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Original Article

Sleep-Related Consequences of the COVID-19 Pandemic: A Survey Study on Insomnia and Sleep Apnea Among Affected Individuals

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ABSTRACT

Background: The global outbreak of the COVID-19 pandemic, starting in December 2019, has profoundly disrupted people's well-being across the globe. Its impact extends far beyond physical health, reaching deep into our psychological well-being, potentially triggering sleep disorders like insomnia and sleep apnea. Numerous surveys are dedicated to assessing the impact of COVID-19 on sleep-related problems in individuals, whether during their infection or post-recovery. To achieve this objective, the study has amassed a wealth of data and insights based on rigorous scientific methods.

Methods: The investigation evaluates and utilizes both insomnia severity index and the stop-bag method to ascertain the persisting presence of sleep issues after recuperation from COVID-19. The study collected data through an online and offline survey involving 403 participants who had contracted COVID-19 in Kurdistan Region of Iraq (KRI). For a clearer examination, data is analyzed using basic and advanced statistical methods.

Results: Out of the participants, 195 (48.39%) had insomnia, 9 (2.23%) were at high risk for OSA, and 394 (97.77%) had low to moderate OSA risk. In the analysis, a statistically significant association was found: females (OR: 1.58, 95% CI: 1.02, 2.46, p = 0.0412) and those needing oxygen therapy (OR: 1.41, 95% CI: 10.66, 3.01, p = 0.3714) had a higher chance of experiencing insomnia.

Conclusions: The study revealed a significant connection between psychological issues and factors like sleep duration, quality impairment, and increased sleep apnea risk among COVID-19 patients during and after their illness.

Keywords: *COVID-19; sleep problem; insomnia; obstructive sleep apnea; psychology; socio-demographic; oxygen support*

Introduction

In 2019, COVID-19, a novel Coronavirus from Wuhan, China, emerged, belonging to a new genetic lineage [1]. It has impacted education, healthcare, the economy, travel, and social interactions [2,3], revealing the complex interplay between humans and viruses. This global outbreak underscores the need for rapid response, research, and collaboration to control outbreaks. The pandemic emphasizes the importance of global healthcare readiness, early detection, and effective infectious threat management [4]. The diverse range of effects, from acute respiratory symptoms to enduring psychological and societal consequences, underscores the need for comprehensive healthcare strategies addressing both immediate and lasting impacts of viral infections. Therefore, the global COVID-19 pandemic has led to widespread mental and emotional issues, including sleep problems like insomnia, depression, and increased irritability [5]. This situation has caused unease and sadness in people experiencing the pandemic in various ways. Our study addresses two key issues in this context. Firstly, the rise of insomnia, often referred to as "Covidsomnia" or "Coronasomnia," signifies a surge in sleep-related problems [6]. Secondly, we focus on a concern that has emerged post-COVID-19, which is OSA observed in individuals recovering from the virus [7].

The COVID-19 pandemic has disrupted sleep patterns, emphasizing the importance of prioritizing quality sleep for bolstering immunity against viruses and infections, both during and after the pandemic. Sleep disturbances in COVID-19 patients have significant psychological and physical consequences [8]. To support this claim, a comprehensive three-day web-based survey involving 2,427 participants from

Greek society found that 37.6% experienced insomnia while dealing with COVID-19 [9]. Additionally, a phone survey of 112 COVID-19 patients with sleep apnea revealed that 38% of them were concerned about COVID-19 due to their sleep apnea, with 26% feeling a heightened risk due to their underlying condition [10].

Quantitative data analysis involves categorizing, scrutinizing, and organizing numerical data to draw conclusions about sampled data from a larger population, with statistics serving as a crucial tool [11]. In a sleep-related study involving 1,563 participants, 36.1% showed insomnia symptoms according to the ISI, highlighting insomnia among medical staff during the COVID-19 outbreak [12]. In 2023, during the COVID-19 pandemic in Korea, a nationwide online survey with 4,000 participants (2035 men and 1965 women) aged 20 to 69 found that 32.9% of respondents (1316 individuals) experienced insomnia, with 37.3% being women and 28.6% being men. Multivariate logistic regression analysis revealed that insomnia was associated with both female (odds ratio of 1.526, 95% confidence interval 1.297-1.796) and male (odds ratio of 1.333, 95% confidence interval 1.062-1.674) genders [13].

According to Rögnvaldsson and colleagues, their study involved 4,756 individuals diagnosed with COVID-19 in Iceland, with 185 of them also having OSA [14]. In Saudi society, there is a widespread prevalence of poor sleep (insomnia). Among 790 respondents primarily from Saudi Arabia, 438 individuals (55.5% of total respondents) reported a decline in sleep quality during the COVID-19 pandemic, and the survey used WhatsApp and Twitter to reach participants [15]. Also, Celik and colleagues' research confirmed a link between observed apneas and morning/daytime tiredness, particularly in individuals with high-risk OSA during the pandemic [16]. Another study found that 39% of 70 participants were at high risk of OSA based on the Berlin questionnaire. While there has been substantial research in this area, further investigation, especially concerning demographic and regional factors, is crucial. This comprehensive approach is essential to develop effective strategies for addressing this issue globally.

This research aims to investigate the relationship between COVID-19 transmission and its impact on sleep quality and breathing patterns during sleep. It seeks to identify factors encompassing biological, psychological, and societal aspects that may contribute to the increase in insomnia and sleep apnea among COVID-19 patients. The ultimate goal is to uncover the true origins of these sleep-related conditions, shedding light on the interaction between the pandemic and sleep difficulties. This knowledge will provide valuable insights for healthcare professionals and decision-makers, enabling them to address these challenges effectively and develop solutions.

To achieve this goal, global data has been collected from actual COVID-19 patients, focusing on the increased occurrences of insomnia and apnea following their infection. After the recovery phase, extensive online surveys were conducted, covering various aspects to extract insights from both scientific and social perspectives related to COVID-19, insomnia, and apnea. This involved evaluating insomnia symptoms using the ISI and assessing nocturnal breathing quality with STOP-Bang. The aim is to identify the primary factors driving these psychological conditions. Understanding the outcome of this research is crucial because compromised sleep quality, or insomnia, often serves as a precursor to a range of physical and psychological disorders. One of the significant contributors to disrupted sleep and nighttime breathing quality is the stress induced by life's demanding circumstances.

Our findings rely on experiments, statistics, and data analysis from the dataset. We investigate how various factors influence the likelihood of insomnia and apnea among patients. Two key aspects are considered: Firstly; we examine the relationship between patients' age groups and the occurrence of sleep-related problems in both psychological conditions. Secondly; we explore the influence of supplementary oxygen administration during the illness phase and its potential role in causing insomnia or apnea during or after COVID-19 recovery, considering its impact on sleep-related issues.

This study identifies several pivotal contributions to research on COVID-19-related illnesses, encompassing a range of psychological, mental, and physical disorders of varying severity, thereby highlighting the virus's diverse impact on human health. The dataset was rigorously analyzed to uncover correlations between features and the occurrence of conditions such as insomnia and apnea, emphasizing the potential link between the COVID-19 pandemic and these disorders. Experimental assessments compared results to identify the most influential features contributing to these psychological conditions, providing valuable insights to researchers for recognizing critical factors and making timely predictions about a patient's future health status.

The following sections of this paper are organized as follows: Section 2 presents the chosen research approach and discusses the dataset's significance. In Section 3, we provide a comprehensive overview of the dataset's findings, along with comparisons to the study's results. Then, Section 4 focuses on exploring predictors of insomnia using logistic regression. To follow, Section 5 examines the correlation between insomnia and OSA. Section 6 discusses the results. The final section summarizes the cumulative findings in a concise conclusion.

Methods

Participants Selection Strategy

After the sequential waves of COVID-19, the disease has left a significant mark on the affected individuals in various aspects, particularly impacting their physiology and psychology. To investigate these impacts on individuals, a segmented online survey was distributed to a diverse and randomly selected cross-section of the population in the KRI

over a span of 109 days, running from December 1, 2022, to March 20 2023. Prior to their participation in the study, informed consent was obtained from any participants. The questionnaires were administered through both manual (paper-based) and electronic (internet-based) distribution methods. For the manual (paper-based) distribution approach, a range of methods such as in-person interviews, paper questionnaires, telephone interviews, and face-to-face interactions were employed.

Electronic methods were employed to conduct the survey, utilizing a Google Form that was widely disseminated across various social networking platforms, including Facebook, Instagram, Twitter, and more. Participants were also encouraged to share the questionnaires within their networks.

Classification Features Measurements

The survey questionnaire consisted of three main sections designed to collect data on three key factors. The first section was dedicated to obtaining demographic information, including gender, age, marital status, employment status, education level, and blood type. Each variable was divided into distinct groups, as shown in Table 2. For example, gender was categorized into two groups: male and female. In the next part of this section, participants were asked to provide their height in centimeters, followed by their weight in kilograms in another subsection. From the data collected in these subsections, the body mass index (BMI) was calculated and then categorized into three groups: underweight (BMI < 18.5), normal weight (BMI between 18.5 and 24.9), and overweight or obese (BMI > 24.9).

In the second section, we assessed insomnia symptoms and the quality of nocturnal breathing through the use of the ISI and STOP-Bag, respectively. The ISI consists of several items, each rated on a scale of 0 to 4. The cumulative score can range from 0 to 28, with higher scores indicating more severe insomnia symptoms. A total score of 8 or above is indicative of the presence of insomnia symptoms. The STOP-Bag [17] questionnaire assesses sleep apnea using a scoring system ranging from 0 to 7. It includes four yes/no questions related to snoring, tiredness, observed breathing cessation and choking during sleep. Additionally, the questionnaire includes three demographic questions: BMI, age, and gender, which are scored based on their category. Scoring for the general population is divided into three sections: low risk for OSA (0-2 yes answers), intermediate risk of OSA (3-4 yes answers), and high risk of OSA (5-7 yes answers).

Data Analysis

The statistical analyses were conducted using Python 3.11.3 programming in Anaconda 23.5.2, specifically in Jupyter Notebook 6.5.4. For data processing and visualization, various Python-based data analysis libraries were utilized, including Pandas, SciPy, Statsmodels, Seaborn, and Matplotlib. Additionally, IBM's Statistical Package for Social Sciences (SPSS - Version 26.0, 64-bit edition) for Windows was employed to enhance certain results.

The study summarized categorical variables using counts and percentages. Furthermore, the study examined the relationships between socio-demographic factors and insomnia (defined as ISI ≥ 8) in the context of COVID-19, as well as non-insomnia (defined as ISI < 8) in the context of COVID-19, using the chi-square test. The same analytical approach was applied to investigate the associations between socio-demographic factors and low or intermediate risk for OSA (defined as OSA < 5) in the context of COVID-19, as well as high risk for OSA (defined as OSA ≥ 5) in the context of COVID-19, using the chi-square test. Moreover, multiple binary logistic regressions have been employed to explore the connections between socio-demographic characteristics and the issue of the insomnia pandemic.

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Results and Comparisons

Prevalence of Insomnia and Sleep Apnea

Table 1 displays the distribution of participants based on the severity of insomnia (as measured by the ISI) and their risk levels for OSA. Regarding insomnia severity, the majority (52.9%) experience no significant insomnia, while 21.8% have subthreshold insomnia, 19.9% have moderate insomnia, and 5.5% have severe insomnia. For OSA risk (as measured by STOP-Bag), the majority of participants are categorized as "Low Risk," constituting 81.9% of the sample, while a smaller proportion falls into the "Moderate Risk" category at 15.8%. A relatively small percentage, 2.3%, is classified as "High Risk".

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Table 1. Prevalence of Insomnia and Sleep Apnea.

	n	%
Insomnia		
No significant insomnia (ISI 0-7)	213	52.9
Subthreshold insomnia (ISI 8-14)	88	21.8
Moderate insomnia (ISI 15-21)	80	19.9
Severe insomnia (ISI 22-28)	22	5.5
OSA		
Low Risk	322	81.9
Moderate Risk	62	15.8
High Risk	9	2.3

Impact of Socio-Demographic Features on Insomnia

The key findings are summarized by analyzing COVID-19 cases among individuals, considering their socio-demographics. The results are categorized into two groups: individuals with insomnia and those without, as presented in Table 2 and Figure 1. Based on the results, among the total of 403 COVID-19-infected individuals, only 195 individuals were affected by insomnia, constituting approximately 48.3% of the total dataset. Our analysis in Table 2 revealed that both gender and educational level were highly significant factors associated with insomnia, with a significance level of $p < 0.05$.

Most of the participants in the study are male, making up about 54% of the total group. Among males, nearly 43% reported experiencing insomnia. Conversely, females constitute roughly 46% of the total participants, and a larger proportion of them, nearly 55%, are affected by insomnia as a result of COVID-19. When examining COVID-19-related insomnia across different education levels, we find a significant difference ($p = 0.005$). This suggests that education level may influence the likelihood of insomnia post-infection. The largest group holds a Bachelor's degree, constituting approximately 44% of participants, with nearly 55% reporting no insomnia after COVID-19. Master's degree holders make up over 20% of the sample. Those with a high school education or less represent 12.4% and have a higher insomnia prevalence at 72%.

The findings displayed in Table 2 indicate that there is no statistically significant association between insomnia and the other factors, including age group, marital status, employment status, BMI category, and oxygen support. However, it's worth noting that the relationship between insomnia and blood group approached significance, with a p-value of 0.057.

Table 2. Socio-demographic categories proportion result in insomnia disease by COVID-19 infection.

Features	Classification Features	Total Sample 403	Insomnia by COVID-19 195	Non-Insomnia by COVID-19 208	Statistical Models
Gender	**Male**	217 (53.8%)	93 (42.9%)	124 (57.1%)	$\chi2$ (1) =5.287, ***p* = 0.021**
	Female	186 (46.2%)	102 (54.8%)	84 (45.2%)	
Age Group	**18 to 30 years**	131 (32.5%)	66 (50.4%)	65 (49.6%)	$\chi2$ (3) =5.257, *p* = 0.154
	31 to 50 years	231 (57.3%)	103 (44.6%)	128 (55.4%)	
	51 to 60 years	27 (6.7%)	17 (63.0%)	10 (37.0%)	
	61 years or more	14 (3.5%)	9 (64.3%)	5 (35.7%)	
Marital Status	**Single**	182 (45.2%)	95 (52.2%)	87 (47.8%)	$\chi2$ (2) =2.103, *p* = 0.349
	Married	218 (54.1%)	99 (45.4%)	119 (54.6%)	
	Divorced	3 (0.7%)	1 (33.3%)	2 (66.7%)	
Employment Status	**Employed**	236 (58.6%)	102 (43.2%)	134 (56.8%)	$\chi2$ (4) =8.101, *p* = 0.088
	Self-employed	30 (7.4%)	14 (46.7%)	16 (53.3%)	
	Unemployed	25 (6.2%)	13 (52.0%)	12 (48.0%)	
	Student	108 (26.8%)	63 (58.3%)	45 (41.7%)	
	retired	4 (1.0%)	3 (75.0%)	1 (25.0%)	
Education Level	**High school or less**	50 (12.4%)	36 (72.0%)	14 (28.0%)	$\chi2$ (4) =14.836, ***p* = 0.005**
	Diploma	59 (14.6%)	31 (52.5%)	28 (47.5%)	
	Bachelor degree	176 (43.7%)	79 (44.9%)	97 (55.1%)	
	Master degree	82 (20.3%)	33 (40.2%)	49 (59.8%)	
	Doctorate degree	36 (8.9%)	16 (44.4%)	20 (55.6%)	
Blood Group	**A+**	118 (29.3%)	54 (45.8%)	64 (54.2%)	$\chi2$ (7) =13.686, *p* = 0.057
	A-	10 (2.5%)	8 (80.0%)	2 (20.0%)	
	B+	71 (17.6%)	29 (40.8%)	42 (59.2%)	

Features	Classification Features	Total Sample	Insomnia by COVID-19	Non-Insomnia by COVID-19	Statistical Models
		403	195	208	
	B-	5 (1.2%)	1 (20.0%)	4 (80.0%)	
	O+	132 (32.8%)	74 (56.1%)	58 (43.9%)	
	O-	20 (5.0%)	11 (55.0%)	9 (45.0%)	
	AB+	42 (10.4%)	17 (40.5%)	25 (59.5%)	
	AB-	5 (1.2%)	1 (20.0%)	4 (80.0%)	
BMI Category	**Underweight**	48 (11.9%)	20 (41.7%)	28 (58.3%)	χ^2 (2) =1.463, p = 0.481
	Normal	177 (43.9%)	84 (47.5%)	93 (52.5%)	
	Overweight and obese	178 (44.2%)	91 (51.1%)	87 (48.9%)	
Oxygen Support	**No**	367 (91.1%)	174 (47.4%)	193 (52.6%)	χ^2 (1) =1.159, p = 0.282
	Yes	36 (8.9%)	21 (58.3%)	15 (41.7%)	

Abbreviations: p—statistical significance, $\chi 2$ = chi-square. Bold values are used to emphasize statistical significance ($p < 0.05$).

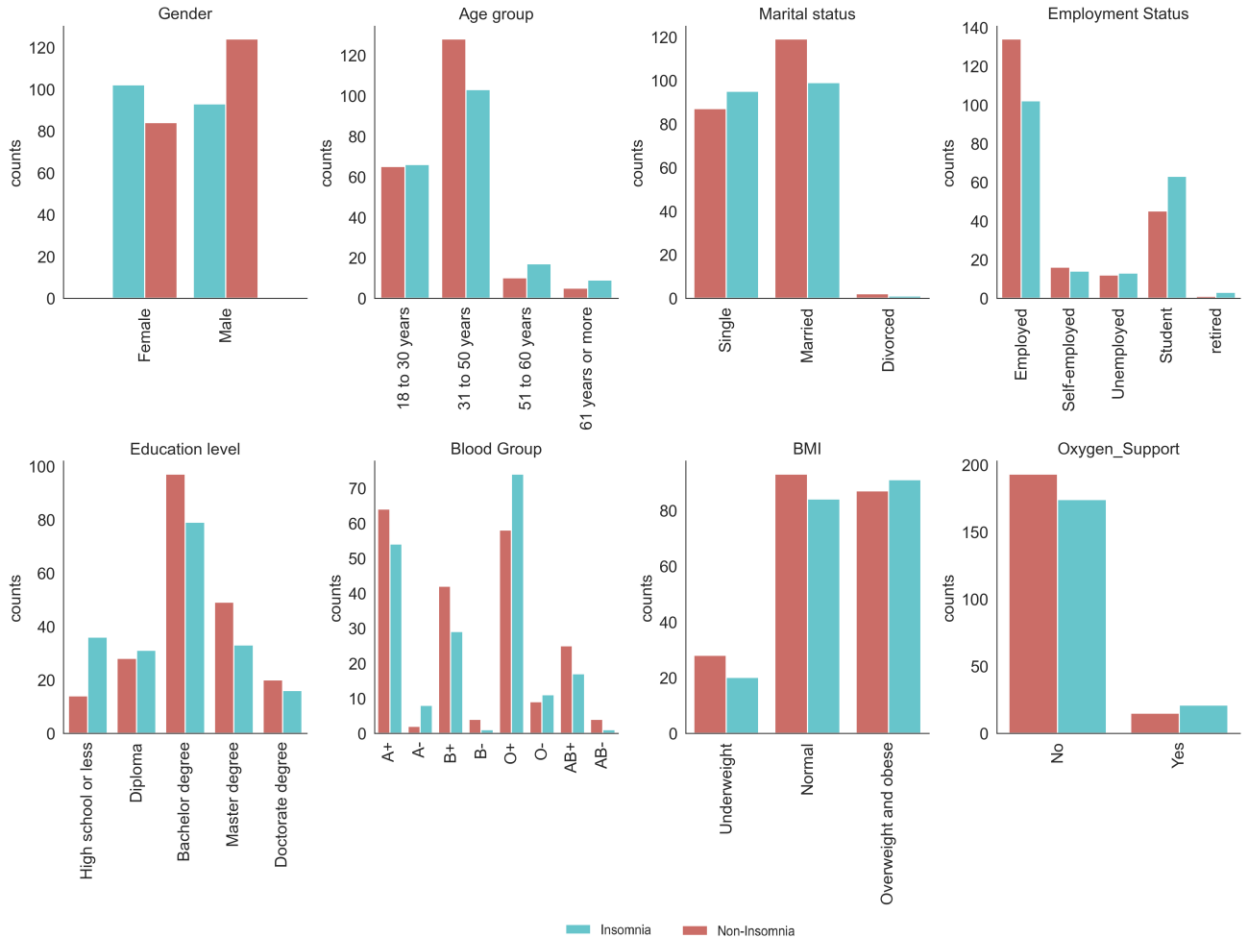

Figure 1. Comparisons of features (gender, age group, marital status, employment status, education degree, and blood group) between insomnia and non-insomnia.

Socio-Demographics and Obstructive Sleep Apnea

Table 3 illustrates the factors with stronger associations to higher risk of OSA among individuals who have contracted COVID-19. According to the result, out of the total 403 COVID-19-infected individuals, a small subset of 9 individuals were categorized as having a high risk of OSA. In

Table 3, our analysis indicated that both age group and oxygen support were highly significant factors for STOP-BAG categories, with a significance level of $p < .001$. Our observation revealed a notable disparity in the likelihood of individuals falling into the high-risk group across different age groups. Specifically, individuals aged "61 years or more" displayed a significantly higher percentage (21.4%) compared to those in the "51 to 60 years" group (14.8%), "18 to 30 years" group (1.5%), and "31 to 50 years" group (0%). Additionally, our findings indicate that among individuals infected with COVID-19, 13.9% of those who required oxygen support belonged to the high-risk group. In contrast, only 1.1% of individuals infected with COVID-19 who did not require oxygen support fell into the high-risk category.

Correlation

In terms of employment status, there was a statistically significant association ($p < 0.025$) with the high-risk category. The analysis revealed that a considerable percentage (25.0%) of retired individuals who were infected with COVID-19 fell into the high-risk group. Conversely, a smaller proportion of self-employed individuals (3.3%), employed individuals (2.5%), students (0.9%), and unemployed individuals (0%) were classified as high risk.

None of the variables, including marital status, education level, blood group, BMI category, and gender, were found to be statistically significant predictors at a level of $p < 0.05$.

Table 3. Distribution of Socio-Demographic Categories and their Impact on OSA in the Context of COVID-19 Infection.

Features	Classification Features	Total Sample	High risk of OSA	Low + intermediate risk of OSA	Statistical Models
		403	9	394	
Gender	Male	217 (53.8%)	8 (3.7%)	209 (96.3%)	$\chi2$ (1) =3.221, p = 0.073
	Female	186 (46.2%)	1 (0.5%)	185 (99.5%)	
Age Group	18 to 30 years	131 (32.5%)	2 (1.5%)	129 (98.5%)	$\chi2$ (3) =48.777, ***p* = 0**
	31 to 50 years	231 (57.3%)	0 (0.0%)	231 (100.0%)	
	51 to 60 years	27 (6.7%)	4 (14.8%)	23 (85.2%)	
	61 years or more	14 (3.5%)	3 (21.4%)	11 (78.6%)	
Marital Status	Single	182 (45.2%)	1 (0.5%)	181 (99.5%)	$\chi2$ (2) =4.492, p = 0.106
	Married	218 (54.1%)	8 (3.7%)	210 (96.3%)	
	Divorced	3 (0.7%)	0 (0.0%)	3 (100.0%)	
Employment Status	Employed	236 (58.6%)	6 (2.5%)	230 (97.5%)	$\chi2$ (4) =11.182, ***p* = 0.025**
	Self-employed	30 (7.4%)	1 (3.3%)	29 (96.7%)	
	Unemployed	25 (6.2%)	0 (0.0%)	25 (100.0%)	
	Student	108 (26.8%)	1 (0.9%)	107 (99.1%)	
	retired	4 (1.0%)	1 (25.0%)	3 (75.0%)	
Education Level	High school or less	50 (12.4%)	1 (2.0%)	49 (98.0%)	$\chi2$ (4) =4.068, p = 0.397
	Diploma	59 (14.6%)	2 (3.4%)	57 (96.6%)	
	Bachelor degree	176 (43.7%)	4 (2.3%)	172 (97.7%)	
	Master degree	82 (20.3%)	0 (0.0%)	82 (100.0%)	
	Doctorate degree	36 (8.9%)	2 (5.6%)	34 (94.4%)	
Blood Group	A+	118 (29.3%)	4 (3.4%)	114 (96.6%)	$\chi2$ (7) =5.679, p = 0.578
	A-	10 (2.5%)	0 (0.0%)	10 (100.0%)	
	B+	71 (17.6%)	0 (0.0%)	71 (100.0%)	

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Features	Classification Features	Total Sample	High risk of OSA	Low + intermediate risk of OSA	Statistical Models
		403	9	394	
	B-	5 (1.2%)	0 (0.0%)	5 (100.0%)	
	O+	132 (32.8%)	5 (3.8%)	127 (96.2%)	
	O-	20 (5.0%)	0 (0.0%)	20 (100.0%)	
	AB+	42 (10.4%)	0 (0.0%)	42 (100.0%)	
	AB-	5 (1.2%)	0 (0.0%)	5 (100.0%)	
BMI Category	Underweight	48 (11.9%)	1 (2.1%)	47 (97.9%)	$\chi2$ (2) =0.006, p = 0.997
	Normal	177 (43.9%)	4 (2.3%)	173 (97.7%)	
	Overweight and obese	178 (44.2%)	4 (2.2%)	174 (97.8%)	
Oxygen Support	No	367 (91.1%)	4 (1.1%)	363 (98.9%)	$\chi2$ (1) =19.084, **p = 0**
	Yes	36 (8.9%)	5 (13.9%)	31 (86.1%)	

Predictors of Insomnia

Table 4 insomnia disease was predicted solely by each variable one by one but the multivariable analysis was adjusted with these variables gender, marital status, employment status, education degree, blood group, and oxygen support. For each feature, the first category has been used as a reference category. This means all odds ratios for the other categories are compared with the reference category.

When compared with male, we found that female was more likely to experience insomnia in both univariable (OR: 1.62, 95% CI: 1.09, 2.4, p = 0.0167) and multivariable (OR: 1.58, 95% CI: 1.02, 2.46, p = 0.0412) analysis. We found that there was a significantly increased risk of insomnia disease in those respondents within the age-group of 51—60 (OR: 4.53, 95% CI: 1.45, 14.17, p = 0.0093) relative to those within the age-group of 18—30 in multivariable analysis. This indicates that the likelihood of experiencing insomnia is 4.53 times greater in the 51—60 age group. Although this association did not reach statistical significance in in univariable analysis (OR: 1.67; 95% CI: 0.71, 3.93; p = 0.2363).

Regarding employment status, individuals who were

In the univariable analysis in

students were found to have a higher likelihood of experiencing insomnia compared to those who were employed. This association was observed in both univariable analysis (OR: 1.84; 95% CI: 1.16, 2.92; p = 0.0096) and multivariable analysis (OR: 2.27; 95% CI: 1.05, 4.91; p = 0.0368).

In terms of education, compared to those with high school or less, individuals with a diploma, bachelor's degree, master's degree, or doctorate degree were found to be less likely to experience insomnia in the univariable analysis (OR:0.43; 95% CI: 0.19, 0.96; p = 0.0393) (OR: 0.32; 95% CI: 0.16, 0.63; p = 0.001) (OR: 0.26; 95% CI: 0.12, 0.56; p = 0.0005) (OR: 0.31; 95% CI: 0.13, 0.77; p = 0.0112), respectively. In the multivariable analysis, this association remained significant for all education levels except for those with a diploma.

None of the items within the variables Blood Group, Oxygen Support, and BMI Category (Body Mass Index) showed significant associations with their respective first category, which serves as the reference category.

Table 4. Logistic regression with univariable and multivariable analyses of multiple risk features affecting insomnia.

Features	Univariable Model			Multivariable Model		
	B (SE)	OR (95% CI)	*p*-Value	B (SE)	OR (95% CI)	*p*-Value
Gender						
Male	Reference					
Female	0.48 (0.2)	1.62 (1.09, 2.4)	**0.0167**	0.46 (0.23)	1.58 (1.02, 2.46)	**0.0412**
Age Group						

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Features	Univariable Model			Multivariable Model		
	B (SE)	OR (95% CI)	*p*-Value	B (SE)	OR (95% CI)	*p*-Value
18 to 30 years	Reference					
31 to 50 years	-0.23 (0.22)	0.79 (0.52, 1.22)	0.2887	0.62 (0.35)	1.87 (0.95, 3.68)	0.0712
51 to 60 years	0.52 (0.44)	1.67 (0.71, 3.93)	0.2363	1.51 (0.58)	4.53 (1.45, 14.17)	**0.0093**
61 years or more	0.57 (0.59)	1.77 (0.56, 5.57)	0.3273	1.39 (0.78)	4.01 (0.88, 18.34)	0.0734
Marital Status						
Single	Reference					
Married	-0.27 (0.2)	0.76 (0.51, 1.13)	0.1767	-0.13 (0.29)	0.88 (0.5, 1.57)	0.6662
Divorced	-0.78 (1.23)	0.46 (0.04, 5.14)	0.5266	-0.76 (1.28)	0.47 (0.04, 5.76)	0.5522
Employment Status						
Employed	Reference					
Self-employed	0.14 (0.39)	1.15 (0.54, 2.46)	0.7201	0.18 (0.44)	1.2 (0.51, 2.86)	0.6787
Unemployed	0.35 (0.42)	1.42 (0.62, 3.25)	0.4023	0.14 (0.47)	1.15 (0.46, 2.87)	0.7665
Student	0.61 (0.24)	1.84 (1.16, 2.92)	**0.0096**	0.82 (0.39)	2.27 (1.05, 4.91)	**0.0368**
retired	1.37 (1.16)	3.94 (0.4, 38.45)	0.238	0.06 (1.38)	1.06 (0.07, 15.9)	0.9676
Education Degree						
High school or less	Reference					
Diploma	-0.84 (0.41)	0.43 (0.19, 0.96)	**0.0393**	-0.71 (0.43)	0.49 (0.21, 1.14)	0.098
Bachelor degree	-1.15 (0.35)	0.32 (0.16, 0.63)	**0.001**	-0.97 (0.37)	0.38 (0.19, 0.79)	**0.0089**
Master degree	-1.34 (0.39)	0.26 (0.12, 0.56)	**0.0005**	-1.19 (0.43)	0.31 (0.13, 0.71)	**0.0055**
Doctorate degree	-1.17 (0.46)	0.31 (0.13, 0.77)	**0.0112**	-1.27 (0.52)	0.28 (0.1, 0.78)	**0.0152**
Blood Group						
A+	Reference					
A-	1.56 (0.81)	4.74 (0.97, 23.28)	0.0553	1.63 (0.83)	5.08 (0.99, 25.98)	0.0511
B+	-0.2 (0.3)	0.82 (0.45, 1.49)	0.5097	-0.11 (0.32)	0.9 (0.48, 1.69)	0.7343
B-	-1.22 (1.13)	0.3 (0.03, 2.73)	0.2831	-1.04 (1.16)	0.36 (0.04, 3.45)	0.3719
O+	0.41 (0.26)	1.51 (0.92, 2.49)	0.1045	0.37 (0.27)	1.45 (0.86, 2.46)	0.1654
O-	0.37 (0.49)	1.45 (0.56, 3.76)	0.4457	0.22 (0.51)	1.24 (0.46, 3.37)	0.6711
AB+	-0.22 (0.37)	0.81 (0.39, 1.65)	0.5541	-0.16 (0.39)	0.85 (0.4, 1.82)	0.6829
AB-	-1.22 (1.13)	0.3 (0.03, 2.73)	0.2831	-1.04 (1.18)	0.35 (0.04, 3.6)	0.3805
Oxygen Support						
No	Reference					
Yes	0.44 (0.35)	1.55 (0.78, 3.11)	0.2136	0.35 (0.39)	1.41 (0.66, 3.01)	0.3714
BMI Category						
Underweight	Reference					
Normal	0.24 (0.33)	1.27 (0.66, 2.41)	0.4759	0.44 (0.36)	1.55 (0.77, 3.15)	0.2205
Overweight and obese	0.38 (0.33)	1.46 (0.77, 2.79)	0.2462	0.47 (0.36)	1.6 (0.8, 3.21)	0.1866

Abbreviations: B—regression coefficient, SE—standard error, OR—odds ratio, 95% CI—95% confidence interval, Bold formatting is applied to highlight statistical significance ($p < 0.05$).

The Correlation Relationship Between Insomnia and OSA

Table 5 presents the results of a Spearman's rho correlation analysis between the variables insomnia and OSA. The correlation coefficient between insomnia and OSA is -0.010, suggesting a very weak negative correlation. Both p-values associated with these correlations are non-significant ($p > 0.05$), with values of 0.838. These results suggest that there is no substantial correlation between the severity of insomnia and the risk levels for OSA among the studied participants.

Table 5. Spearman correlation analysis between Insomnia and OSA

			Insomnia	OSA
Spearman's rho	Insomnia	Correlation Coefficient	1.000	-0.010
		Sig. (2-tailed)		0.838
		N	403	403
	OSA	Correlation Coefficient	-0.010	1.000
		Sig. (2-tailed)	0.838	
		N	403	403

Discussion

In this study, we unveiled notably compromised sleep quality and heightened severity of insomnia and OSA in individuals afflicted by COVID-19. What sets this study apart is its ability to showcase the degree to which COVID-19 infection can contribute to the development of insomnia and sleep apnea. To achieve this, the study used a number of factors that have been previously shown to be strongly associated with COVID-19 infection and or OSA. The data presented in

Table 2 shows that gender and educational degree are the two factors that are significantly associated with insomnia among covid-19 infection individuals. Previous studies proved that gender [18,19] and educational level [20] are strongly associated with insomnia.

Numerous studies have been undertaken to investigate the potential connection between COVID-19 infection and OSA [21–23]. This exploration is motivated by shared predictive factors such as body mass index (BMI), advanced age, and male gender, which are associated with both OSA and COVID-19. This article highlights a noteworthy association between age groups and a high risk of OSA, as evidenced by the data presented in

Table 3. When comparing younger COVID-19-infected individuals (1.5% of those aged 18 to 30 and 0.0% of those aged 31 to 50), a noticeably higher proportion of older adults (14.8% for those aged 51 to 60 and 21.4% for those aged 61 or above) exhibit severe OSA. This observation aligns with recent research that consistently indicates an elevated risk of OSA associated with advancing age [24–26].

As indicated in

Table 2 and

Table 3, individuals who required supplemental oxygen therapy during their COVID-19 infection are at a higher likelihood of experiencing severe OSA and insomnia in comparison to those who did not necessitate oxygen therapy. Oxygen therapy is a mean that supplies patients with more oxygen [27–29] but those who need it, have suffered from severe COVID-19 infection and their lungs have been so damaged [30,31], and infection affecting either the upper or lower respiratory tract. Therefore, according to our result, a considerable percentage of individuals who needed oxygen therapy experienced more severe cases of OSA and insomnia in comparison to those who did not require such treatment. Although oxygen therapy is primarily administered to COVID-19 patients facing respiratory challenges, it can also offer acute relief for OSA [32] and insomnia [33].

Our study in

Table 4 found that gender is a significant risk factor for insomnia, with females having a 58% greater chance of experiencing insomnia than males. This finding is consistent and in line with the finding of previous studies, which indicated a notably higher prevalence of insomnia among females when compared to males [19,34–36]. Another interesting finding was that there is a strong correlation between educational qualification and insomnia. Individuals with a bachelor's degree, master's degree, or doctorate degree were 0.62, 0.69, and 0.72 times, respectively, less likely to experience insomnia than those with a high school education or less. In studies [20,37], similarly to our study, they found that those who have higher degrees were less prone to experience insomnia. Another notable factor strongly linked to insomnia was employment status. Students were found to have a 2.27 times higher risk of experiencing insomnia compared to those who were employed. This

observation is substantiated by numerous studies [38–40], indicating that students are more susceptible to insomnia.

Table 5 of this article is the absence of a significant correlation between the severity of insomnia and the risk levels for obstructive sleep apnea (OSA) among the participants under study. This finding aligns with earlier research [41,42], which has also found no statistical association between OSA and the prevalence of insomnia.

Some limitations of the current study need to be addressed. Firstly, while we did assess participants' socio-demographic factors, we lacked data concerning their physical activity, dietary habits, vaccination status, and the potential presence of concurrent medical conditions or treatments that might impact sleep-related issues. Secondly, due to the challenges associated with measuring neck circumference in an online survey, a STOP-BAG score was computed as a substitute for a STOP-BANG score.

Conclusions

In conclusion, this study establishes a clear link between COVID-19 infection and the development of insomnia and sleep apnea. Additionally, certain socio-demographic factors have emerged as robust predictors of these sleep disorders. For insomnia, factors such as gender and education degree play a significant predictive role, while age group, employment status, and the requirement for oxygen support have demonstrated significance in relation to OSA. The study indicated that a small proportion of participants were at high risk of OSA and faced severe insomnia. However, those affected by insomnia were not in the low-risk category, with nearly half of the participants experiencing insomnia to some degree. These findings can provide valuable insights for both governmental bodies and the medical community, aiding in the development of comprehensive interventions to mitigate psychological issues among individuals with insomnia.

Based on the study presented, it is recommended that healthcare professionals focus on the psychological and sleep-related effects of COVID-19, particularly insomnia and sleep apnea, as key areas requiring attention. Given the high prevalence of insomnia, especially among females and those with lower education levels, targeted interventions for these groups may be beneficial. Additionally, the study highlights that patients requiring oxygen therapy during their COVID-19 infection are more likely to experience severe sleep disorders, suggesting that targeted monitoring and therapeutic strategies for these individuals should be prioritized. Age was also a significant factor for sleep apnea risk, with older adults, particularly those aged 51 and above, showing higher susceptibility to OSA. Thus, age-specific screening and interventions for sleep disorders in COVID-19 care should be considered.

The research further emphasizes the need for a holistic approach that includes addressing the social and psychological dimensions of recovery from COVID-19. Expanding future studies to explore factors such as physical activity, dietary habits, and pre-existing health conditions could provide a more comprehensive understanding of the pandemic's impact on sleep. Additionally, enhancing awareness about the importance of sleep hygiene and offering support to individuals experiencing insomnia and OSA should be integral to public health strategies. Healthcare providers can use these findings to develop preventative measures and early interventions to mitigate long-term psychological and physical health issues among individuals affected by COVID-19.

Another discovery highlighted in

Deleted:

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