Published online 2023 March 20 **Original Article**

Assessment of Positive Airway Pressure Treatment Adherence and Sleep Quality in Sleep Apnea Patients during COVID-19 Pandemic: Multi-center Cross-sectional Study Results

Cigdem Ozdilekcan[1*], Hikmet Firat[2], Ahmet Ugur Demir[3], Melike Yüceege[2] and Bulent Devrim Akcay[4]

[1]University of Health Sciences, Dr. Abdurrahman Yurtaslan Oncology Research and Training Hospital, Department of Chest Diseases and Sleep Medicine, Ankara, Turkey
[2]University of Health Sciences, Dışkapı Yıldırım Beyazıt Educational and Research Hospital Department of Chest Diseases and Sleep Medicine, Ankara, Turkey
[3]Hacettepe University, Faculty of Medicine, Department of Chest Diseases and Sleep Medicine, Ankara, Turkey
[4]University of Health Sciences, Gulhane Research and Training Hospital, Department of Psychiatry and Sleep Medicine, Ankara, Turkey

*** *Corresponding author:*** Cigdem Ozdilekcan, University of Health Sciences, Dr. Abdurrahman Yurtaslan Oncology Research and Training Hospital, Department of Chest Diseases and Sleep Medicine, Ankara, Turkey. Tel: +905336548612; Email: cigdemozdilekcan@yahoo.com.tr

Received 2021 May 18; **Revised** 2023 February 15; **Accepted** 2023 March 04.

Abstract

Background: Patients with obstructive sleep apnea (OSA), related to cardiovascular and metabolic consequences of the disease, are physically and mentally vulnerable during the outbreak.

Objectives: To investigate the association between pandemic-related changes and positive airway pressure (PAP) adherence and sleep quality in OSA patients.

Methods: This was a multi-center cross-sectional study, and the necessary data were collected prospectively. A total of 221 patients were included in the study, who were invited from four different centers from June 1 - December 1, 2020. Pittsburgh Sleep Quality Index (PSQI) was administered to evaluate sleep quality. Information on demographics positive airway pressure (PAP) device use and Coronavirus disease (COVID-19 were collected by a questionnaire. Patients >18 years with a diagnosis of OSA and prescribed PAP treatment before the pandemic period were included in the study. Lack of cooperation with the questionnaires and incompliant with PAP treatment for longer than one year were the exclusion criteria.

Results: Of the 221 participants, 79.2% were men. The mean apnea-hypopnea index was obtained at 40.8±24.3. A positive COVID-19 test was reported in nine cases, and three patients had hospitalization. During the pandemic, 102 (46.2%) subjects were retired, 26 (11.8%) lost their jobs, and 34 (15.3%) reported home office work or on-call or on leave. Poor sleep quality was found in 54 (24.4%) individuals. It was also reported that poor sleep quality was more common in those who reported mask use difficulty (38.7% vs. 18.9%; P=0.004) and increased or decreased PAP use (increased, decreased, no change in PAP use: 45.5%, 36.0%, 19.4%, respectively; P=0.01). The good sleep quality group had higher PAP use than the poor sleep quality group (6.2±1.5 vs. 5.3±2.4 night/week; P=0.002; 6.2±1.5 vs. 5.5±2.2 hour/night; P=0.01).

Conclusion: Pandemic period had several negative effects on sleep apnea patients regarding sleep quality and social lives which also influenced PAP adherence in OSA patients. Most patients did not change their regular PAP use attitudes during this period. Similar to the pre-COVID-19 disease period, PAP adherence and compliance positively influenced sleep quality; people who were "good sleepers" were the ones who were the "good PAP device users".

Keywords: Coronavirus, COVID-19, Pandemic, PAP treatment, Sleep quality

1. Background

Despite the known and unknown aspects of the mysterious disease named novel coronavirus disease “COVID-19”, the global pandemic period caused urgent alterations in individuals' social life and national healthcare implementations. The restrictions during the pandemic led to changes in social interactions, employment situations, mobility, and physical and mental activities, disrupting chronobiological rhythms. After the official announcement of the disease as a pandemic by the World Health Organization (WHO) in March 2020, this dynamic period was mentioned with the “nothing shall be the same as it used to be” concept with the social life changes mainly indicating supportive approaches that were endowed with interest and knowledge (1).

The COVID-19 pandemic and its consequences could promote sleep disturbances with an ultimate immune system dysfunction. Circadian rhythm alterations caused by the results of the COVID-19 pandemic had a negative impact on sleep quality and immunity (2). As previously reported, the pandemic has resulted in societal-level changes to sleep and other behavioral patterns. Besides the global pandemic's morbidity and mortality results, it led to financial strain and social isolation worldwide, devastatingly affecting mental health and well-being (3-5).

Individuals with obstructive sleep apnea (OSA0 diagnosis needed to be physically and mentally protected during the pandemic. They could be attributed as relatively higher risk groups with vulnerable conditions by having co-morbid conditions and specific treatment modalities. This fragile condition could lead to fear of aerosolization, diminished adherence to positive airway pressure (PAP) treatment, and impaired sleep quality, which would be the reason for mortality and morbidity in OSA patients (6).

2. Objectives

Our hypothesis was “the impairment in social

life by an impact of a viral disease outbreak is associated with impairment in adherence to PAP treatment and sleep quality among OSA patients". To test this hypothesis, we investigated the association between sleep quality and pandemic-related changes, including PAP adherence in OSA patients.

3. Methods

3.1. Study design and patient selection

This was a multi-center cross-sectional study, and the required data were collected prospectively. OSA patients, who were on PAP treatment and referred to outpatient clinics of four different tertiary health care centers, were invited to the study from June 1 to December 1, 2020. All of these 221 patients who accepted to participate in the study were either those who were admitted to the hospital for the prescription of their devices, masks, and other consumables or were asked for PAP device attachment by telephone calls. After signing an informed consent, patients were asked about their demographic data, including age, gender, marital status, degree of education, employment status, body mass index (BMI) values, duration of PAP treatment, type of PAP device used, comorbidities, and employment status during the pandemic period. Apnea-hypopnea index values (AHI/hour) in the diagnostic polysomnography were obtained from the patient charts. The inclusion criteria were being over 18 years old with a diagnosis of OSA and prescribed PAP treatment before the pandemic period, initiated by the Ministry of Health of Turkey's first official announcement of the pandemic period on March 11, 2020. On the other hand, patients who were incompliant with PAP treatment for longer than one year were excluded.

3.2. Changes due to COVID-19 *infection*

Participants were asked for the application and results of the COVID-19 polymerase chain reaction (PCR) test, weight changes, a history of hospitalization, isolation, and death and infection due to severe acute respiratory syndrome coronavirus 2 in household family members.

3.3. Adherence to PAP treatment

Participants were asked about the frequency and duration of PAP device use and alterations during the pandemic period. Participants were also questioned for their knowledge and information about the effect of a pandemic on their device usage.

3.4. Quality of Sleep

Participants were evaluated by the Pittsburg Sleep Quality Index (PSQI), a 19-item self-rated questionnaire for evaluating subjective sleep quality. This questionnaire was developed by Buysse et al. to measure sleep quality and help evaluate "poor" sleep quality. The items are combined into 7 clinically-derived component scores, each weighted equally from 0-3. The 7 component scores are added to obtain a total score ranging from 0-21, with higher scores indicating worse sleep quality. Significant sleep disturbance was defined as the values with a cut-off score of 5. The authors have described the validity of PSQI with a sensitivity of 89.6% and specificity of 86.5% for identifying cases with a sleep disorder (7, 8). Turkish version of PSQI by Agargun et al. was applied using the validity and reliability of the questionnaire (9).

Participants were asked to compare the alterations in sleep duration, awakening times, and subjective sleep quality before and after pandemics.

3.5. Ethical considerations

Written informed consent was obtained from all participants. Data of the patients were treated according to the Declaration of Helsinki Guidelines. The Ethics Committee of Ankara Oncology Hospital, Turkey, approved this study with the number 2020-07/694.

3.6. Statistical analysis

The gathered data were analyzed in SPSS, version 18 for Windows. Categorical variables were presented as numbers and percentages, while continuous variables were described as mean and standard deviation (SD). Comparisons were made between good and poor sleep quality groups, which were defined according to the total PSQI scores (>5: poor sleep quality, <6: good sleep quality). Chi-square testing was used for the comparisons of categorical variables, whereas independent samples t-test and Mann-Whitney U test were used to compare continuous variables, with and without normal distribution, respectively. A p-value of less than 0.05 in the two-tailed testing was used to determine statistical significance. A correction was not applied for multiple testing.

4. Results

Of the 221 participants, 79.2% were men. The subjects' mean scores for age and BMI were obtained at 51.8±10.3 years and 32.4±5.2 kg/m^2, respectively. As for the working conditions during a pandemic, 102 (46.2%) participants were retired, 26 (11.8%) lost their jobs during the pandemic period, and 34 (15.3%) reported home office work, on-call, or on leave. A total of 54 (24. 4%) participants reported poor sleep quality, according to the PSQI. As compared to good sleep quality, the poor sleep quality group reported more frequently losing a job (poor vs good sleep quality: 14.8% vs 10.8%) or home office work, or on-call or on leave (27.8% vs 11.4%, P=0.011 for work status). Gender, age, comorbidities, or smoking status were not associated with poor sleep quality. Fewer subjects were married in the poor sleep quality group than in the good sleep quality group (79.6% vs. 92.8%, P=0.012).

COVID-19 testing and positivity were reported by 46 (20.8%) and 37 (16.7%), respectively (P=0.100). COVID-19-related variables were not associated with poor sleep quality (Table 1).

As reported in Table 2, the mean of AHI was 40.8±24.2/h. PAP devices were Bilevel-PAP and Automatic-PAP in 33 (14.9%) and 111 (50.2%) patients, respectively. PAP use duration was estimated at 40.8±37.2 months. The poor sleep quality group had less PAP use than the good sleep quality group during the pandemic, as both nights per week (5.3± 2.4 vs. 6.2±1.5, P=0.002) and hour per night (5.5±2.2 vs. 6.2±1.5, 0.013); more frequent difficulty in mask use (44.4% vs. 22.8%, P=0.004), change in PAP use during pandemic (increased 9.3% vs. 3.6%; decreased 33.3% vs. 19.2%, respectively, P=0.014), at least one hour shorter night sleep during the last month (33.3% vs. 7.2%, P<0.001), and at least 30 min earlier waking in the last month (22.2% vs. 4.2%, P<0.001).

Table 1. Comparison of demographic characteristics and COVID-19 pandemic-related factors

	Total (n=221)	Good Sleep Quality (n=167)	Poor Sleep Quality (n=54)	P
Men, n (%)	175 (79.2)	136 (81.4)	39 (72.2)	0.209
Age (year), mean±SD	51.8±10.3	52.3±9.8	50.5±11.8	0.264
BMI (kgm-2), mean±SD	32.4±5.2	32.6±5.3	31.6±4.9	0.206
Married, n (%)	198 (89.6)	155 (92.8)	43 (79.6)	0.012
Work status				0.011
Retired, n (%)	102 (46.2)	85 (50.9)	17 (31.5)	
Have a job, n (%)	59 (26.7)	45 (26.9)	14 (25.9)	
Lost a job, n (%)	26 (11.8)	18 (10.8)	8 (14.8)	
Home office/on-call/on leave, n (%)	34 (15.4)	19 (11.4)	15 (27.8)	
Education status completed				0.512
≤5 years, n (%)	89 (40.3)	66 (39.5)	23 (42.6)	
6-11 years, n (%)	71 (32.1)	57 (34.1)	14 (25.9)	
≥12 years, n (%)	44 (26.3)	44 (26.3)	17 (31.5)	
Current smoker, n (%)	79 (36.2)	55 (33.3)	24 (45.3)	
Weight change				0.353
Gained weight	71 (32.1)	50 (29.9)	38.9	
Lost weight	25 (11.3)	21 (12.6)	4 (7.4)	
COVID testing, n (%)	46 (20.8)	30 (18.0)	16 (29.6)	0.100
COVID positive, n (%)	37 (16.7)	24 (14.4)	13 (24.1)	0.184
COVID patient hospitalized in the family, n (%) *	8 (3.7)	5 (3.0)	3 (5.7)	0.407
Any comorbidity, n (%)	184 (83.3)	139 (83.2)	45 (83.3)	1.000
Hypertension, n (%)	96 (43.4)	73 (43.7)	23 (42.6)	1.000
Diabetes mellitus, n (%)	64 (29.0)	48 (28.7)	16 (29.6)	1.000
Cardiovascular disease, n (%)	38 (17.2)	31 (18.6)	7 (13.0)	0.459

BMI: Body mass index; SD: Standard deviation. Column percentages are provided in the Table.
Chi-square testing was used for categorical variables. Independent samples t-tests were used for continuous variables. *Fisher exact test

Table 2. Comparison of PAP use and COVID-19 pandemic-related changes in OSA patients

	Total (n= 221)	Good Sleep Quality (n=167)	Poor Sleep Quality (n=54)	P
AHI/hour, mean±SD	40.8±24.3	40.6±24.2	41.5±24.5	0.811
PAP device type				0.206
CPAP, n (%)	77 (34.8)	61 (36.5)	16 (29.6)	
BIPAP, n (%)	33 (14.9)	21 (12.6)	12 (22.2)	
APAP, n (%)	111 (50.2)	85 (50.9)	26 (48.1)	
PAP use				
Night/week, mean±SD	6.0±1.8	6.2±1.5	5.3±2.4	0.002
Hour/night, mean±SD	6.0±1.7	6.2±1.5	5.5±2.2	0.013
Month, mean±SD	40.8±37.2	39.6±36.7	44.3±38.8	0.418
Interruption/month, mean±SD	3.0±0.8	3.0±1.0	3.0±0.8	1.000
Mask use difficulty, n (%)	62 (28.1)	38 (22.8)0	24 (44.4)	0.004
PAP use during pandemic				0.014
Increased, n (%)	11 (5.0)	6 (3.6)	5 (9.3)	
Decreased, n (%)	50 (22.6)	32 (19.2)	18 (33.3)	
No change, n (%)	160 (72.4)	129 (77.2)	31 (57.4)	
Night sleep last month compared to that before the pandemic				<0.001
At least 1 hour longer, n (%)	22 (10.0)	18 (10.8)	4 (7.4)	
No change, n (%)	169 (76.5)	137 (82.0)	32 (59.3)	
At least 1 hour shorter, n (%)	30 (13.6)	12 (7.2)	18 (33.3)	
Wake from sleep last month compared to that before the pandemic				<0.001
At least 30 min earlier, n (%)	19 (8.6)	7 (4.2)	12 (22.2)	
No change, n (%)	175 (79.2)	142 (85.0)	33 (61.1)	
At least 30 min later, n (%)	27 (12.2)	18 (10.8)	9 (16.7)	

AHI: Apnea-hypopnea index. PAP: Positive airway pressure, CPAP: Continuous positive airway pressure, BIPAP: Bi-level positive airway pressure, APAP: Automatic positive airway pressure. Column percentages are provided in the Table
Chi-square testing was used for categorical variables. Independent samples t-tests were used for continuous variables

5. Discussion

This study showed that through its national realities and dynamics, the novel outbreak negatively impacted the social lives, sleep patterns, and sleep quality of patients with sleep apnea. Patients who lost their jobs and changed working schedules, such as home office work, and those with lower PAP adherence had a higher frequency of poor sleep quality. The majority of patients did not change their regular PAP use attitudes during the pandemic period, which could be considered a positive finding during this period. Similar to the pre-COVID-19 disease period, PAP adherence and compliance positively influenced sleep quality. In other words, the majority of people who were "good sleepers" were the ones who were the "good PAP device users".

Gupta et al. showed that the lockdown influenced sleep patterns during pandemics. A shift to a later bedtime, delayed sleep onset, reduction in nighttime sleep, and eventually increase in daytime sleepiness and napping were observed in their study (10). In another cross-sectional online survey, an altered sleep pattern was observed. Reported problems included dozing off unintentionally during the day, disrupted sleep, difficulties falling or staying asleep, and later bedtimes (11).

The course and dynamics of the pandemic period presented several employment alternatives (home office, on-call, on leave) for the workers. However, the devastating result of the pandemic period, apart from mortality and morbidities, was unemployment by losing work within the pandemic period. Our study results revealed work loss in 11.8% of the participants. Throughout history, contagious diseases as well as wars and socio-political shifts have changed the economics and politics of countries globally (12). The COVID-19 outbreak has led to economic disruption, manifesting as job losses and changes in work schedules (insecure employment), which have resulted in anxiety, depression, and symptoms of stress (13). The findings of our study showed a higher frequency of poor sleep quality among OSA patients who reported job loss or working schedule changes. Insecure working conditions, including "working from home", were expected to rise during the COVID-19 pandemic. This condition, broadly defined as precarious employment, increases exposure to severe stressors and dramatic life changes (14). Poor sleep quality associated with losing a job and working from home in OSA patients is a consequence of the drastic changes in the work environment. Observing this unfair state, we ask the medical community and the governments to focus on these social changes and share the concerns of the WHO, emphasizing the impact of broadened social inequities during the pandemic (13).

Most of our patients did not change their PAP use attitudes during the pandemic, which was a similar result to that of a study conducted by Anwar et al. (15). In a cohort study, Attias et al. analyzed the impact of the COVID-19 lockdown in France on objective adherence to continuous-PAP by telemonitoring. From the pre-COVID-19 period to post-lockdown, there was a 3.9% increase in the adherence rate, and the proportion of very low adherers dropped by 18% within the same period (16).

Weight changes of the participants during the pandemic period were also remarkable for our study group; almost a third of the patients reported weight gain. It was mentioned that the pandemics, in many ways, impacted the individuals' eating behavior and eating disorder-related triggers, including psychosocial stressors and stay-at-home orders (17, 18). Sleep quality in short sleepers was found to be worse in our study group; since sleep duration is a component of PSQI, this finding was expected. We presume that this single question, "*Is there any change in your bedtime or wake time*?" can be used to screen the quality of sleep in OSA patients using PAP treatment. Similar to our results, Shillington has emphasized that the total PSQI score indicates poor sleep quality; several sleep disturbances were observed during the early days of the pandemic (19).

5.1. Limitations

Our study had certain limitations. We could not prove the causal associations as a cross-sectional study. The association between job loss or working schedule changes due to the pandemic and quality of sleep was almost certain, but that of PAP adherence and sleep quality could be causal or reverse causal. The questionnaire data were based on the self-reports of the participants. Since only some of the PAP devices had the technical feature of showing the usage data, we had to rely on patients' self-reports about PAP adherence. We only included the patients who were diagnosed and given treatments, who could have higher adherence to PAP treatment. However, this selection bias would not affect the association between PAP adherence and sleep quality.

6. Conclusion

In conclusion, the pandemic period had several effects on sleep apnea patients regarding sleep quality, and social lives (job loss and changes in work schedules), which also influenced PAP adherence and sleep quality in OSA patients. Current and future perspectives of public health measures and managing (diagnosis, treatment, and follow-up) sleep apnea patients will have to change during the pandemic. Identifying sleep disturbances, strong recommendations, and support for the use of PAP treatment are crucial during the pandemic.

Acknowledgments

The authors would like to thank the healthcare workers globally who fight against the viral outbreak and have excellent public health support during the pandemic.

Footnotes

Conflicts of Interest: None.

References

1. World Health Organization. Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations. 2020. Available from: https://www.who.int/news-room/commentaries/detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations
2. Silva ESME, Ono BHVS, Souza JC. Sleep and immunity in times of COVID-19. *Rev Assoc Med Bras*. 2020;**66**(2):143-7. doi:10.1590/1806-9282.66.S2.143. [PubMed:32965373]
3. Rezaei N, Grandner MA. Changes in sleep duration, timing, and variability during the COVID-19 pandemic: large-scale Fitbit data from 6 major US cities. *Sleep Health*. 2021;**7**(3):303-13. doi:10.1016/j.sleh.2021.02.008. [PubMed:33771534]
4. Coiro MJ, Asraf K, Tzischinsky O, Hadar-Shoval D, Tannous-Haddad L, Wolfson AR. Sleep quality and COVID-19-related stress in relation to mental health symptoms among Israeli and US adults. *Sleep Health*. 2021;**7**(2):127-33. doi:10.1016/j.sleh.2021.02.006. [PubMed:33691986]
5. Voulgaris A, Ferini-Strambi L, Steiropoulos P. Sleep medicine and COVID-19. Has a new era begun? *Sleep Med*. 2020;**73**:170-6. doi:10.1016/j.sleep.2020.07.010. [PubMed:32836085]
6. Tufik S, Gozal D, Ishikura IA, Pires GN, Andersen ML. Does obstructive sleep apnea lead to increased risk of COVID-19 infection and severity? *J Clin Sleep Med*. 2020;**16**(8):1425-6. doi:10.5664/jcsm.8596. [PubMed:32441246]
7. Buysse DJ, Reynolds CF 3rd, Monk TH, Berman SR, Kupfer DJ. The Pittsburgh sleep quality index: a new instrument psychiatric practice and research. *Psychiatry Res*. 1989;**28**(2):193-213. doi:10.1016/0165-1781(89)90047-4. [PubMed:2748771]
8. Backhaus J, Junghanns K, Broocks A, Riemann D, Hohagen F. Test-retest reliability and validity of the Pittsburgh sleep quality index in primary insomnia. *J Psychosom Res*. 2002;**53**(3):737-40. doi:10.1016/s0022-3999(02)00330-6. [PubMed:12217446]
9. Agargün MY, Kara H, Anlar O. The validity and reliability of the Pittsburgh sleep quality index. *Turk Psikiyatr Derg*. 1996;**7**:107-15.
10. Gupta R, Grover S, Basu A, Krishnan V, Tripathi A, Subramanyam A, et al. Changes in sleep pattern and sleep quality during COVID-19 lockdown. *Indian J Psychiatry*. 2020;**62**(4):370-8. doi:10.4103/psychiatry.IndianJPsychiatry_523_20. [PubMed:33165382]
11. Pérez-Carbo nell L, Meurling IJ, Wassermann D, Gnoni V, Leschziner G, Weighall A, et al. Impact of the novel coronavirus (COVID-19) pandemic on sleep. *J Thorac Dis*. 2020;**12**(2):163-75. doi:10.21037/jtd-cus-2020-015. [PubMed:33214921]
12. Ceylan RF, Ozkan B, Mulazimogullari E. Historical evidence for economic effects of COVID-19. *Eur J Health Econ*. 2020;**21**(6):817-23. doi:10.1007/s10198-020-01206-8. [PubMed:32500243]
13. Brenner MH, Bhugra D. Acceleration of anxiety, depression, and suicide: secondary effects of economic disruption related to COVID-19. *Front Psychiatry*. 2020;**15**(11):592467. doi: 10.3389/fpsyt.2020.592467. [PubMed:33384627]
14. Matilla-Santander N, Ahonen E, Albin M, Baron S, Bolíbar M, Bosmans K, et al. COVID-19 and precarious employment: consequences of the evolving crisis. *Int J Health Serv*. 2021;**51**(2):226-8. doi:10.1177/0020731420986694. [PubMed:33430684]
15. Batool-Anwar S, Omobomi OS, Quan SF. Impact of the novel coronavirus disease on treatment adherence and sleep duration in patients with obstructive sleep apnea treated with positive airway pressure. *J Clin Sleep Med*. 2020;**16**(11):1917-20. doi:10.5664/jcsm.8746. [PubMed:32780011]
16. Attias D, Pepin JL, Pathak A. Impact of COVID-19 lockdown on adherence to continuous positive airway pressure by obstructive sleep apnoea patients. *Eur Respir J*. 2020;**56**(1):2001607. doi:10.1183/13993003.01607-2020. [PubMed:32430426]
17. Shah M, Sachdeva M, Johnston H. Eating disorders in the age of COVID-19. *Psychiatry Res*. 2020;**290**:113122. doi: 10.1016/j.psychres.2020.113122. [PubMed:32480115]
18. Rodgers RF, Lombardo C, Cerolini S, Franko DL, Omori M, Fuller-Tyszkiewicz M, et al. The impact of the COVID-19 pandemic on eating disorder risk and symptoms. *Int J Eat Disord*. 2020;**53**(7):1166-70. doi:10.1002/eat.23318. [PubMed:32476175]
19. Shillington KJ, Vanderloo LM, Burke SM, Ng V, Tucker P, Irwin JD. Not so sweet dreams: adults' quantity, quality, and disruptions of sleep during the initial stages of the COVID-19 pandemic. *Sleep Med*. 2022;**91**:189-95. doi:10.1016/j.sleep.2021.02.028. [PubMed:33685852]