

The Impact of Post-COVID-19 Conditions on Sleep and Quality of Life in Indonesia: A Nationwide Cross-Sectional Study

Astri Budikayanti¹, Manfaluthy Hakim¹, Faradillah Mutiani¹, Sri Handayani², Nushrotul Lailiyya³, Herlyani Khosama⁴, Seilly Yunita Jehosua⁴, Vivien Puspitasari⁵, Pricilla Yani Gunawan⁵, Yetty Hambarsari⁶, Wardah Rahmatul Islamiyah⁷, Abdul Gofir⁸, Amelia Nur Vidyanti⁸, Asnelia Devicaesaria⁹, Rizka Ibonita⁹, Herlina Suryawati¹⁰, Rimawati Tedjasukmana¹¹

¹Department of Neurology, Faculty of Medicine, Universitas Indonesia – Dr. Cipto Mangunkusumo Hospital, Jakarta, Indonesia; ²Department of Neurology Faculty of Medicine Universitas Sriwijaya – Dr. Mohammad Hoesin Hospital, Palembang, Indonesia; ³Department of Neurology Faculty of Medicine Universitas Padjajaran – Dr. Hasan Sadikin Hospital, Bandung, Indonesia; ⁴Department of Neurology Faculty of Medicine Universitas Sam Ratulangi – Prof. dr. RD Kandou Hospital, Manado, Indonesia; ⁵Department of Neurology Faculty of Medicine Universitas Pelita Harapan – Siloam Kelapa Dua Hospital, Tangerang, Indonesia; ⁶Department of Neurology Faculty of Medicine Universitas Sebelas Maret – Dr. Moewardi Hospital, Surakarta, Indonesia; ⁷Department of Neurology Faculty of Medicine Universitas Airlangga – Dr. Soetomo Hospital, Surabaya, Indonesia; ⁸Department of Neurology Faculty of Medicine Universitas Gajah Mada – Dr. Sardjito Hospital, Yogyakarta, Indonesia; ⁹Department of Neurology, National Brain Center Hospital, Jakarta, Indonesia; ¹⁰Department of Neurology Faculty of Medicine Universitas Diponegoro – Dr. Kariadi Hospital, Semarang, Indonesia; ¹¹Faculty of Medicine, Universitas Kristen Krida Wacana, Jakarta, Indonesia

Correspondence: Astri Budikayanti, Email astri.budikayanti@ui.ac.id



Background: Sleep disturbances are included in the six most commonly cited complaints in post-COVID-19 conditions. In order to find the optimal management approach and enhance Quality of Life (QoL), we intend to explore sleep disturbances that occur in post-COVID-19 conditions.

Methods: This was a cross-sectional study conducted with interviews and questionnaires using the Pittsburgh Sleep Quality Index (PSQI) for assessing sleep quality, Insomnia Severity Index (ISI) for assessing insomnia, Epworth Sleepiness Scale (ESS) for assessing Excessive Daytime Sleepiness (EDS), STOP-BANG questionnaire for assessing Obstructive Sleep Apnea (OSA), and Short Form 36 (SF-36) for assessing QoL. We recruited respondents from several cities in Indonesia and performed an analysis to find the relationship between sleep disturbance and its association with QoL.

Results: This study involved 757 respondents. They were predominantly female, with a median age of 39 years, no comorbidities, and had exhibited mild COVID-19 severity. Subjects with post-COVID-19 conditions experienced insomnia, poor sleep quality, normal sleepiness, and low risk of OSA. Sleep quality caused role limitations due to decreased physical and mental health. Insomnia caused role limitations due to emotional and social functioning problems. Meanwhile, OSA only affected physical functioning.

Conclusion: Numerous aspects of patients' QoL are affected by sleep disturbance in post-COVID-19 conditions. A comprehensive approach and coordinated care pathways must be effectively managed to improve QoL among individuals experiencing sleep disturbance.

Keywords: COVID-19, long COVID, post-COVID-19 conditions, sleep, sleep quality, insomnia

Introduction

A growing number of individuals who have previously been infected with SARS-CoV-2, the virus that causes COVID-19, have reported persisting symptoms or the beginning of long-term symptoms for 4 weeks or more after having acute COVID-19.¹

According to the World Health Organization, these symptoms are recognized as post-COVID-19 conditions.² A year after onset, 85% of patients still reported having these symptoms, and their impact worsened patients' quality of life (QoL) after six months' duration.³

At one-year follow-up, sleep disturbance was one of the six most frequently cited complaints.⁴ According to a related study, people who had experienced more severe symptoms during COVID-19 infection had worst sleep quality.⁵ Sleep disturbances can occur for less than 3 months to more than 12 months following an acute infection.⁶ Understanding the difference in time-frame is essential to comprehend the symptom progression following COVID-19 infection since different definitions of sleep disturbance possess different underlying processes that require different management.⁶ A global prevalence meta-analysis study, based on sleep questionnaires, found that the most frequent types of sleep disturbance were poor sleep quality, excessive daytime sleepiness (EDS), insomnia, and sleep apnea.⁶

Sleep disturbances in post-COVID-19 conditions are frequently reported by female individuals in their twenties and thirties who also exhibit comorbidity and had experienced moderate to severe COVID-19 symptoms.⁷ Furthermore, poor sleep quality has been associated with severe depression and anxiety symptoms.^{8,9} The fact that there was a bidirectional relationship between depression/ anxiety symptoms and sleep emphasizes the importance of offering COVID-19 survivors mental health support services after hospital discharge.⁸

As a vital part of preserving overall health, physical, mental, social, and spiritual functioning, and overall QoL, sleep is a crucial biological process for ensuring internal homeostasis.⁷ It also plays a crucial regulatory role in the immune system.¹⁰ Given the reciprocal association between sleep and the immune system, sleep is likely crucial for recovery in COVID-19 survivors.¹¹ Sleep issues might worsen the adverse effects of COVID-19 on both physical and mental well-being. Furthermore, a number of studies have found that, in post-COVID-19 conditions, there was a connection between sleep-related health issues and lower QoL; they also had a negative impact on a variety of QoL dimensions.^{5,12}

Until now, there have been no comprehensive studies on sleep disturbances in Indonesia following COVID-19 infection. Due to the differences in prevalence of COVID-19 in each region in Indonesia, sleep patterns, and sleep habits based on geographical differences, we collected sleep screening data from several regions. Accordingly, this study offers a comprehensive analysis of sleep characteristics, specifically focusing on poor sleep quality, insomnia, OSA, and EDS in individuals experiencing post-COVID-19 conditions. By engaging respondents from various regions in Indonesia, our study is able to provide in-depth knowledge on the impact of these sleep-related issues on individuals' QoL. In addition, we hope that the study's findings will be useful as a clinical guide to providing further support for COVID-19 survivors who are experiencing sleep disturbances and also to advocate for improved management of post-COVID-19 conditions in order to enhance individuals' QoL.

Materials and Methods

Study Population and Data Collection

This is a cross-sectional study from December 2022 until October 2023 to investigate sleep disturbance in post-COVID-19 conditions and their impact on different domains of QoL. Our study has been approved by the ethics committee of the Faculty of Medicine, Universitas Indonesia (KET-1179/UN2.F1/ETIK/PPM.00.02/2021). We fully explained the study to respondents before they enrolled, and they completed an informed consent form indicating their willingness to participate. All data and examination results were kept confidential.

The following questionnaires were used for assessments: the Pittsburgh Sleep Quality Index (PSQI), Insomnia Severity Index (ISI), Epworth Sleepiness Scale (ESS), STOP-BANG (snoring, tiredness, observed apnea and high blood pressure, BMI, age, neck circumference and gender) questionnaire, and Short Form 36 (SF-36). Subjects included were respondents with a confirmed history of COVID-19 at least 1 month before data collection, who were aged ≥ 18 years, and who had agreed to complete the questionnaires. Meanwhile, those who had sleep disturbance before COVID-19 infection were excluded, identified by questions on the questionnaire regarding sleep disturbance, the use of sleep aids or medication for sleep disturbance.

The sampling method was total sampling with an unlimited target population. Consequently, the minimum number of respondents required for the study was 140. The majority of respondents were recruited at several hospitals in Indonesia,

with each one having 2–3 data collectors. Apart from that, we also recruited respondents online by distributing the survey form on social media and at several hospitals. By analyzing sleep disturbance screening data from several regions in Indonesia, we observed variations in the prevalence of sleep disturbance in individuals across these regions.

Age, sex, COVID-19 severity, and comorbidity were independent variables. Comorbidity data was taken based on respondent responses regarding pre-existing conditions as well as information from medical records. According to Health Ministry guidelines in Indonesia, COVID-19 symptoms and severity were classified into four categories: no symptoms, mild symptoms, moderate symptoms, and severe symptoms.¹³

The Pittsburgh Sleep Quality Index (PSQI) is a self-reported survey to calculate monthly sleep quality. It consists of seven main elements: daytime dysfunction, subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disruptions, and usage of sleep medications. A total score greater than 5 denotes poor sleep quality.¹⁴ Insomnia was assessed using the Insomnia Severity Index (ISI), which calculates the degree of dysfunction caused by these sleep disturbances as well as subjective complaints and effects of insomnia.¹⁵ ISI is scored as follows: absence of insomnia (0–7), sub-threshold insomnia (8–14), moderate insomnia (15–21), and severe insomnia (22–28). Excessive Daytime Sleepiness (EDS) assessment using the Epworth Sleepiness Scale (ESS). it is scored as follows: 0–10 normal, 11–14, 15–17, and 18–24 indicate mild, moderate, and severe sleepiness, respectively.¹⁶ Assessment of OSA with a STOP-BANG score of 0–2 indicates a low risk; a moderate risk score is 3–4; and a high risk score is ≥ 5 .¹⁷

In addition, we conducted an analysis of QoL using the SF-36 questionnaire. The SF-36 Health Survey's Quality of Life (QoL) is a 36-item self-report questionnaire that rates eight dimensions of physical and mental wellness on a scale of 0 to 100, with the higher score denoting the best health-related quality of life (HRQoL). The eight domains are: physical functioning, general health, vitality, social functioning, role limitations due to emotional problems and physical health, pain and emotional well-being.^{15,18,19}

Statistical Analysis

Statistical analysis was conducted using the SPSS version 26.0 program. A one-sample Kolmogorov–Smirnov test was used to determine the data's normality before qualitative data were quantified and explained in percentages. To examine the mean difference between the 2 groups on normally distributed data, an independent *t*-test was used. However, if the data was not normally distributed, a Mann–Whitney test was used to test the median difference between the 2 groups. The Kruskal–Wallis test was used to compare more than two medians, and the ANOVA test was used to compare more than two means. We performed chi-square analysis on categorical data. In terms of numerical data, the Pearson correlation test was used for normally distributed data and the Spearman correlation test for abnormally distributed data.

Results

This study involved 757 respondents. Of all respondents, 473 (62.5%) were women. The median age of all respondents was 39 years. The study's respondents were approximately equally distributed between those who had comorbidities (49.7%) and those who did not (50.3%). The majority of respondents in the study were individuals who exhibited mild symptoms (50.7%) (Table 1).

According to the PSQI score, a total greater than 5 denotes poor sleep quality. Of 653 respondents, 69.2% experienced poor sleep quality (Table 1). The evaluation of sleep quality scores in relation to respondent characteristics revealed a statistically significant difference between respondents with and without comorbidities ($p=0.001$; see Table 2). Previous studies have also reported that the presence of comorbid physical health disorders increased the risk of poor sleep quality.^{20,21} On the other hand, a systematic review study found that sleep disturbance was related to the presence of 2 or more comorbidities, the most frequent being hypertension, diabetes, and heart disease.²¹ However, we did not classify the different kinds of comorbidity for further analysis of sleep assessments in this study. Furthermore, there was a noticeable disparity in sleep quality between respondents from some regions in Indonesia (Figure 1). Most subjects who reported poor sleep quality were in Semarang and Jakarta. Meanwhile, in Bandung, adequate and poor sleep quality were found to be similar. Conversely, in Surabaya, the majority of respondents were having adequate sleep quality.

The prevalence of insomnia was found to be prominent among respondents in this study. Moreover, the analysis of insomnia scores revealed notable differences in terms of sex ($p=0.035$). The differences in insomnia by region are shown

Table 1 Clinical Characteristics of All Respondents

Characteristics	n (%)
Age (median [min, max]) (n=757)	39 (18.0, 89.0)
Sex (n=757)	
Male	284 (37.5)
Female	473 (62.5)
Comorbidity (n=757)	
Without comorbidity	381 (50.3)
With comorbidity	376 (49.7)
COVID-19 severity (n=757)	
No symptoms	71 (9.4)
Mild	384 (50.7)
Moderate	200 (26.4)
Severe	102 (13.5)
Sleep quality (PSQI) (n=653)	
Adequate sleep quality	201 (30.8)
Poor sleep quality	452 (69.2)
Insomnia (ISI) (n=717)	
Absence of insomnia	316 (44.1)
Insomnia	401 (55.9)
Sub-threshold insomnia	255 (63.6)
Moderate insomnia	120 (29.9)
Severe insomnia	26 (6.5)
EDS (ESS) (n=674)	
Normal sleepiness	521 (77.7)
EDS	196 (27.3)
Mild sleepiness	110 (56.1)
Moderate sleepiness	57 (29.1)
Severe sleepiness	29 (14.8)
OSA (STOP-BANG) (n=613)	
Low risk	462 (75.4)
Moderate risk	115 (18.8)
High risk	36 (5.9)

in Figure 2. Once again, a distinct disparity was observed between respondents who had insomnia and those who did not, namely, in the regions of Semarang and Jakarta. The occurrence of severe insomnia was observed only among the respondents residing in Central Jakarta and Semarang. In contrast, the cities of Palembang, Bandung, Yogyakarta, and Surakarta revealed most respondents who did not suffer from insomnia.

A significant proportion of respondents experienced normal sleepiness (72.7%) and had low OSA risk (75.4%). Low risk of OSA was significantly associated with sex ($p=0.000$); it was found to be higher in women and in those without comorbidities ($p=0.042$).

The eight SF-36 dimensions and sleep problems in post-COVID-19 conditions were examined in order to analyze patients' QoL (Table 3). SF-36 consists of physical and mental domains. Poor sleep quality had an impact on role limitations due to physical health and emotional problems. Emotional problems and social functioning were impacted by insomnia. OSA only impacts the domain of physical functioning. In contrast, it can be observed that EDS does not exert any discernible impact on various aspects of an individual's QoL.

Discussion

This was the first collaborative study of sleep disorders carried out in Indonesia. It examined the manifestation of post-COVID-19 sleep issues in individuals of diverse ethnic backgrounds from several regions in Indonesia.

Table 2 Analysis of Sleep Assessments and Characteristics of Respondents

Sleep Assessments	Age (p [Coefficient Correlation])	Sex		Sex (p)	Comorbidity		Comorbidity (p)	COVID-19 Severity				COVID-19 Severity (p)
		Male (n, %)	Female (n, %)		Without Comorbidity (n, %)	With Comorbidity (n, %)		No Symptoms (n, %)	Mild Symptoms (n, %)	Moderate Symptoms (n, %)	Severe Symptoms (n, %)	
Poor sleep quality	0.019 (0.110) ^a	152 (33.6)	300 (66.4)	0.359 ^b	228 (50.4)	224 (49.6)	0.001^b	39 (8.6)	257 (56.9)	116 (25.7)	40 (8.8)	0.080 ^c
Insomnia	0.967 (-0.002) ^a	135 (33.7)	266 (66.3)	0.035^b	215 (53.6)	186 (46.4)	0.369 ^b	29 (7.2)	225 (56.1)	111 (27.7)	36 (9.0)	0.814 ^c
OSA												
Low risk	0.026 (0.104) ^a	135 (29.2)	327 (70.8)	0.000^b	263 (56.9)	199 (43.1)	0.042^b	59 (12.8)	273 (59.1)	111 (24.0)	9 (4.1)	0.877 ^c
Moderate risk	0.143 (0.137) ^a	56 (48.7)	59 (51.3)	0.120 ^b	54 (47.0)	61 (53.0)	0.960 ^b	9 (7.8)	66 (57.4)	29 (25.2)	11 (9.6)	0.974 ^c
High risk	0.901 (-0.21) ^a	23 (63.9)	13 (36.1)	0.363 ^b	12 (33.3)	24 (66.7)	0.209 ^b	3 (8.3)	21 (58.3)	8 (22.2)	4 (11.1)	0.874 ^c
EDS	0.127 (0.109) ^a	63 (32.1)	133 (67.9)	0.656 ^b	102 (52.0)	94 (48.0)	0.373 ^b	17 (8.7)	115 (58.7)	46 (23.5)	18 (9.2)	0.170 ^c

Notes: ^aSpearman correlation. ^bMann-Whitney. (Bold text in the table showed significance [$p < 0.05$]). ^cKruskal-Wallis.

PSQI



Figure 1 Overview of sleep quality in individuals with post-COVID-19 conditions in several regions in Indonesia (red-colored blocks indicate poor sleep quality, while green-colored blocks indicate adequate sleep quality).

ISI_Cat_2

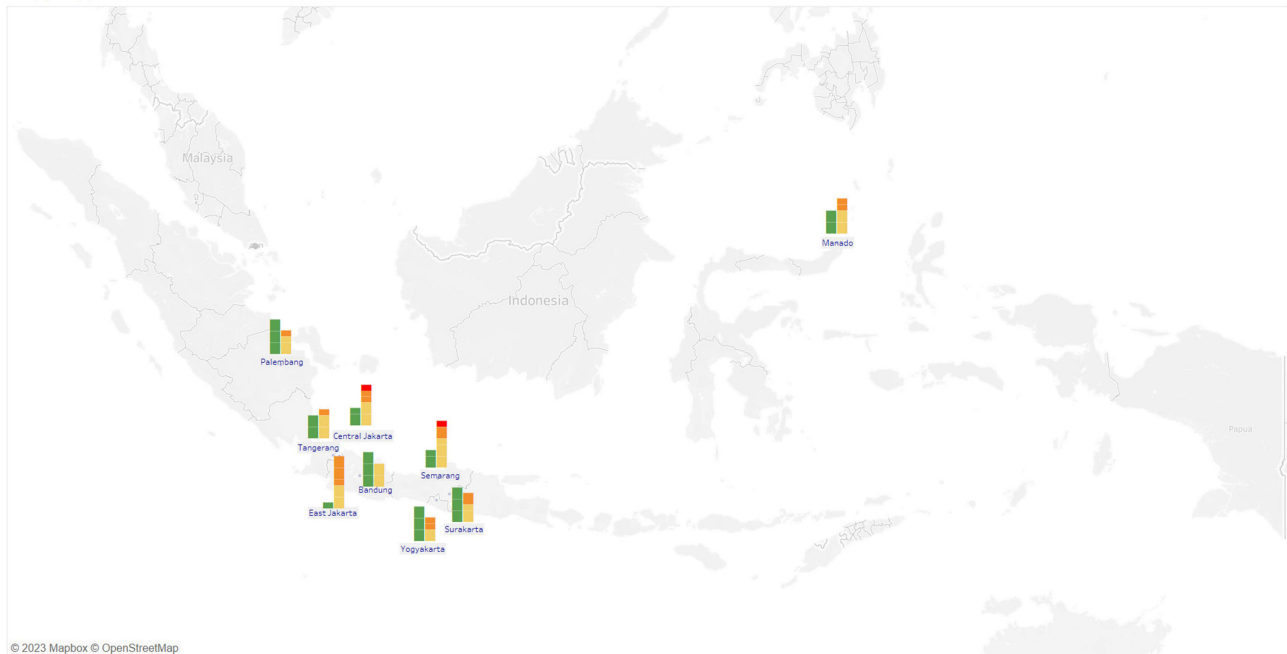


Figure 2 Overview of insomnia in individuals with post-COVID-19 conditions in several regions of Indonesia (red-colored blocks indicate severe insomnia, orange-colored blocks indicate moderate insomnia, yellow-colored blocks indicate sub-threshold insomnia, while green-colored blocks indicate absence of insomnia).

According to our study, the majority of respondents experienced insomnia, poor sleep quality but normal sleepiness, and had low OSA risk. Our study revealed that sleep disturbance had a significant impact on numerous aspects of QoL, although with weak correlations. Role limitations due to physical health only significantly correlated with poor sleep

Table 3 Analysis of Sleep Assessments and QoL*

SF-36 (n= 548)	Median	Min, Max	Poor Sleep Quality (p [Coefficient Correlation])	Insomnia (p [Coefficient Correlation])	EDS (p [Coefficient Correlation])	OSA (p [Coefficient Correlation])
Physical Functioning	95.0	0.0, 100.0	0.000 (-0.188)	0.000 (-0.222)	0.293 (-0.078)	0.000 (-0.304)
Role limitation due to physical health	75.0	0.0, 100.0	0.000 (-0.333)	0.000 (-0.265)	0.007 (-0.198)	0.000 (-0.257)
Role limitation due to emotional problems	100.0	0.0, 100.0	0.000 (-0.303)	0.000 (-0.303)	0.026 (-0.164)	0.000 (-0.173)
Energy/fatigue	65.0	0.0, 100.0	0.000 (-0.261)	0.000 (-0.295)	0.076 (-0.131)	0.000 (-0.214)
Emotional well-being	64.0	8.0, 100.0	0.185 (-0.067)	0.003 (-0.160)	0.023 (-0.168)	0.101 (-0.070)
Social functioning	75.0	0.0, 100.0	0.000 (-0.244)	0.000 (-0.332)	0.203 (-0.094)	0.000 (-0.240)
Pain	67.5	0.0, 100.0	0.000 (-0.249)	0.000 (-0.193)	0.000 (-0.275)	0.009 (-0.079)
General health	60.0	0.0, 100.0	0.000 (-0.270)	0.000 (-0.252)	0.350 (-0.070)	0.000 (-0.234)

Note: *Spearman correlation (bold text showed significance, low level of correlation).

quality. Role limitations due to emotional problems was significantly affected by poor sleep quality and insomnia. Social functioning was significantly impacted by insomnia. Meanwhile, physical functioning was impacted by OSA.

Patients with poor sleep quality in post-COVID-19 conditions based on PSQI were predominantly female, with a median age of 36 years, had no comorbidities, and had experienced mild COVID-19 severity. Our study found that female respondents had lower-quality sleep than males, which is consistent with another study on this topic.²² A meta-analysis study also revealed that females are at higher risk for experiencing post-COVID-19 conditions.²³ It has been proposed that hormones may contribute to the COVID-19 chronic hyperinflammatory state, which persists even after recovery.^{24,25}

This study involved a comprehensive examination of sleep quality and the prevalence of insomnia in various regions of Indonesia. Poor sleep quality and insomnia were found to occur more frequently in the urban areas of Jakarta and Semarang. The data from the Surabaya region indicates that a significant proportion of individuals demonstrate adequate sleep quality. In contrast, the regions of Palembang, Bandung, Yogyakarta, and Surakarta had a higher proportion of respondents who did not experience symptoms of insomnia. A previous study on sleep disturbance in different locations was inadequate in terms of elucidating the underlying factors contributing to the observed variations in sleep. While not examined in this study, there are potential independent effects of geography, such as variations in social norms, public policies, views and beliefs, and behavioral patterns associated with these results.²⁶ A large-scale observational study measuring sleep in wearable device users in 35 countries, reported that Asians experienced less nocturnal sleep and went to sleep later. In spite of this, weekday sleep variability was higher and sleep efficiency worse.²⁷ However, there has never been any research on geographical factors that may affect sleep conditions in Indonesia, thus the data is limited and cannot be further examined using the study's findings. Further study is required to examine the effects of sleep disturbance on quality of life, taking into account geographical differences and the factors that contribute to them.

A further independent risk factor for post-COVID-19 conditions appeared to be older age.²³ A broad variety of comorbidities were also linked to a higher probability of persistent COVID-19 symptoms, one of them sleep disturbance.^{28,29} However, post-COVID-19 conditions are more common in those who survive the acute stage of COVID-19 infection.²³ Our study was dominated by respondents who were less than 40 years old. Older patients, who may have several underlying comorbidities, may not survive the acute phase of COVID-19 because they are more likely to experience a severe condition.³⁰

In this study, poor sleep quality was more common in patients with mild symptoms in post-COVID-19 conditions. This result differs from those of earlier studies, which showed that patients with sleep disturbance in post-COVID-19 conditions had experienced moderate-severe symptoms.²² Since most respondents in this study were accessed from referral hospitals in Indonesia, patients with moderate-severe symptoms may have had multiple comorbidities and did not survive.

Moreover, our study reports a high prevalence of insomnia, similar to previous studies.³¹ Insomnia was influenced by advanced age, alienated relationships, feeling unsupported by family or friends, and mental health issues.³¹ It is also

possible that alterations linked to the acute infection could have triggered dysfunctional habits, such as increased caffeine intake or inadequate sleep behaviors, which might additionally lead to insomnia through a multifactorial mechanism.³²

Poor sleep quality was prevalent in our study. In a prior multicenter investigation, it was shown that nearly half of the individuals who had been hospitalized due to COVID-19 exhibited poor sleep quality.³³ Furthermore, another study showed that the domains most impacted by poor sleep quality were sleep duration and sleep efficiency, with 73.9% of patients experiencing insufficient sleep duration and 57.5% exhibiting sleep efficiency below the recommended threshold of 85%.³⁴

The majority of respondents displayed normal sleepiness, however 27.3% had EDS. The results of our study are similar to other studies that show a low prevalence of EDS.³² The study revealed that patients reporting EDS were young and had no sleep disturbance prior to COVID-19 infection, suggesting a strong association with SARS-CoV-2 infection. The study also demonstrated an association between the consumption of steroids during the acute phase of infection and the coexistence of depression with EDS.³²

In contrast to the findings of research conducted at the post-COVID-19 conditions clinic, it was observed that a majority of patients had symptoms of sleep apnea, followed by insomnia and EDS.³⁵ Our study indicated that a significant proportion of the respondents displayed a low risk for OSA, 18.8% a moderate risk, and the remaining 5.9% a high risk. Nevertheless, the findings in this study align with prior research indicating that a significant proportion of individuals have a low risk for OSA.¹⁶ OSA occurs more frequently in males; 70.2% are current or former smokers; and there are significant differences according to age and COVID-19 severity.³⁶

Sleep is a biological necessity, and lack of sleep or untreated sleep problems are detrimental to an individual's health, happiness, and safety.³⁷ Earlier studies have shown that sleep disturbances have significant effects on numerous aspects of QoL and must be treated during this crucial post-COVID-19 period.¹⁵ According to other studies, individuals with post-COVID-19 conditions have a poor QoL, which may be partially attributed to poor sleep quality.^{38,39} The intricate connections between sleep, cognition, neuroinflammation, and overall health signify that sleep may not only be a symptom. This issue not only merits more investigation but could also be a tool for recovery from post-COVID-19 conditions.⁵ With a holistic approach and integrated care pathways, patients with post-COVID-19 conditions – especially sleep disturbance – may be able to access the right care, and physicians may be better prepared to manage patients who are at high risk of developing such conditions.²³

Strength and Limitations

To date, only a few studies have examined the impact of COVID-19 on sleep in Indonesia. The findings of this study have the potential to improve management protocols and subsequent interventions aimed at developing approaches to treatment for sleep disturbance, hence mitigating the decline in QoL observed in individuals with post-COVID-19 conditions.

Our study accessed respondents from various regions in Indonesia with various characteristics, including different sociodemographic conditions. However, in this study, we did not collect data on respondents' sociodemographic and further health conditions, for example smoking or caffeine intake behavior, the use of medication, and sleep medication. Additionally, we have not evaluated depression and anxiety, as well as other comorbid/premorbid conditions into the variables analysis, which may impact on sleep disturbance in post-COVID-19 conditions.

Conclusion

Our study revealed that individuals with post-COVID-19 conditions experienced poor sleep quality, insomnia, normal sleepiness, and a low risk for OSA. Poor sleep quality, insomnia, and OSA impact numerous aspects of QoL, such as role limitation due to physical or emotional problems, social, and physical functioning. A holistic approach and integrated care pathways must be properly managed to enhance sleep quality and QoL among individuals with sleep disturbance, especially insomnia. Additionally, future studies using sleep diagnostic tools and interventions are necessary in the management of post-COVID-19 sleep disturbance.

Research Ethics and Consent

This research was approved by the ethics committee of the Faculty of Medicine, Universitas Indonesia (KET-1179/UN2.F1/ETIK/PPM.00.02/2021) and was performed in accordance with the principles stated in the Declaration of Helsinki. Prior to conducting the study, all patients were fully informed and signed an informed consent form indicating their agreement to participate in the study.

Acknowledgments

The authors would like to convey their sincere gratitude to the Neuroscience and Brain Development (NBD) cluster of Indonesia Medical Education and Research Institute for its support of this study. The authors would also like to thank Wahida Larastianing, MD, Anastasia Melissa Ayu Larasati Witjaksono, MD, Mega Iriani, MD, Rifka Humaida, MD, and Ema Ratna Kartinawati, MD for participating in data collection and providing valuable contributions to this study.

Disclosure

The authors declare that the research was conducted in the absence of any commercial or financial relationship that could be construed as a potential conflict of interest.

References

1. Bull-Ottersen L, Baca S, Saydah S, et al. Post-COVID conditions among adult COVID-19 survivors aged 18–64 and ≥65 years — United States, March 2020–November 2021. *MMWR Morb Mortal Wkly Rep.* 2022;71(21):713–717. doi:10.15585/mmwr.mm7121e1
2. World Health Organization. A clinical case definition of post COVID-19 condition by a Delphi consensus; 2021. Available from: https://www.who.int/publications-detail-redirect/WHO-2019-nCoV-Post_COVID-19_condition-Clinical_case_definition-2021.1. Accessed June 11, 2024.
3. Tran VT, Porcher R, Pane I, Ravaud P. Course of post COVID-19 disease symptoms over time in the ComPaRe long COVID prospective e-cohort. *Nat Commun.* 2022;13(1):1812. doi:10.1038/s41467-022-29513-z
4. Han Q, Zheng B, Daines L, Sheikh A. Long-term sequelae of COVID-19: a systematic review and meta-analysis of one-year follow-up studies on post-COVID symptoms. *Pathogens.* 2022;11(2):269. doi:10.3390/pathogens11020269
5. Alzueta E, Perrin PB, Yuksel D, et al. An international study of post-COVID sleep health. *Sleep Health.* 2022;8(6):684–690. doi:10.1016/j.sleh.2022.06.011
6. Linh TTD, Nguyen NN, Hu CJ, Yang CH, Wu D. Global prevalence of post-COVID-19 sleep disturbances in adults at different follow-up time points: a systematic review and meta-analysis. *Sleep Med Rev.* 2023;71:101833. doi:10.1016/j.smrv.2023.101833
7. Abuhammad S, Alzoubi KH, Khabour OF, Hamaideh S, Khasawneh B. Sleep quality and sleep patterns among recovered individuals during post-COVID-19 among Jordanian: a cross-sectional national study. *Medicine.* 2023;102(3):e32737. doi:10.1097/MD.00000000000032737
8. Fu L, Wang B, Chan PSF, et al. Associations between COVID-19 related stigma and sleep quality among COVID-19 survivors six months after hospital discharge. *Sleep Med.* 2022;91:273–281. doi:10.1016/j.sleep.2021.10.020
9. Pacho-Hernández JC, Fernández-de-las-Peñas C, Fuensalida-Novo S, Jiménez-Antona C, Ortega-Santiago R, Cigarán-Mendez M. Sleep quality mediates the effect of sensitization-associated symptoms, anxiety, and depression on quality of life in individuals with post-COVID-19 pain. *Brain Sci.* 2022;12(10):1363. doi:10.3390/brainsci12101363
10. Munteanu I, Marc M, Gheorghievici C, et al. Sleep quality aspects in post-COVID-19 patients. *J Personal Med.* 2023;13(7):1125. doi:10.3390/jpm13071125
11. Besedovsky L, Lange T, Haack M. The Sleep-Immune Crosstalk in Health and Disease. *Physiol Rev.* 2019;99(3):1325–1380. doi:10.1152/physrev.00010.2018
12. Tedjasukmana R, Budikayanti A, Islamiyah WR, Witjaksono AMAL, Hakim M. Sleep disturbance in post COVID-19 conditions: prevalence and quality of life. *Front Neurol.* 2023;3:13.
13. Buku Pedoman Tatalaksana COVID-19 Edisi 4 (Januari 2022); 2024. Available from: <https://www.papdi.or.id/download/1153-buku-pedoman-tatalaksana-covid-19-edisi-4-januari-2022>. Accessed June 11, 2024.
14. Carpenter JS, Andrykowski MA. Psychometric evaluation of the Pittsburgh Sleep Quality Index. *J Psychosom Res.* 1998;45(1):5–13. doi:10.1016/S0022-3999(97)00298-5
15. El Sayed S, Gomaa S, Shokry D, Kabil A, Eissa A. Sleep in post-COVID-19 recovery period and its impact on different domains of quality of life. *Egypt J Neurol Psychiatr Neurosurg.* 2021;57(1):172. doi:10.1186/s41983-021-00429-7
16. Kalamara E, Pataka A, Boutou A, et al. Persistent sleep quality deterioration among post-COVID-19 patients: results from a 6-month follow-up study. *J Personal Med.* 2022;12(11):1909. doi:10.3390/jpm12111909
17. Iannella G, Vicini C, Lechien JR, et al. Association Between Severity of COVID-19 Respiratory Disease and Risk of Obstructive Sleep Apnea. *Ear Nose Throat J.* 2021;3:01455613211029783.
18. Ware JE, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care.* 1992;30(6):473–483. doi:10.1097/00005650-199206000-00002
19. Milic M, Gazibara T, Pekmezovic T, et al. Tobacco smoking and health-related quality of life among university students: mediating effect of depression. *PLoS One.* 2020;15(1):e0227042. doi:10.1371/journal.pone.0227042
20. Scott D, Paterson JL, Happell B. Poor sleep quality in Australian adults with comorbid psychological distress and physical illness. *Behav. Sleep Med.* 2014;12(4):331–341. doi:10.1080/15402002.2013.819469

21. Zhou Y, Jin Y, Zhu Y, et al. Sleep problems associate with multimorbidity: a systematic review and meta-analysis. *Public Health Rev.* 2023;44:1605469. doi:10.3389/phrs.2023.1605469
22. Abdelghani M, Alsadik M, Abdelmoaty A, Atwa S, Said A, Hassan M. Sleep disturbances following recovery from COVID-19: a comparative cross-sectional study in Egypt. *East Mediterr Health J.* 2022;28(1):14–22. doi:10.26719/emhj.22.006
23. Tsampasian V, Elghazaly H, Chattopadhyay R. Risk factors associated with post-COVID-19 condition - PMC. *JAMA Intern Med.* 2023;183(6):566–580. doi:10.1001/jamainternmed.2023.0750
24. Bienvenu LA, Noonan J, Wang X, Peter K. Higher mortality of COVID-19 in males: sex differences in immune response and cardiovascular comorbidities. *Cardiovasc Res.* 2020;2:cvaa284.
25. Mohamed MS, Moulin TC, Schiöth HB. Sex differences in COVID-19: the role of androgens in disease severity and progression. *Endocrine.* 2021;71(1):3–8. doi:10.1007/s12020-020-02536-6
26. Grandner MA, Jackson NJ, Pigeon WR, Gooneratne NS, Patel NP. State and regional prevalence of sleep disturbance and daytime fatigue. *J Clin Sleep Med.* 2012;8(1):77–86. doi:10.5664/jcsm.1668
27. Willoughby AR, Alikhani I, Karsikas M, Chua XY, Chee MWL. Country differences in nocturnal sleep variability: observations from a large-scale, long-term sleep wearable study. *Sleep Med.* 2023;110:155–165. doi:10.1016/j.sleep.2023.08.010
28. Davis HE, Assaf GS, McCorkell L, et al. Characterizing long COVID in an international cohort: 7 months of symptoms and their impact. *eClinicalMedicine.* 2021;1:38.
29. Subramanian A, Nirantharakumar K, Hughes S, et al. Symptoms and risk factors for long COVID in non-hospitalized adults. *Nat Med.* 2022;28(8):1706–1714. doi:10.1038/s41591-022-01909-w
30. Romero Starke K, Reissig D, Peterit-Haack G, Schmauder S, Nienhaus A, Seidler A. The isolated effect of age on the risk of COVID-19 severe outcomes: a systematic review with meta-analysis. *BMJ Glob Health.* 2021;6(12):e006434. doi:10.1136/bmjgh-2021-006434
31. Huynh G, Nguyen HV, Vo LY, Le NT, Nguyen HTN. Assessment of insomnia and associated factors among patients who have recovered from COVID-19 in Vietnam. *Patient Preference Adherence.* 2022;16:1637–1647. doi:10.2147/PPA.S371563
32. Moura AEF, Oliveira DN, Torres DM, et al. Central hypersomnia and chronic insomnia: expanding the spectrum of sleep disorders in long COVID syndrome - a prospective cohort study. *BMC Neurol.* 2022;22(1):417. doi:10.1186/s12883-022-02940-7
33. Fernández-de-las-Peñas C, Gómez-Mayordomo V, de-la-Llave-Rincón AI, et al. Anxiety, depression and poor sleep quality as long-term post-COVID sequelae in previously hospitalized patients: a multicenter study. *J Infect.* 2021;83(4):496–522. doi:10.1016/j.jinf.2021.06.022
34. Benítez ID, Moncusí-Moix A, Vaca R, et al. Sleep and circadian health of critical COVID-19 survivors 3 months after hospital discharge. *Crit Care Med.* 2022;50(6):945–954. doi:10.1097/CCM.0000000000005476
35. Nowakowski S, Kokonda M, Sultana R, et al. Association between sleep quality and mental health among patients at a post-COVID-19 recovery clinic. *Brain Sci.* 2022;12(5):586. doi:10.3390/brainsci12050586
36. Labarca G, Henríquez-Beltrán M, Lamperti L, et al. Impact of Obstructive Sleep Apnea (OSA) in COVID-19 Survivors, Symptoms Changes Between 4-Months and 1 Year After the COVID-19 Infection. *Front Med.* 2022;4:9.
37. Ramar K, Malhotra RK, Carden KA, et al. Sleep is essential to health: an American Academy of Sleep Medicine position statement. *J Clin Sleep Med.* 2021;17(10):2115–2119. doi:10.5664/jcsm.9476
38. Garrigues E, Janvier P, Kherabi Y, et al. Post-discharge persistent symptoms and health-related quality of life after hospitalization for COVID-19. *J Infect.* 2020;81(6):e4–6. doi:10.1016/j.jinf.2020.08.029
39. Carfi A, Bernabei R, Landi F. Persistent symptoms in patients after acute COVID-19. *JAMA.* 2020;324(6):603–605. doi:10.1001/jama.2020.12603

Nature and Science of Sleep

Dovepress

Publish your work in this journal

Nature and Science of Sleep is an international, peer-reviewed, open access journal covering all aspects of sleep science and sleep medicine, including the neurophysiology and functions of sleep, the genetics of sleep, sleep and society, biological rhythms, dreaming, sleep disorders and therapy, and strategies to optimize healthy sleep. The manuscript management system is completely online and includes a very quick and fair peer-review system, which is all easy to use. Visit <http://www.dovepress.com/testimonials.php> to read real quotes from published authors.

Submit your manuscript here: <https://www.dovepress.com/nature-and-science-of-sleep-journal>