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Poor Sleep Quality in post-COVID-19 – Pittsburgh Sleep Quality Index Questionnaire

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Abstract: *Since the global outbreak of COVID-19, knowledge about the long-term effects of the disease has grown rapidly. One of the symptoms of post- COVID-19 condition is sleep disturbance. This study aims to analyse the impact of SARS-CoV-2 infection on sleep quality, using the Pittsburgh Sleep Quality Index questionnaire (PSQI), administered by phone, in a group of 82 patients, who were hospitalised with COVID-19 between March 2020 and February 2021 in two hospital units in Romania. The demographics data were retrospectively collected from patients charts. In addition to the PSQI questionnaire, health-related questions, such as post-COVID-19 symptoms were also asked. The overall results showed that sleep quality was significantly affected in post COVID-19 patients, as indicated by a PSQI score ≥ 5. This follow-up questionnaire, conducted three years later shows the persistence of poor sleep quality in these patients. Excessive worry about the progression of the pandemic, experiencing an unfamiliar disease, financial difficulties and social problems contributed to sleep impairment. Poor sleep quality can be an important symptom of various sleep and medical disorders. Since sleep quality impacts daytime functioning it remains an important clinical construct.*

Keywords: *post COVID condition; sleep disturbance; insomnia; PSQI questionnaire.*

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1. Introduction

Post-COVID Condition, or Long COVID, is a multisystemic condition characterised by often severe symptoms that follow SARS-CoV-2 infection. Symptoms may persist after the initial infection, or reappear after a period of recovery, or fluctuate in quality and severity over time (World Health Organization, 2021). The consequences of the COVID-19 pandemic have been associated with increased stress, anxiety, and reduced sleep quality.

Sleep is a fundamental physiological process that plays a vital role in maintaining overall health and well-being. Sleep disturbances not only impact the quality of life for patients and caregivers but may also contribute to the progression and severity of underlying conditions (Anghel et al., 2023).

The pathological mechanism underlying poor sleep quality after COVID-19 has not yet been fully elucidated. It is believed that persistent viral infection, as indicated by the detection of SARS-CoV-2 RNA for up to 230 days after symptom onset, may affect the hypothalamus and brainstem, disrupting the sleep-wake cycle and leading to insomnia and poor sleep quality (Tedjasukmana et al., 2023).

The prevalence of sleep disturbances in post-COVID patients varies widely, ranging from 6% to more than 70%. An online survey on post-COVID-19 Condition conducted in various countries found that 78.58% of participants experienced sleep disturbances, including insomnia, sleep-disordered breathing, central disorders of hypersomnolence, circadian rhythm sleep-wake disorders, parasomnias, and sleep-related movement disorders (Davis et al., 2021). Patients infected with SARS-CoV-2 have an increased predisposition to sleep disturbance due to disease-related symptoms such as dyspnoea, cough, pain, or fever, as well as the side effects of medications used in treatment (Mekhael et al., 2022). This study aims to evaluate aspects of sleep quality in patients who have undergone SARS-CoV-2 infection.

2. Materials and Methods

The objective of our study was to assess sleep quality in post-COVID-19 patients using the Pittsburgh Sleep Quality Index (PSQI) questionnaire and health-related questions, including the types of post-COVID-19 symptoms and the need for medication.

The PSQI questionnaire is a valid and reliable international instrument to assess subjective sleep quality. The total score ranges from 0 to 21, with scores equal to or greater than 5 indicating disturbed sleep quality. The Pittsburgh Sleep Quality Index is the most widely used measure of subjective, self-report sleep quality. It was developed not only to quantify sleep quality but has also been used for convergent validity, suggesting that the PSQI can be considered an accepted reference or gold standard for self-perceived sleep quality. The PSQI consists of 24 questions or items to be rated (0-3 for 20 items, while 4 items are open-ended). Of these, 19 items are self-reported, and 5 require secondary feedback from a roommate or bed partner. The 19 self-reported items are used to evaluate sleep quality as perceived by the individual, and to generate scores ranging from 0 (no difficulty) to 3 (severe difficulty). These scores represent the PSQI's seven components: sleep quality (C1), sleep latency (C2), sleep duration (C3), habitual sleep efficiency (C4), sleep disturbance (C5), use of sleep medications (C6), and daytime disturbance (C7).

In this study, we enrolled 82 patients (53 male patients and 29 female patients), who were hospitalised with a diagnosis of COVID-19 infection, between March 2020 and February 2021, in two hospital units, designated for treating COVID-19 in Romania: Sfântul Ioan cel Nou County Emergency Hospital, Suceava and the Clinical Hospital of Pulmonary Diseases Iasi.

Demographics and clinical data, as well as the severity of COVID-19 at admission and discharge, were retrospectively collected from patient charts.

The data collection received approval from the Ethics Committee of the County Emergency Hospital, Suceava (no. 4/ 27.11.2020) and the Ethics Committee of the Clinical Hospital of Pulmonary Diseases (no. 86/31.03.2022). The PSQI questionnaire was administered

by telephone after each patient was informed and gave informed consent. Verbal informed consent was obtained from COVID-19 survivors willing to participate in the telephone survey three years after infection. The study was conducted in accordance with the ethical standards outlined in the Declaration of Helsinki.

3. Participants: Inclusion and Exclusion Criteria

The study included 42 patients diagnosed with COVID-19 infection and acute respiratory complications, such as pneumothorax, pneumomediastinum, or both (Group 1). The control group (Group 0) consisted of 40 patients diagnosed with SARS-CoV-2 infection but without pneumothorax or pneumomediastinum.

The inclusion criteria were:

- aged over 18 years;
- a confirmed diagnosis of SARS-CoV-2 infection;
- presence of pneumothorax/pneumomediastinum (for Group 1);
- Manifestation of a sleep disturbance, such as insomnia, during COVID-19 hospitalisation.

The exclusion criteria were:

- aged under 18 years;
- pregnant individuals;
- absence of COVID-19 infection;
- refusal to participate.

Additionally, patients who initially agreed to the assessment but did not complete the questionnaire were excluded.

These 42 participants were part of a retrospective study on COVID-19 infection and its associated acute respiratory complications conducted on a total of 100 patients. Among these survivors, 19 had pneumothorax and were treated surgically with pleural drainage, while 23 had pneumomediastinum and were managed conservatively. These patients reported high levels of stress caused by both the novel coronavirus, an unknown and unpredictable threat, and by the onset of acute complications requiring medical intervention. The resulting surgical stress contributes to symptoms such as anxiety. Dyspnoea, chest pain, cough, fatigue, and insomnia persisted both during hospitalisation and in the post-COVID-19 period, even more than two years later. The control group, consisting of 40 patients with COVID-19 infection but without acute complications such as pneumothorax or pneumomediastinum, closely matched the study group in terms of gender and other general characteristics. These patients also exhibited increased levels of stress and insomnia during hospitalisation and in the post-COVID-19 period, even more than two years later.

4. Results

4.1. Participants' Characteristics and Sleep Quality

The general characteristics of the participants are presented in Table 1. Regarding the general characteristics of the two groups, we observed that the patients included were predominantly male and originated from urban areas. This is because the development of pneumothorax or pneumomediastinum in COVID-19 infection was more frequently observed in men than in women. There were no statistically significant differences between the two groups regarding gender. Regarding educational status, most of the participants had a medium level of education, followed by those with higher education. As for employment status, no statistically significant differences were observed, although the majority of the participants were full-time workers. Moreover, Group 1 had a higher prevalence of smoking and a lower BMI (body mass index), compared with the control group.

We found significant differences between the two groups regarding age (54.74±11.78 vs. 59.95±10.48, $p < 0.05$) and BMI (26.61±5.39 vs. 29.26±4.82, $p < 0.05$). For statistical analysis of

these data, the independent samples t-test was used for BMI and hospitalisation days, while the Pearson chi-square test was applied to the remaining parameters.

Table 1. General characteristics of the two study groups (n, %, mean, DS).

Characteristics	GROUP 1= 42 WITH PTX/PNM	GROUP 0 = 40	p value
Gender n (%)			
Male	27 (64.28 %)	26 (65.00 %)	0.946
Female	15 (35.72 %)	14 (35.00 %)	
Age, years (mean ± DS)	54.74 ± 11.78	59.95 ± 10.48	0.037
Living environment n (%)			
Rural	17 (40.48 %)	10 (25.00 %)	0.710
Urban	25 (59.52 %)	30 (75.00 %)	
Education status n (%)			
No education	1 (2.38%)	0 (0.00%)	0.071
Medium level	21 (50.00 %)	23 (57.50 %)	
High level	14 (33.33 %)	16 (40.00 %)	
Unspecified	6 (14.29 %)	1 (2.50 %)	
Employee status n (%)			
Household	3 (7.13%)	2 (5.0 %)	0.547
Full-time	25 (59.54 %)	20 (60.0 %)	
Retired	14 (33.3 %)	18 (45.0 %)	
Smoking status n (%)	16 (38.1 %)	13 (30.0 %)	0.649
BMI kg/m^2 (mean ± DS)	26.61 ± 5.39	29.26 ± 4.82	0.021
Comorbidities			
Hypertension	12 (28.6 %)	17 (42.5 %)	0.411
Diabetes	5(11.9%)	10 (25.00 %)	0.500
COPD*	3 (7.15 %)	2 (5.00 %)	0.174
Bronchiectasis	1(2.38%)	2(5.00%)	0.520
Bronchial asthma	2 (4.70 %)	2 (5.00 %)	0.960
Tuberculosis secular	0 (0.00%)	2 (5.00%)	0.144
Chronic Kidney Disease	2 (4.70 %)	1 (2.50 %)	0.220
Days of hospitalisation (mean ±DS)	13.90 ± 5.05	13.03 ± 8.02	0.550

COPD* Chronique Obstructive Pulmonary Disease

Table 2 illustrates the prevalence of COVID-19 infection types in the study group with pneumothorax or pneumomediastinum, where the mild form (17 patients) and moderate form (19 patients) were the most common. In contrast, in the control group, only the moderate form had the highest prevalence.

Table 2. Types of the COVID-19 infection within the study groups n, %, p-value

Type of disease	Group 1 (n = 42)	Group 0 (n = 40)	p-value
Mild	17 (40.47%)	11 (27.5%)	0.250
Moderate	19 (45.41%)	18 (45.00%)	1.000
Severe	6 (14.28%)	11 (27.5%)	0.177

Comorbidities were analysed in both groups. The most frequently reported comorbidities included arterial hypertension, diabetes, and COPD (Table 1).

Participants' PSQI scores for each component and the global score are shown in Table 3. The mean global PSQI score was 11.29, indicating poor sleep quality. Among the individual components, sleep latency had the highest mean score, suggesting that many participants

experienced delayed sleep onset. Conversely, the lowest score was found for the use of sleeping medications, indicating that most participants did not use sleep aids.

Table 3. Descriptive statistics of PSQI Scores (N=82 participants, mean ±DS, min ~ max) and interpretation of Total Score.

Total Score PSQI Interpretation		
= 5 associated with good sleep quality 2 (2.44%) participants		**>5 associated with poor sleep quality 80 (97.56%)participants**
Categories	**Mean ± DS**	**Min ~ Max**
Total Score PSQI	11.29±3.6	5 ~ 18
C1: sleep quality	1.80±0.85	0 ~ 3
C2: sleep latency	2.87±0.36	0 ~ 3
C3: sleep duration	2.33±0.56	0 ~ 3
C4: sleep efficiency	2.33±1.37	0 ~ 3
C5: sleep disturbances	1.54±0.52	0 ~ 3
C6: use of sleeping meds	0.12±0.42	0 ~ 3
C7: daytime dysfunction	1.54±0.52	0 ~ 3

4.2. Differences in Pittsburgh Sleep Quality Index Between the Two Groups

Regarding Component C1 of the Pittsburgh Sleep Quality Index, which assesses subjective sleep quality on a scale from 0 to 3, with 3 indicating very poor sleep quality, a significant difference was observed between the two groups. In Group 1 (patients with pneumothorax or pneumomediastinum), 20 out of 42 participants reported very poor sleep quality, compared with only 2 out of 40 participants in Group 0 (control group), with a p-value < 0.001 indicating a statistically significant difference.

Sleep latency (Component C2) is measured from the moment a person tries to fall asleep until they reach the first stage of sleep. In our study, more than half of the 42 participants in Group 1 had a C2 score of 3, based on the combined score from questions 2 and 5a of the PSQI questionnaire, indicating severe difficulty falling asleep. In contrast, 25 participants from Group 0 had a C2 score of 2, suggesting moderate difficulty with sleep latency. Regarding Component C3 (Sleep Duration), 23 out of 42 participants in the study group obtained a score of 3, indicating a sleep duration of less than 5 hours.. In contrast, 28 out of 40 participants in the control group obtained a score of 2, representing 5-6 hours of sleep, with a p- p-value of 0.002, indicating a statistically significant difference between the two groups.

For Component C4 (Sleep Efficiency), which is measured on a scale from 0(≥ 85%) to 3 (< 65%), 28 participants from the study group had a score of 3, compared with 16 participants in the control group, suggesting poorer sleep efficiency in the study group.

Regarding Component C5 (Sleep Disturbance), 26 participants from the study group obtained a score of 2 (experiencing disturbances once or twice a week),k, whereas 23 participants from the control group obtained a score of 1 (experiencing disturbances less than once a week).

For Component C6 (Use of Sleeping Medications), the majority of participants in both groups reported no need for sleep medications.

Finally, for Component C7 (Daytime Dysfunction), more than half of the participants in the study group and the vast majority of participants in the control group (95% participants reporting mild impairment and 5% participants reporting moderate impairment), experienced daytime impairments, including excessive sleepiness, fatigue, low energy, reduced motivation, and cognitive symptoms such as poor attention, concentration, and memory.

Table 4. PSQI Scores distribution between the two groups of participants (n, %, p value).

	Group 1 (n=42)				**Group 0 (n=40)**				**p value**
SCORE n(%)	**0**	**1**	**2**	**3**	**0**	**1**	**2**	**3**	
C1	2 (4.8%)	13 (31.0%)	7 (16.7%)	20 (47.6%)	0 (0.0%)	21 (52.5%)	17 (42.5%)	2 (5.0%)	0.00
C2	0 (0.0%)	2 (4.8%)	17 (40.5%)	23 (54.8%)	0 (0.0%)	2 (5.0%)	25 (62.5%)	13 (32.5%)	0.119
C3	0 (00.0)	0 (00.0)	19 (45.2%)	23 (54.8%)	0 (00.0)	4 (10.0%)	28 (70.0%)	8 (20.0%)	0.002
C4	5 (11.9%)	5 (11.9%)	4 (9.5%)	28 (66.7%)	10 (25.0%)	6 (15.0%)	8 (20.0%)	16 (40.0%)	0.097
C5	0 (00.0%)	16 (38.1%)	26 (61.9%)	0 (0.0%)	0 (0.0%)	23 (57.3%)	16 (40.0%)	1 (2.5%)	0.101
C6	38 (90.5%)	4 (9.5%)	0 (0.0%)	0 (0.0%)	36 (90.0%)	3 (7.5%)	0 (0.0%)	1 (2.5%)	0.563
C7	11 (26.2%)	18 (42.9%)	13 (31.0)%	0 (0.0%)	0 (0.0%)	38 (95.0%)	2 (5.0%)	0 (0.0%)	0.000

4.3. Correlations Between our Groups and Total Score PSQI (≥ 5)

Figure 1 illustrates the distribution of global PSQI scores between the two groups. In the study group, the most frequent scores were:

- 7 participants with a global score PSQI of 15;
- 9 participants with a global score PSQI of 16;
- 4 participants with a global score PSQI of 17.

In contrast, in the control group, there were:

- 7 participants with a global score PSQI of 10;
- 8 participants with a global score PSQI of 8, exhibiting the highest prevalence.

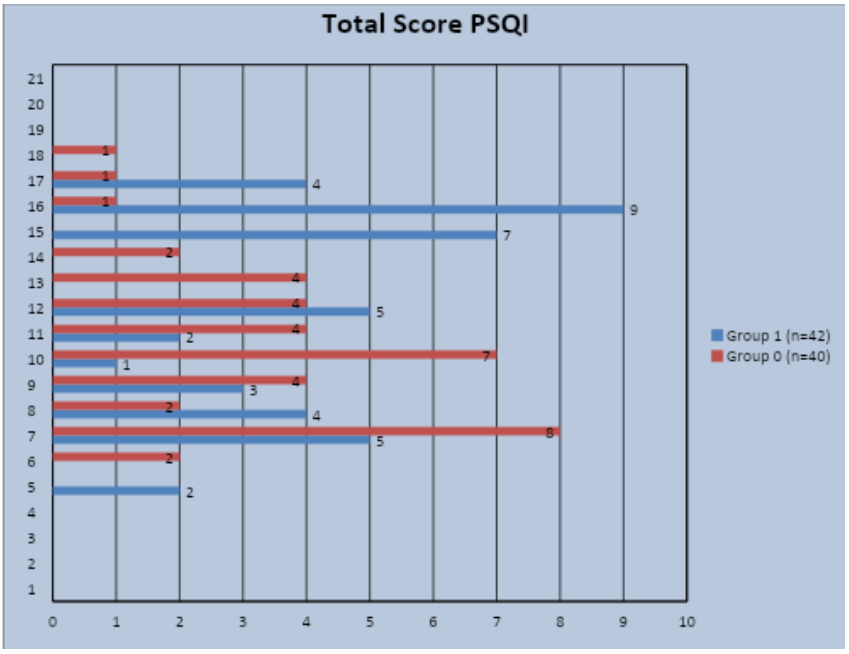

Figure 1. Total Score PSQI distribution between the two groups

5. Discussions

Our analysis of sleep quality in post-COVID-19 patients contributed to the limited number of studies on this topic conducted in Romania over the past four years. The global PSQI score, , which was equal to or greater than 5 in both groups, raises significant concerns about the

high prevalence of poor sleep quality in Romanian populations following the COVID-19 pandemic.

However, the results of this study should be interpreted with caution, given its limitations. This study involved a relatively small sample size, with a study group of 42 patients with COVID-19 infection and pneumothorax or pneumomediastinum, and a control group, 40 patients with COVID-19 infection, , rather than a control group COVID-19 infection. All the patients experienced symptoms such as dyspnoea, chest pain, fatigue, or insomnia during hospitalisation and more than two years after discharge. Data regarding the persistence of symptoms were collected by telephone call. Post-COVID-19 sleep disorders have been frequently reported in the recovery period (El Sayed et al., 2021). While previous studies have shown a higher prevalence of sleep disturbance in females, in our study, a higher prevalence was observed in males, likely due to the fact that pneumothorax related to COVID-19 infection occurred more frequently in male patients. A meta-analysis by Jahrami et al. (2022) found that age and gender have no significant impact on the estimated prevalence of sleep disturbances. In our study, the mean age was lower in the study group (42 participants), which also had a higher proportion of full-time employee status (25 participants) compared with the control group, which had a higher mean age.

Other studies show that the post-COVID-19 immune response can lead to sleep dysfunction. A study by Morin et al. (2022) involving 594 adult patients compared the prevalence of insomnia symptoms and the diagnosed cases before the COVID-19 pandemic (2018) and during the first wave (2020). The study included data on the incidence, prevalence, and persistence of insomnia, as well as anxiety, depressive symptoms, and stress levels. After analysing data from both periods, the authors concluded that insomnia rates increased by 26.7%. Additionally, 32.6% of patients who were previously considered good sleepers before the pandemic developed insomnia during the COVID-19 period (Morin et al., 2022). Limitations of our study include the lack of information on pre-existing sleep symptoms prior to acute COVID-19 illness, as well as the absence of follow-up during the early post-COVID-19 period. Scientific evidence suggests that sleep disorders associated with COVID-19 may become chronic (AlRasheed et al., 2022). Another important factor in understanding sleep disturbances during the COVID-19 pandemic was the impact of lockdown measures. Social isolation and loneliness have been shown to negatively affect mental health and sleep quality (Andrade et al., 2025).

A prospective study on COVID-19 complications involving 200 patients showed that the prevalence of insomnia in the early post-COVID-19 recovery period is high (Pudlo et al.,2022). While clinicians and researchers have primarily focused on the acute phase of COVID-19, there is a growing need for continued monitoring after discharge to understand the long-term effects of the disease. So far, comprehensive assessments of COVID-19 survivors regarding physical health, psychological well-being, and organ function have mostly been conducted within a 2-year timeframe following the onset of symptoms. Our data analysis, based on the PSQI questionnaire, was conducted three years post-COVID-19. A recent meta-analysis revealed that nearly 30% of individuals previously infected with SARS-CoV-2 continued to experience symptoms even two years after the acute phase of infection. The most prevalent symptoms included fatigue, cognitive impairments, and pain. Additionally, survivors reported ongoing anxiety and depression (up to 15%) and sleep problems (up to 25%) (Fernandez-de-Las-Peñas et al., 2024). Poor sleep quality was found to be associated with dyspnoea and impaired lung function. Furthermore, higher levels of anxiety and muscle weakness were identified as mediators in the relationship between sleep disturbance and dyspnoea (Jackson et al., 2023). In our study, 42 patients diagnosed with pneumothorax and pneumomediastinum during the COVID-19 infection reported dyspnoea, fatigue, and anxiety. Similarly, another retrospective study of 287 patients who presented to post-COVID care in the Pulmonology Department, more than four weeks after the acute course of COVID-19 infection (third, fourth, and fifth waves of infection), found that PSQI scores

exceeded normal values (Percze et al., 2023). In our study, all participants had a global PSQI score greater than 5, which reflects a clinically significant level of sleep disturbance consistent with poor sleep quality in the post-COVID-19 period. Components of the PSQI questionnaire, such as sleep latency, sleep duration or sleep efficiency, were significantly affected. Given the strong link between sleep disturbances and mental health, implementing targeted interventions and prevention strategies addressing mental health concerns may improve both health-related quality of life (HRQoL) and sleep quality in patients with post-COVID-19 conditions (Mahmoudi et al., 2021).

6. Conclusions

Post-COVID-19 has emerged as one of the major challenges currently confronting global healthcare systems. Several studies have identified sleep disturbances as a significant issue that negatively affects multiple domains of quality of life in post-COVID-19 patients. Assessing and monitoring sleep disorders should become a routine component of post-COVID care. Improving sleep quality can have a positive impact not only on physical health but also on the psychological well-being and social functioning of affected individuals. Our analysis raises a new warning signal regarding the aforementioned aspects, highlighting the importance of monitoring and intervention for sleep quality in post-COVID-19 patients.

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