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Sleep Pattern Changes and the Level of Fatigue Reported in a Community Sample of Adults During COVID-19 Pandemic

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Abstract

Purpose The study aimed to (a) assess the sleep pattern changes and the level of fatigue among COVID positive adults (b) determine the association of sociodemographic and lifestyle factors (*age, gender, marital status, occupation, income, exercise, nap, diet, and comorbidities*) on sleep pattern and level of fatigue c) examine the relationship between sleep and fatigue, and between sleep problems, sleep quality and fatigue, among a community sample of COVID-19 affected adults.
Methods A non-experimental, descriptive, cross-sectional survey design was used. Participants were adults, between 18 and 63 years *(n = 782)*, who tested positive for COVID-19 infection using RT–PCR or Antigen test, confined to home quarantine/ under observation, and without any complications. Data was collected using the socio-demographic-sleep and related activity questionnaire, Fatigue Assessment Scale, and Sleep Quality Scale.
Results A majority of the participants reported either mild to moderate sleep quality problems (97.31%) and 377 of them (48.21%) reported fatigue levels. A significant association between sleep quality and fatigue with gender, and lifestyle factors such as sleep duration, food intake, napping, exercise pattern, and influence of COVID-19 on livelihood after being affected with COVID-19, and time of experiencing sleep problems after COVID-19 infection (all, $p < 0.01$) were observed, as well as age with sleep quality. Poor sleep quality and fatigue were significantly correlated with each other, and also with sleep problems before being affected with COVID-19 ($p = 0.000$).
Conclusions The study has shown that COVID-19 has an effect on an individual's demographic factors and a multitude of lifestyle factors, and highlights the need for post-COVID-19 monitoring even after recovery from the disease.

Keywords COVID-19 · Sleep · Fatigue · Sociodemographic factors · Community sample · Adults

1 Background

The Coronavirus disease of 2019 (COVID-19) pandemic is a major health problem, with over 100 million cases and 2 million deaths worldwide as of February 2021, which had placed an enormous burden on the global health care system [1, 2]. A total of 32,730,945 cases of COVID-19, including 991,224 deaths have been reported, globally, by September 27th, 2020 [3]. In India, the first case of COVID-19 was reported on 30th January 2020 and as of 7th September 2020, India has the largest number of confirmed cases in Asia and the second-highest number of confirmed cases in the world [4]. Empirical data from many countries had reported the two-wave pattern in cases of coronavirus

disease-19 during the 2020 pandemic, with characteristics and effects of the virus, such as age range and severity of the disease, varying between the two periods [5, 6]. The vast majority of Western European countries are currently facing the devastating effects of this second wave, with the appearance of a new variant of the SARS-CoV-2 [7]. Since April 2021, India was also having an upsurge of COVID 19 cases, recording the highest daily cases globally, surpassing the US and Brazil on an average [8].

Sleep is an essential physiological activity that enhances the physical and mental well-being of an individual as well as augments the overall well-being of the person, leading to a better quality of life. Sleep health associated with COVID 19 is gaining increased momentum in the past few months [8, 9], as there has been a significant prevalence of sleep disorders among population affected by COVID-19, which can create a public health burden, affecting the mental and physical health of people over a long run [10].

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Significant sleep problems in adults [3, 11], and fatigue after resolving the acute episode of COVID 19 infection [12, 13] had been reported in various studies. Few studies also have indicated the sleep pattern changes in patients with *long-COVID* (*long-term effects of COVID-19, persisting beyond 3 or 12 weeks*), with substantial curtailment in sleep quality and quantity [14–16]. Fatigue was listed as the most common concern in 44–69.9% of infected patients within and outside Wuhan, China [17–19] and in 53% of post-discharge COVID patients in Italy [13]. Similarly, a recent systematic review evaluating the prevalence of fatigue in post-recovery from SARS-CoV-2 infection had reported a significantly higher level of fatigue in 50% of patients compared to healthy controls, and more among females [11]. Insufficient sleep and its impact on health can lead to sleep disturbances or problems, such as insomnia, nightmares, impaired daytime functioning, and fatigue [9].

Even though recent evidence shows that these problems are highly prevalent among hospitalized than non-hospitalized patients, who demonstrated milder forms of the disease, it is not uncommon that young adults are not subjected to increased consequences of the viral infection exhibiting sleep deprivation and residual fatigue [3]. Evidence suggests that increased sleep problems reported among young adults during the pandemic are due to the ordeal of psychological distress experienced by them [20]. The study also had reported that the higher rates of sleep problems encountered by the young adults were higher than that of the nationally representative sample of US adults aged 18–94 years, especially in the beginning months of the pandemic. A recent meta-analysis which covered data from 13 countries showed a high global prevalence rate of sleep problems, 35.7%, with COVID-19 patients being the most affected group [21]. Even under normal conditions, young adults are vulnerable to acute sleep deprivation, with up to 60% of college students suffering from poor sleep [20, 22, 23]. The potential neuropathologic mechanisms of SARS-CoV-2 and a range of neurological symptoms which have been reported in patients affected with this viral infection are typically attributed to the involvement of structures in the central nervous system dominating the sleep–wake cycle [23].

The COVID 19 patients with mild symptoms and those with moderate, but uncomplicated conditions are confined to home, employing self-isolation measures, quarantine, and community confinement [24]. Apart from the direct effect of the disease, significant social and lifestyle changes can have both direct and indirect effects on the health and well-being of infected people as well as their families [23]. In a study carried out in the UK, a significant association between the ongoing symptoms of COVID 19 with insomnia, and disrupted sleep with more nightmares had been reported in 21% of the suspected COVID 19 cases [23].

One of the most common long-term health issues facing survivors of the disease as per the initial reports of the pandemic is post-viral fatigue [12, 25]. Even mild to moderately affected COVID-19 patients are likely to develop moderate to severe intensity of chronic fatigue and exertion intolerance [26]. Psychological distress secondary to the illness itself or associated with other stressful life events is predicted as the strongest risk factor for this fatigue [11] and viewed to be higher than other infections due to its potentially fatal outcome of the disease and many other social and cultural effects of the disease [27, 28].

Sleep disturbances have been reported as a recurrent symptom during this pandemic [29, 30] in many studies. On the other hand, few studies have documented no change or even improved sleep quality during COVID 19 as their daily schedule became more flexible [31, 32]. However, despite many studies reporting how the outbreak might affect the overall sleep health in the population [33, 34], data on sleep quality during COVID 19 pandemic are limited [20].

To our knowledge, there is limited information on the prevalence of sleep problems and fatigue among adults related to the COVID 19 pandemic. Moreover, only very few studies have explored the sleep problems and fatigue in a community sample of COVID-19 positive adults in the pandemic. Therefore, the purpose of the current study is to assess the sleep pattern changes and the level of fatigue among COVID-positive adults. This study also attempts to determine the association of sociodemographic and lifestyle factors (*age, gender, marital status, occupation, income, exercise, nap, diet, and comorbidities*) on sleep pattern and level of fatigue, and to examine the relationship between sleep and fatigue, and between sleep problems, sleep quality and fatigue, among a community sample of COVID-19 affected adults.

2 Methods

The study used a non-experimental, descriptive, cross-sectional survey design. The participants were 782 COVID-19 positive, community sample of adults (*who have tested positive for Real-time reverse transcriptase-polymerase chain reaction (RT-PCR) or Antigen test or any other confirmatory tests for detecting COVID infection),* in the age group of 18–63 years (*both young and middle-aged adults),* who was confined to home on quarantine/under observation, or people who became COVID-19 negative or have recovered from it in the recent past (participants were included from early infection period to ≤ past 3 months), and belonged to mild or moderate categories without complications.

The participants were selected using a non-probability, snowball sampling technique from India. Participants were included if (a) they were above 18 years, who are/had been

COVID positive irrespective of their vaccination status, (b) who can comprehend the English language and have access to digital /electronic media, and (c) are willing to participate in the study. Participants were excluded if they had any pre-existing sleep problems which they are on treatment or on prescription for anti-allergic medications and (b) those who are having psychiatric/mental health problems for which they are on counseling or treatment, (c) and patients with COVID-19 who are currently admitted in the hospital. To decide on the inclusion or exclusion criteria for the eligibility to participate in the study, the following 'yes/no' questions were included in the survey form ('*Before you were tested COVID-19 positive, did you have continuous sleep problems, lasted more than 3 months?*'; '*Have you been on prescription with any sleep tablets before you were tested COVID-19 positive?*'; '*Are you on treatment for any psychiatric or mental health problems?*'; '*Are you on any anti-allergic tablets which makes you sleepy always?*'; '*Are you a person who got hospitalized for COVID-19 treatment and got discharged?*').

The study was approved by the Institutional review board and the ethical permission for this study was obtained from the Institutional Ethics Committee of the researchers', LISIE/IEC/JUL-2021/01 dated 13th July 2021. The data collection was carried out from 15th July 2021 to 30th September 2021.

2.1 Instruments for Data Collection

1. *The socio-demographic-sleep and related activity questionnaire*: This questionnaire consists of 34-items including socio-demographic information, with a few supplementary questions on clinical parameters and food and lifestyle patterns (*Body Mass Index (BMI), vaccination status, existing medical disease and conditions, and practices, such as exercise, food intake, sleep duration, naps, and sleep-related rituals*). A comprehensive, thorough, and substantial review of the literature was carried out for developing the questionnaire and the content validation of the tool was performed by a team of subject experts relevant to this field.

2. *Sleep quality Scale (SQS):* Developed by Yi et al. [35], the SQS is a 28-item tool on a 4 -point Likert scale and validated in the adult population *(0 = Rarely, 1 = Sometimes, 2 = Often, 3 = Almost always).* Eight of the items in the tool relating to the factors such as '*restoration after sleep*' and '*satisfaction with sleep*' are reverse-scored. The total score ranges from 0 to 84, with *higher scores* indicating more acute sleep problems. For the better presentation and visualizing and reporting of sleep quality, the scores have been categorized as *mild* (Scores from 0 to 28); *moderate* (Scores from 29 to 56); and *Severe* (Scores from 57 to 84) *sleep quality problems*.

The internal consistency, the Cronbach's alpha coefficient of the scale is 0.92 and the test-rest reliability is 0.81. Permission had been obtained from the developers for its use in this study.

3. *Fatigue Assessment Scale (FAS):* Developed by ild Foundation (www.ildcare.nl [36], the Fatigue Assessment Scale is a 10-item scale rated on a 5-point Likert scale *(1 = Never, 2 = Sometimes, 3 = Regularly, 4 = Often, 5 = Always).* The scores when summed range from 10–50. Two of the items on the scale *(item No. 4 and item No. 10)* are reverse scored. A score of < 22 indicates no fatigue and ≥ 22 indicates fatigue and scores ≥ 35 indicate severe fatigue. The internal consistency of the scale is 0.90. Permission had been obtained for using this tool in the study.

All the tools have been pre-tested in 10 participants before implementing the data collection, to ensure if the instrument is clear and there is no ambiguity. Two questions in the demographic tool had been modified after the pre-test and the revised version had been pre-tested again and found that it is suitable for the study, and then had been adapted by the researchers.

2.2 The Procedure of Data Collection

The study was conducted as an anonymous survey, without asking for the subjects' identification details, such as name, email address, or telephone number. Data were collected using an electronic survey questionnaire, prepared in Google Forms. The survey forms with the link had been sent initially via WhatsApp through the researchers' personal and professional contacts.

Through the contacts, the primary participants were approached and the link had been shared. After this initial distribution of the survey links, the participants were asked to disseminate these questionnaires through their contacts and further share them among their profiles. The process continued till the required sample size was completed. Informed consent for the participants was kept with the explanation of the study procedure on the beginning page of the survey form so that they could proceed with the survey after its agreement. Then, those who agreed to participate, completed the survey questionnaire, by clicking the link given in the survey form. The researcher had gone through the completed/received forms for checking the appropriateness to be included in the study or to discard.

2.3 Data Analysis

The data were analyzed using the SPSS version 20. Mean, frequency, percentages, and standard deviation were used for descriptive analysis. Chi-square tests were used to examine

the association of selected demographic variables with sleep quality and fatigue levels. Karl Pearson's correlation coefficient was applied for determining the correlation between sleep quality and fatigue and between sleep problems before being affected with COVID-19 and sleep quality and fatigue levels.

3 Results

3.1 Demographic and Lifestyle-Related Characteristics of Participants

A total of 1054 people attempted the survey, of which 272 participants were excluded for not fulfilling the inclusion criteria *(25.81%)*. A total of N = 782 participants, from India, were finally included in the study. The demographic and clinical characteristics of the participants are given in Table.1. Most of the participants *(45.52%)* were aged between 18 and 46 years *(Mean age M = 31.82 ± 11.31 years)*, females *(64.45%)*, married *(52.8%)*, held a professional degree *(37.3%)*, employed *(59.3%)*, and had an income less than Rupees 90,000 per annum *(43.7%, n = 342)*. Figure 1 depicts the participants' age and gender distribution.

A majority of the participants *(46.9%, n = 367)* reported that they were diagnosed with COVID-19 infection before 4 weeks, and 62.9% of them confirmed their diagnosis through the RT–PCR test. A total of 36.2% of them got vaccinated with both doses of vaccine (e.g., Covishield, and Covaxin,) and 33.4% (n = 261) of the participants stated being in the overweight category based on their body mass index (BMI). In addition, 14.6% (n = 114) of the participants reported having a medical disease (s) at the time of diagnosis of COVID-19. Nearly 26.7% (n = 209) of the participants reported that they were experiencing sleep problems before confirming the diagnosis with COVID-19; snoring is the most frequent *(n = 85, 10.9%); but none of them were on any treatment.

It was found that 21.2% of the participants had an effect of COVID-19 on their livelihood. The most common influence of COVID-19 among the participants was the negative outcome of the disease on their physical and health issues *(n = 87, 11.1%)* (Table.1).

The details of the participants' sleep duration, food, and lifestyle-related factors are given in Table. 2. Participants reported that their average sleep duration before COVID-19 infection was M = 7.84 ± 1.33 h and the sleep duration after COVID-19 was M = 8.15 ± 2.00 h. In addition, it was found that 22.1% (n = 173) of the participants experienced sleep problems within the first 7 days of the COVID-19 infection period, whereas 12.8% *(n = 100)* of them had sleep problems both during and after the COVID-19 infection period.

COVID-19 had affected the dietary pattern/ problems among the participants with 37.2% *(n = 291)* of them stating that they were taking less food than usual. In addition, 57.2% *(n = 447)* of them reported that they had some problems which affected the intake of food, the most frequent reason cited was not having a normal appetite *(n = 220, 28.1%)* (Fig. 2).

A majority of the participants *(n = 487, 62.3%)* mentioned that they took daytime naps before they were affected with COVID-19, and a significant percentage of them took naps either once in a while or during holidays or weekends *(n = 116, 14.8% and n = 159, 20.3%, respectively)*. A prominent change in the pattern of a nap after COVID-19 infection was noted was the time of nap becoming longer *(n = 158, 20.2%)* (Fig. 3).

Nearly half of the participants (47.2%, *n = 369*) engaged themselves in exercise/home-based activities before COVID-19 infection. In addition, 9.3% *(n = 73)* stated that they tried to perform exercises following COVID-19 infection, but were feeling tired (Fig. 4). Nearly 36.1% *(n = 282)* revealed that they practiced some activity or sleep ritual before their sleep after they were tested positive for COVID-19, of which, praying before going to bed *(n = 178, 22.8%)* and breathing techniques *(n = 105, 13.4%)* were the most common ones.

3.2 Sleep Problems Among the Participants

Assessment of the sleep problems among the participants demonstrated a total sleep quality score of M = 28.89 ± 12.22 *(range 3.0–67.0)*. A majority of the participants *(n = 396, 50.6%)* showed mild sleep quality problems, 365 *(46.7%)* showed moderate sleep quality problems and 2.7% *(n = 21)* of the participants reported severe sleep quality problems.

3.3 Fatigue Levels of the Participants

The fatigue levels of the participants ranged from 10.0 to 44.0 *(M = 22.09 ± 7.06)*. A majority of the participants *(n = 405, 51.8%)* were having no fatigue, whereas 377 *(48.21%)* of them had reported to have fatigue, in which 48 *(6.1%)* had severe fatigue levels.

3.4 Correlation of Significant Variables with Sleep Quality, Fatigue Levels

Sleep quality was significantly correlated with fatigue among the participants. A highly significant, positive correlation was observed between poor sleep quality and fatigue levels *(r = 0. 426, at p = 0.000)*.

Also, a significant, weak negative correlation was found between sleep problems before being affected with COVID-19 in participants, and the observed sleep quality scores and

Table 1 Demographic and clinical characteristics of the participants

Characteristics	Value (N = 782)	Percent
Gender		
Male	277	35.4
Female	504	64.5
Educational level		
Primary School	21	2.7
Secondary school	45	5.8
Degree	219	28.0
Post-graduation	175	22.4
Professional degree	292	37.3
Other	30	3.8
Marital Status		
Married	413	52.8
Single	357	45.7
Widowed	4	0.5
Divorced	2	0.3
Other	6	0.8
Employment status		
Employed	464	59.3
Unemployed	318	40.7
Annual Income		
Less than Rupees 90,000 per annum	342	43.7
Rupees 90,000- 5,00,000 per annum	310	39.6
More than Rupees 5,00,000 per annum	130	16.6
Body Mass Index (BMI)		
Below 18.5 kg/ m2 (Underweight)	81	10.4
18.5–24.9 (Normal or Healthy Weight)	295	37.7
25.0- 29.9 (Overweight)	261	33.4
30.0 and above (Obese)	145	18.5
The test employed to confirm COVID-19 status		
RT PCR	492	62.9
Rapid Antigen Test	283	36.2
Other	6	0.8
Time of confirming COVID-19 positive diagnosis		
More than 4 weeks	367	46.9
Within 4 weeks	53	6.8
Within 3 weeks	28	3.6
Within 2 weeks	30	3.8
Within 1 week	304	38.9
Vaccination status		
Vaccinated with a single dose	199	25.4
Vaccinated with both doses	283	36.2
Not vaccinated	300	38.4
Influence of COVID-19 on livelihood and the way it affected		
Yes, affected	166	21.2
Not affected	616	78.8
Stress and psychological effects*	43	5.5
Direct and indirect effect on family income*	36	4.6
Physical health issues affecting area of performance*	87	11.1
Past history of medical disease while affected with COVID-19		
Yes	114	14.6
No	668	85.4

Table 1 (continued)

Characteristics	Value (N = 782)	Percent
Diabetes	37	4.7
Hypertension	40	5.1
Thyroid problems	22	2.8
Arthritis	6	0.8
Cardiac problems	3	0.4
Asthma & Lung problems	6	0.77
Allergies	2	0.3
Other health problems	14	1.8
Sleep problems before being affected with COVID-19 and the type of problem		
Experienced sleep problems before infected with COVID-19	209	26.7
Not had sleep problems before infected with COVID-19	573	73.3
Snoring	85	10.9
More time for falling asleep	55	7.0
Daytime sleepiness	59	7.5
Not getting refreshed after sleep	50	6.4
Difficulty in maintaining sleep	31	4.0
Sleep disturbances	60	7.7

*Note: The expressed percentages are calculated in the total population *(n = 782)*
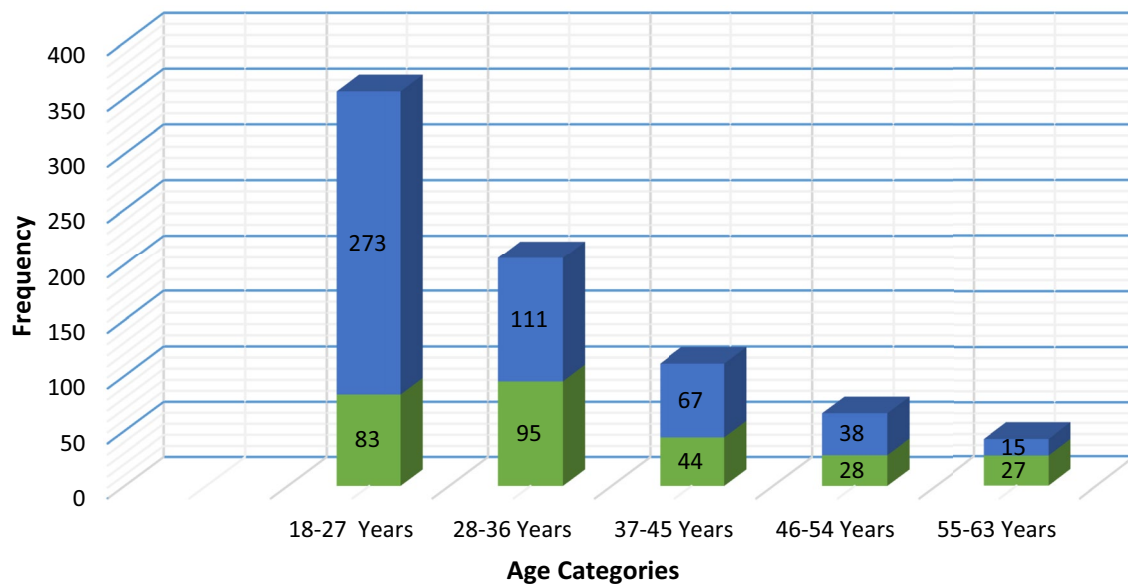
Fig. 1 Age and gender distribution of the participants

fatigue levels *(r = − 0. 190, at p = 0.000 and r = − 0. 182, at p = 0.000, respectively)*.

3.5 Association of Demographic, Sleep Duration, Food, and Other Lifestyle-Related Variables with Sleep and Fatigue

As shown in Table. 3, sleep quality was significantly associated with age *(χ2 = 25.77, p = 0.001)*, gender *(χ2 = 15.77 p = 0.003)*, having sleep problems before being affected with COVID-19 *(χ2 = 28.38, p = 0.000)*, sleep duration

Table 2 Sleep duration, food intake, and lifestyle-related factors among the participants

Characteristics	Value ($N=782$)	Percent
Sleep duration before and after getting infected with COVID-19	(Mean h ± SD)	
Sleep duration before being affected by COVID-19	7.84 h ± 1.33	
Sleep duration after infection with COVID-19	8.15 h ± 2.00	
Time of experiencing sleep problems during or after the COVID-19 infection period		
Within the first 7 days of the COVID-19 infection	173	22.1
After 1 week of COVID-19 infection	60	7.7
Throughout the COVID-19 infection period	106	13.6
Only after the COVID-19 infection period	58	7.4
Both during and after the COVID-19 infection period	100	12.8
Not experienced sleep problems	285	36.4
Changes in the dietary pattern after testing positive for COVID-19		
No changes in food intake	352	45.0
Taking less food than usual	291	37.2
Taking more food than usual	139	17.8
The habit of taking naps before getting affected with COVID-19		
Take daytime naps	487	62.3
Do not take naps	295	37.7
Duration and frequency of naps before getting affected with COVID-19		
Less than 30 min	87	11.1
Lasting for 30–45 min	97	12.4
Lasting for more than 45 min	81	10.4
Take naps once in a while	116	14.8
Take naps during holidays or weekends	159	20.3
Engagement in exercise/home-based activities before COVID-19 infection		
Yes	369	47.2
No	413	52.8
Engagement in various practices/rituals before going to sleep after becoming COVID-19 positive		
Yes	282	36.1
No	500	63.9
Types of engagement in various practices/rituals before going to sleep after becoming COVID-19 positive		
Yoga	32	4.1
Meditation	30	3.8
Relaxation techniques	42	5.4
Breathing exercises	105	13.4
Praying before going to sleep	178	22.8
Others	12	1.5

after COVID-19 infection ($\chi2 = 150.20$, $p = 0.000$), influence of COVID-19 on livelihood after becoming COVID-19 positive ($\chi2 = 8.30$, $p = 0.016$), the time of experiencing sleep problems during/or after the COVID-19 infection period ($\chi2 = 133.92$, $p = 0.000$), changes in the food pattern and problems with food intake after testing positive for COVID-19 ($\chi2 = 40.83$, $p = 0.000$ and $\chi2 = 18.04$, $p = 0.000$, respectively), changes in the napping pattern after getting infected with COVID-19 ($\chi2 = 30.50$, $p = 0.000$), and the changes in the exercise pattern following COVID-19 infection ($\chi2 = 46.02$, $p = 0.000$).

No associations of sleep quality were observed with other demographic, food, and lifestyle-related variables.

Significant associations of fatigue with gender ($\chi2 = 33.90$, $p = 0.000$), time of confirming COVID-19 positive diagnosis ($\chi2 = 23.15$, $p = 0.003$), influence of COVID-19 on livelihood ($\chi2 = 39.18$, $p = 0.000$), the way in which COVID-19 had affected the livelihood ($\chi2 = 32.49$, $p = 0.000$), having sleep problems before being affected with COVID-19 ($\chi2 = 25.98$, $p = 0.000$), sleep duration after COVID-19 infection ($\chi2 = 136.66$, $p = 0.003$), the time of experiencing sleep
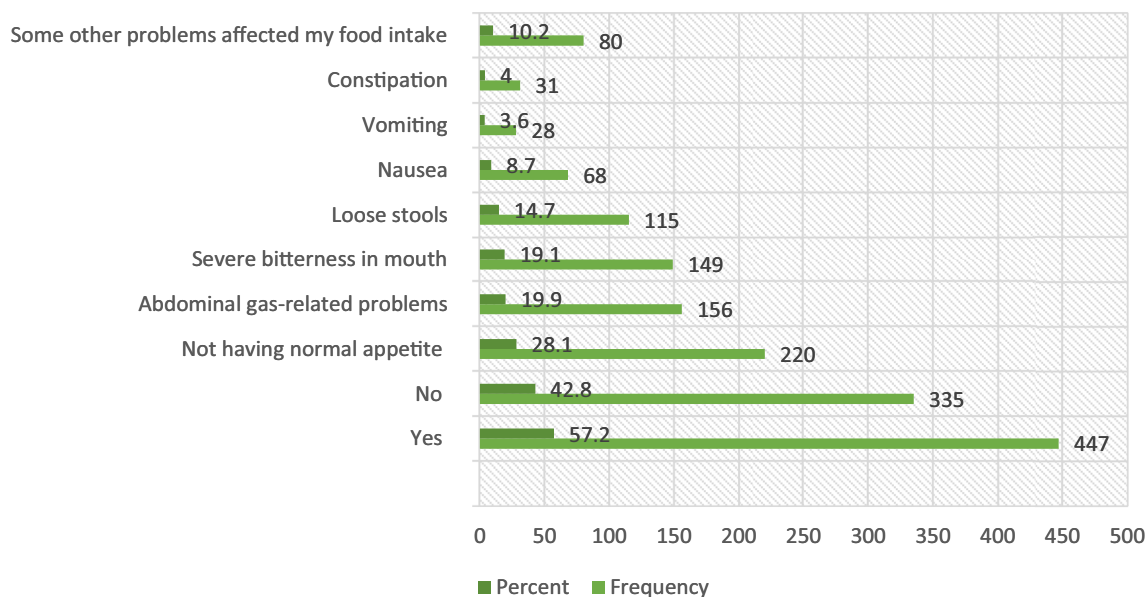
Fig. 2 Factors influencing the dietary intake after testing positive for COVID-19
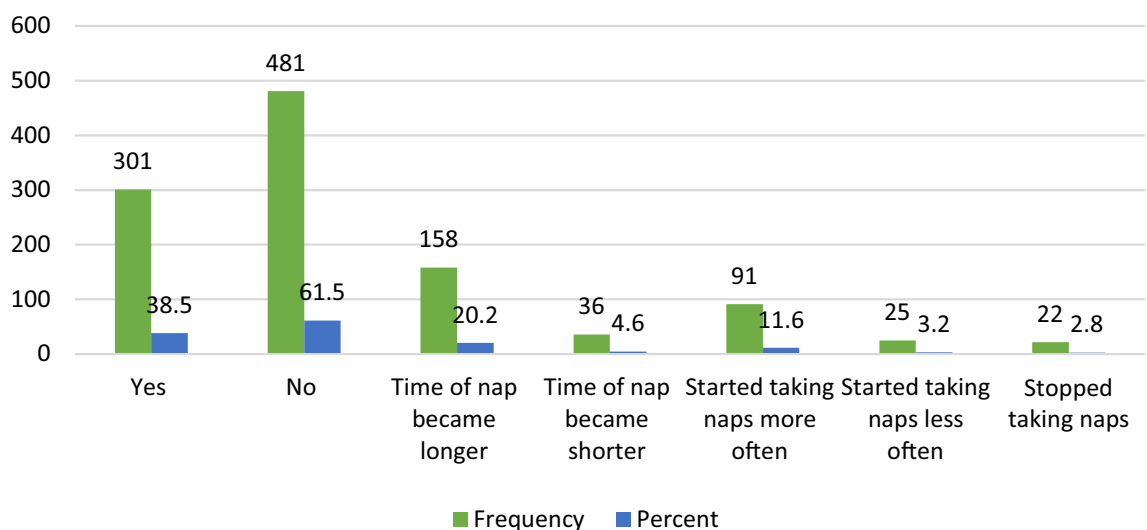

Fig. 3 Habit of taking naps and its changes after being diagnosed with COVID-19

problems during/ or after the COVID-19 infection period $(\chi2 = 88.26, p = 0.000)$, changes in the food pattern and problems with food intake after testing positive for COVID-19 $(\chi2 = 59.80, p = 0.000$ and $\chi2 = 41.19, p = 0.000, respectively)$, changes in the napping pattern after testing COVID-19 positive $(\chi2 = 68.74, p = 0.000)$, and changes in the exercise pattern following COVID-19 infection $(\chi2 = 96.81, p = 0.000)$ (Table.3).

No associations of fatigue levels were observed with the remaining demographic, food, and lifestyle-related variables.

4 Discussion

The present study aimed at assessing the sleep pattern changes and level of fatigue in a community sample of COVID-19 positive adults and attempted to determine the association of various demographic and lifestyle factors on their sleep and fatigue levels. Many of the study results supported the previous research studies conducted across the globe [37–40], with consistent findings indicating a strong association of demographic and lifestyle factors
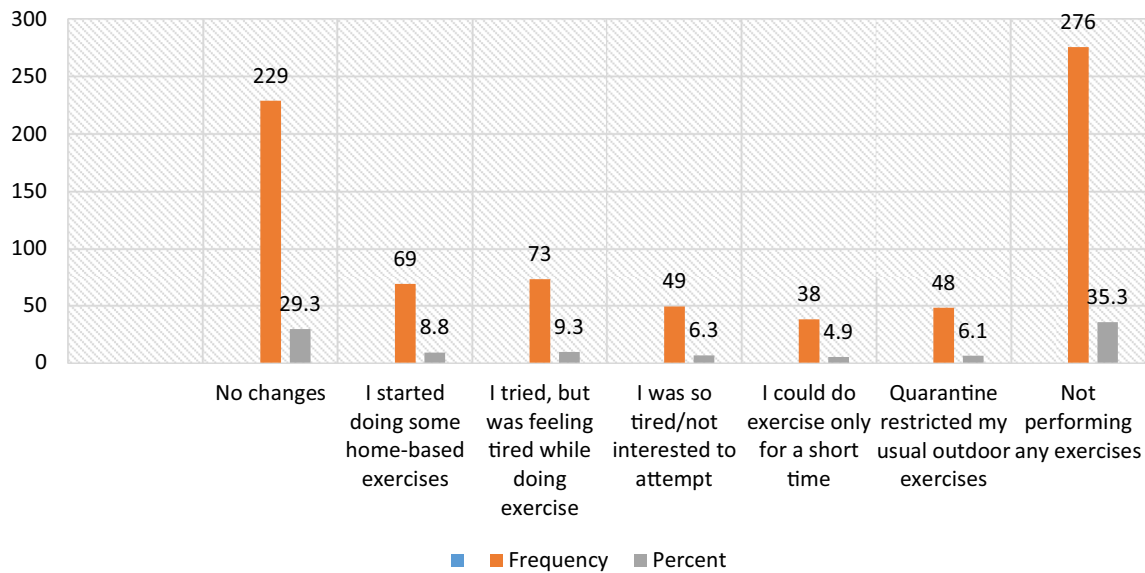
Fig. 4 Exercise pattern following COVID-19 infection

Table 3 Association of sleep and fatigue with demographic, sleep duration, food, and other lifestyle-related variables

Association of demographic, sleep duration, food, and other lifestyle-related variables with sleep quality and fatigue	Sleep quality		Fatigue level	
	Test Statistics χ^2	*p*-value	Test Statistics χ^2	*p*-value
Association of demographic variables with sleep and fatigue				
Age	25.77	0.001**	9.437	0.307
Gender	15.77	0.003**	33.90	0.000**
Educational Level	10.12	0.430	8.286	0.601
Employment status	3.08	0.215	3.788	0.150
Annual Income	3.62	0.452	2.860	0.582
Marital Status	14.49	0.070	9.711	0.286
Association of clinical parameters of participants with sleep and fatigue				
BMI	5.01	0.543	3.414	0.755
Time of confirming COVID-19 positive diagnosis	5.17	0.739	23.15	0.003**
Vaccination status	1.42	0.840	1.52	0.822
Influence of COVID-19 on livelihood after becoming COVID-19 positive	8.30	0.016*	39.18	0.000**
How the COVID-19 had affected the livelihood	12.12	0.059	32.49	0.000**
Existing medical disease/ conditions	0.568	0.753	0.170	0.919
Having sleep problems before being affected with COVID-19 infection	28.38	0.000**	25.98	0.000**
Association of sleep duration, food, and other lifestyle-related variables with sleep and fatigue				
Sleep duration after COVID-19 infection	150.20	0.000**	136.66	0.003**
Time of experiencing sleep problems during/after the COVID-19 infection period	133.92	0.000**	88.26	0.000**
Changes in the food pattern after testing positive for COVID-19	40.83	0.000**	59.80	0.000**
Problems with the food intake after becoming COVID-19 positive	18.04	0.000**	41.19	0.000**
The habit of taking naps before being affected with COVID-19	1.904	0.386	3.286	0.193
Changes in the napping pattern after getting infected with COVID-19	30.50	0.000**	68.74	0.000**
Engagement in exercise/home-based activities before COVID-19 infection	1.749	0.417	1.64	0.442
Changes in the exercise pattern following COVID-19 infection	46.02	0.000**	96.81	0.000**
Engagement in various practices/rituals before sleep after testing positive for COVID-19	4.350	0.114	2.83	0.243

* Significant at 0.05 level **Significant at 0.01 level

influencing sleep and fatigue, and a clear link indicating sleep problems before getting affected with COVID and sleep quality, and with sleep quality and fatigue. The present study results are organized as an interpretation of the study results for the following research questions of the study (a) What is the pattern of sleep and fatigue among COVID-19 positive adults in the community? (b) What is the association of *demographic* factors with sleep and fatigue levels in the adults affected with COVID-19 in the community? (c) What is the association of *lifestyle factors* with sleep and fatigue levels in the adults affected with COVID-19 in the community? (d) Is there a relationship between sleep quality and fatigue levels of the adults affected with COVID-19 in the community? (e) Does the sleep problems existing in the individuals before COVID-19 infection has an impact on their sleep quality and fatigue levels after they became COVID-19 positive?

4.1 Examination of Sleep and Fatigue, and Its Association with Demographic Factors

In the current study, almost 97% of the participants had either mild or moderate sleep quality problems, and nearly 48% of them had fatigue. Fatigue and sleep disorders were experienced by 72.5% of the patients and reported as persistent symptoms for at least 60 days after the diagnosis, onset, or hospitalization with COVID-19 in a systematic review [41]. In a study conducted in Nepal, a significant variation of sleep quality compared to the pre-pandemic levels, measured using the Insomnia Severity Index, had been reported among the residents [42]. Even though many studies had reported sleep quality problems among the subjects during lockdown, very few studies had explored sleep quality among COVID-19 positive adults in the community. A higher prevalence of sleep problems or a worse sleep quality had been reported in patients who were tested positive for COVID-19, or who were having symptoms [34, 43].

The fatigue levels reported in the study participants were slightly lower than a study that assessed the persistence of symptoms beyond a month among the patients affected with COVID-19, which reported a prevalence of 70% post-viral fatigue among the participants after initial clinical and virological cure of the disease [44], and the fatigue reported in a systematic review, where 97.7% of the post-COVID recovered patients had fatigue [11]. It could be due to the fact that many of the reported studies had assessed patients who have been hospitalized and have recovered from COVID-19, whereas the present study had assessed patients who were tested positive, but confined to community/home quarantine. Similar to the present study results, in a study conducted in Italy, a high proportion of patients who had recovered from COVID-19 (53.1%), had still reported fatigue [13].

In line with many other studies, gender showed a significant association with sleep and fatigue in the present study, and age a significant association with sleep quality. In contrast, the educational level of the participants, marital status, employment status, and income have not demonstrated any significant association with their sleep or fatigue levels. Sleep parameters are shown to be influenced by several sociodemographic and personal factors including age, sex, income, and current personal worries [37]. Insomnia related to COVID-19 is reported in studies as a specific worry among the population, and as its strong predictor contributing to sleep disturbance, difficulty falling asleep, poor sleep quality, and shorter sleep duration, and can be related to specific stressful situations like a stressful work environment, or stress from family life [37]. Age is positively associated with insomnia [45, 46], but demonstrated variable results conducted in many studies. Younger individuals were reported to have more insomnia than older individuals in a study [37], whereas the older population had a higher risk of insomnia is reported in few other studies [47, 48]. Much of the literature available, had linked insomnia to higher ages than younger adults [49–52], and would have missed the important information, such as a potential increased risk of insomnia in younger adults. It could be also possible that while handling daily life's challenges, the younger adults may have been at greater risk of experiencing stress during stressful times, such as a pandemic [37]. The elderly population had a better quality of sleep in comparison with younger adults in a study carried out in Spain which suggests the possibility of the older population adapting better to the pandemic [39]. In the current study group, there was a higher percentage of professionals, and it is also possible that they would have been exposed to job challenges and increased digital screen time owing to '*work from home*' with no time restrictions on their jobs, more than any other persons, which might have resulted or contributed to increased insomnia. Even though longer screen time is reported to increase poor sleep quality by reducing sleep efficiency [53], this aspect was not included in the tool used for this study, and thus could not be assessed. Lower socioeconomic factors had been reported as a consistent predictor for both greater insomnia and excessive daytime sleepiness in a few studies [54–57]. Similarly, a higher educational level among the participants was associated with worse sleep or insomnia [38], along with lack of family support, such as living alone [58], or being single [59].

Gender influence on sleep quality and fatigue levels showed highly inconsistent results in reported studies. One of the research studies has reported that insomnia can be predicted from sex, age, and income levels [37]. Females were more likely to have greater daytime sleepiness than males [38], and there is evidence that females [3, 37, 60], and individuals with lower incomes, contributed greater than

males, and those with higher income, in predicting insomnia [37]. In one study, being a woman, being unemployed, having suffered from COVID-19, or having someone suffer from COVID-19 is reported as predictors of poor sleep quality, whereas reported advanced age or sleeping for longer hours were predictors of better sleep quality [47]. Similar study results have been reported in other studies as well [42]. On the contrary, being a male [43, 59, 61], and higher age were significant factors for a higher prevalence of sleep problems in a subgroup of patients with COVID-19 [43]. In another study conducted to estimate the sleep problems, no gender difference was noted in the prevalence of sleep problems [62].

About the influence of demographic factors on fatigue, one systematic review conducted had reported that fatigue was common among females when assessed using a self-report, but this difference disappeared when it was assessed using rating scales at two-timepoints of 12–48 day and 72–81 day post-COVID-19 recovery [11]. The same study also reports that age does not affect fatigue, which was similar to the present study results. In a study conducted in the United Kingdom [12], fatigue was the most common reported symptom by 72% of the ICU group, and 60.3% of the ward group participants, who were the post-COVID-19 survivors. In addition, moderate-to-severe fatigue was reported more frequently by female patients than male patients in both the groups (61%) in that study. A large cohort study carried out in China [34], to know the long-term health consequences of COVID-19 on confirmed COVID-19 patients (*6 months after acute infection*) who were discharged from the hospital, had reported that 76% of the patients presented with at least one symptom at follow-up, such as fatigue or muscle weakness or sleep difficulties, which was higher in women, and with increasing age.

In the present study, the impact of COVID-19 on livelihood and the way it had affected had shown significant association with sleep and fatigue levels in the participants. This was similar to a large international study in which an adverse impact on livelihood was showing an independent association with worse sleep quality during the pandemic, along with characteristics, such as being female, in quarantine, and belonging to the age group of 31–45 years [62]. In one of the studies, sleep disturbances showed a significant association with sleep vulnerability to stress [42].

4.2 Examination of Sleep and Fatigue, and Its Association with Lifestyle Factors

A significant proportion of participants in this study were found to be overweight or obese (33.4% and 18.5%, respectively), but it did not show any significant association with sleep or fatigue levels. Consistent with the study findings, a study conducted in the United Kingdom among survivors of COVID-19 infection, to know the post-discharge symptoms, also had demonstrated no significant differences in moderate to severe fatigue levels of the participants with their BMI, even though it had been reported more frequently among female patients than in male patients [12]. In contrast, one of the studies had reported that respondents in the older age group had a higher BMI, had more sleep restriction, and slept for less than 6 h [23].

The time at which the sleep problems were experienced, during/ or after testing positive for COVID-19, showed a significant association with both sleep quality and fatigue levels in the present study. In a study conducted in the United Kingdom, almost half of the participants reported to have a change in their sleep pattern, which was predicted by multiple factors, such as the presence of ongoing COVID-19 symptoms, mental health impact, sleep medication use, younger age, and a worse general health rating [23]. In one study, fatigue during the first week of diagnosis with COVID-19 was a strong predictor for the patients who had been reported with fatigue during their post-discharge follow-up at 28 days [63].

Similarly, the presence of medical disease or conditions did not show any significant associations with sleep or fatigue in the current study. A systematic review had reported that individuals with preexisting chronic disease and perceived poor health have a higher prevalence of insomnia [3]. In a study conducted among health care workers [64] to know the COVID-19 illness concerning sleep and burnout, it is reported that the presence of a medical condition was associated with a higher frequency of COVID-19. It could be possible that since the majority of the participants in the present study remained without any existing medical problems (85.4%), it was not significant enough to make an impact on the reported variables. The long duration of symptom persistence of the pre-existing health condition would have also made the participants live with the disease and adapt to its changes, thus manifesting no variations in their sleep and fatigue levels.

Regarding the average hours of sleep, the participants in this study were sleeping almost 8.15 h per day, compared to the average 7.84 h per day before being affected with COVID-19. This sleep duration was slightly higher than the average sleep reported in a study conducted among the Spanish population during quarantine (6.55 h) and the Spanish average before COVID-19, which was 7.27 h. [39]. Unrefreshing sleep and aggravated sleep problems had been reported as predominant features of the post-COVID-19 syndrome in studies [21, 65]. A shift in the bedtime to later duration, delayed sleep onset, and a reduction in the nighttime sleep are reported in one of the studies carried out in India during COVID-19 lockdown, which had resulted from participants' delayed bedtimes [66]. Decreased quality of nighttime sleep and poorer consolidation of night sleep is

attributed to insufficient sunlight exposure in research [67]. This would have resulted in our participants sleeping for fewer hours due to being confined to indoors during the COVID-19 period. It is also reported that individuals with heightened sensitivity to stress-induced sleep problems are having a higher chance of developing chronic sleep disturbance [66, 67]. This cannot be overlooked, as COVID-19 had harmed the lives of people 68.

Similarly, the habit of taking naps did not show any significant association with sleep or fatigue. On the other hand, there was a significant association of changes in the napping or exercise pattern with sleep and fatigue levels after getting affected by COVID-19 in the present study. Increased daytime napping was reported in an online survey conducted on the general population [67]. In a study carried out in India [66], it was shown that there was a significant difference in the daytime napping of participants before and after COVID-19 lockdown, with an increased napping pattern observed among the participants, whereas a greater number of daytime napping hours were associated with a greater incidence of COVID-19 in another study [64]. Reduced physical activity was associated with worsening sleep quality during the pandemic [62]. Exercise intolerance is reported as a key feature of COVID-19 with physical and cognitive exertion, leading to debilitating fatigue, which is not alleviated by rest or sleep [12, 25, 69]. There was also no gender difference or difference in the BMI level among the participants [12]. In one of the studies conducted in the United Kingdom, households, where COVID-19 had been experienced or suspected, were associated with a lot more physical activity, while households with no experience or suspicion of COVID-19 maintained physical activity or were a little more active [70]. One of the previous research had reported long-term health consequences of post-discharge patients with COVID-19, and compared participants on their ability to walk in meters in 6 min. The participants who were admitted to the hospital, but did not require supplemental oxygen were able to walk better compared to other subjects who required supplemental oxygen or required high-flow nasal cannula or non-invasive mechanical ventilation [34]. Exercise tolerance problems or reduction in daily activities ability can be multifactorial similar to fatigue. In a systematic review, 41% of the patients had reduced aerobic capacity at 3 months post-illness [71]. Subjects who had breathlessness likely have more chance of developing reduced fitness to work or a reduced tolerance to activities [71], but this will have to be explored further.

COVID-19 also had caused changes in the dietary pattern and problems with the food intake among participants in the current study, which was significantly associated with their sleep and fatigue levels. Supporting these results, a United Kingdom-based study had reported gastrointestinal problems, such as lack of appetite, diarrhea, and anosmia in patients who were discharged from the hospital due to COVID-19 [13]. Likewise, one study reported dietary pattern changes owing to changes in the work status resulting from COVID-19 [70].

4.3 Examination of the Relationship Between Sleep, Fatigue, and Sleep Problems

In the present study, both poor sleep quality and higher fatigue levels showed a significant, but negative relationship with participants' type of sleep problems before getting affected with COVID-19. Even though not comparable, similar study results had been reported by Maestro-Gonzalez in Spain [39], where sleep-quality factors were significantly associated with poorer quality of sleep, during the time of the pandemic. It is reported that sleep quality may be worsened in individuals who had been exposed, or are susceptible to pre-existing stressors if they have increased caregiving responsibilities, and if their life had been adversely affected by COVID-19 [39, 62]. Almost 78.8% of the subjects in the present study did not have any impact of COVID-19 on their livelihood, and only 5% of the participants had either a direct or indirect effect of COVID-19 on family income and were facing stress and psychological issues, which would have affected the results. Whereas in fatigue, there can be other factors, such as increased work responsibilities, or screen timings, which may negatively affect their health. This was not explored in our study.

To conclude, the various research evidence available on COVID-19 suggests that sleep and fatigue problems are present in adults, which demonstrates a significant association with the sociodemographic variables. Study findings are variable when it reported age, gender, marital status, income, and presence of prior medical diseases or conditions. Lifestyle factors such as napping, exercise pattern, and dietary pattern were significantly associated and had a difference with sleep and fatigue levels, after getting affected with COVID-19. Comparisons of research data across numerous variables had been highly challenging, since studies on COVID-19 are still emerging or not much available.

4.4 Limitations and Recommendations

The major limitations of the study are the predominance of females in the sample, probably this would have been the result of females responding more than males, and the non-probability sampling method. This would necessitate the generalization of the study results to the entire population to be interpreted with a bit of caution. The online survey and the English language questionnaire would have also negatively influenced people who would prefer to answer questions in their vernacular. As the questionnaire was lengthy, the researchers could not include the questions related to the

potential impact of media usage on participants' sleep and fatigue. The current data set is limited as no conclusions can be drawn for the causal relationship between the various demographic, lifestyle factors and with sleep and fatigue. Consolidating data on COVID-19 statistics also have been highly variable, and differed from country to country in published studies, which made the reporting difficult.

However, the researchers believe that the results obtained are relevant as much information about this issue has not yet emerged. The large sample size and the inclusion of people from various parts of the country were added advantages in this current study and increases the credibility of the results. In the future, longitudinal studies illustrative of fatigue as a long-term effect persisting after 6 months or beyond following COVID-19 can be conducted in the community, as well as a comparative evaluation of fatigue in hospitalized and non-hospitalized cohorts can be carried out to assess its nature and severity. Moreover, follow-up studies could be conducted from selected sub-samples of the affected population from a particular geographical area of the community, to know the long-term effects of the disease on sleep and fatigue as well as on the quality of life. However, there is a paucity of studies in adults affected with COVID-19 in the community, especially concerning demographic and lifestyle factors, which made the comparison difficult and in detail.

5 Conclusions

This study has shown that coronavirus disease has an effect on individuals' demographic factors and a multitude of lifestyle factors, thus having an impact on their daily lives, routines, and performance. The findings brought to light from the present research findings have important clinical and public health implications. It is worth noting that fatigue and sleep problems can be reported as presenting symptoms even in people who were not hospitalized for COVID-19, which could impair the quality of life affecting their performance in various fields. The present study also highlights the need for post-COVID-19 monitoring even after recovery from the disease, even in patients presenting with milder forms of the disease, and female gender. It is required that the long-term consequences, such as sleep problems and fatigue need to be addressed in a community sample of adults, especially young adults, to optimize the health outcomes and enhance their wellbeing.

Surprisingly, unlike some previous research findings, the participants' marital status, income, BMI, and presence of medical disease or conditions were not found to be associated with sleep and fatigue in the present study. It could be because, in the present study, the majority of the participants had a professional degree, and they would not have felt the adverse effect of lack of income, as they were paid, and also would have had the privilege of 'work from home' which was relaxing to a certain extent. This was not explored in the study.

Declarations

Conflict of Interest The authors declare that they have no conflicts of interest/competing interests in this study.

Ethics Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

The ethical permission for this study was obtained from the Institutional Ethics Committee of the researchers', LISIE/IEC/JUL-2021/01 dated 13th July 2021.

Consent to Participate Informed consent was obtained from the individual participants for their participation in the study.

Consent for Publication Not applicable.

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