

# Correlation of Sleep Quality with Cognition, Exercise Capacity, and Fatigue in Patients with Chronic Respiratory Diseases

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## ABSTRACT

**Background:** Sleep is an important component for person's well-being. It is a basic human need.<sup>1</sup> Studies have reported increased incidence of cognitive errors and increased fatigue in sleep-deprived normal individuals after 8 hours of work.<sup>2</sup> Sleep quality is known to be affected in COPD patients but less studied in other chronic respiratory diseases though the symptoms may be the same. This study aims to assess sleep quality in patients suffering from both COPD and non-COPD respiratory conditions and correlate sleep quality with cognition, exercise capacity, and fatigue in patients with chronic respiratory diseases.

**Material and methodology:** An observational cross-sectional study consisting of 142 stable chronic respiratory disease patients was conducted from September 2016 to March 2017. Sleep quality was evaluated using Pittsburgh sleep quality index (PSQI), cognition using montreal cognitive assessment (MoCA), exercise capacity was measured with incremental shuttle walk test, and fatigue with fatigue severity scale (FSS).

**Results:** Spearman's test was used to assess correlation of sleep quality with cognition, exercise capacity, and fatigue. Significant but very weak and poor inverse correlation of sleep quality was found with cognition and exercise capacity, respectively, whereas there was weak and linear correlation of sleep quality with fatigue. There was no significant difference in sleep quality of COPD and non-COPD patients as well as hypoxemic and non-hypoxemic patients.

**Conclusion:** Though there is very weak correlation of sleep quality with cognition, sleep quality is poor in 55.63% of patients and cognition is affected in 93.6% of patients ( $n = 133$ ).

**Clinical significance:** Sleep quality should be assessed regularly as a part of primary assessment in all chronic respiratory disease patients.

**Keywords:** Chronic respiratory diseases, Cognition, Exercise capacity, Fatigue, Sleep quality.

**Key Message:** Evaluation of sleep quality must be included in routine assessment of patients with chronic respiratory diseases.

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## INTRODUCTION

Sleep is essential for a person's health and well-being. Sleep disturbances in chronic respiratory diseases may have an impact on quality of life and health outcome measures. Significant differences have been observed in quality and quantity of sleep between patients with stable mild to moderate chronic obstructive pulmonary disease (COPD) and normals.<sup>1</sup> Chen et al. studied sleep quality and functional capacity in COPD patients and concluded that shorter 6MWD, greater age, worse quality of life, and more depression were seen in subjects with poor sleep quality. Though sleep quality assessment has been done in COPD patients, its correlation with cognition, exercise capacity, and fatigue has not been studied. Also, whether non-COPD patients with respiratory diseases also have impaired sleep quality is not known. This study aimed to assess the correlation of sleep quality with cognition, exercise capacity, and fatigue in patients with chronic respiratory diseases.

## MATERIALS AND METHODS

An observational, cross-sectional study was undertaken after obtaining ethical clearance from Institutional Ethics Committee of the tertiary care hospital. Stable chronic respiratory disease patients diagnosed by chest physician were recruited during 6-month period from October 2016 to March 2017.

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One-hundred forty-two patients of either sex in the age range of 30–60 years were included. Patients with COPD, bronchial asthma (BA), and obstructive airway disease (OAD) were clubbed together in COPD group considering their similar obstructive pattern, while non-COPD group consisted of patients with infectious diseases such as pulmonary tuberculosis (PTB), bronchiectasis, and allergic bronchopulmonary aspergillosis (ABPA).

Patients with obstructive sleep apnea, active tuberculosis, primary cardiac disorder, lung cancer, and neuromuscular disorder, and those with difficulty in hearing and cognition were excluded from the study.

Each patient was interviewed for demographic data and history after obtaining written informed consent from them. Scales to evaluate sleep quality, fatigue, and cognition were administered to the patients through interview method in local language after obtaining permissions from respective authors.

Sleep quality was assessed using Pittsburgh sleep quality index (PSQI). It consists of seven components—subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of medications, and daytime dysfunction.

Each component is scored from one to three. Total possible score is 21. The greater the score, the poorer is the sleep quality. A subject having global score of >5 is considered as having poor sleep quality. PSQI has diagnostic sensitivity of 89.6% and specificity of 86.5% ( $\kappa = 0.75, p < 0.001$ ).<sup>2</sup>

Montreal Cognitive Assessment (MoCA) tool was used to evaluate the cognitive level. It has total possible score of 30; a score of >26 is considered as normal. It consists of seven components: spatial/executive, naming, attention, language, abstraction, delayed recall, and orientation (internal consistency—Cronbach's  $\alpha$  0.83, sensitivity—90%, and specificity—100%). This test has high retest reliability with a mean change of  $0.9 \pm 2.5$  points and a retest correlation of 0.92,  $p, 0.001$ .<sup>3</sup>

Fatigue Severity Scale (FSS) was used to measure fatigue. It consists of nine questions scored on the basis of Likert scale of agreement from 1–7. Total possible score is 63. The greater the score, the more severe is the fatigue (internal consistency—0.751, Cronbach's  $\alpha$  coefficient—0.93, and construct validity—0.491).<sup>4</sup>

Exercise capacity and exercise-induced hypoxemia were measured on performance of incremental shuttle walk test (ISWT) through standardized protocol as per Singh et al. ISWT is a maximal walk test in which patient repeatedly walks to and fro on the beats of an audiotape. Each lap is 10 m. The speed gradually increases at every level from 0.5 m/s in level one to 2.37 m/s in level 12. Peak maximal oxygen consumption was measured using a derived formula [ $VO_2 \text{ peak} = 4.19 + (0.025 * \text{Distance})$ ].<sup>5</sup> Patients were classified as hypoxemic if their saturation dropped  $\geq 4\%$  on performing the incremental shuttle walk test.<sup>6</sup>

## RESULTS

Data were analyzed using SPSS version 16.  $p$  value of  $< 0.05$  was considered as statistically significant at confidence interval of 95%. Spearman correlation coefficient was used to find the correlation of sleep quality with cognition, exercise capacity, and fatigue. In order to compare sleep quality in hypoxemic and non-hypoxemic patients, Chi-square test was applied. Sleep quality in COPD and non-COPD patients was also compared with Chi-square test.

There were 49.3% males ( $n = 70$ ) and 50.7% females ( $n = 72$ ) with a mean age of  $45.89 \text{ years} \pm 9.52$  (Table 1). Moreover, 48.59% of patients ( $n = 69$ ) belonged to COPD group, whereas 51.40% of patients ( $n = 73$ ) belonged to non-COPD group. Mean body mass index was  $23.67 \text{ kg/m}^2 \pm 4.5$ . Mean modified Medical Research Council grade was  $1.12 \pm 0.67$ .

Sleep quality was impaired in 55.63% of patients ( $n = 79$ ). Mean PSQI score was  $6.54 \pm 3.38$ . Overall cognition was found to be impaired in 93.6% of patients ( $n = 133$ ). Mean MoCA score was

18.8, and significant fatigue was seen in 44.36% of patients ( $n = 63$ ). Mean FSS score was 4.62 (Table 1).

Exercise capacity was reduced in all patients. Mean distance covered was  $301.62 \pm 133.728 \text{ m}$ , and mean  $VO_2$  was  $11.735 \text{ mL/kg/minute}$  with the mean score of  $3.36 \text{ METs} \pm 0.95$ . Patients were not hypoxemic at rest, but irrespective of exercise-induced hypoxemia, sleep quality and exercise capacity were impaired in all patients. Moreover, 45.77% of patients ( $n = 65$ ) showed hypoxemic response to exercise, whereas 54.22% of patients ( $n = 77$ ) showed non-hypoxemic response to exercise on ISWT. On comparing sleep quality between the two groups, it was found to be statistically insignificant ( $6.8 \text{ vs } 6.25, p = 0.393$ ).

An inverse correlation was found between sleep score and cognition as well as sleep score and exercise capacity, and it suggests that the higher the sleep score, the poorer is the cognition and exercise capacity (sleep with cognition:  $p = 0.004, \rho = -0.243$ ; sleep with exercise capacity:  $p = 0.026, \rho = -0.187$ ). The linear correlation found between sleep quality and fatigue ( $p = 0.0001, \rho = 0.483$ ) indicates that the greater the sleep score, the more is the fatigue (Table 2). Sleep quality was found to be affected in COPD as well as non-COPD groups, but the difference was not statistically significant ( $7.18 \text{ vs } 5.93, p = 0.402$ ) (Table 3).

## DISCUSSION

We found that there is significant correlation of sleep quality with cognition, exercise capacity, and fatigue in patients with chronic respiratory diseases. Sleep quality was impaired in 55.63% of subjects ( $n = 79$ ). Nocturnal hypoxemia, higher age, severity of COPD, concomitant medications, underlying depression, periodic limb movements, hyperinflation, and any underlying sleep-related disorders are some of the contributing factors to poor sleep quality in COPD. As given in Table 4, the highest proportion of patients had sleep disturbance because of nocturia. Nocturia—excessive

**Table 1:** Means and standard deviations of age, PSQI, MoCA, FSS and  $VO_2$  peak

Variable	Mean $\pm$ SD	Minimum–maximum
Age (in years)	$45.89 \pm 9.52$	30–60
PSQI	$6.54 \pm 3.38$	0–21
MoCA	$18.8 \pm 4.76$	0–30
FSS	$4.62 \pm 1.74$	0–9
$VO_2$ peak (in METs)	$3.35 \pm 0.95$	1.48–6.76

**Table 2:** Correlation of sleep quality with cognition, exercise capacity, and fatigue

Correlation of	Rho	$p$ value
Sleep quality with cognition	-0.243	0.004
Sleep quality with exercise capacity	-0.187	0.026
Sleep quality with fatigue	0.483	0.0001

**Table 3:** Comparison of sleep quality between hypoxemic and non-hypoxemic as well as COPD and non-COPD patients

PSQI score	Mean $\pm$ SD, $p$ value	$p$ value
Hypoxemic vs non-hypoxemic	$6.8 \pm 3.5 \text{ vs } 6.25 \pm 3.28$	0.393
COPD vs non-COPD	$7.18 \pm 3.52 \text{ vs } 5.93 \pm 3.15$	0.402

**Table 4:** Percentage-wise distribution of patients according to the reason for sleep disturbance

<i>Reason for sleep disturbance</i>	<i>% of patients</i>
Nocturia	73.84
Coughing/snoring	53.84
Dyspnea	32.3
Stress	6.9
Noise	3.52
Musculoskeletal pain	5.63

**Table 5:** Component-wise mean scores of PSQI scale in patients with chronic respiratory disease

<i>Component</i>	<i>Mean score</i>
Subjective sleep quality	1.15
Sleep latency	1.5
Sleep duration	1.3
Habitual sleep efficiency	0.37
Sleep disturbances	0.96
Use of medications	0.0634
Daytime dysfunction	1.26

urination at night being one of the primary causes of sleep disturbance—showed effect on functioning, quality of life, health, and productivity.<sup>7,8</sup>

As given in **Table 5**, sleep latency was the most affected component, which indicates that these patients take more than 15 minutes to fall asleep, whereas normal healthy individuals take 6.1–10 minutes.<sup>9</sup> When sleep quality was compared in hypoxemic and non-hypoxemic patients, we found it was affected in both the groups and no statistically significant difference between them. This implies that like hypoxemic patients, non-hypoxemic patients also suffer from equal affection in sleep quality and sleep quality is impaired, irrespective of the presence of hypoxemia.

Cognitive decline is seen in patients with chronic respiratory disease.<sup>10</sup>

Moreover, 93.7% of patients ( $n = 133$ ) had impaired cognition. Impaired cognition was found in both hypoxemic and non-hypoxemic patients. This correlates with the study done by Diptiwich, which concluded that there is significant amount of cognitive impairment in stable non-hypoxemic COPD patients also.<sup>11</sup> Poor and short sleep is associated with and may even precede cognitive declines in middle-aged adults. A recent study showed that sleep disorders increase the cognitive impairment and severity of disease in COPD patients.<sup>12</sup>

Physiological effects of poor sleep include fatigue also. Fatigue is another factor, which affects quality of life in chronic respiratory disease patients. These patients describe fatigue as feeling of generalized tiredness and sapped energy that occurs daily, sometimes persistently, or with exacerbation of the disease.<sup>13</sup> It contributes to general decline in performing activities of daily living. Moreover, 63.4% of patients ( $n = 90$ ) in this study had significant fatigue. Dyspnea, exacerbation frequency, time spent outdoors, and health status are some of the known factors related to fatigue.<sup>14</sup> As seen from this study, it can be said that sleep is the other important contributing factor to fatigue. When COPD patients were studied in two groups of high and low fatigue,

exercise capacity was found to be more reduced in high fatigue group. Decreased sleep has been found to increase energy expenditure.<sup>15</sup> Also, it is known to cause metabolic dysregulation, which impairs the muscle function, thereby inducing fatigue and reducing the exercise capacity.

Sleep quality has been closely related to exercise capacity in COPD patients.<sup>15</sup>

Reduced exercise tolerance is predominantly because of dyspnea in case of chronic respiratory diseases. In our study, we found reduced exercise capacity in both COPD and non-COPD groups.

## CLINICAL IMPLICATIONS

Considering the psychological burden placed by the management of chronic respiratory disease on these patients regarding the use and timing of medications, an exercise protocol as well as lifestyle modifications advised by physical therapist, improving and maintaining cognitive level become vital. As seen in this study, sleep quality is correlated significantly with cognition. But sleep quality is routinely assessed mostly in obstructive sleep apnea patients. Although, in this study, patients with OSA were excluded, it is found that sleep quality is impaired in these patients also and it is significantly correlated with extrapulmonary symptoms like cognition, exercise capacity, and fatigue. Hence, routine assessment of sleep quality should be included in the evaluation of patients with chronic respiratory diseases. Measures to improve sleep quality like sleep hygiene should be practiced as a part of pulmonary rehabilitation. The problem of cognitive decline can be tackled by using cognitive exercises such as memory games. These patients suffer from significant levels of fatigue, which impairs their daytime functioning by increased energy demands. Incorporation of energy conservation techniques and activity pacing would help in reducing the fatigue levels. All the factors will help in improving the quality of life of these patients.

## CONCLUSION

There is significant correlation of sleep quality with cognition, exercise capacity, and fatigue in patients with chronic respiratory diseases.

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