

## Research Paper

## Effects of Pre-operative Physical Therapy on Functional Capacity, Kinesiophobia, and Post-operative ICU Stay in Coronary Artery Bypass Grafting Candidates



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**ABSTRACT**

**Objectives:** This study was done to find out the impact of a pre-operative physical therapy plan with inspiratory muscle training on functional capacity, kinesiophobia, and post-operative intensive care unit (ICU) stay in subjects with coronary artery disease (CAD) candidates for coronary artery bypass grafting (CABG).

**Methods:** Fifty subjects who fulfilled the inclusion criteria were recruited and randomly distributed into the intervention and control group by concealed envelop method. Participants in the experimental group were provided with inspiratory muscle training (IMT) with breathing exercises and chest clearance techniques, while the control group received breathing exercises and chest clearance techniques. Both groups received three treatment sessions before their scheduled surgery. The assessment was done at three-time intervals: At baseline, after three sessions, and after surgery. The outcome measures were oxygen saturation, heart rate, respiratory rate, Borg scale of perceived exertion (Borg PRE), Tampa scale of kinesiophobia for the heart (TSKH), and days spent at ICU after CABG.

**Results:** Oxygen saturation, respiratory rate, functional capacity, and pulmonary endurance improved significantly among the treatment groups with a  $P < 0.001$  and a large effect size. The pulse rate showed no significant improvement;  $P$  and effect size were 0.38 and 0.60, respectively. Kinesiophobia and ICU stay also showed significant changes with a  $P < 0.001$ . The effect size was large for both kinesiophobia and ICU stay.

**Discussion:** IMT as a component of a pre-operative physical therapy plan can improve oxygen saturation, respiratory rate, functional capacity, and pulmonary endurance in CAD patients going for CABG. IMT reduces the level of kinesiophobia and duration of ICU stay after CABG.

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## Highlights

- This article highlights the importance of respiratory physiotherapy in admitted patients who are candidates for coronary artery bypass grafting, particularly in the pre-operative phase.
- Kinesiophobia is a condition that can be managed through pre-operative inspiratory muscle training.
- The results will help healthcare professionals add up to the evidence-based physical therapy regime of CABG candidates.

## Plain Language Summary

In clinical practices, patients who were active by having physiotherapy sessions before going for heart surgeries showed tremendous positive health outcomes after surgeries. This article highlights the rehabilitation perspectives of physiotherapy by focusing on the role of physiotherapy before surgeries specifically heart surgeries. Pre-operative physiotherapy proves to be beneficial in improving oxygen levels of blood, respiratory health, and a person's functional capacity and reduces irrational fear of movement and activity, which results from a feeling of being vulnerable to painful injury or re-injury. Thus, incorporating these results in clinical practice can significantly lessen days of admission and lower hospitalization cost.

### 1. Introduction

Cardiovascular pathologies are one of the major causes of high mortality rates and economic burdens, which have risen globally. The expected deaths are 23.6 million with coronary artery diseases (CAD) being at the top among these pathologies. The common treatment for the disease is coronary artery bypass grafting surgery (CABG), which reduces the produced symptoms i.e., reduced coronary circulation, decreased left ventricular function, occlusion of multi vessels, and unstable angina. The surgery is also used for uncontrollable myocardial infarction. The procedure itself is associated with certain complications, such as increased inflammatory response, immune system suppression, and impaired capillary permeability. The common complications postoperatively include lung collapse, build-up of excess fluid in pleura, pneumonia, acute renal injury, neuromuscular disorders, postoperative hemorrhage, and infections. The more severe the symptoms are, the more the chances of development of complications and consequently, prolonging patient recovery due to decreased mobility and functional capacity. The duration of hospital stay can serve as a predetermining factor of how quickly the patient returns to his or her activities of daily life and the associated threat of re-admission to a hospital facility [1, 2].

Several clinical studies have shown the positive effects of exercise training on patients with cardiovascular diseases with a marked decrease in overall mortality rate. There is substantial evidence of improving psychological well-being through cardiac rehabilitation and exercise [3]. One of the hindrances in this field is the phenomenon of Kinesiophobia, which can be defined as “an excessive, irrational, and debilitating fear of movement and activity resulting from a feeling of vulnerability to painful injury or re-injury” and is associated with a reduction in physical activity and quality of life (QoL) along with a negative impact on independent occupational duties. A certain level of fear is expected and even acceptable following a cardiac event; however, some patients fail to cope with this fear, which ultimately leads to avoiding physical activity and exercise in the long run [3, 4].

Pre-operative cardiac rehabilitation involves inspiratory muscle training using a spirometer device and breathing exercises to stimulate ventilation along with chest clearance techniques to promote evacuation of sputum. This is accompanied by aerobic training to maintain or enhance physical fitness [5]. Inspiratory muscle training (IMT) is a technique to strengthen the weekend respiratory muscles. The inspiratory muscle is associated with various cardiorespiratory pathologies, including CAD, and can be seen in patients who are chronically ill or admitted to the intensive care unit (ICU) for various reasons [6]. The target of IMT is the diaphragm and accessory inspiratory muscles and it improves their strength and endurance. There are various techniques for IMT,

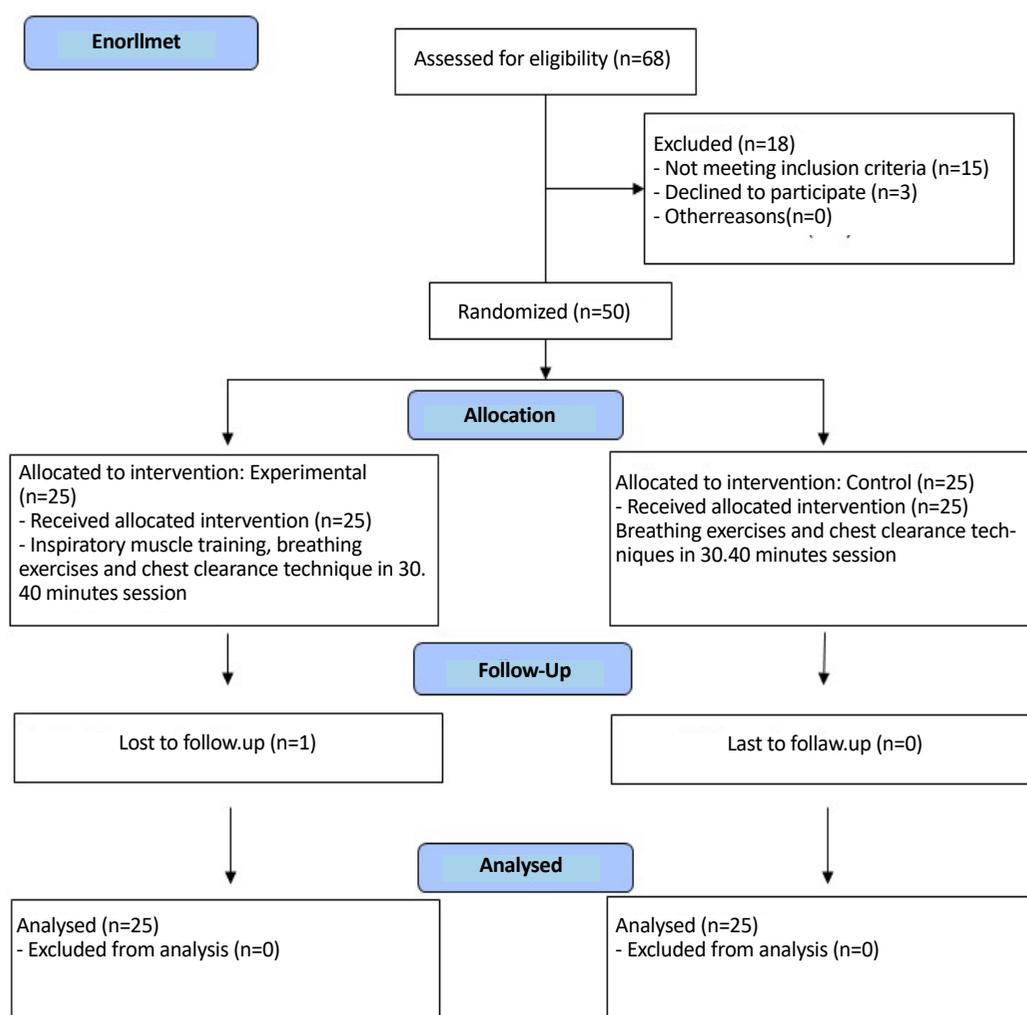


Figure 1. Consort flow diagram

which include resistive loading, threshold loading, and whole-body mobilization. The regimens may vary in frequency, duration, and load. IMT can improve inspiratory muscle strength, exercise performance, or QoL in patients [7]. The subjects suffering from CAD or other cardiac issues, like a cardiac failure are prone to develop inspiratory muscle weakness [8].

This study aimed to find out the effects of pre-operative physical therapy comprising of inspiratory muscle training, breathing exercises, and chest clearance techniques on functional capacity, pulmonary endurance, kinesiophobia, and ICU stay in CAD patients candidates for CABG. This will also elaborate on the use of pre-operative physiotherapy in subjects with cardiac and pulmonary disorders.

## 2. Materials and Methods

A concealed, randomized, double-blinded, clinical trial with a parallel group design of 50 patients Was done on

subjects who met the inclusion criteria, including the age of 25 to 60 years with ejection fraction  $\geq 25\%$ , exercise intensity of below angina threshold, being able to perform a 6-minute walk test and tolerate mild to moderate activity level. Subjects with other systemic diseases or those who had any surgical procedures previously were excluded from the study. Subjects were divided into two groups randomly by concealed envelope method. Blinding of care provider as well as outcome assessor was maintained. The research duration was from March to September 2019. The trial was registered at the [Iranian Clinical Trial Registry \(IRCT\)](#) (Code: IRCT20180417039344N2).

The intervention group received inspiratory muscle training, breathing exercises, and chest clearance techniques. Three sessions were given for 30 to 40 minutes each before their surgery. Inspiratory muscle training was direct gentle resistance in the inward and upward direction below the xiphoid process during inspiration. To

**Table 1.** Within-group analysis at three-time intervals

Variables		Mean±SD			F	P
		Baseline values (T1)	After 3 sessions (T2)	After Procedure (T3)		
Oxygen saturation	Experimental	78.56±3.66	81.06±3.65	91.44±3.00	149.91	<0.001***
	Control	77.56±3.68	78.88±3.62	85.56±3.22	226.72	0.005
Pulse rate	Experimental	105.40±9.09	101.84±7.85	96.36±6.86	105.63	<0.001***
	Control	107.60±9.97	105.20±9.54	101.52±9.93	161.57	<0.001
Respiratory rate	Experimental	12.08±1.52	13.40±1.52	16.92±1.11	130.02	<0.001***
	Control	11.36±1.18	11.84±1.06	14.12±1.20	90.54	<0.001***
Borg RPE	Experimental	5.04±0.88	4.40±0.75	3.24±0.43	79.23	<0.001
	Control	5.92±0.90	5.72±0.93	4.92±0.75	58.26	<0.001***
6MWT	Experimental	138.12±25.4	145.08±25.44	149.20±25.28	432.54	<0.001***
	Control	120.00±20.75	124.48±21.05	127.16±21.17	207.53	<0.001***
TSKH	Experimental	37.00±4.96	29.52±3.79	23.32±2.60	188.43	<0.001***
	Control	36.88±4.84	31.88±4.26	26.36±3.36	260.25	<0.001***

\*\*\*0.000.

Abbreviations: SD: Standard deviation; Borg RPE: Borg scale of perceived exertion; 6MWT: 6-minute walk test; TSKH: Tampa scale of kinesiophobia for heart.

enhance thoracic expansion, an incentive spirometer was also used. Chest clearance was done by the active cycle of breathing technique (ACBT) and manual therapeutic chest percussion. The control group received breathing exercises and chest clearance techniques. They also received three sessions of 30 to 40 minutes each.

The main outcome measures were functional capacity, kinesiophobia, and cardiovascular and pulmonary endurance, ICU stay. Functional capacity was measured by a 6-minute walk test, kinesiophobia by the Tampa scale of kinesiophobia for the heart (TSKH), cardiovascular and pulmonary endurance by Borg scale of perceived exertion (Borg RPE), and ICU stay by the number of days spent in ICU after the procedure. The assessment was done at three levels: At baseline (T1), after giving three physiotherapy sessions (T2), and then after their surgical procedure (T3). The analysis was done by SPSS, version 21. The data collection procedure is explained in the consort diagram in Figure 1.

### 3. Results

Fifty subjects were enrolled and completed the study. There were 34 males and 16 females: 17 males and

8 females in each of the groups. The mean age of the experimental and control groups was 53.96±5.74 and 52.24±5.50 years, respectively. Repeated-measures ANOVA results for both groups are explained in Table 1. Table 2 describes the between-group analysis of the subjects at baseline and after surgery. Post-CABG comparison of both groups is explained in Table 3 along with effect size, which was measured by Cohen's d.

### 4. Discussion

The goal of this study was to determine the impact of pre-operative rehabilitation regime comprised of inspiratory muscle technique along with breathing exercises and chest clearance techniques on functional capacity, pulmonary endurance, kinesiophobia, and ICU stay compared to breathing exercises and chest clearance techniques. Weakness of respiratory muscles is often associated with numerous cardiopulmonary disorders and critical illnesses. The physical therapy exercise plan can improve the overall function as well as pulmonary endurance in such patients. Weakness and a sense of frailty lead to the development of symptoms during exercise in subjects with CAD, which gives rise to kinesiophobia.

Table 2. Between-group comparison at T1 and T3

Variables	Group	Mean±SD		P
		T1	T3	
Oxygen saturation	Experimental	78.56±3.66	91.44±3.00	<0.001***
	Control	77.56±3.68	85.56±3.22	<0.001***
Pulse rate	Experimental	105.40±9.09	96.36±6.86	<0.001***
	Control	107.60±9.97	101.52±9.93	0.001
Respiratory rate	Experimental	12.08±1.52	16.92±1.11	<0.001***
	Control	11.36±1.18	14.12±1.20	<0.001***
Borg RPE	Experimental	5.04±0.88	3.24±0.43	0.001
	Control	5.92±0.90	4.92±0.75	<0.001***
6MWT	Experimental	138.12±25.4	149.20±25.28	<0.001***
	Control	120.00±20.75	127.16±21.17	<0.001***
TSKH	Experimental	37.00±4.96	23.32±2.60	<0.001***
	Control	36.88±4.84	26.36±3.36	<0.001***

\*\*\*0.000.

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Abbreviations: SD: Standard deviation; Borg RPE: Borg scale of perceived exertion; 6MWT: 6-minute walk test; TSKH: Tampa scale of kinesiophobia for heart)

The subjects restrict themselves from physical activity and exercises, which further adds to the severity of their disease and functional capacities [6, 7].

The impact of IMT was measured by the value of significance and effect size. All the outcome measures improved in terms of P except pulse rate. Effect sizes measured via Cohen's d were found to be medium for pulse rate, large for oxygen saturation, TSKH, and ICU duration, and huge for Borg RPE and respiratory rate.

Oxygen saturation, pulse rate, and respiratory rate were found to improve in both the experimental and control groups. However, the oxygen saturation and respiratory rate showed significant changes in the experimental group, where pulse rate was not found to be significantly different in both groups, although the effect size for pulse rate was medium. Abeer et al. used IMT in subjects with CAD after their CABG and found improvements in pulse rate, whereas the current study showed no significant changes in the respective outcome. The improvements occurred due to an alteration in sympathetic rhythm. Their intervention in their study was post-operative, which could be a reason for such changes [9]. Figueiredo et al. also found the positive effects of

cardiac rehabilitation on heart rate and heart variability in subjects who underwent CABG [10]. Patil et al. compared conventional cardiac rehabilitation maneuvers with closed kinematic chain exercises (CKC) in a similar population and found positive effects on the CKC group in terms of respiratory rate and blood pressure, but heart rate showed no significant changes [11]; the differences in results could be due to the provision and duration of the intervention.

Laohachai et al. conducted a trial and after six weeks of IMT concluded that IMT improves ventilatory efficiency, inspiratory muscle strength, and resting cardiac output. Hence, it is beneficial to add IMT to the cardiac rehabilitation plan of subjects with cardiac diseases. In the current study, functional capacity improved along with pulmonary endurance in the experimental group [8]. In a trial by Cordeiro et al., IMT based on the aerobic threshold was given to post-CABG patients and substantial changes were observed and it was concluded that it reduces the losses in functional capacity and respiratory muscle strength. Functional capacity improved in the IMT group in the recent study as well [12]. A systematic review by Karanfil et al. on preoperative inspiratory

**Table 3.** Post-CABG (T3) comparison of the experimental and control groups

Variables	Mean±SD		Mean difference	P	Effect Size Cohen's d
	Intervention	Control			
Oxygen saturation	91.44±3.00	85.56±3.22	5.88	<0.001	1.88
Pulse rate	96.36±6.86	101.52±9.93	5.16	0.38	0.60
Respiratory rate	16.92±1.11	14.12±1.20	2.80	<0.001	4.39
Borg RPE	3.24±0.43	4.92±0.75	1.68	<0.001	2.74
6MWT	149.20±25.28	127.16±21.17	22.04	0.002	0.94
TSKH	23.32±2.60	26.36±3.36	3.04	0.001	1.01
ICU duration	1.76±0.59	2.60±0.52	0.84	<0.001	1.51

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Abbreviations: SD: Standard deviation; Borg RPE: Borg scale of perceived exertion; 6MWT: 6-minute walk test; TSKH: Tampa scale of kinesiophobia for heart; ICU: Intensive care unit.

muscle training after cardiac surgery concluded that pre-operative IMT reduces the development of post-surgical pulmonary complications [13]. The recent trial found significant improvements in oxygen saturation, respiratory rate, and pulmonary endurance, which are major components of pulmonary functions, and their improvement suggests that there would be a lesser risk of development of pulmonary complications, like pneumonia and atelectasis. Turkey et al. also concluded substantial improvements in inspiratory muscle power, oxygen saturation, and alveolar-arterial gradient in CABG subjects with pre- and post-operative IMT [14].

Post-CABG IMT performed did not show significant changes in muscle strength and functional capacity in patients with a high risk of pulmonary complications. These results signify the improvements in the provision of physical therapy intervention for cardiorespiratory functions pre- and post-operatively [15]. According to Santos et al., inspiratory muscle strength influences the exercise capacity in subjects with CABG. An improvement was observed in exercise capacity in subjects who were provided with cardiac rehabilitation, including IMT [16].

Kinesiophobia is an extreme, debilitating, irrational fear of movement and activity, which results from the feeling of being vulnerable to painful injury or re-injury [17]. Kinesiophobia is considered a barrier to physical activity and is a hindrance in way of good prognosis in subjects with CAD. The level of kinesiophobia was moderate to low among the population and further declined to low levels after interventions. Scores on TSKH reduced in both groups after interven-

tion, although the level of significance showed better results in the experimental group. The effect size of IMT was also large. A systematic review by Altug et al. suggested that cardiac rehabilitation programs in CAD improved kinesiophobia ultimately resolving the level of activity in such patients. Kinesiophobia adversely affects the participation of subjects in physical therapy plans as well; thus, addressing this factor is necessary [17]. Nair et al. also recommended that in-patient cardiac rehabilitation reduces fear avoidance belief and kinesiophobia in CABG subjects [18].

There are various factors, which prolong the recovery and duration of subjects' stay in the ICU post-CABG, including cardiac, renal, and pulmonary functions. Impairments of respiratory muscle performance and functions lead to low response to treatment and can prolong the stay at ICU [19]. Physical therapy protocols can resolve these problems and improve the functional capacity of CAD patients post-CABG [20]. The recent study also found a positive effect of IMT upon ICU stay in terms of the as well as effect size.

## 5. Conclusion

This trial concluded that IMT as a component of pre-operative cardiac rehabilitation can improve respiratory rate, functional capacity, and pulmonary endurance in subjects with CAD undergoing CABG but there was no significant effect on pulse rate. IMT is also effective in reducing kinesiophobia and time spent at ICU post-CABG.

## Ethical Considerations

### Compliance with ethical guidelines

The study protocol was approved by the ethical committee of [Kulsum International Hospital](#), Islamabad (Pakistan) (NO.: KIH-EC-PT-011). Written consent was obtained from the participants and their families on the first day of treatment whereas verbal consent was obtained before the intervention.

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### Authors' contributions

All authors equally contributed to prepare this article.

### Conflict of interest

The authors declared no conflicts of interest.

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