

<https://doi.org/10.48047/AFJBS.6.14.2024.8869-8887>



African Journal of Biological Sciences

Journal homepage: <http://www.afjbs.com>



Research Paper

Open Access

## Innovative Approaches in Cardiopulmonary Rehabilitation: A Review of Recent Randomized Controlled Trials

Dr Flavia Castelino<sup>1\*</sup>, Divya V<sup>1</sup>, Loretta Veena Dsilva<sup>2</sup>, Roshani Rodrigues<sup>3</sup> Jenifer Silvy Mathias<sup>4</sup>, B Shivashankar Pai<sup>5</sup>

PhD RN Professor and Principal, Department of Medical-Surgical Nursing, Niraamaya CON, Bantakal, Udupi Karnataka India [castelinoflavia@gmail.com](mailto:castelinoflavia@gmail.com)

2Assistant Professor, Department of Medical-Surgical Nursing, Niraamaya CON, Bantakal, Udupi Karnataka India. Mail Id: [divya.dew.v@gmail.com](mailto:divya.dew.v@gmail.com)

3Lecturer, Department of Medical-Surgical Nursing, Niraamaya CON, Bantakal, Udupi Karnataka India Mail Id: [lorettaveena@gmail.com](mailto:lorettaveena@gmail.com)

4Associate Professor, Department of Fundamentals of Nursing, Niraamaya CON, Bantakal, Udupi Karnataka India. Mail Id: [roshani.stella@gmail.com](mailto:roshani.stella@gmail.com)

5Lecturer, Department of Fundamentals of Nursing, Niraamaya CON, Bantakal, Udupi Karnataka India. Mail Id: [jeni28.castelino@gmail.com](mailto:jeni28.castelino@gmail.com)

6, Associate Professor and Principal, Niraamaya College of Allied Health Sciences, Bantakal, Udupi Karnataka India. Mail Id: [shivashankarpai@gmail.com](mailto:shivashankarpai@gmail.com)

**Corresponding Author:** Dr Flavia Castelino RN Professor and Principal Department of Medical-Surgical Nursing Niraamaya College of Nursing Bantakal, Udupi Karnataka India. Mail Id: [castelinoflavia@gmail.com](mailto:castelinoflavia@gmail.com)

Volume 6, Issue 14, Aug 2024

Received: 15 June 2024

Accepted: 25 July 2024

Published: 15 Aug 2024

*doi:* [10.48047/AFJBS.6.14.2024.8869-8887](https://doi.org/10.48047/AFJBS.6.14.2024.8869-8887)

### Abstract

**Aim:** This review assesses the recent Randomized Controlled Trials (RCTs) in Cardio-pulmonary Rehabilitation. It focuses on innovative therapies to enhance the outcomes of patients and identify new research domains in cardiopulmonary rehabilitation.

**Method:** The review looks at studies on sleeping positions that are somewhat upright for obstructive sleep apnea. Text messaging can be used in cardiac and lung rehabilitation programs. Hospitals can offer online singing sessions as a part of the structured lung rehabilitation program. The effectiveness of cardiopulmonary rehabilitation can be measured through patient compliance, quality of life, physical activity, breathing exercises, and overall health conditions.

**Findings:** Innovative approaches such as semi-upright position, integrated text messaging, structured pulmonary rehabilitation programs, and last but not least, online singing programs demonstrated promising improvement in patient compliance, quality of life, physical activity, breathing exercises, and overall health conditions

**Results:** New treatments like semi-upright positions, text message systems, organized lung rehabilitation, and online singing classes have led to better physical activity, improved breathing, and better quality of life. These results show how important it is to add new methods to regular cardiopulmonary rehabilitation programs.

**Conclusions:** The innovative rehabilitation approach provides huge potential to improve health outcomes through cardiopulmonary rehabilitation. Future studies should aim to further prove these treatments work, put them into practice, and look into more new ways to improve patient care and cut down on healthcare costs.

**Keywords:** Cardio Pulmonary Rehabilitation, Randomized Controlled Trials, Obstructive Sleep Apnea, Integrated Text Messaging, Pulmonary Rehabilitation, Quality of Life.

## **Introduction**

Cardiopulmonary disease is a dual health condition of the cardiac and pulmonary systems. When abnormal respiratory function coexists with anatomical or functional alterations in the right ventricle, it's called "Pulmonary Heart Disease" (PHD). The main cause of PHD can be, impaired gas exchange to vital organs like the heart, kidney, neurohormonal systems, and pulmonary vasculature. Pulmonary heart disease is a catch-all phrase for a variety of clinical, echocardiographic, and hemodynamic symptoms because abnormalities in lung function can affect the heart in diverse ways. The majority of the patients suffer from cardiac instability and are at risk of pulmonary vascular disease which is mainly due to improper exchange of gas in the lungs(Forfia et al., 2013). COPD was the third most common cause of death (nearly 3.23 million) worldwide in 2019. Hence effective preventive measures along with promising Innovative therapies are very much needed to reduce health care burden and out-of-pocket expenditure(Vos et al., 2020)

Some of the cardiopulmonary disorders are: Coronary Artery Disease, Congestive Heart Failure, Cardiomyopathy, Valvular Heart Disease, Myocardial Infarction (MI), Hypertensive Heart Disease, Arrhythmias, Pulmonary Hypertension, Chronic Obstructive Pulmonary Disease (COPD), Asthma, Pulmonary Embolism (PE), Interstitial Lung Disease (ILD), Pneumonia and Acute Respiratory Distress Syndrome (ARDS)(CPR 10, n.d.)

There are two types of cardiopulmonary patients: patients with primary cardiac or pulmonary disorders for whom rehabilitation is required or patients with other physical disabilities who have comorbid cardiopulmonary conditions. Cardiopulmonary Rehabilitation- is little utilized but very beneficial to patients who have had a stroke or vascular disease. The provision of this sort of care makes it necessary for rehabilitation specialists to be well-equipped to handle primary and secondary cardiopulmonary conditions(CPR 10, n.d.)

Cardiac rehabilitation has advanced from simple monitoring of activities to a comprehensive approach that gives priority to patient education, individualized exercise, risk factor reduction, and general well-being. It works for patients with heart diseases and the benefits include reduced mortality rates, symptom relief, decreased smoking rates, improved exercise capacity, and better psychosocial functioning. However, despite its advantages, it is not widely used because of problems in referral and enrolment. To solve this problem, telephonic programs as well as other forms of monitoring need to be expanded to make cardiac rehabilitation more available and used by more people(Mampuya, 2012).

Post COPD pulmonary rehabilitation helped in minimizing hospital readmissions and also the improvement in strength in performing exercise and quality of life was noted in a Cochrane review done in 2017. Also, the study said that there are many barriers like healthcare system limitations, referrer awareness, and patient reluctance. Despite of high-quality evidence supporting PR benefits, uptake and completion rates remain low. Strategies like home-based PR and less effort-dependent methods show promise but require further research(Jones et al., 2018) As technology and Health services are advanced the need for new rehabilitation processes to improve the health of Cardiopulmonary patients is essential. The Randomized control Trials done in the past 5 years show a promising improvement in the overall health of cardio-pulmonary patients (Lukachan et al., 2023)

**Purpose of the study:**

This paper reviews the most recent Randomized Controlled Trials (RCTs) in the field of cardiopulmonary rehabilitation. It evaluates novel interventions, identifies research gaps, and outlines new trends by examining recent developments. The ultimate aim is to enhance medical care for patients who are undergoing the cardiopulmonary rehabilitation process, set directions for further studies, and educate clinical practice.

**Aim:**

This review article looks at new developments in cardiopulmonary rehabilitation by studying Randomized Controlled Trials (RCTs). It has an influence on medical care for cardiopulmonary patients by checking out new treatments and finding research gaps. The study also aims to guide future research and help doctors in their day-to-day work

**Research question:**

"Innovative Approaches in Cardiopulmonary Rehabilitation: A Review of Recent Randomized Controlled Trials"

**Methods**

**Types of studies:** RCTs of "Cardiopulmonary Rehabilitation" were considered for the inclusion criteria

**Participants:** participants who were diagnosed with cardiopulmonary disorders

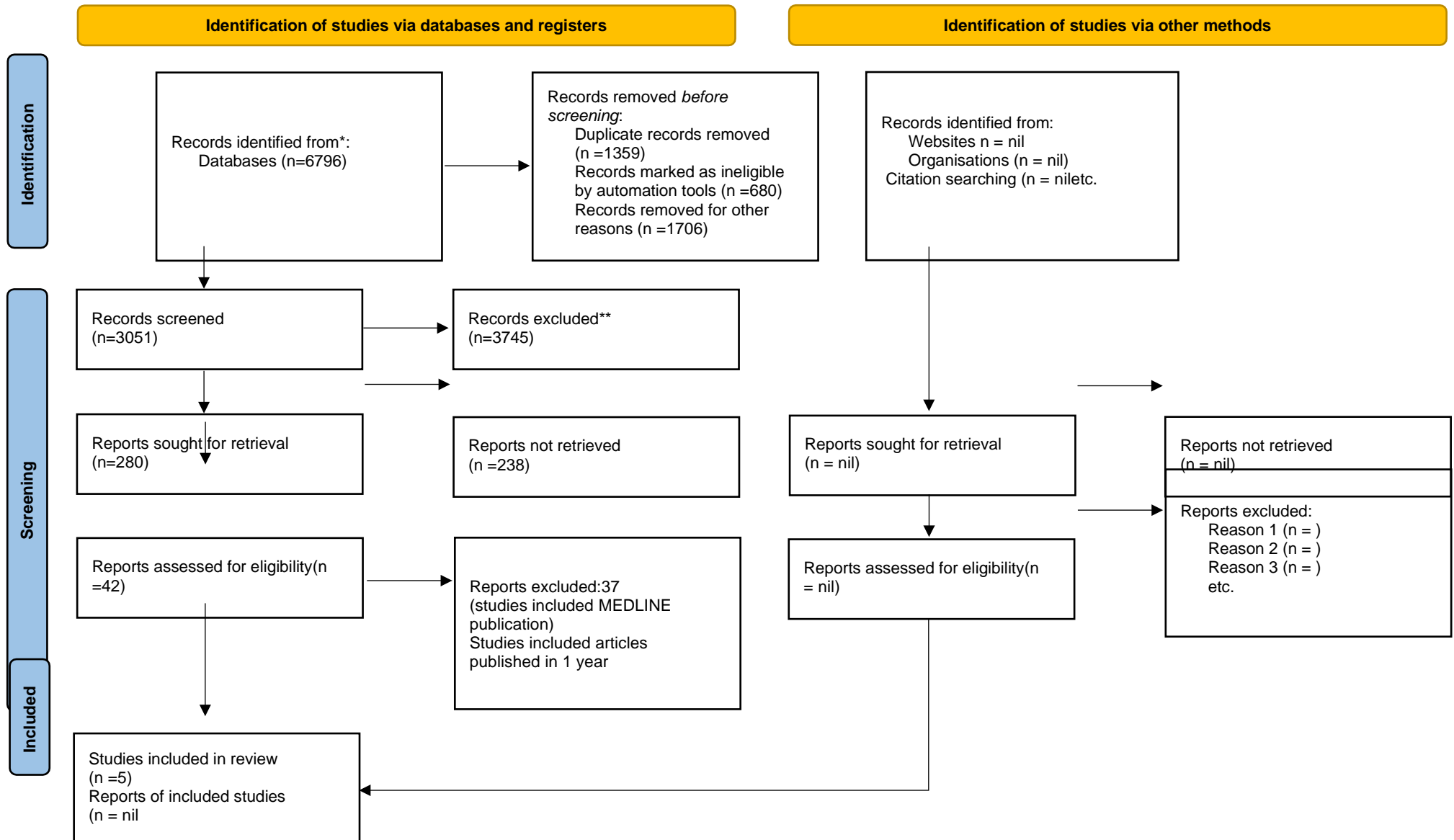
**Interventions:** semi-upright position for OSA, Integrated text messaging for people attending cardiac and pulmonary rehabilitation, Singing for lung health in COPD, physical activity, physical fitness, and well-being.

**Outcome:** improved physical activity, improved breathing, and better quality of life.

**Search strategy:**

Following electronic databases were used to search: PubMed, and Medline for the review article "Cardiopulmonary rehabilitation". Initially, the database identified 6,796 records. After removing duplicates we had 1359 records, 680 records were marked as not eligible by the automation tools and later 1706 were removed as it was not of free full article. 3051 records were screened. From these, 280 reports were retrieved as we had included only RCT studies. Eventually, 37 reports were excluded as they had irrelevant outcomes, inadequate study design, and a population mismatch. After the meticulous search process, only the relevant articles were included in the final review, which had 6 studies meeting the inclusion criteria

**PRISMA 2020 flow diagram** (Page et al., 2021)



**Table 1: Demographic Characteristics of Studies**

Study	Author/ Year	Journal	Sample Size	Age Group	Gender	Population
The impact of semi-upright position on the severity of sleep-disordered breathing in patients with obstructive sleep apnea: a two-arm, prospective, randomized controlled trial	Gincy A. Lukachan et al. 2023	BMC Anesthesiology	35 Control Group: 14 Intervention Group: 21	Control Group: 63±10 Intervention Group: 65±12	Female/ Males	Perioperative patients, undergoing elective non-cardiac inpatient surgeries
Integrated Text Messaging (ITM) for people attending cardiac and pulmonary rehabilitation: A multi-center randomized controlled trial	Julie Redfern et al. 2024	Annals of Physical and Rehabilitation Medicine	257 Control Group: 58 Intervention Group: 199	Control Group: 62±10 Intervention Group: 62±12	Female/ Males	Participants in cardiac and pulmonary rehabilitation using a smartphone and an active SIM card

Pulmonary rehabilitation in Iranian outpatients with mustard gas lung disease: a randomized controlled trial	Mostafa Ghanei, et al. 2024	BMJ OPEN	60 Control Group: 29 Intervention Group: 31	Control Group: 53.26 Intervention Group: 52.03	Males	Men with breathlessness due to respiratory disease caused by documented mustard gas-exposure
Singing for lung health in COPD: a multicenter randomized controlled trial of online delivery	Keir E J Philip et al. 2024	BMJ Open Respiratory Research	100 Control Group: 50 Intervention Group: 50	(62-74)	Female/ Males	Adults with stable COPD
Effects on physical activity, physical fitness and well-being in a 36-month randomized controlled study, comparing a multimodal hospital-based intervention programme for primary cardiovascular prevention with usual care	Hilde Bergum et al. 2024	BMC Cardiovascular Disorders	228 Control Group: 108 Intervention Group: 120	(35-67)	Not available	Participants from the original Hjerteløftet Study

**Table 2: Methodological Characteristics of Studies**

Author	Country	Focus	Data analysis	Research design
Gincy A. Lukachan et al. 2023	Canada	To investigate whether sleeping in a semi-upright position reduces the severity of sleep-disordered breathing in patients with obstructive sleep apnea	<ul style="list-style-type: none"> <li>• Baseline comparison</li> <li>• Primary &amp; secondary Outcome Analysis using paired t-tests (ANCOVA)</li> <li>• Intention-to-treat &amp; per-protocol Analysis &amp; sensitivity analyses, and adverse events analysis.</li> </ul>	two-arm, prospective, RCT
Julie Redfern et al. 2024	Sydney, Australia	To gain insight into the extent to which people receiving cardiac and pulmonary rehabilitation can be assisted by using Integrated Text Messaging (ITM).	<ul style="list-style-type: none"> <li>• Baseline comparison using descriptive &amp; inferential statistics</li> <li>• Primary &amp; secondary Outcome Analysis using paired t-tests (ANCOVA)</li> <li>• Intention-to-treat &amp; per-protocol Analysis &amp; sensitivity analyses, and adverse events analysis.</li> </ul>	RCT



Mostafa Ghanei, et al. 2024	Iran	To ascertain whether pulmonary rehabilitation is beneficial for Iranian outpatients with mustard gas lung illness	<ul style="list-style-type: none"> <li>• Baseline comparison using descriptive statistics</li> <li>• Primary &amp; secondary Outcome Analysis using paired t-tests (ANCOVA)</li> <li>• Intention-to-treat &amp; per-protocol Analysis &amp; sensitivity analyses, and adverse events analysis.</li> </ul>	RCT
Keir E J Philip et al. 2024	London	To explore whether people with COPD might enhance their lung health by participating in online singing therapies.	<ul style="list-style-type: none"> <li>• Baseline comparison using descriptive &amp; inferential statistics</li> <li>• Primary &amp; secondary Outcome Analysis using paired t-tests (ANCOVA)</li> <li>• Intention-to-Treat &amp; per-protocol Analysis &amp; sensitivity analyses.</li> </ul>	RCT
Hilde Bergum et al. 2024	Norway	To explore whether people with COPD might enhance their lung health by participating in online singing therapies.	<ul style="list-style-type: none"> <li>• Baseline comparison using descriptive &amp; inferential statistics</li> <li>• Primary &amp; secondary Outcome Analysis using paired t-tests (ANCOVA)</li> <li>• Intention-to-Treat &amp; per-protocol Analysis &amp; sensitivity analyses.</li> </ul>	RCT

## **Interventions**

### **Semi-Upright Position**

An RCT study was conducted on the effectiveness of sleeping in semi upright position in patients with newly identified Obstructive sleep apnea. This study had an experimental group and a controlled group, where the experimental group received semi upright position and the control group received normal sleeping in either supine or lateral positions. The Apnea Hypopnea index was used to measure the main outcome i.e. number of apneas and hypopneas per hour during sleep. The apnea hypoxia index was significantly lower in the experimental group along with improvement in the sleep quality and oxygen saturation level than the control group which received normal care. Therapy helped in relieving the onset of obstructive apnea. Hence the results show sleeping in a semi-upright position shows promise as a non-invasive strategy for addressing(Lukachan et al., 2023)

### **Integrated Text Messaging (ITM)**

This study assessed the value of integrated text messaging as a patient support tool for cardiac and pulmonary rehabilitation. The control group received standard treatment devoid of the texting feature but the experimental group was exposed to tailored motivational, instructional, and supportive messages through their cell phones. The primary objective was evaluating adherence to the rehabilitation program whereas secondary objectives were quality of life, health outcomes, and physical activity levels. In conclusion, the study found that patients in the intervention group had a higher attendance rate, more physical activity, and better clinical results than those in the control group. ITM intervention improved adherence significantly too. Patients also reported greater enjoyment and involvement with their rehabilitation activities. Therefore, it is recommended that integrated text messaging can be used on a large scale to improve compliance with cardiac and pulmonary rehabilitation programs leading to

enhancement in patients' well-being and overall health status.(Redfern et al., 2024)

### **Organized Pulmonary Rehabilitation Program**

To investigate the efficacy of pulmonary rehabilitation among patients with mustard gas lung disease, researchers carried out a study. The intervention here involved a well-structured pulmonary rehabilitation program with education in lung disease control, breathing exercises, and supervised exercise training. On one hand, the control group received general medical care without additional rehabilitation, while on the other hand, the intervention group's subjects underwent a comprehensive program. Changes in respiratory functions, exercise tolerance and quality of life were applied as benchmarks for assessing how beneficial this intervention was. After comparing with their counterparts in the control group, it was found that patients in this study utilized substantial changes that resulted from having pulmonary rehabilitation programs like; Pulmonary function; Exercise tolerance; and Health-related quality of life. This was supported by improved exercise tolerance, better lung function as well as enhanced quality of life among participants in the program.(Ghanei et al., 2024)

### **Singing For Lung Health**

In the study titled "Singing for lung health in COPD: a multicentre randomized controlled trial of online delivery," Keir E J Philip et al, researched the impact of an online singing intervention on patients with COPD. A structured online singing program was integrated to improve general well-being and lung functioning within the scheme. Participants involved in virtual singing sessions as part of the intervention group were engaged in vocal exercises to enhance their breathing power and capability. Conversely, the control group received normal medical care without any extra singing lessons. The gains recognized included respiratory function change, exercise capacity change and quality of life change used to establish how effective the online singing intervention was. Consequently, results indicated that people who participated in an online singing program have better qualities of life compared to those who belong to a control

group, while also being more capable of exercising and having healthier lungs. Based on these findings, it would be possible to say that online signing can be one new way to help individuals suffering from COPD achieve better respiratory health.(Philip et al., 2024)

### **Multimodal Hospital-Based Intervention Programme**

This study evaluated the effect of a full intervention on cardiovascular health. As an intervention to prevent primary cardiovascular diseases, it included a range of nutritional counselling, behavioral support, physical education, and organized physical activity within a hospital-based programme. The control group underwent usual care without any further elements of the intervention program while in the experimental group, this period was 36 months. Changes in physical fitness levels, general well-being, and physical activities were used to determine how effective the intervention was. Over standard treatment for persons with heart diseases, multi-component interventions significantly raised exercise amounts for individuals and their level of physical fitness as well as overall quality of life according to this study. Therefore, it can be concluded that a comprehensive hospital-based approach can have favorable implications for cardiovascular health and quality of life(Bergum et al., 2024)

### **Key Findings of The Study:**

The studies bring to light very important insights into different health interventions across different populations. Gincy A. Lukachan et al. showed in a study that, indeed, a semi-upright sleeping position considerably lessens the seriousness of sleep-disordered breathing, in patients suffering from obstructive sleep apnea, with the sample size of 35 patients representing this study in perioperative patients. A study by Julie Redfern et al. (2024) has returned findings that indicate ITM did significantly help cardiac and pulmonary rehabilitation participants for better adherence and recovery outcomes in a sample size of 257. Mostafa Ghanei et al. (2024) reported that pulmonary rehabilitation benefited Iranian outpatients with mustard gas lung disease by improving respiratory function in a sample size of 60 men. In a separate study, Keir

E. J. Philip et al. (2024) and Hilde Bergum et al. (2024) reported that online singing therapies improve lung health and quality of life for those living with COPD, based on samples of 100 and 228 participants, respectively. Each utilized rigorous designs based on randomized controlled trials, which had comprehensive data analysis techniques to validate the findings

## **Discussion**

Cardio-pulmonary rehabilitation has seen progression over recent years using novel strategies supported by existing data from various RCTs. These papers have examined a range of unique approaches to improving patients with cardiopulmonary disorders' recovery and, subsequently, their quality of life. Based on the following evaluation concerning several types of key trials, the author points out that these newly developing strategies are possibly permitting optimistic changes in the clinical realm. As a result of this paper, the potential uses and outcomes of these new approaches will be evaluated, and potential future directions delineated to contribute to exemplary modern rehabilitation studies.

### **Semi-upright position for obstructive sleep apnea**

This study was conducted to determine the efficiency of Head of Bed End Elevation (HOBE) at 30 degrees to address upper airway obstruction in patients with OSA. It is a prospective case series study that includes 45 patients who underwent drug-induced sleep endoscopy (DISE) as well as polysomnography (PSG). All patients were examined for airway obstruction and collapse at 0 and 30-degree positions. Findings in this study revealed that velum and oropharynx lateral wall collapses were minimized at the angle of 30° elevation without observing any differences concerning tongue base and epiglottis obstructions. There is also a significant improvement in the mean apnea-hypopnea index (AHI) from 23 to 14 in the same study. undefined Average of 3 at 0° to 17. undefined  $1-44 \pm 25.8$  ( $p = 0.05$ ). The experiment then states that a 30° head and trunk elevation will minimize upper airway collapses and the effectiveness of apnea/hypopnea episodes and nightly respiratory disruptions in OSA

patients(Iannella et al., 2022)

### **Cardiopulmonary Exercise Testing**

This paper evaluated the effectiveness of cardiopulmonary exercise testing (CPET) in CAD patients who underwent percutaneous coronary intervention (PCI). In this RCT the interventional group underwent CPET and strengthening exercises and the control group underwent health education and resistance training. Lipid profiles were significantly better in the intervention group along with better cardiopulmonary function, with a decrease in heart rate and fatigue and improved emotional well-being and quality of life of patients where CPET has been identified to deliver potential benefits in CAD patients.(Wang et al., 2024)

### **Singing For Lung Health**

(Kaasgaard et al., 2022) did a post hoc study on the effects of Singing on Lung Health (SLH) in COPD patients which was contrasted to physical exercise training (PEXT). In the next 10 weeks, they observed and quantified changes in lung function, inspiratory muscle strength, dyspnea, and heart rate response. In the 195 SLH patients of the study, 31 % of patients have crossed the 6-Minute Walking Distance Test achieving Minimal Important Distance (MID) and 49 % of patients have crossed the St. George's Respiratory Questionnaire (SGRQ) with Minimal Important Distance (MID). A subgroup analysis found that SLH participants with increased BMI and lower initial 6MWD gained significant increases. No physiologic alterations were detected in the patients undergoing PEXT. From the study, it was evident that SLH improved the physical health and overall quality of life of COPD patients.

### **Integrated text messaging for Rehabilitation**

A cross-sectional survey by Battista et al. assessed the feasibility of using SMS to enhance physical activity outside the CR program. This early-phase randomized controlled pilot trial provided proof that using daily text message reminders can lead to significant increases in moderate physical activity time and a decrease in sedentary behavior compared with the control

group. Moreover, follow-up rates and exercise performance have been significantly higher in the control group; the text messaging was effective in boosting adherence to physical activity after rehabilitation (Foccardi et al., 2021)

On the whole, these studies show how groundbreaking approaches in Cardio-pulmonary Rehabilitation can make a difference. They point to positive shifts and better ways of doing things in clinical settings. If we keep looking into these methods and put them to use, patients with cardiopulmonary problems could get better faster and enjoy a higher quality of life.

### **Pulmonary Rehabilitation**

The research looked at how pulmonary rehabilitation (PR) affects daily activities for people with chronic obstructive pulmonary disease (COPD). Researchers at Ciro, a special center in the Netherlands, studied COPD patients going through a full PR program. They checked how PR changed daily activities by asking patients and measuring their physical activity and function. The results showed that PR helped COPD patients do daily tasks better, based on what patients said. Also, patients moved more after PR doing more medium to hard physical activities. Tests showed patients could exercise longer and do more. These improvements in daily activities and movement led to a better life quality for patients, who said they had less trouble breathing and felt less tired (Vaes et al., 2019).

### **Conclusion**

The present review focuses on the important advancements and potential benefits of several new treatments in cardiopulmonary rehabilitation as evidenced by new randomized controlled trials (RCTs). Research on sleeping in a semi-upright position using text messages structured lung rehabilitation programs, singing to improve lung health, and multi-faceted hospital-based treatments have shown good results in boosting the quality of life and overall health for people with cardiopulmonary problems. These treatments have proven to make daily tasks easier, make people more active, reduce symptoms, and help patients stick to their rehabilitation plans.

Even with these clear benefits, challenges like limits in the healthcare system, referrer awareness, and patients being hesitant still stand in the way of making these rehabilitation strategies available and used.

The results highlight how crucial it is to add new proven methods to regular cardiopulmonary rehabilitation programs. Research down the road should work to further confirm these treatments, tackle current obstacles, and look into more groundbreaking ways to boost patient results. By always fine-tuning and growing rehabilitation programs, health workers can improve how they handle cardiopulmonary diseases. This can lead to better experiences for patients less healthcare burden, and improved health in the long run.

### References

1. Bergum, H., Grimsmo, J., Anderssen, S. A., & Klemsdal, T. O. (2024). Effects on physical activity, physical fitness and well-being in a 36-months randomized controlled study, comparing a multimodal hospital-based intervention programme for primary cardiovascular prevention with usual care. *BMC Cardiovascular Disorders*, 24(1). <https://doi.org/10.1186/s12872-024-03892-1>
2. CPR 10. (n.d.).
3. Foccardi, G., Vecchiato, M., Neunhaeuserer, D., Mezzaro, M., Quinto, G., Battista, F., Duregon, F., Carlon, R., & Ermolao, A. (2021). Effectiveness of text messaging as an incentive to maintain physical activity after cardiac rehabilitation: A randomized controlled pilot study. *International Journal of Environmental Research and Public Health*, 18(12). <https://doi.org/10.3390/ijerph18126645>
4. Forfia, P. R., Vaidya, A., & Wiegers, S. E. (2013). Pulmonary heart disease: The heart-lung interaction and its impact on patient phenotypes. In *Pulmonary Circulation* (Vol. 3, Issue 1, pp. 5–19). Taylor and Francis Inc. <https://doi.org/10.4103/2045-8932.109910>
5. Ghanei, M., Philip, K. E. J., Moghadam, M. R. S., Hosseini, H., Babaie, A.,



- Roustanezhad, M., & Hopkinson, N. S. (2024). Pulmonary rehabilitation in Iranian outpatients with mustard gas lung disease: A randomised controlled trial. *BMJ Open*, 14(5). <https://doi.org/10.1136/bmjopen-2023-083085>
6. Iannella, G., Cammaroto, G., Meccariello, G., Cannavici, A., Gobbi, R., Lechien, J. R., Calvo-Henríquez, C., Bahgat, A., Di Prinzio, G., Cerritelli, L., Maniaci, A., Cocuzza, S., Polimeni, A., Magliulo, G., Greco, A., de Vincentiis, M., Ralli, M., Pace, A., Polimeni, R., ... Vicini, C. (2022). Head-Of-Bed Elevation (HOBE) for Improving Positional Obstructive Sleep Apnea (POSA): An Experimental Study. *Journal of Clinical Medicine*, 11(19). <https://doi.org/10.3390/jcm11195620>
  7. Jones, S. E., Barker, R. E., Nolan, C. M., Patel, S., Maddocks, M., & Man, W. D. C. (2018). Pulmonary rehabilitation in patients with an acute exacerbation of chronic obstructive pulmonary disease. In *Journal of Thoracic Disease* (Vol. 10, pp. S1390–S1399). AME Publishing Company. <https://doi.org/10.21037/jtd.2018.03.18>
  8. Kaasgaard, M., Rasmussen, D. B., Løkke, A., Vuust, P., Hilberg, O., & Bodtger, U. (2022). Physiological changes related to 10 weeks of singing for lung health in patients with COPD. *BMJ Open Respiratory Research*, 9(1). <https://doi.org/10.1136/bmjresp-2022-001206>
  9. Lukachan, G. A., Yadollahi, A., Auckley, D., Gavrilovic, B., Matelski, J., Chung, F., & Singh, M. (2023). The impact of semi-upright position on severity of sleep disordered breathing in patients with obstructive sleep apnea: a two-arm, prospective, randomized controlled trial. *BMC Anesthesiology*, 23(1). <https://doi.org/10.1186/s12871-023-02193-y>
  10. Mampuya, W. M. (2012). Cardiac rehabilitation past, present and future: an overview. *Cardiovascular Diagnosis and Therapy*, 2(1), 38–49.

<https://doi.org/10.3978/j.issn.2223-3652.2012.01.02>

11. Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., Shamseer, L., Tetzlaff, J. M., Akl, E. A., Brennan, S. E., Chou, R., Glanville, J., Grimshaw, J. M., Hróbjartsson, A., Lalu, M. M., Li, T., Loder, E. W., Mayo-Wilson, E., McDonald, S., ... Moher, D. (2021). The PRISMA 2020 statement: An updated guideline for reporting systematic reviews. In *The BMJ* (Vol. 372). BMJ Publishing Group. <https://doi.org/10.1136/bmj.n71>
12. Philip, K. E. J., Buttery, S. C., Bowen, S., Lewis, A., Jeffery, E., Alghamdi, S. M., Williams, P., Alasmari, A. M., Alsulayyim, A. S., Orton, C. M., Conway, F., Chan, L., Vijayakumar, B., Tana, A., Tonkin, J., Perkins, A., Garner, J. L., Srikanthan, K., Sadaka, A., ... Hopkinson, N. S. (2024). Singing for lung health in COPD: a multicentre randomised controlled trial of online delivery. *BMJ Open Respiratory Research*, 11(1). <https://doi.org/10.1136/bmjresp-2024-002365>
13. Redfern, J., Singleton, A. C., Raeside, R., Santo, K., Hafiz, N., Spencer, L., Leung, R. W., Roberts, M., King, M., Cho, J. G., Carr, B., Jenkins, C., Partridge, S. R., Hayes, A., Chow, C. K., & Hyun, K. (2024). Integrated Text Messaging (ITM) for people attending cardiac and pulmonary rehabilitation: A multicentre randomised controlled trial. *Annals of Physical and Rehabilitation Medicine*, 67(3). <https://doi.org/10.1016/j.rehab.2023.101800>
14. Vaes, X. A. W., Delbressine, J. M. L., Mesquita, R., Goertz, Y. M. J., Janssen, D. J. A., Nakken, N., Franssen, F. M. E., Vanfleteren, L. E. G. W., Wouters, E. F. M., & Spruit, M. A. (2019). Impact of pulmonary rehabilitation on activities of daily living in patients with chronic obstructive pulmonary disease. *J Appl Physiol*, 126, 607–615. <https://doi.org/10.1152/jappphysiol.00790.2018.-A>
15. Vos, T., Lim, S. S., Abbafati, C., Abbas, K. M., Abbasi, M., Abbasifard, M.,

- Abbasi-Kangevari, M., Abbastabar, H., Abd-Allah, F., Abdelalim, A., Abdollahi, M., Abdollahpour, I., Abolhassani, H., Aboyans, V., Abrams, E. M., Abreu, L. G., Abrigo, M. R. M., Abu-Raddad, L. J., Abushouk, A. I., ... Murray, C. J. L. (2020). Global burden of 369 diseases and injuries in 204 countries and territories, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. *The Lancet*, 396(10258), 1204–1222. [https://doi.org/10.1016/S0140-6736\(20\)30925-9](https://doi.org/10.1016/S0140-6736(20)30925-9)
16. Wang, L., Mei, F., Min, M., He, X., Luo, L., & Ma, Y. (2024). Adoption of the cardiopulmonary exercise test in the exercise ability and cardiopulmonary function rehabilitation of coronary artery disease (CAD) patients. *BMC Cardiovascular Disorders*, 24(1). <https://doi.org/10.1186/s12872-024-03958-0>