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Association of sleep with symptoms of anxiety and depression in individuals with chronic obstructive pulmonary disease

Associação do sono com sintomas de ansiedade e depressão em indivíduos com doença pulmonar obstrutiva crônica

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Abstract

Background: Chronic obstructive pulmonary disease (COPD) is primarily a respiratory condition, although it also presents extrapulmonary effects such as sleep disturbances and symptoms of anxiety and depression. Although sleep plays a crucial role in COPD, previous research on its association with mental health has focused mainly on hospitalized patients, with few studies examining individuals in stable conditions. **Aim:** To correlate subjectively and objectively assessed sleep quality with levels of anxiety and depression in individuals with stable COPD, and to investigate how sleep characteristics influence these symptoms in this population**. Methods:** In this cross-sectional study, participants underwent the following assessments: spirometry; screening for anxiety and depression symptoms using the Hospital Anxiety and Depression Scale (HADS); subjective sleep quality assessment using the Pittsburgh Sleep Quality Index (PSQI); and objective sleep measurement with actigraphy. Statistical analyses included the Shapiro–Wilk test, Spearman's correlation coefficient and simple linear regression. A *p*-value < 0.05 was considered statistically significant. **Results:** A total of 36 individuals diagnosed with COPD were evaluated. Moderate correlations were observed between PSQI scores and both the anxiety and depression domains of the HADS. Simple linear regression indicated that PSQI scores were influenced by HADS results. No significant correlations were found between HADS scores and objectively measured sleep variables. **Conclusion:** In individuals with stable COPD, subjectively assessed sleep quality showed a moderate correlation with symptoms of anxiety and depression, suggesting an interdependent relationship between these variables. However, no association was found between objectively measured sleep and symptoms of anxiety and depression in this population.

Keywords: Chronic Obstructive Pulmonary Disease; Sleep; Anxiety; Depression.

Resumo

Introdução: A doença pulmonar obstrutiva crônica (DPOC) é uma doença essencialmente respiratória, mas com repercussões extrapulmonares, como comprometimento do sono e sintomas de ansiedade e depressão. Apesar da relevância do sono na DPOC, pesquisas prévias da sua associação com a saúde mental focaram apenas em indivíduos hospitalizados, carecendo de investigações em condições estáveis. **Objetivo:** Correlacionar a qualidade do sono avaliado subjetivamente e objetivamente com níveis de ansiedade e depressão em indivíduos com DPOC estável e investigar a influência das características do sono sobre esses sintomas nessa população. **Métodos:** Neste estudo transversal, os indivíduos foram submetidos à espirometria, rastreio de sintomas de ansiedade e depressão pela Escala Hospitalar de Ansiedade e Depressão (HADS), avaliação da qualidade do sono subjetivo pelo Índice de Qualidade do Sono de Pittsburgh (PSQI) e mensuração do sono objetivo por actígrafo. Para análise estatística utilizou-se os testes de Shapiro-Wilk, coeficiente de Spearman e regressão linear simples com um *p*<0,05 representando significância estatística. **Resultados:** Estudou-se 36 indivíduos com diagnóstico de DPOC. Encontrou-se correlações moderadas do PSQI com a escala HADS domínio ansiedade e depressão. A regressão linear simples mostrou que o PSQI é influenciado pela escala HADS. Não foi encontrada correlação significativa entre a escala HADS e variáveis de sono avaliado objetivamente. **Conclusão:** Em indivíduos com DPOC estável, a qualidade do sono avaliado subjetivamente correlacionou-se moderadamente com sintomas de ansiedade e depressão, assim como há relação de influência entre essas variáveis. Entretanto, não há correlação entre o sono avaliado objetivamente e sintomas de ansiedade e depressão nessa população.

Palavras-chave: Doença Pulmonar Obstrutiva Crônica; Sono; Ansiedade; Depressão.

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INTRODUCTION

Chronic obstructive pulmonary disease (COPD) is characterised by airflow obstruction[1], with smoking being the main causal factor[2]. The structural changes involved range from destruction of the lung parenchyma to narrowing of the airways and decreased lung compliance[3]. These changes lead to the characteristic symptoms of the disease, among which dyspnoea is the most reported[4]. In addition, most individuals present extra-pulmonary clinical manifestations and associated comorbidities such as peripheral muscle dysfunction, nutritional changes, cardiovascular and metabolic problems, as well as psychological aspects such as anxiety, depression, and sleep disorders, which are associated with morbidity and mortality in this population[1,5].

The repercussions of anxiety and depression often overlap with the symptoms of COPD[6], which were previously associated with dyspnoea, exacerbation of symptoms, and increased hospitalisations[7,8]. In addition, sleep disorders feature among the main complaints of individuals with COPD[9], characterised by increased sleep latency, longer time awake after sleep onset, fragmentation, and reduction in total sleep time[10], as well as high rate of awakenings and low sleep efficiency[11]. All these impairments can be partially explained by unfavourable respiratory biomechanics during sleep, making this period a challenge for the respiratory system of individuals with COPD[12]. Thus, it is key to further investigate different aspects of sleep and its associations, such as mental/psychological health, for better management of the disease. However, to the best of our knowledge, only one study has addressed the relationship between sleep and psychological aspects in individuals exacerbated by the disease, thus remaining a gap regarding stable individuals.

Therefore this study aimed to investigate the associations and possible influences between sleep characteristics (assessed both objectively and subjectively) and symptoms of anxiety and depression in individuals with stable COPD.

METHODS

This is a cross-sectional study conducted at the Pulmonary Physiotherapy Research Laboratory (*Laboratório de Pesquisa em Fisioterapia Pulmonar* – LFIP) of the State University of Londrina (*Universidade Estadual de Londrina* – UEL), in the state of Paraná (PR). This study is a sub-analysis of the baseline data from a cohort study approved by the Research Ethics Committee of the State University of Londrina (opinion number 3,471,646). Participants were recruited through convenience sampling from the Pulmonology and Respiratory Physiotherapy outpatient clinics of the UEL Clinical and University Hospitals, respectively, and signed an informed consent form.

The following inclusion criteria were applied: clinical diagnosis of COPD, established according to the criteria of the Global Initiative for Chronic Obstructive Lung Disease (GOLD 2023)[1]; clinical stability, *i.e.*, absence of exacerbations or infections in the last month; absence of severe or unstable heart disease; and absence of osteomioarticular changes that could limit the assessments. The exclusion criterion was failure to use the sleep monitor for the minimum time considered acceptable for a valid assessment (more details below in the section "Objective assessment of sleep quality").

Assessments

Pulmonary function

Pulmonary function was assessed by spirometry using a body plethysmograph (Vmax Series®, Vyasis, Germany). The techniques were performed according to the guidelines of the American Thoracic Society[13], determining forced expiratory volume in the first second (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio before and after the use of bronchodilator. The reference values used followed Pereira et al.[14] and Neder et al.[15]

Subjective assessment of sleep quality

Sleep quality was assessed through the Pittsburgh Sleep Quality Index (PSQI)[16], a questionnaire consisting of 19 self-administered questions and five questions answered by the bed partner. The latter were used for clinical information only. All 19 questions are categorised into seven components, rated between 0 and 3. The following PSQI components are addressed: subjective sleep quality (C1); sleep latency (C2); sleep duration (C3); habitual sleep efficiency (C4); sleep disturbances (C5); use of sleep medication (C6); and daytime disturbances (C7). The sum of the scores for the seven components provides an overall score, which ranges from 0 to 21, with the maximum score indicating the worst sleep quality. An overall PSQI score greater than 5 indicates significant difficulties in at least two components or moderate difficulties in more than three components[16].

Objective assessment of sleep quality and duration of blocks of sleep and wakefulness

Objective assessment of sleep quality and duration of blocks of sleep and wakefulness was performed using the Actiwatch® actigraph (Philips Respironics, United States of America)[17]. The participant wore the actigraph device on the non-dominant wrist for 24 hours, for seven consecutive days. Throughout these days, individuals were instructed to fill out a sleep diary containing information about bedtime and wake-up time, whether they needed to get up during the night, and whether they had episodes of daytime napping. The minimum acceptable time of use for the assessment to be considered valid was four days, 24 hours/day.

Symptoms of anxiety and depression

The Hospital Anxiety and Depression Scale (HADS)[18] is an instrument composed of 14 items and two domains: the anxiety subscale (HADS-A, with seven items) and the depression subscale (HADS-D, with seven items). The instrument was used only for screening symptoms and not as a diagnostic criterion. The seven questions about depression measure cognitive and emotional aspects of depression (depressive symptoms), predominantly anhedonia, while the remaining seven questions refer to anxiety symptoms. The HADS uses a four-point Likert scale, ranging from zero to three points. The overall score ranges from zero to 42, with intervals from zero to 21 for the subscales, with higher scores indicating greater severity of anxiety and depression symptoms. Within each subscale, individuals can be classified according to the severity of the disorder as follows: 0 to 7 – normal; 8 to 10 – mild; 11 to 15 – moderate; and ≥ 16 – severe symptoms[18].

Statistical analysis

The Shapiro-Wilk test was used to analyse the normality of data distribution. Data were described as mean ± standard deviation or median [25–75% interquartile range]. Correlations between the subjective and objective assessment of sleep characteristics and symptoms of anxiety and depression were investigated through the Spearman's correlation coefficient, proceeding to simple linear regression upon relevant findings (*i.e.*, at least moderate Spearman's correlation). Data were organised on Microsoft Excel software, and statistical analysis was performed on IBM SPSS 20.0 software, with a *p*-value of <0.05 being adopted.

RESULTS

Table 1 describes all demographic and clinical characteristics of the individuals studied. The table shows that 36 individuals diagnosed with COPD were included, including 20 women, with a mean age of 69±8 years, body mass index (BMI) ranging from normal to overweight, and airflow obstruction ranging from moderate to severe. In addition, the sample showed poor sleep quality and signs of anxiety and mild depression.

Table 2 shows the characteristics of the objective assessment of sleep. Overall, individuals spent approximately 7.8 hours lying in bed per night; however, the actual amount of sleep was approximately six hours. Individuals spent more than one hour per night awake after falling asleep, and the number and duration of blocks of sleep and wakefulness during sleep cycles indicate highly fragmented sleep.

Tables 3 and 4, respectively, show the correlations between the objective assessment of sleep and symptoms of anxiety and depression using the HADS scale. The variables showed both positive and negative correlations, but with low values reaching no statistical significance or clinical relevance.

The associations between the subjective assessment of sleep by the PSQI questionnaire and the HADS presented moderate and statistically significant correlations with

Table 1. Demographic and clinical characteristics of the total sample.

Variables	N = 36
Age, years	69 ± 8
Sex M/F, n	16 / 20
Weight, kg	66 [61 – 88]
Height, cm	160 ± 8
BMI, kg/m^2	28 ± 5
FVC, litres	2.61 ± 0.66
FVC, predicted %	82 ± 16
FEV_1, litres	1.39 ± 0.46
FEV_1, predicted %	57 ± 19
FEV_1 / FVC, predicted %	53 ± 11
PSQI, scores	9 [7 – 12]
HADS anxiety scores	6 [3 – 12]
HADS depression scores	6 [1 – 10]

Values are presented as mean ± standard deviation, median [interquartile range], or frequency. M: male; F: female; BMI: body mass index; FVC: forced vital capacity; FEV_1: forced expiratory volume in the first second; PSQI: Pittsburgh Sleep Quality Index; HADS: Hospital Anxiety and Depression Scale.

Source: Elaborated by the authors based on research data.

Table 2. Objective assessment of sleep characteristics in the total sample.

Variables	N = 30
Sleep start time, hours: minutes	22:15 [21:57 – 23:49]
Sleep end time, hours: minutes	6:38 [6:06 – 7:33]
Total registration time, min	473 ± 69
Total sleep time, min	395 ± 74
Efficiency, %	79 ± 11
Latency, min	15 ± 20
WASO, min	79 ± 45
Wakefulness blocks, n	38 ± 16
Average wakefulness blocks, min	2.05 ± 0.75
Sleep blocks, n	38 ± 16
Average sleep blocks, min	60 ± 141

Values are presented as mean ± standard deviation or median [interquartile range]. WASO: Wake time After Sleep Onset.

Source: Elaborated by the authors based on research data.

Table 3. Correlation between objectively assessed sleep and the HADS scale in the anxiety domain.

Variables	*r*	*p*
Sleep start time, hours: minutes	0.079	0.680
Sleep end time, hours: minutes	0.200	0.288
Total registration time, min	- 0.005	0.978
Total sleep time, min	- 0.118	0.536
Efficiency, %	- 0.245	0.191
Latency, min	- 0.253	0.178
WASO, min	0.289	0.121
Wakefulness blocks, n	0.206	0.275
Average wakefulness blocks, min	0.211	0.282
Sleep blocks, n	0.224	0.233
Average sleep blocks, min	- 0.191	0.313

WASO: Wake time After Sleep Onset, or time awake after sleep onset.
Source: Elaborated by the author based on survey data.

Table 4. Correlation between objectively assessed sleep and the HADS scale in the depression domain.

Variables	*r*	*p*
Sleep start time, hours: minutes	- 0.062	0.746
Sleep end time, hours: minutes	0.220	0.243
Total registration time, min	0.113	0.483
Total sleep time, min	- 0.061	0.747
Efficiency, %	- 0.284	0.129
Latency, min	- 0.064	0.736
WASO, min	0.327	0.078
Wakefulness blocks, n	0.222	0.239
Average wakefulness blocks, min	0.210	0.282
Sleep blocks, n	0.234	0.214
Average sleep blocks, min	- 0.188	0.321

WASO: Wake After Sleep Onset, or time awake after sleep onset.
Source: Elaborated by the author based on survey data.

both the anxiety domain (r = 0.510; p = 0.002) and the depression domain (r = 0.603; p < 0.001). Figure 1 illustrates the positive correlations between PSQI and HADS scores, indicating that poorer subjective sleep quality is correlated with more severe symptoms of anxiety and depression.

Given the moderate correlations, a simple linear regression was performed between the subjective assessment of sleep and symptoms of anxiety and depression (Table 5). The simple linear regression showed that the PSQI is significantly influenced by both the HADS depression [R^2=0.329; p=0.001] and anxiety domains [R^2 = 0.260; p<0.001].

Finally, considering the sample of 36 individuals, with an effect size of 0.5 and an α error probability of 0.05, a power of 0.91 was achieved.

DISCUSSION

To the best of our knowledge, this is the first study to show an association between the subjective assessment of sleep quality and symptoms of anxiety and depression, as well as the relationship of the influence of these variables in individuals with stable chronic obstructive pulmonary disease. Sleep assessment by actigraphy showed that individuals had reduced sleep compared to the National Sleep Foundation's sleep recommendations for older adults. In addition, individuals also spent more than one hour per night awake and had highly fragmented sleep. Our results corroborate the findings of Valipour et al., in which individuals with COPD had lower overall sleep efficiency and shorter total sleep time compared to the control group matched

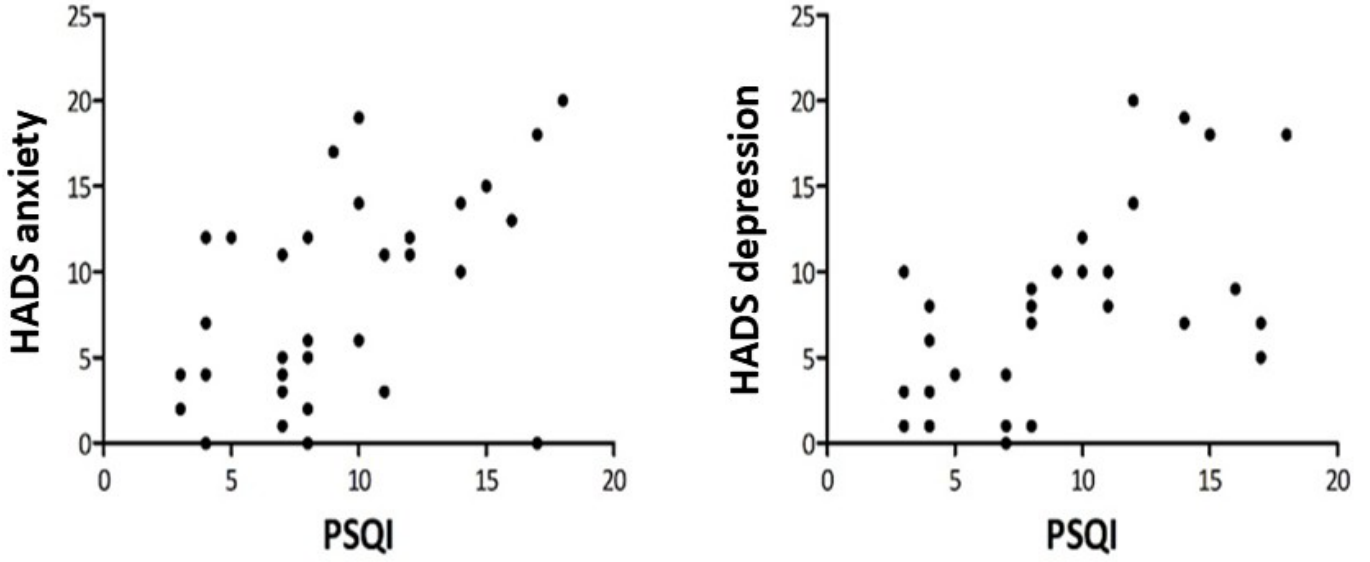

Figure 1. Correlation between sleep assessed subjectively using the PSQI and the HADS scale in the anxiety domain (r = 0.510; p = 0.002) and depression domain (r = 0.603; p < 0.001). PSQI: Pittsburgh Sleep Quality Index; HADS: Hospital Anxiety and Depression Scale.
Source: Prepared by the author based on survey data.

Table 5. Simple linear regression between subjectively assessed sleep, anxiety, and depression.

PSQI	R^2	p	Constant	Angular coefficient
HADS anxiety scores	0.260	0.001	5.858	0.387
HADS depression scores	0.329	<0.001	5.807	0.447

HADS: Hospital Anxiety and Depression Scale.
Source: Elaborated by the author based on survey data.

for age, sex, and body weight[19]. In turn, Cormick et al. found that 36% of individuals with stable COPD reported difficulty falling asleep and 76% reported frequent awakenings at night, reinforcing that the cause of such disturbed sleep remains unclear, complex, and likely multifactorial[20].

The correlation between the subjective assessment of sleep quality and symptoms of anxiety and depression indicates that poorer sleep quality is associated with more severe symptoms of anxiety and depression in patients with COPD. Gharsalli et al.[21] studied the prevalence of anxiety and depression in individuals with obstructive sleep apnea (OSA) and found that anxiety and depression overlap with OSA symptoms, such as fatigue and excessive daytime sleepiness. In addition, OSA and depression share biological mechanisms and risk factors that suggest a potential association between them. Although our study did not investigate the presence of OSA, the symptoms and pathophysiology of the disease in sleep, such as fatigue and excessive daytime sleepiness, are close to those of individuals with COPD[21]. However, unfortunately, we could not assess sleep-disordered breathing in our sample.

Kahn-Greene et al.[22] investigated the effects of prolonged sleep deprivation on psychopathological symptoms in healthy individuals. The sample consisted of 25 people subjected to 56 hours of sleep deprivation with the effects of caffeine every two hours. As a result, the author found a significant increase in self-reported symptoms of anxiety and depression. The authors report that to the extent that sleep deprivation is associated with hypoactivation of prefrontal systems like those observed in depression, sleep loss may provide a useful neurobiological model of affective psychopathology[22]. Although the population studied by Kahn-Greene et al.[22] consisted of healthy individuals and sleep deprivation was induced and prolonged, we could draw a connection with our findings. Due to the underlying lung disease itself, coupled with the physiological repercussions of sleep, which, although normal, overload the respiratory system of individuals with lung disease, sleep ends up representing a very troubled period. This can be even more problematic when combined with nocturnal respiratory symptoms, nocturia, and insomnia, which are often present in the lives of individuals with COPD. Thus, sleep is no longer a period of rest and becomes an important challenge that these individuals face every, which can further worsen their quality of life and affect their mental/psychological health.

Neale et al.[23] investigated the association between sleep quality, self-reported symptoms of anxiety and depression, and physical activity in individuals with COPD during an exacerbation of the disease. The study included 148 hospitalised individuals, most of whom were GOLD 3 and 4. As a result, the study showed that each one-point increase in

the anxiety score on the HADS-A corresponded to a significant increase in steps per day, while each one-point increase in the depression score on the HADS-D corresponded to a significant decrease in steps per day. Regarding sleep, no significant associations were found between steps per day and time in bed and sleep disturbances. Although Neale et al.[23] investigated hospitalised individuals and addressed the issue of physical activity regarding sleep and symptoms of anxiety and depression, their research features among the few studies[24] in the scientific literature that investigated associations between mental health and sleep in this specific population, which further highlights the research gap in this area.

Studies investigating the potential relationship between sleep and mental health have proposed several hypotheses and possible explanatory mechanisms. Some authors believe that there is a unidirectional causal relationship between these variables, since poor sleep quality can easily affect mood and mental health. However, others suggest that there is a bidirectional relationship between sleep and mental health, especially with anxiety and depression[25].

One hypothesis for the absence of association between anxiety and depression with the objective assessment of sleep is that, since the assessment of anxiety and depression symptoms is self-reported by the HADS questionnaire, the quality of sleep, also assessed on a self-reported basis, may have been more compatible because both deal with the individual's perception of themselves. Despite international recommendations for sleep quantity and quality, an individual's perception may completely differ from what is actually achieved and what is recommended, as perception involves multiple factors, such as the individual's own personal experiences, cultural aspects, educational level, and social factors.

This study has both strengths and limitations. Its strengths include its innovative nature in the field of sleep research in individuals with COPD by addressing a topic that the literature had not explored. In addition, we use an objective sleep assessment tool over several days of the week, which could provide a detailed investigation of the individual's sleep block in their natural environment. Combined with the sleep diary, this provides even greater certainty to the results found. Meanwhile, the limitations include the restricted sample size. In addition, most of the our sample consisted of individuals classified as having GOLD II and III COPD severity, which limits the generalisation of the results to those individuals with mild or very severe disease classification (*i.e.*, GOLD I and IV). Finally, unfortunately, the participants in this study could not be assessed for the presence of sleep-disordered breathing, which could have generated further unprecedented results.

CONCLUSION

In conclusion, there is an association between the subjective assessment of sleep quality and symptoms of anxiety and depression in individuals with COPD, as well as the relationship of the influence of these variables, although this very association was not present in the objective assessment of sleep.

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CONFLICT OF INTEREST

Nothing to declare.

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Nothing to declare.

RESEARCH DATA AVAILABILITY

Research data are available upon request only.

ARTIFICIAL INTELLIGENCE USE STATEMENT

Not applicable.

AUTHOR CONTRIBUTIONS

Study design: Elis Moraes Martins; Daniele Dala Pola; Fabio Pitta. Data curation: Daniele Dala Pola. Formal analysis: Elis Moraes, Thaiuana Maia, Daniele Dala Pola. Funding acquisition: Fabio Pitta. Research: Elis Moraes Martins; Daniele Dala Pola; Thaiuana Maia Ferreira; Letícia Yumi Ogochi; Maria Gabriela Fernandes; Ana Lívia Trindade; Giovanna Alves, Raquel Hirata. Methodology: Elis Moraes, Daniele Dala Pola, Fabio Pitta. Project management: Daniele Dala Pola; Fabio Pitta. Resources: Daniele Dala Pola; Fabio Pitta. Software: Formal analyses. Supervision: Daniele Dala Pola; Fabio Pitta. Validation: Daniele Dala Pola; Fabio Pitta. Visualisation: Elis Moraes Martins. Writing (original draft): Elis Moraes Martins, Daniele Dala Pola, Fabio Pitta. Writing (revision and editing): Elis Moraes Martins, Daniele Dala Pola, Fabio Pitta.

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