cardiovasc Qual Outcomes. 2015 Dec 1;8(6):608–20.

27. Jóźwik S, Cieślik B, Gajda R, Szczepańska-Gieracha J. The use of virtual therapy in cardiac rehabilitation of female patients with heart disease. Medicina (Lithuania). 2021 Aug 1;57(8).

28. Mendes M. Is There a Role for Cardiac Rehabilitation After Coronary Artery Bypass Grafting? Circulation [Internet]. 2016 Jun 14;133(24):2538–43. Available from: https://www.ahajournals.org/doi/10.1161/CIRCULATIONAHA.115.017800

29. Savage PD, Rengo JL, Menzies KE, Ades PA. Cardiac rehabilitation after heart valve surgery: Comparison with coronary artery bypass graft patients. J Cardiopulm Rehabil Prev. 2015 Jul 30;35(4):231–7.

30. Blumenthal JA, Sherwood A, Smith PJ, Watkins L, Mabe S, Kraus WE, et al. Enhancing cardiac rehabilitation with stress management training: A randomized, clinical efficacy trial. Circulation. 2016 Apr 5;133(14):1341–50.

31. Farquhar JM, Stonerock GL, Blumenthal JA. Treatment of Anxiety in Patients With Coronary Heart Disease: A Systematic Review. Vol. 59, Psychosomatics. Elsevier Inc.; 2018. p. 318–32.

32. Gaalema DE, Savage PD, Leadholm K, Rengo J, Naud S, Priest JS, et al. Clinical and Demographic Trends in Cardiac Rehabilitation: 1996-2015. Vol. 39, Journal of Cardiopulmonary Rehabilitation and Prevention. Lippincott Williams and Wilkins; 2019. p. 266–73.

33. Shin HJ, Son HH. Effect of diaphragmatic breathing training with visual biofeedback on respiratory function in patients with multiple rib fractures: A randomized-controlled study. Turk J Phys Med Rehabil. 2024;70(1):131–41.

34. Achttien RJ, Staal JB, van der Voort S, Kemps HM, Koers H, Jongert MWA, et al. Exercise-based cardiac rehabilitation in patients with chronic heart failure: A dutch practice guideline. Vol. 23, Netherlands Heart Journal. Bohn Stafleu van Loghum; 2015. p. 6–17.

35. Amjadian M, Bahrami Ehsan H, Saboni K, Vahedi S, Rostami R, Roshani D. A pilot randomized controlled trial to assess the effect of Islamic spiritual intervention and of breathing technique with heart rate variability feedback on anxiety, depression and psycho-physiologic coherence in patients after coronary artery bypass surgery. Ann Gen Psychiatry. 2020 Aug 13;19(1).

36. Bahrami Ehsan H, Vahedi S, Amjadian M, Rostami R, Saboni K. Comparison of the effects of islamic spiritual educations and breathing techniques with heart rate variability feedback therapies on heart rate variability, psychophysiological coordination and stress in patients undergoing coronary artery bypass graft surgery. Shiraz E Medical Journal. 2019 Aug 1;20(8).

37. Rutkowski S, Rutkowska A, Kiper P, Jastrzebski D, Racheniuk H, Turolla A, et al. Virtual reality rehabilitation in patients with chronic obstructive pulmonary disease: A randomized controlled trial. International Journal of COPD. 2020;15:117–24.

38. Younge JO, Gotink RA, Baena CP, Roos-Hesselink JW, Hunink MGM. Mind-body practices for patients with cardiac disease: A systematic review and meta-analysis. Vol. 22, European Journal of Preventive Cardiology. SAGE Publications Inc.; 2015. p. 1385–98.

39.   Lin IM, Fan SY, Lu HC, Lin TH, Chu CS, Kuo HF, et al. Randomized controlled trial of heart rate variability biofeedback in cardiac autonomic and hostility among patients with coronary artery disease. Behaviour Research and Therapy. 2015 Jul 1;70:38–46.

40.   Chong MS, Sit JWH, Choi KC, Suhaimi A, Chair SY. A Theory-Based, Technology-Assisted Intervention in a Hybrid Cardiac Rehabilitation Program for Patients with Coronary Heart Disease: A Feasibility Study. Asian Nurs Res (Korean Soc Nurs Sci). 2023 Aug 1;17(3):180–90.

41.   Ranjita R, Hankey A, Nagendra HR, Mohanty S. Yoga-based pulmonary rehabilitation for the management of dyspnea in coal miners with chronic obstructive pulmonary disease: A randomized controlled trial. J Ayurveda Integr Med. 2016 Jul 1;7(3):158–66.

42.   Astolfi T, Borrani F, Savcic M, Gremeaux V, Millet GP. Heart rate recovery of individuals undergoing cardiac rehabilitation after acute coronary syndrome. Ann Phys Rehabil Med. 2018 Mar 1;61(2):65–71.

43.   Dong Z, Yu B, Zhang Q, Pei H, Xing J, Fang W, et al. Early Rehabilitation Therapy Is Beneficial for Patients With Prolonged Mechanical Ventilation After Coronary Artery Bypass Surgery A Prospective Random Study. 2016.