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A cross-sectional survey on sleep disturbances with special reference to sleep quality among COVID-19-recovered patients attending outpatient department of a medical college hospital in Eastern India

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ABSTRACT

Background: The prevalence of sleep problems is approximately 40% among the general and health-care populations. Post-covid-19 sleep disturbances may persist for a long time and are often precursors of psychiatric disorders and expeditors of many systemic diseases. Studies on sleep quality in COVID-19 patients are considerable but in post-COVID-recovered subjects are scanty. There is no study on sleep quality of such patients in Eastern India. **Aims and Objectives:** We hypothesize that both sleep disturbances and sleep quality may be affected in subjects in their post-COVID state. Therefore, we planned to study the prevalence of sleep disturbances, sleep quality, severity of insomnia, and the relationship of different parameters with respect to sleep quality. **Materials and Methods:** Two hundred and fifty COVID-19-recovered patients were administered a pre-structured questionnaire including Pittsburgh sleep quality index and insomnia severity index containing various sleep parameters. **Results:** Majority of the study participants had sleep disturbances in the form of change in sleep pattern (59.6%), poor sleep quality (77.6%), reduced sleep duration (29.6%), daytime sleepiness (20%), difficulty in sleep initiation (29.6%), and subthreshold insomnia (53.6%). Poor sleep quality was strongly associated with reinfection, change in sleep pattern after infection, sleep pattern alteration during pandemic, and those who felt tired during daytime. **Conclusion:** This study concludes that a significant number of COVID-19-recovered subjects experienced sleep disturbances including poor sleep quality.

Key words: COVID-19 recovered patients; Subthreshold insomnia; Poor sleep quality; Daytime sleepiness; Post-COVID insomnia

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INTRODUCTION

Novel human coronavirus disease 2019 (COVID-19) was declared a pandemic on March 11th, 2020.[1] Globally, as of October 12, 2022, there have been 619,770,633 confirmed cases, including 6,539,058 deaths, reported to WHO.[2] In India, from January 3rd, 2020 to October 12th, 2022, there have been 44,618,533 confirmed cases with 528,835 deaths.[3] Among the common issues during the pandemic, one neglected but concerning aspect was sleep problems.

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The prevalence of sleep problems during the COVID-19 pandemic is approximately 40% of people from the general and health-care populations. Patients with active COVID-19 appeared to have a higher prevalence rate of sleep problems.[4] Traumatic events, such as those related to the global spread of unknown epidemics, generate psychological distress and anxiety symptoms, which impact sleep quality.[5] Large-scale confinement, social distancing, lockdown, stress due to physical problems, emotional disturbances, and fear due to the pandemic have affected the mental health of population.[6] Home confinement led to a decrease in physical activity and diminished exposure to daylight. There is an increased level of stress due to social isolation and this can disrupt night-time sleep[7] as well as increase the risk of mental health problems.[8]

Tanriverdi et al. showed 50% of post-COVID participants in their study had poor sleep quality.[9] Insomnia in post-COVID patients has been reported to be as high as 45.1% of participants.[10] A change in sleep pattern was associated with medication use, ongoing COVID-19 symptoms, and impaired mental health, and it was negatively associated with age, male gender, and general health.[11] According to the Ministry of Health and Family welfare, 18% of people can have sleep dysfunction and insomnia as a post COVID-19 sequelae.[12] The circadian rhythm maintains our sleep cycle, which keeps us awake in the daytime and makes us sleepy in the night. The circadian rhythm is controlled by the daylight and other factors such as mealtimes and exercise. Light exposure affects the melatonin production, which helps in inducing sleep. Bright light exposure during the day helps in the better production of melatonin in the night. Physical activity also affects the sleep quality as evidenced by a negative correlation between sleep and low activity level as well as high activity levels during daytime.[7]

The exact pathophysiology of post-COVID insomnia is not fully understood. Post-COVID insomnia is likely to be multifactorial, with contributions from the dysregulation of the circadian rhythm, psychological factors, respiratory, cardiovascular complications, and neuroinflammation.[11,13,14] Most of the studies have been conducted on the COVID-19 hospitalized or home-isolated patients. Studies done on COVID-recovered patients were scanty and of them mostly are online surveys[5,10,11,15,16] and few on hospitalized patients[10] and addressing many aspects[9,16-18] other than the sleep quality.[8]

The aim of the study was to estimate the sleep disturbances in patients who recovered from COVID-19. This was the first study on such patients from Eastern India.

Aims and objectives

- To estimate the proportion of individuals recovered from covid-19 experiencing sleep disturbance
- To assess the sleep quality among the participants
- To study the severity of insomnia if present
- To study the the relationship of different parameters with respect to sleep quality

MATERIALS AND METHODS

We performed out a cross-sectional study from August 2022 to October 2022 in the General Medicine outpatient department of Nil Ratan Sircar Medical College and Hospital, Kolkata, after getting approval from the Institutional Ethics Committee Board (ECR/609/Instt/WB/2014/RR-20). This study was a part of the ICMR Short-Term Studentship program (Reference ID: 2022–07914). Written informed consent was obtained from the study participants.

Inclusion criteria

Patients aged between 18 and 60 years and those who had recovered from COVID-19 within 1–6 months.

Exclusion criteria

Persons with pre-existing sleep disorders and psychiatric problems, on drugs affecting sleep, systemic cancer, fibromyalgia, chronic pain syndrome, cardiac disease, pulmonary disorders, renal disease as well as keyworkers were excluded from the study. Pre-existing sleep disorders have been excluded by detailed history taking from patient, bed partner/patient's family members, and past medical records.

According to the Ministry of Health and Family Welfare, 18% of people can have sleep dysfunction and insomnia as a post COVID-19 sequelae.[12]

Hence, taking 18% and applying it to the formula, n=([Z 1-a/2] 2 p*q/d 2]=(3.84*18*82)/25 taking z as 1.96 (two tail) as standard normal deviate, d=5 as absolute error and prevalence as 18 % (p), and q=complement of P=(100-p)=82% gives the value 226.71 rounding it off to 227 and adding 10% due to incomplete questionnaire. This gives a total of 250 patients.

We included 250 patients in our study which was done over a period of 7 weeks from August 1st, 2022 to October 2nd, 2022.

Study objectives

- To estimate the proportion of individuals recovered from COVID-19 experiencing sleep disturbances
- To assess the sleep quality among the participants
- To study the severity of insomnia if present.

Good sleep is when you fall asleep quite easily, do not fully wake up during the night, do not wake up too early,

and feel refreshed in the morning. Deviation from the above will be regarded as poor sleep.[19] Respondents were asked to answer a pre-structured questionnaire based on sociodemographic data, such as age, gender, marital status, educational level, occupation status, residence, clinical data, baseline characteristics as well as the impact of the pandemic/lockdown, including COVID-19 infection history, self-isolation, mental health, addiction history, sleep medication use, and sleep profile (current quality/quantity, pre-COVID sleep quality/quantity, change in sleep pattern, and specific sleep symptoms). Specific questions related to COVID were asked. Pittsburgh sleep quality index (PSQI) and insomnia severity index (ISI) questionnaires were applied to know good sleep and bad sleep.

PSQI is a valid and reliable scale to study the subjective quality of sleep over a period of 1 month through 19 items.[20] The subdomains of the scale include subjective sleep quality, latency of sleep, habitual sleep duration, use of sleep medicines, and daytime impacts. The results of the index were estimated on a scoring scale from 0 to 3, and all the subdomains were summated to form the total index score. The total score is from 0 to 21 and, scores PSQI score more than 5 indicates poor sleep quality.

ISI is a brief scale evaluating the patient's insomnia for subjective complaints, results of insomnias, and the level of dysfunction from these sleep disturbances.[21] The ISI is composed of seven domains, which include the following (A) the degree of severity of onset (initial), (B) the maintenance of sleep, (C) early morning awakening (terminal) problems, (D) to what extent the patient was satisfied with the current sleep pattern, (E) impact on daily life activities, (F) observed by others/interfering with the quality of life, and (G) distress level caused by sleep problem. Each item is scaled on a 5-point Likert scale from 0 to 4, and this total score ranges from 0 to 28. The ISI score used to measure the insomnia severity is divided into the following categories: 0–7=no clinically significant insomnia; 8–14=subthreshold insomnia; 15–21=clinical insomnia (moderate severity); and 22–28=Clinical insomnia (severe).

Statistical analysis

The data collected were entered into a Microsoft Excel 2016 spreadsheet and were analyzed using IBM SPSS Statistics 25.0 software. The Chi-square test was used to test the statistical association of sleep quality with sociodemographic profile, general sleep-related questions related to the COVID-19 pandemic, PSQI, and ISI and different variables. The level of significance for the Chi-square test was considered $P<0.05$. Binary logistic regression analysis was applied to find out the predictors of poor sleep taking dependent variable sleep quality categorized into two groups, good sleep and poor sleep. Independent variables were selected by univariate analysis having $P<0.25$. Backward stepwise likelihood ratio was used for the significant predictors among the study subjects.

RESULTS

The total number of the study participants was 250, of whom 52% were males and the rest were females. The mean age was 36.45 years. They came in same numbers from rural and urban backgrounds. 59.2% were married, and the rest were unmarried. 37.6% subjects were educated up to graduate level and above, whereas the rest were below graduate. 42.8% were unemployed, and the rest were semi-skilled, skilled, or professional. Basal metabolic index (BMI) distribution was 53.2% having normal, 11.2% obese, 35.2% overweight, and 0.4% underweight.

COVID-19 RT PCR test was positive in 71.6% of study participants, and the rest had symptoms of COVID-19 and were treated as suspected cases. 71.2% had self-isolated themselves during the infection. 45% of people said that the pandemic had affected their mental health.

60.8% of the study participants said they felt refreshed after getting sleep, whereas rest were either uncertain or did not feel refreshed. The same people told they had adequate sleep. 58.8% admitted that their sleep pattern had changed after COVID infection, while a little more, i.e., 59.6% had altered sleep pattern during the infection. 73.6% suffered from daytime sleepiness. 40% reported increased addiction and 30% were using sedatives during and post-COVID recovery. 87.6% said that they did not feel healthy after COVID. Only 24% were getting 7–8 h of sleep,14.6% were getting more than 8 h sleep, while the rest 62.4% were getting <7 h of sleep. While the majority (94%) had mild symptoms, 5% had moderate and rest 1% had severe symptoms. Maximum participants (62%) had both pulmonary and neurological symptoms, around one-fifth (21%) had purely pulmonary, whereas multisystem involvement was seen in 10% and only neurologic symptoms affected only 5%.

These results are depicted in Table 1.

Most common sleep disorder reported was insomnia (36.4%). Next most common was sleep phase disorders (28.8%). Excessive daytime sleepiness was the third common symptom with prevalence of 20%. Least common symptoms were restless legs syndrome (RLS) (4%), breath holding (4.4%), and choking (5.2%) (Table 2).

34.4% of the participants had poor sleep quality. Sleep latency was prolonged in 85.2%.[20] 29.6% participants had

Table 1: General sleep-related information of the study participants during the COVID-19 pandemic and infection

Sleep-related questions	Categories	Frequencies	Percentage
Do you currently	Yes	152	60.8
Feel refreshed from sleep	No	55	22.0
	Can't say	43	17.2
Are you getting sufficient sleep	Yes	152	60.8
	No	55	22.0
	Can't say	43	17.2
Was there any change in the sleep pattern during the infection	Yes	149	59.6
	No	101	40.4
Has your sleep pattern changed after recovery from COVID-19	Yes	147	58.8
	No	103	41.2
Do you suffer from daytime sleepiness?	Yes	184	73.6
	No	66	26.4
Has your addiction increased?	Yes	100	40.0
	No	150	60.0
Did you use sleep medication after infection	Yes	75	30.0
	No	145	58.0
	Prefer not to say	30	12.0%
Are you currently feeling healthy	Yes	31	12.4
	No	219	87.6
How long do you currently sleep?	<4 h	7	2.8
	4–5 h	22	8.8
	5–6 h	45	18
	6–7 h	77	30.8
	7–8 h	60	24
	8–9 h	28	11.2
	9–10 h	7	2.8
	10–11 h	3	1.2
	11–12 h	1	0.4
How severe were your symptoms?	Mild	235	94
	Moderate	13	5
	Severe	2	1
What type of symptoms did you have (from medical records)	Only pulmonary	57	21
	Only neurological	13	5
	Pulmonary+Neurological	155	62
	Multi system	25	10

restricted sleep duration (<6 h).[21] 44.8% had less than normal (<85%) sleep efficiency.[22] Sleep disturbances of more than once a week were observed in near one-third (30.4%). None of the participants used sleep medication in the last 1 month. One-third of participants had more than one episodes of daytime dysfunction (Table 3).

While most of the study participants suffered from subthreshold insomnia (53.6%), moderate severity insomnia was seen in 17.2% and severe insomnia in only 3.6% (Figure 1).

It was observed that, with increasing age, the sleep quality became poorer (P=0.002). There was no difference in sleep quality with respect to gender. It was observed that unemployed persons had better sleep quality as compared to those who were working (P=0.001). Further, those who were unmarried were getting better sleep than the married (P=0.001). With regard to sleep quality, there was no significant difference between rural and urban people. No difference in the quality of sleep between different groups based on the education. No difference with regard to different groups based on BMI was observed. Although more people who had undergone self-isolation had poor sleep, the difference was not statistically significant. Those participants whose mental health got affected due to illness

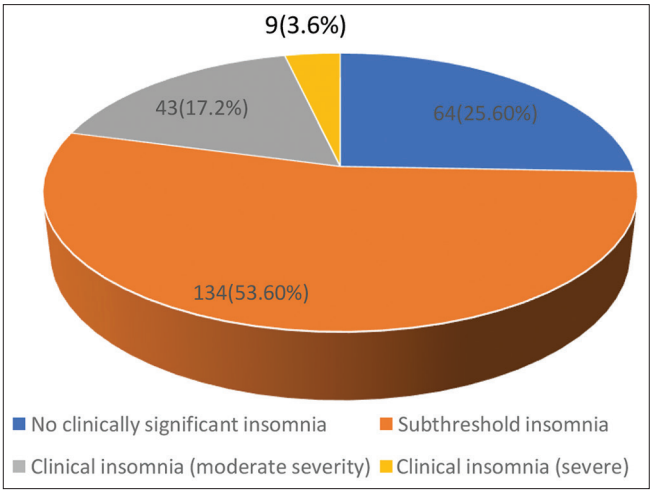

Figure 1: Distribution of study participants according to insomnia severity index (n=250)

Table 2: Sleep symptoms among the study participants (n=250*)

Categories	Frequency	Percentage
Insomnia and disrupted sleep		
Difficulty falling asleep	74	29.6
Difficulty staying asleep	50	20.0
Disrupted sleep	63	25.2
Falling asleep unintentionally	17	6.8
Daytime naps	27	10.8
Excessive Daytime sleepiness	50	20.0
Abnormal behaviors in sleep		
Nightmares	36	14.3
Sleepwalking	12	4.8
Sleep talking	23	9.2
Eating while asleep	9	3.6
Sleep paralysis	22	8.8%
Sleep disordered breathing		
Morning headaches	31	12.4
Breathlessness	19	7.6
Choking/gasping at night	13	5.2
Breath-holding	11	4.4
Restless legs		
Restless legs	10	4.0
Cramps	11	4.4
Abnormal movements (trunk or limbs)	14	5.6
Sleep phase disturbance		
Going to bed earlier (advanced sleep phase)	20	8.0
Going to bed later (delayed sleep phase)	52	20.8

*Multiple response

Table 3: Distribution of study participants according to the different components of PSQI

PSQI components	Frequency	Percentage
Subjective sleep quality	26	10.4
Very good	138	55.2
Fairly good fairly bad	77	30.8
Very bad	9	3.6
Sleep latency		
<15 min	37	14.8
16–30 min	100	40.0
31–60 min	63	25.2
>60 min	50	20.0
Sleep duration		
≥7 h	89	35.6
6–6.9 h	87	34.8
5–5.9 h	49	19.6
<5 h	25	10.0
Habitual sleep efficiency		
>85%	138	55.2
75–84%	49	19.6
65–74%	38	15.2
<65%	25	10.0
Sleep disturbances		
None during the past month	17	6.8
<Once per week	157	62.8
1–2 times per week	75	30.0
≥3 times per week	1	0.4
Use of sleep aid medication		
None during the past month	250	100
<Once per week	0	0
1–2 times per week	0	0
≥3 times per week	0	0
Daytime dysfunction		
None during the past month	52	20.8
Less than once per week	115	46.0
1–2 times per week	69	27.6
≥3 times per week	14	5.6

and pandemic had poorer sleep quality (P<0.001). Persons who did not feel refreshed after sleep were having poorer sleep quality (P<0.001). Those who were getting sufficient quantity of sleep had good sleep quality (P<0.001). Lower quantity of sleep (<7 h) was associated with poor sleep quality (P=0.015). A change in pattern of sleep during infection and also after recovering from infection were both associated with poor sleep quality (P<0.001). Increase in addiction in the recovery phase was linked with poor sleep (P<0.001). The use of sleep medication was seen with the poor quality sleep (P<0.001). The respondents who did not feel refreshed currently were poor sleepers (P=0.023). Increased daytime sleepiness was seen in poor sleepers (P=0.023). Insomnia was linked to the poor quality of sleep (P=0.023). Sleep-disordered breathing was associated with poor sleep quality (P=0.002). Abnormal behavior in sleep led to poor sleep (P<0.001). RLS was associated with poor sleep (P=0.049). Sleep phase disturbances were supposed to produce low-quality sleep (P=0.003). Increased severity of insomnia as measured by ISI was strongly associated with a poor sleep quality (P<0.001) (Table 4).

Multivariate analysis has been depicted in Table 5.

Distribution of ISI among the study participants included in Figure 1.

DISCUSSION

Adequate sleep is necessary for multiple functions of the body, namely, waking cognition, alertness, clear thinking, vigilance, sustained attention, and emotional regulation.[21] The American Academy of Sleep Medicine recommends that adults should sleep at least 7 h per night regularly to promote optimal health.[22] Sleep is not an optional requirement, and a lack of healthy sleep results in negative emotional responses to mild stresses, changes in mood, reduced cognitive performance, and decreased vigilant attention and eventually may lead to drowsy driving and motor vehicle accidents.[21]

This study highlights the fact that sleep quality was poor, and subthreshold insomnia was common in patients after recovering from COVID-19 infection. The period after recovery during which such disturbances may manifest could be more than 6 months. These could form a part of the "long COVID syndrome."[14] Our study was conducted on 250 patients over a 3-month period. Mean age was 36.45 years, almost equal number of persons of both

Table 4: Association tables among different variables and sleep quality

Variables	Good sleep (n=56)	Poor sleep (n=194)	P-value
Age			
18–30	34	69	0.002
30–50	13	59	
51–69	9	66	
Gender			
Male	33	97	0.239
Female	23	97	
Occupation			
Unemployed	37	70	0.001
Unskilled/semi-skilled	9	72	
Skilled	1	8	
Professional	9	44	
Marital status			
Unmarried	34	68	0.001
Married	22	126	
Residence			
Urban	23	100	0.167
Rural	33	94	
Education			
Up to class X	13	44	0.244
Higher Secondary	9	54	
Undergraduate	8	23	
Postgraduate	68	68	
BMI category			
Normal	31	102	0.884
Obese	7	21	
Overweight	18	70	
Underweight	0	1	
Self-isolation history			
Yes	35	143	0.103
No	21	51	
Mental health affected			
Yes	14	100	<0.001
No	36	51	
Cannot say	6	43	
Feeling refreshed			
Yes	46	106	<0.001
No	3	52	
Cannot say	7	36	
Sufficient sleep currently			
Yes	46	106	<0.001
No	3	52	
Cannot say	7	36	
Current sleep time			
<6 h	26	125	0.015
>6 h	30	69	
Changes in sleep pattern during infection			
Yes	15	134	<0.001
No	41	60	
Changes in sleep pattern after infection			
Yes	11	136	<0.001
No	45	58	
Increased addiction			
Yes	11	84	<0.001
No	45	105	
Use of sleep medication			
Yes	5	70	<0.001
No	43	102	
Won't say	8	22	
Currently refreshed			
Yes	2	29	0.023
No	54	165	
Daytime sleepiness			
Yes	2	29	0.023
No	54	165	

(*Contd*...)

Table 4: (*Continued*)

Variables	Good sleep (n=56)	Poor sleep (n=194)	P-value
Insomnia			
Yes	2	29	0.023
No	54	165	
Sleep-disordered breathing			
Yes	7	56	0.002
No	49	138	
Abnormal sleep behavior			
Yes	3	61	<0.001
No	53	133	
RLS			
Yes	3	30	0.049
No	53	164	
Sleep phase disturbance			
Yes	6	66	0.003
No	52	148	
ISI			
No	47	17	<0.001
Subthreshold	9	125	
Moderate	0	43	
Severe	0	9	

ISI: Insomnia, BMI: Basal metabolic index, RLS: Restless legs syndrome

Table 5: Binary logistic regression analysis for the predictors of poor sleep

Variables	P-value	AOR	95% CI
Marital status	0.051	2.123	0.995–4.528
Previous COVID history	0.032	2.710	1.087–6.757
Self-isolation	0.061	0.430	0.178–1.038
Currently feeling refreshed	0.109	1.577	0.903–2.754
Change in sleep pattern during the pandemic	0.008	0.312	0.132–0.734
Change in sleep after recovery from infection	0.012	0.303	0.119–0.768
Use of medication	0.081	0.523	0.252–1.083
Felt tired during day	0.022	0.364	0.153–0.865

AOR: Adjusted odds ratio, CI: Confidence interval

genders, equal representation from rural and urban areas, 60% married, and the rest unmarried, 37.6% graduated and rest were undergraduate or illiterate, 42.8% were unemployed and rest were semi-skilled, skilled, or professional. The BMI distribution group was 53.2% normal, 35.2% overweight, 11.2% obese, and 0.4% were underweight. The mean age of our study participants was almost similar to one Egyptian study.[23] In the other studies, the gender ratio was not equal. The urban versus rural background of participants was 3:2 in a study by El Sayed et al.,[23] In the same study, the proportion of married people was higher and 37.6% had gone to University.[24] The rate of unemployment was higher in our population. A study showed average BMI to be in the overweight to obese range.[11] In our population, more than half were in the normal range for BMI, 11.2% obese, 35.2% overweight, and 0.4% underweight.

According to the National Comprehensive guidelines for managing post-COVID sequelae,[23] sleep dysfunction and insomnia can occur in 18–30% of cases and may persist beyond 1 year. We found that 53.2% of our patients had subthreshold insomnia, 25.6% had moderate, and 3.6% had severe insomnia. Near similar observations have been made in an Egyptian study.[24] In a study from Vietnam, the prevalence of insomnia in the post-COVID cases was 34.5%.[17] Among the various types of sleep disorders, insomnia was the most common in our study (36.4%) followed by sleep phase disturbances (28.8%) and excessive daytime sleepiness (20%), while choking (5.2%), breath holding (4.4%), and RLS (4%) were less common. 14.3% reported having nightmares. Sleep disorders and poor sleep quality were more frequent in post-COVID 19 patients than in controls, as observed by an Arabian survey.[15] A Vietnamese study also found a similar prevalence of insomnia of 34.5% among COVID 19-recovered patients.[17] Pérez-Carbonell et al.[11] have found 46% of people in the pandemic including post-COVID patients reporting excessive daytime sleepiness. The higher values in this study may partly be due to the inclusion of overweight to obese individuals (mean BMI 29.4). Besides this, 69.4% of this population had a change in sleep pattern as well as 52.3% cases reported sleep phase disturbances. Study wise, a significant chunk of vulnerable adults (25.4%) and disabled (23.3%), were part of their study population, which may account for this. The prevalence of choking/gasping and breath-holding spells was almost similar to our study. However, RLS (11.1%) and nightmares were more frequent (19.1%).

In our study, 71.6% were COVID-19 RT-PCR positive and the rest was COVID-19 rapid antigen positive. The majority (71.2%) had self-isolated themselves. Less than half of

them (45%) claimed that their mental health had been affected by infection. More than 50% (58.8%) had a change in their sleep pattern after COVID-19 infection, whereas a majority (73.6%) had daytime sleepiness. A significant number of individuals (40%) reported increased addiction, whereas 30% had to use sedatives for sleep. A large number of individuals (87.6%) said they did not feel healthy after infection, and almost 30% were getting <6 h of sleep. In our study group, the testing rate was lower as some patients did not want to take long queues for the COVID test as well as limited availability of the COVID-19 RT-PCR test. Systematic reviews have shown that social isolation has led to poorer mental health[8] which has impact on sleep.[11] In 550 out of 844 participants, a change in sleep pattern had occurred during the pandemic, as observed by Pérez-Carbonell et al.[11] The differences noted by us is because Pérez-Carbonell et al., have included health-care workers, people with COVID infection, and those without COVID infection. The increased percentage of addictions, sedative use, and a high proportion of people not feeling healthy post-infection in our population probably led to daytime sleepiness.

Subjective sleep quality was poor in more than one-third (34.4%) of participants. Previous studies showed that sleep latency was prolonged in 85.2%,[12] whereas restricted sleep duration of <6 h[25] was seen in 29.6% subjects. Poor sleep quality was seen in 78% of subjects in an Indian online survey.[13] This study had included patients with comorbidities such as hypertension, asthma, diabetes, mild anxiety, and mild depression, which can explain the higher prevalence of poor sleep quality. Seventy percent of subjects had prolonged sleep latency in the same study. Sleep duration was reduced in 50%, sleep disturbances were observed in 30%, and 70% had reduced sleep efficiency. 60% had daytime dysfunction, whereas 20% had to use sedatives. The presence of comorbid conditions and higher education status (60% master's degree), and possibly a higher proportion of urban residents (90%) may have accounted for the difference from our study. Higher educational attainment has been shown to be associated with lower sleep duration.[26] Although most studies on sleep-related problems were conducted in urban residents, studies from Japan and China showed 25.5% and 49.5% of rural individuals presented poor sleep quality.[27,28] Analysis of individual PSQI components has not been performed in the previous studies.

Regarding the distribution of ISI scores, major chunk (53.6%) of participants suffered from subthreshold insomnia, moderate severity insomnia was seen in 17.2%, severe insomnia in only 3.6%, and a quarter (25%) had no insomnia. El Sayed et al. found higher prevalence of subthreshold insomnia (59.2%), moderate severity insomnia in 26.6%, severe insomnia in 5.4% (like our findings), and no insomnia in 8.8%.[24]

We compared the patients having good sleep with patients having poor sleep and observed that factors such as increasing age, employment, self-isolated condition, married state, and mentally handicapped position were associated with poor sleep quality in contrast to gender, educational status, body weight, and rural/urban living. While persons who did not feel refreshed immediately after getting up, who did not feel refreshed in daytime, increased daytime sleepiness, reduced duration of sleep (<6 h), a change in sleep pattern during or after infection, increased addiction, and sedative use; all were associated with poor sleep quality. Sleep disorders such as insomnia, RLS, sleep-phase disturbances, sleep- disordered breathing, abnormal behavior in sleep, and increased insomnia severity on ISI score were associated with poor sleep quality. El Sayed et al. found a clinically significant correlation between increasing age, female gender, unmarried status, and emotional problems with poor sleep.[24] Chhajer and Shukla found association between poor sleep quality with female gender, lower annual income, and unmarried state.[13] The impact of different sleep-related problems has been studied by Pérez-Carbonell et al.[11] However, studies on the association of poor sleep quality with the different sleep disorders in COVID-recovered patients have rarely been addressed. We examined these factors in association with sleep quality and would like to hypothesize that these factors probably got worsened during or after the infection. A higher prevalence of insomnia among females, as observed in other studies may be because premorbid insomnia which got aggravated after infection.

Poor sleep quality was associated with increasing age, married persons, job holders, insomnia, severe score on ISI, sleep phase disturbances, reduced sleeping hours, recurrent arousal from sleep, excessive daytime sleepiness, abnormal behavior in sleep, abnormal respiration in sleep, increased sleep latency, impaired mental health, use of sedatives and addictives. Thus, multiple factors were found to impact the quality of sleep. Lifestyle changes such as home confinement and self-isolation during infection have led to the loss of daily routine activities. Insufficient exposure to sunlight, reduced exercise, long COVID syndrome,[14] increased time spent on digital media, increasing addiction, and the use of sedatives have led to reduced sleep as well as impaired mental health and sleep quality.[5,11]

Along with this, different types of sleep phase disturbances were noted, such as delayed bedtime, delayed rising time, early bedtime, and early rising time. Different sleep parameters such as hours spent in bed, time to sleep onset,

frequency of sleep disturbances increased and daytime sleepiness all got affected. Different sleep disorders in the form of nightmares, apneic spells, RLS, insomnia, sleep-phase disturbances, and excessive daytime somnolence were observed in our study. Some studies suggested that sleep deprivation leads to immunological disturbances in the form of production of pro-inflammatory cytokines[11,13] and may increase the risk of contracting recurrent COVID infection and prolonged "long COVID syndrome." Insomnia has multiple adverse effects such as poor decision-making ability, increased irritability, reduced productivity, poor interpersonal relations, increased pain sensitivity, and gastrointestinal discomfort. If left as such in the long-term increases the risk of hypertension and cardiovascular diseases.[10] SARS-CoV-2 induced neuroinflammation mediated by various cytokines and involving structures controlling sleep–wake cycle, as proposed by multiple studies[11,19] is the underlying cause of COVID-related sleep problems. Sleep deprivation, in turn, induces neuroinflammation. This is popularly known as "coronasomnia."[14]

The main highlight of our study was sleep disturbances following common infections are frequent but they do not persist for a long time and they are not severe enough in most cases. Due to the unique neurotropism of COVID-19 virus to brainstem structures, especially medulla oblongata which is also the center of sleep promoting system, the effects of sleep disturbances following COVID-19 infection is likely to be long continued to adversely affect quality of life.

Limitations of our study

It is a single-center cross-sectional study. Therefore, the cause-effect relationship could not be established. Longitudinal studies are required to explain the causality and long-term impact of sleep deprivation.

CONCLUSION

This cross-sectional study has observed that a significant number of COVID-19-recovered subjects experience sleep disturbances, including impaired sleep quality, and thus highlighting the importance of investigating for long-COVID as early as 4 weeks of initial symptoms as per NICE Guidelines.[29] Novelty of this study lies in the fact that it picked up the usually overlooked long burden of COVID-19 infection on apparently cured patients. Future studies on the role of pro-inflammatory cytokines in perpetuating these sleep disorders and poor sleep quality need to be undertaken to establish causality and for better treatment options.

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MM- Contributed to the study concept, study design, and wrote the first draft of the manuscript; **JK-** Contributed to design, acquisition of data, analysis, and interpretation; **MC, AKM-** Contributed in critical revision of the manuscript and provided intellectual input; **PD, DH-** Contributed in writing study design, methodology, data planning, and data analysis; **PKY, JM, JC-** Contributed by meticulous supervision of the study and guidance.

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