



## A QUINQUENNIAL REVIEW OF ADVANCEMENTS AND EMERGING TRENDS IN CARDIORESPIRATORY PHYSIOTHERAPY-AN EVIDENCE BASED REVIEW.

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### ABSTRACT

The field of Cardiorespiratory in physiotherapy represents a specialized domain that is dedicated to the enhancement of pulmonary function, the optimization of cardiovascular health, and the improvement of overall quality of life for individuals suffering from respiratory and cardiovascular diseases. With the rise in the incidence of chronic conditions such as Chronic Obstructive Pulmonary Disease (COPD), asthma, and complications following COVID-19, innovative physiotherapy interventions have garnered considerable attention. This review aims to provide a comprehensive overview of the latest advancements in cardiorespiratory physiotherapy, encompassing pulmonary rehabilitation, high-intensity interval training (HIIT), airway clearance techniques, and the integration of emerging technologies such as tele-rehabilitation and artificial intelligence (AI)-driven monitoring systems. The recent research highlights the effectiveness of personalized rehabilitation strategies in enhancing exercise tolerance, reducing hospital admissions, and improving patient adherence. The discussion also includes the role of AI and wearable technologies in optimizing physiotherapy outcomes. Despite these advancements, numerous challenges remain, including issues related to accessibility, affordability, and adherence. This review presents findings from recent clinical studies and meta-analyses, offering insights into the dynamic landscape of cardiorespiratory physiotherapy. The paper highlights the necessity for standardized treatment protocols, greater accessibility to tele-rehabilitation services, and further investigation into AI applications within physiotherapy. By evaluating the effectiveness of these interventions, this review adds to the expanding body of evidence that supports innovative physiotherapy methods for individuals with respiratory and cardiovascular disorders.

**KEYWORDS :** Cardiopulmonary rehabilitation, telerehabilitation, AI Enabled Wearables, HIIT.

### INTRODUCTION

The rehabilitation of patients with chronic respiratory diseases, cardiovascular issues, and complications following surgery the Cardiorespiratory physiotherapy is essential. There is a variety of evidence-based interventions aimed at enhancing lung function, maximizing cardiovascular endurance, and improving the overall well-being of patients. In the last decade, the progression of rehabilitation science and medical technology has resulted in more effective physiotherapy interventions, transforming the treatment landscape for respiratory and cardiovascular ailments [1]. A fundamental aspect of cardiorespiratory physiotherapy is Pulmonary rehabilitation. The combined application of drug therapy and pulmonary rehabilitation exercise training contributed to promoting cardiopulmonary function and respiratory muscle recovery in LC patients after thoracoscopic lobectomy. This was crucial for improving the quality of life of patients, as enhanced cardiopulmonary function and respiratory muscle recovery can alleviate postoperative respiratory difficulties, [2]. Furthermore, recent research indicates that High-intensity interval training (HIIT), involving repeated bursts of vigorous exercise ( $>85\%$   $\text{VO}_2$  peak) interspersed with periods of recovery, has been proposed as a more effective alternative [3]. Telerehabilitation has shown a positive impact in many medical fields. It has also proved to be as effective as conventional face-to-face rehabilitation programs. It is a progressing field that has the opportunity to foster fascinating rehabilitation paradigms with an appreciable cost-benefit ratio. [4]. In addition, AI-driven rehabilitation programs have shown assurance in personalizing treatment plans and improving rehabilitation outcomes via predictive analytics and real-time monitoring.

Wearables have proven effective for monitoring hypertension, detecting arrhythmias, and aiding cardiac rehabilitation. In respiratory health, these devices enhance asthma management and continuous monitoring of critical parameters [5]. Despite these advancements, numerous challenges persist. Many patients have faced obstacles in accessing advanced physiotherapy interventions due to economic limitations, lack of awareness, and insufficient healthcare infrastructure. however, the standardization of

rehabilitation protocols continues to be a significant concern. facing these challenges is vital to guarantee that innovative physiotherapy approaches are accessible to all patients.

### Methodology:

This systematic review methodology was employed to evaluate recent studies about advancements in cardiorespiratory physiotherapy. The research articles were gathered from peer-reviewed journals that are indexed in databases such as PubMed, Science Direct, and Google Scholar. The criteria for inclusion in this review were:

1. Research studies published within the last five years (2019–2024).
2. Clinical trials, systematic reviews, and meta-analyses that concentrate on pulmonary rehabilitation, high-intensity interval training (HIIT), tele-rehabilitation, and AI-driven interventions.
3. Studies assessing patient outcomes, adherence rates, and the effectiveness of rehabilitation.

Exclusion criteria encompassed studies lacking empirical data, duplicate publications, and articles that do not possess clinical relevance. The chosen studies were evaluated based on the effectiveness of interventions, patient outcomes, and technological advancements in the field of physiotherapy.

### Literature Review

#### 1. Pulmonary Rehabilitation

Pulmonary rehabilitation has been extensively researched as a beneficial intervention for individuals suffering from COPD, asthma, and complications following COVID-19. Studies indicate that pulmonary rehabilitation (PR) is a fundamental intervention for managing chronic obstructive pulmonary disease (COPD) in individuals who remain symptomatic despite optimal medical therapy. Indeed, it is more cost-effective than any pharmacological treatment. Generally, it improves activity-related symptoms (e.g., dyspnoea and fatigue), exercise capacity and quality of life [7]. Research conducted by Wencheng Tao, suggested that pulmonary rehabilitation exercise training contributed to promoting cardiopulmonary function and respiratory muscle recovery in

LC patients after thoracoscopic lobectomy. This was crucial for improving the quality of life of patients, as enhanced cardiopulmonary function and respiratory muscle recovery can alleviate postoperative respiratory difficulties, increase the physical stamina and activity levels of patients.

Figure 1

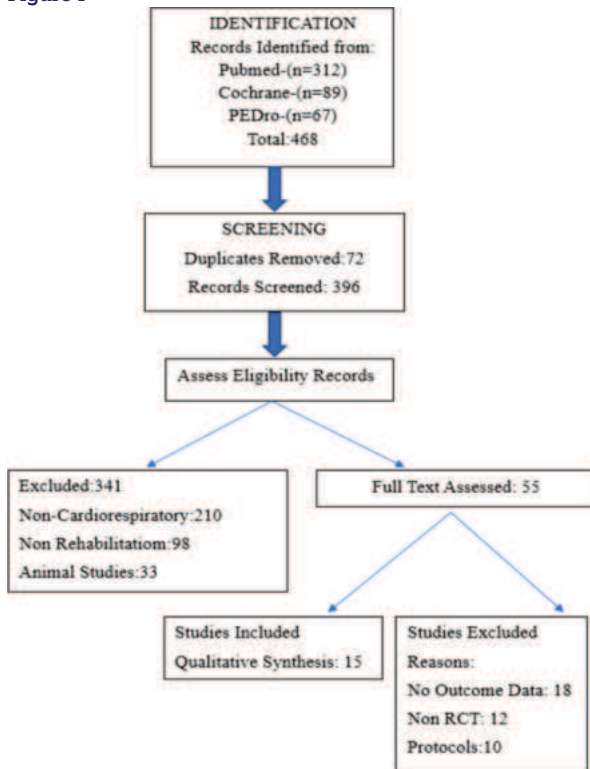


Figure 1: The PRISMA diagram visually outlines the systematic literature search and screening process

## 2. High-Intensity Interval Training (HIIT)

HIIT has surfaced as an effective approach in cardiac rehabilitation. High-intensity interval training was more effective than moderate-intensity exercise training for improving cardiorespiratory fitness in people with coronary artery disease attending cardiac rehabilitation. [3]. Additional research indicates that HIIT boosts autonomic function and diminishes inflammation, establishing it as a superior choice for cardiovascular rehabilitation [9].

## 3. Airway Clearance Techniques

Airway clearance techniques, such as percussion, postural drainage, and oscillatory positive expiratory pressure (OPEP) devices, have been proven to enhance lung function in patients with chronic respiratory ailments. A systematic study conducted by Jennifer Phillips, Annemarie Lee (2020) concluded that airway clearance devices effectively minimize mucus retention and improve respiratory efficiency, and ACTs reported in this review appeared safe for adults experiencing an acute exacerbation in individuals with bronchiectasis [6].

## 4. Tele-Rehabilitation and AI-Based Interventions

Tele-rehabilitation has emerged as a crucial element of contemporary physiotherapy, especially during the COVID-19 pandemic. Research suggests that remote rehabilitation programs enhance patient adherence, eliminate travel-related obstacles, and improve long-term engagement in treatment. alternative modes of pulmonary rehabilitation delivery include home-based models and the use of telehealth. Telerehabilitation is the delivery of rehabilitation services at a distance, using information and communication technology.[8] This review suggests that primary pulmonary

rehabilitation, or maintenance rehabilitation, delivered via telerehabilitation for people with chronic respiratory disease achieves outcomes similar to those of traditional centre-based pulmonary rehabilitation, with no safety issues identified. [8] Furthermore, VR also has the potential to be a therapeutic tool. One of the main clinical applications of VR is to enhance mental health, such as alleviating pain during medical treatments and decreasing stress, depression, and anxiety. VR has also demonstrated significant levels of effectiveness in rehabilitation programs, where the focus is on patient recovery, including motor performance [9].

Table 1

| Intervention Type                       | Key Benefits                                          | Supporting Studies                 |
|-----------------------------------------|-------------------------------------------------------|------------------------------------|
| Pulmonary Rehabilitation                | Improves exercise tolerance, reduces hospitalizations | (Li et al., 2024)                  |
| High-Intensity Interval Training (HIIT) | Enhances peak oxygen uptake                           | Gordon McGregor (2023)             |
| Airway Clearance Devices                | Improves mucus clearance and lung function            | (Jennifer Phillips ,et.al, (2020)) |
| Tele-Rehabilitation                     | Enhances adherence and accessibility                  | (Agnihotri S 2024)                 |
| AI-Based Physiotherapy                  | Provides personalized treatment plans                 | (Vogiatzis & Zakynthinos, 2024)    |

## Findings:

### This Review Has Revealed Several Important Findings:

1. Pulmonary rehabilitation after COVID-19 should be considered an effective therapeutic strategy to improve the functional capacity and quality of life of patients with COVID-19. exercise capacity and decreases hospital admissions for individuals suffering from chronic lung diseases [12].
2. In recent years, growing evidences supported a beneficial effect of HIIT on exercise capacity, cardiovascular function[13]. A systematic review found the superiority of HIIT in improving peak  $\text{VO}_2$  in post-MI patients compared with MICT or other current exercise prescription[14]. HIIT appears to be safe[14]. It shows promising application value and prospects in the rehabilitation of MI patients [14].. Rehabilitation based on High-Intensity Interval Training (HIIT) improves cardiovascular endurance and proves to be more effective than conventional moderate-intensity training.
3. Techniques for airway clearance led to better lung function and less mucus retention in patients with chronic respiratory issues.
4. Tele-rehabilitation initiatives boost patient involvement and compliance with physiotherapy programs.
5. AI-enhanced physiotherapy programs improve the personalization of treatment and lead to better rehabilitation results through the use of predictive analytics.

Table 2- Grade Evidence Quality Ratings For Cardiorespiratory Rehabilitation Interventions

| Intervention  | Risk of Bias                                                    | Inconsistency                            | Indirectness                                     | Precision                   |
|---------------|-----------------------------------------------------------------|------------------------------------------|--------------------------------------------------|-----------------------------|
| Home-based CR | Low robust RCTs with adequate blinding & allocating concealment | Moderate $I^2 = 45\%$ , some variability | None – population and setting match intended use | Serious – CIs somewhat wide |

|                 |                                                     |                                     |                                                                                            |                                                           |
|-----------------|-----------------------------------------------------|-------------------------------------|--------------------------------------------------------------------------------------------|-----------------------------------------------------------|
| Hybrid rehab    | Moderate some unblinded designs                     | Low consistent direction of effects | Some - concerns applied primarily to long-COVID patients rather than broader CR recipients | Moderate – CI overlapping clinically meaningful threshold |
| Asthma training | Low RCTs, minimal bias                              | Low I <sup>2</sup> <30%             | None – directly targeted adult asthma patients                                             | None – tight CIs around effect size                       |
| Digital CBT     | Moderate some studies lacked allocation concealment | High I <sup>2</sup> =65%            | Moderate some protocols used symbols or non-standard delivery                              | Moderate – CI wide, borderline significance               |

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DISCUSSION:

The results suggest that contemporary rehabilitation methods have revolutionized the treatment of cardiorespiratory disorders. Although conventional techniques are still vital, the incorporation of tele-rehabilitation, artificial intelligence, and high-intensity interval training has greatly enhanced patient recovery outcomes. Nonetheless, issues such as cost, accessibility, and standardization need to be tackled to facilitate the broad adoption of these innovations . Future studies should concentrate on refining rehabilitation protocols, enhancing access to advanced treatment options, and investigating the possibilities of AI-based physiotherapy solutions. Furthermore, healthcare policies must evolve to support tele-rehabilitation and technology-oriented treatment strategies .

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