# Don’t fall asleep at the threadmill: the role of pulmonary rehabilitation in improving sleep in COPD.

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## WHAT IS CHRONIC OBSTRUCTIVE PULMONARY DISEASE?

Chronic Obstructive Pulmonary Disease (COPD) is characterized by persistent and progressive airflow obstruction, usually associated with chronic bronchitis and pulmonary emphysema. These alterations contribute to symptoms such as dyspnea, excessive mucus production and fatigue. The diagnosis is confirmed by spirometry when the $FEV_1$/FVC ratio is lower than 0.70 after the use of bronchodilator [(1)].

## SYSTEMIC MANIFESTATIONS

Although the general disease definition involves essentially respiratory features, COPD is strongly associated with several systemic alterations, including peripheral muscle dysfunction [(2)], low levels of physical activity [(3)], increased time spent in sedentary behavior [(4)], reduced functional capacity and a high prevalence of psychological disorders such as anxiety and depression [(5)]. Together, these alterations contribute to poorer quality of life, greater exercise intolerance and increased risk of mortality.

## THE ROLE OF PULMONARY REHABILITATION

Pulmonary rehabilitation (PR) is an important strategy to mitigate both respiratory and systemic effects of COPD. The benefits of PR in individuals with COPD are widely recognized through consolidated evidence. This multidimensional intervention reduces dyspnea and fatigue while improving quality of life, exercise capacity and muscle strength. Beyond the known solid effects of PR in these outcomes, research has more recently begun to explore other gaps in disease management. Among them, sleep disturbances have emerged as a relevant and potentially modifiable yet still underexplored factor, which is related to symptom control and the overall burden of COPD [6].

## WHAT IS THE RELATIONSHIP BETWEEN SLEEP AND COPD?

The answer for this question largely involves physiological issues. During sleep, changes occur in respiratory control and ventilatory mechanics, including loss of voluntary control of ventilation, reduced ventilatory response to chemical stimuli and hypotonia of the respiratory muscles—changes that generally have no clinically relevant consequences in healthy individuals. However, in people with COPD, these changes may further overload an already compromised respiratory system [7].

In this context, nocturnal oxygen desaturation, increased upper airway resistance, bronchoconstriction and worsened lung hyperinflation may occur [8]. Now imagine this scenario repeating itself every night, over the course of years.

It is therefore not surprising that sleep-related difficulties are among the most common complaints of individuals with COPD [9]. Poor sleep affects approximately 75% of individuals with COPD [10]. Additionally, poor sleep may worsen several of the disease's systemic manifestations [11-13] and impact disease severity and the risk of mortality [14].

Taking this into account, a natural question arises: how can we intervene in these sleep-related difficulties and their multiple consequences? For example: in addition to improving all the previously mentioned outcomes, could PR also improve sleep parameters? And we already know the answer for this question: yes, it can!

## PULMONARY REHABILITATION AND SLEEP IN COPD

Around 2013 and 2014, some clinical trials suggested that, alongside all known and well-established benefits, PR could also improve subjective sleep quality, usually assessed through questionnaires [15-16]. Later studies also began to report reductions in daytime sleepiness following PR programs [17].

Between 2021 and 2023, more recent investigations suggested that not all patients respond equally to sleep-related interventions [18]. Some studies indicate the existence of patient subgroups that may be more responsive, particularly those who already present more pronounced alterations in sleep patterns at baseline [19]. This also applies when assessing sleep parameters through objective methods such as actigraphy.

And even more recently, in 2025, the first systematic review with meta-analysis specifically dedicated to investigating this relationship was published [20]. Results indicate consistent evidence that PR can have beneficial effects on sleep quality in individuals with COPD, particularly when sleep is assessed subjectively using the Pittsburgh Sleep Quality Index (PSQI). Benefits include improvement in overall sleep quality, efficiency and latency [20].

## WHAT REMAINS TO BE BETTER UNDERSTOOD?

Despite the progress made so far, we are still far from the full picture. The impact of PR on sleep parameters assessed objectively (i.e., not self reported) has not yet been fully elucidated. The same applies when considering the outcome of sleep fragmentation.

Although most studies include aerobic training and muscle strengthening as components of PR, there is still a lack of standardization regarding the duration and frequency of interventions.

Another crucial point is that sleep is still mostly investigated merely as another outcome of PR (among many others), rather than as a potential treatable trait or as part of the intervention itself. If PR programs aim to improve sleep, they must incorporate specific interventions targeting this outcome, in addition to the traditional model. These specific interventions may, for example, include educational sessions addressing topics such as sleep disorders, sleep hygiene habits and behavior change. Another possibility is the addition of nocturnal non-invasive ventilation (NIV), especially in cases of more severe sleep impairment and in the presence of obstructive sleep apnea (OSA). After all, expecting different results while using the same methods is almost always an ineffective strategy.

**FINAL MESSAGE**

Sleep disturbances have always hindered the lives of so many individuals with COPD, but for a long time this important feature of the disease has been absent from our aims and interventions. Current evidence suggests that PR can indeed contribute to improving sleep in COPD. However, for this potential to be fully explored, sleep must move beyond being merely a secondary outcome and take a more central place in care strategies. Perhaps the next big step in PR is not only to help these patients breathe better during the day, but also to sleep better at night.

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