

# Decrease in sleep quality during COVID-19 outbreak

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## Research Article

**Keywords:** COVID-19, restrictive measures, sleep, mood

**Posted Date:** September 23rd, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-82381/v1>

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**Version of Record:** A version of this preprint was published at Sleep and Breathing on September 29th, 2020. See the published version at <https://doi.org/10.1007/s11325-020-02202-1>.

# Abstract

**Purpose:** The COVID-19 outbreak witnessed in the first months of 2020 has led to unprecedented changes in society's lifestyle. In the current study, we aimed to investigate the effect of this unexpected context on sleep.

**Methods:** During the COVID-19 outbreak, we performed an online survey with individuals formerly recruited for validation of the Spanish version of the sleep questionnaire Satisfaction, Alertness, Timing, Efficiency, and Duration (SATED). In the current survey, we asked the participants to complete the previously answered questionnaires, including the Pittsburgh Sleep Quality Index (PSQI), a modified version of the Epworth Sleepiness Scale (ESS), and the SATED questionnaire. We also assessed mood using the Profile of Mood States (POMS) questionnaire.

**Results:** The 71 participants were mostly women (75%), with a mean ( $\pm$ SD) age of  $40.7 \pm 11.9$  years. Comparing the previous PSQI score to that during the COVID-19 outbreak, we observed worsening sleep quality ( $5.45 \pm 3.14$  to  $6.18 \pm 3.03$  points,  $p = 0.035$ ). In parallel, there was an increase in the negative mood ( $p = 0.002$ ). Accordingly, the decrease in sleep quality was substantially correlated with negative mood ( $p < 0.001$ ). There were no differences in the ESS or SATED.

**Conclusions:** The COVID-19 outbreak-associated events correlate with decreased sleep quality in association with an increase in negative mood. Considering the importance of sleep for a healthy life, and in particular for immune function, efforts should be made to improve awareness of this matter and to offer psychological assistance to affected individuals.

## Introduction

The COVID-19 outbreak witnessed in the first months of 2020 led to unprecedented changes in society's lifestyle. In a tentative to counteract the growing number of positive cases and avoid the health care system collapse, most of the world leaders determined home confinement as the most effective measure to be followed. In Spain, restrictions on the movement of individuals started on March 14, exceeding two months up to this date (and likely to be extended). As a consequence, the population was compelled to adjust personal and professional life to this condition, working from home, home teaching their children, and reducing social interaction.

Sleep is an important and highly susceptible behavior within this context. The flexibility in schedules due to social restraintment led to changes in the wake-up time and bedtime. Accordingly, recent studies reported that individuals are waking up and sleeping later during the confinement, possibly influenced by the increased use of digital media near bedtime [1]. Also, reduced exposure to sunlight, limited activity during the day, and alterations in food timing may lead to dysregulation in circadian rhythms and, in consequence, may affect sleep [2, 3]. Furthermore, sleep quality is closely related to the mood, which was demonstrably altered during this time [4, 5]. Huang and collaborators (2020) observed a high prevalence of generalized

anxiety disorder, which seemed to be associated with the time spent focusing on the COVID-19 ( $\geq 3$  hours per day) [6]. In addition, in a study performed during the initial stage of the COVID-19 outbreak in China, 54% of participants rated the psychological impact as moderate or severe, and approximately one-third reported moderate-to-severe anxiety [7]. Accordingly, the few studies evaluating sleep during this period also evaluated anxiety, depression, or stress. Xiao and collaborators (2020) reported an association between anxiety and poor sleep quality assessed by the Pittsburgh Sleep Quality Index (PSQI) questionnaire [4]. Similarly, poor quality sleep was demonstrably increased in those with depression, anxiety, and stress [1]. However, proper evaluation of the effect of the COVID-19 outbreak on sleep is hindered by the design of the available studies. Considering this, we conducted an online survey from April 28, 2020, to May 12, 2020 (during the COVID-19 outbreak) with individuals who had previously answered the same survey (pre-COVID-19 period). The survey included the PSQI, a modified version of the Epworth Sleepiness Scale (ESS), the Satisfaction Alertness Timing Efficiency Duration (SATED), and the Profile of Mood States (POMS) questionnaire.

## Methods

### *Study population*

Our population was composed of part of the individuals recruited as an independent sample aiming to validate the Spanish version of the SATED questionnaire [8]. The participants were older than 18 years of age and considered to be physically and mentally able to participate in the study. The original sample was stratified by sex, age, educational and socioeconomic level to properly represent the general population (for a detailed description, see [8]). This study was approved by the Clinical Research Ethics Committee of the Arnau de Vilanova University Hospital in Lleida (CEIC-1694) and conducted according to the principles outlined by the Declaration of Helsinki.

### *Study design*

The population was first recruited in 2017 as an independent sample to validate the Spanish version of the SATED questionnaire [8] (Fig. 1). Clinical and sociodemographic data were collected, and the participants completed the PSQI, ESS, SATED, and POMS questionnaires. During the COVID-19 outbreak in Spain, the individuals were contacted by their electronic addresses and asked to complete the previously answered questionnaires. The survey was available for a limited time window (from April 28 to May 12, 2020), and we obtained the answer from 71 individuals. Clinical and sociodemographic data were collected again due to possible changes over the years.

### *Clinical and sociodemographic variables*

The following variables were collected: age, sex, educational level, work schedule, physical activity, previous diseases, medication intake, alcohol consumption, smoking, and caffeine-based drinks ingestion. Body

mass index (BMI) was calculated as body weight (in kg)/height (in m<sup>2</sup>).

#### *Pittsburgh Sleep Quality Index (PSQI)*

Sleep quality was assessed by the PSQI [9]. The questionnaire was composed of 19 questions representing one of the seven components of sleep quality: subjective sleep quality, sleep latency, sleep duration, sleep efficiency, sleep disturbance, sleep medication intake, and daytime dysfunction. Each component score was rated on a three-point scale, leading to a sum of up to 21 points. A PSQI score >5 indicated poor sleep quality, whereas a PSQI score ≤5 indicated good sleep quality.

#### *Modified Epworth Sleepiness Scale (ESS)*

Excessive daytime somnolence was assessed by the ESS [10]. The questionnaire is originally composed of 8 questions to assess the chance of falling asleep during different daily situations. Three questions that were considered inappropriate due to the restrictive measures were excluded. Each question was rated on a three-point scale, in which 0 represented no chance of occurrence, and 3 indicated a high chance of occurrence. The overall score ranged from 0 to 15 points. Higher scores represented increased daytime somnolence.

#### *Satisfaction Alertness Timing Efficiency Duration (SATED)*

Sleep health was further assessed by the SATED [8]. The questionnaire was composed of 5 questions representing one of the 5 following sleep-related dimensions: subjective satisfaction, alertness during waking hours, appropriate timing, efficiency, and duration. Each question was rated on a two-point scale, leading to a sum of up to 10 points. Higher scores indicated better sleep health.

#### *Profile of Mood States (POMS)*

The mood was assessed by the POMS [11]. The questionnaire was composed of 28 questions representing one of the 5 following dimensions: tension (5 questions), depression (6 questions), anger (7 questions), vigor (6 questions), and fatigue (4 questions). Each question was rated on a five-point scale, with 0 representing 'not at all' and 4 indicating 'extremely'. The score of each dimension was the sum of the given rates for each of the corresponding questions. The positive subscale corresponded to 'vigor', and the negative subscale was the sum of tension, depression, anger, and fatigue. The total score was calculated by subtracting the positive subscale from the total of the negative subscale (+100, to avoid negative values). Thus, higher scores indicated a negative mood.

### *Statistical analysis*

The means (standard deviation, SD) were estimated for quantitative variables, and the absolute and relative frequencies were used for qualitative variables. We compared the questionnaires outcomes between both periods (pre- and during COVID-19 outbreak) using t-test or Wilcoxon rank sum test for paired samples. Furthermore, the relationship between POMS and PSQI scores during the COVID-19 outbreak was assessed through Spearman's rank correlation coefficient. Finally, the differences in the PSQI components according to the working condition were assessed by linear models. All statistical analyses and data processing procedures were performed using R software, version 3.5.2 (Vienna, Austria).

## **Results**

### *Participants characteristics*

The 71 participants were mostly women (75%), with a mean ( $\pm$ SD) age of  $40.7 \pm 11.9$  years old and a mean ( $\pm$ SD) BMI of  $23.0 \pm 3.7 \text{ kg.m}^{-2}$  (Table 1). Only 1 (1%) individual had been diagnosed with COVID-19 by the time of the survey, and no positive case at the same home was reported. The working condition was altered in most of the cases, with 32 (45%) individuals working from home and 12 (17%) unemployed due to the lockdown, while 16 (23%) remained working at the workplace and 10 (14%) were already unemployed before the COVID-19 outbreak.

### *COVID-19 outbreak, sleep, and mood*

According to the PSQI, there was a decrease in sleep quality during this period, demonstrated by a mean ( $\pm$ SD) change of  $0.73 \pm 3.01$  ( $p = 0.035$ ) between the baseline evaluation and that during the COVID-19 outbreak (Table 2). A similar outcome was observed in relation to sleep latency, with a mean ( $\pm$ SD) change of  $0.27 \pm 0.96$  ( $p = 0.028$ ) between the two time points. Differently, we did not observe changes related to excessive daytime somnolence and other sleep-related aspects, as indicated by the ESS ( $p = 0.127$ ) and SATED ( $p = 0.110$ ), respectively.

The negative mood was significantly increased during the COVID-19 outbreak, as demonstrated by a mean ( $\pm$ SD) change of  $6.27 \pm 14.92$  ( $p = 0.002$ ) between the two time points in the POMS total score (Table 3). Accordingly, there was an increase in the negative subscale with a mean ( $\pm$ SD) change of  $5.63 \pm 13.88$  ( $p = 0.001$ ) as a result of increases in tension [mean ( $\pm$ SD) change:  $1.9 \pm 4.38$ ;  $p = 0.001$ ], depression [mean ( $\pm$ SD) change:  $1.17 \pm 4.15$ ;  $p = 0.017$ ] and anger [mean ( $\pm$ SD) change:  $2.07 \pm 5.88$ ;  $p = 0.002$ ].

### *Correlations between sleep quality and mood*

To evaluate whether the observed decrease in sleep quality was associated with the increase in the negative mood, we investigated the correlations between the PSQI and POMS questionnaires (Table 4). There was substantial correlation between POMS total score and different PSQI items, such as the PSQI total score (corr = 0.55,  $p < 0.001$ ), subjective sleep quality (corr = 0.49,  $p < 0.001$ ), sleep latency (corr = 0.31,  $p = 0.008$ ), sleep duration (corr = 0.33,  $p = 0.005$ ), sleep medication intake (corr = 0.24,  $p = 0.040$ ) and daytime dysfunction (corr = 0.49,  $p < 0.001$ ). Similarly, distinct correlations were observed among PSQI items and the specific dimensions of POMS.

## Discussion

In the current study, we investigated the influence of COVID-19 outbreak-associated events on sleep. According to the PSQI, there was a decrease in sleep quality during this period, possibly associated with an increase in sleep latency. In parallel, the mood state evaluation indicated an increase in the score of dimensions representing a negative mood such as tension, depression, and anger. Accordingly, there was substantial correlation between sleep quality and mood states. On the other hand, we did not observe any differences in relation to the daytime somnolence as indicated by the ESS or on the sleep dimensions assessed by the SATED questionnaire.

The findings herein presented seem to confirm the available data in the literature. Cellini and collaborators (2020) evaluated 1310 individuals living in the Italian territory and reported a decrease in sleep quality, which was stronger in individuals with higher symptoms of depression, anxiety, and stress [1]. Similarly, Xiao and collaborators (2020) demonstrated that the decrease in sleep quality in individuals confined at home for 14 days in central China was associated with an increase in anxiety and stress [4]. Although those outcomes are headed towards the same direction to the ones observed in this study, proper conclusions were hindered by limitations related to these studies' designs. Here, we compared an evaluation before the COVID-19 outbreak to that during this period, which confirmed a deleterious effect of this context on sleep quality. Accordingly, there was a substantial correlation between sleep-related parameters and mood. The most affected parameter in the PSQI was sleep latency, which presented a negative correlation with the positive subscale of POMS, i.e., the lack of positive mood appeared to be associated with increased sleep latency. In fact, the PSQI total score presented a positive correlation with all the parameters of POMS that composed the negative subscale, such as tension, depression, anger, and fatigue.

Other factors may have accounted for the observed decrease in sleep quality in addition to the negative mood. Changes in social- and work-related schedules lead to alterations in sleep. We did not observe an influence of the working condition on sleep quality (see Table S1 in the supplemental material), however, recent studies reported that people are waking up and sleeping later during this period [1]. Although this may be due to the late chronotype, such situation could be related to the reported increased use of digital media near bedtime associated with the COVID-19 outbreak [1, 12]. In fact, the changes in sleep latency here presented may be a consequence of excessive screen time at night. Furthermore, the imposed restrictions lead to a decrease in sunlight exposure and physical activity, which are important factors for circadian rhythms maintenance [3, 13, 14]. Accordingly, these behaviors altogether lead to a disruption of circadian rhythms, further aggravating sleep behavior and mood [15, 16]. Also, such disturbance may affect the

immune response [17], body temperature [18], blood pressure [19], metabolism, and energy homeostasis [20].

It is important to address that although the original sample was stratified by sex, age, educational and socioeconomic level to properly represent the general population, our sample was reduced to the individuals who answered the questionnaires during the COVID-19 outbreak. Accordingly, our population was mostly composed of women with a mean age of approximately 40 years. Studies showed that women are more susceptible to worry and to increased psychological burden [21, 22]. In addition, schedules, screen time at night, and the perception of the context may be distinct across the different ages. Thus, the results herein presented should be taken with caution, especially when making generalizations to a broader population. Besides this, this study has some limitations. Considering the influence of age on sleep quality, the three-years of difference between baseline and follow-up evaluations may have affected the sleep quality, in addition to the context of the COVID-19 outbreak. Also, although we have considered alterations in health conditions, changes in medication, differences in food and drink habits during this period, other modifications in lifestyle may have contributed to the observed outcomes. Our study has some strengths as well. Sleep was evaluated by different validated questionnaires. In addition, we investigated the influence of COVID-19 outbreak-associated events on sleep with a baseline assessment when the individuals were not under this context.

In summary, we observed a decrease in sleep quality during the COVID-19 outbreak according to the PSQI. In parallel, the mood state evaluation indicated an increase in the scores of dimensions representing a negative mood such as tension, depression, and anger. Accordingly, the decrease in sleep quality was substantially correlated with negative mood. Considering the importance of sleep for a healthy life, and in particular for immune function, efforts should be made to improve awareness of this matter and to psychologically assist the individuals during this period. These findings unravel a possible facet associated with the restrictive measures, which should be considered in case of future situations.

## Abbreviations

**BMI** Body mass index

**ESS** Modified Epworth Sleepiness Scale

**POMS** Profile of Mood States

**PSQI** Pittsburgh Sleep Quality Index

**SATED** Satisfaction, Alertness, Timing, Efficiency, and Duration

## Declarations

### Acknowledgments

We would like to express our gratitude to all the individuals who answered the questionnaires.



## **Funding**

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

## **Disclosure statement**

The authors declare that no conflict of interests exists.

## **Ethics approval**

This study was performed in line with the principles of the Declaration of Helsinki. Approval was granted by the Clinical Research Ethics Committee of the Arnau de Vilanova University Hospital in Lleida (CEIC-1694).

## **Consent to participate**

The individuals signed an informed consent form to participate.

## **Consent to publish**

The individuals signed an informed consent form to publish.

## **Availability of data and material (data transparency)**

All data support our published claims and comply with field standards.

## **Code availability (software application or custom code)**

Not applicable.

**Author's contributions:** Adriano Targa: Conceptualization, Methodology, Writing - original draft/review & editing. Iván D. Benítez: Conceptualization, Methodology, Data curation, Formal analysis, Writing - review &

editing. Anna Moncusí-Moix: Conceptualization, Methodology, Data curation, Writing - review & editing. Maria Arguimbau: Methodology, Writing - review & editing. Jordi de Batlle: Writing - review & editing. Mireia Dalmases: Conceptualization, Writing - review & editing. Ferran Barbé: Conceptualization, Writing - review & editing.

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## Tables

<b>Table 1.</b> Characteristics of the participants.	
<b>Global</b>	
n = 71	
<i>n (%), mean (SD)</i>	
<b><i>Sociodemographic data</i></b>	
Sex, woman	53 (75%)
Age, years	40.7 (11.9)
BMI, kg·m <sup>-2</sup>	23.0 (3.7)
Education, years	9.0 (2.2)
<b><i>Health condition</i></b>	
Rhinitis	5 (7%)
Hypo-thyroidism	4 (6%)
Hypertension	3 (4%)
<b><i>COVID-19</i></b>	
Diagnosis	1 (1%)
Hospital admission	0 (0%)
Household cases	0 (0%)
<b><i>Working condition</i></b>	
Workplace	16 (23%)
Home working	32 (45%)
Unemployed due to lockdown	12 (17%)
Previously unemployed	10 (14%)
BMI, body mass index; n, number; SD, standard deviation.	

**Table 2.** COVID-19 outbreak and sleep.

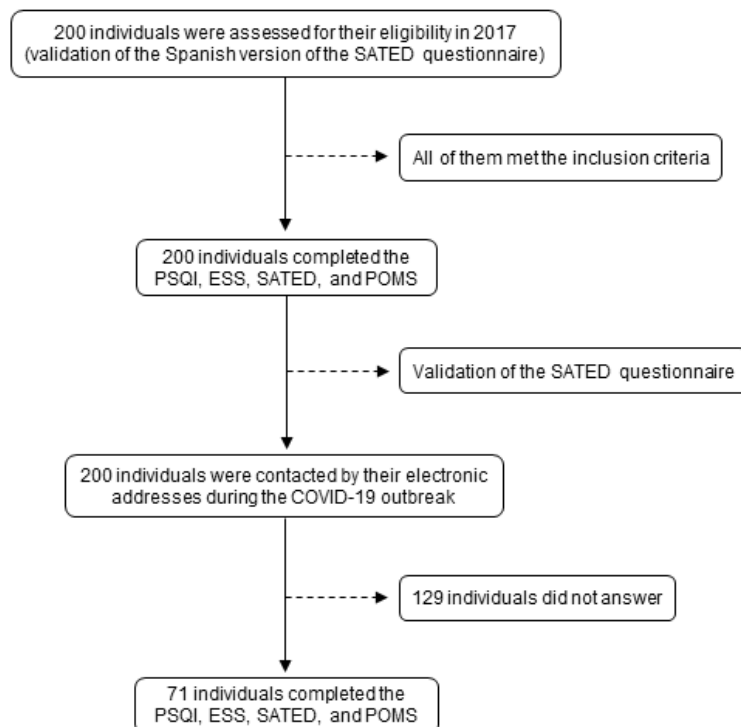
	Pre-COVID-19	COVID-19		
	n = 71	n = 71	Change	p-value
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>	
<b><i>PSQI</i></b>	5.45 (3.14)	6.18 (3.03)	0.73 (3.01)	0.035
Subjective sleep quality	1.13 (0.67)	1.20 (0.67)	0.07 (0.78)	0.442
Sleep latency	1.07 (0.90)	1.34 (0.92)	0.27 (0.96)	0.028
Sleep duration	0.83 (0.61)	0.72 (0.66)	-0.11 (0.75)	0.207
Sleep efficiency	0.34 (0.77)	0.55 (0.82)	0.21 (0.91)	0.090
Sleep disturbance	1.21 (0.56)	1.20 (0.43)	-0.01 (0.62)	0.860
Sleep medication intake	0.24 (0.73)	0.35 (0.83)	0.11 (0.77)	0.283
Daytime dysfunction	0.63 (0.68)	0.83 (0.79)	0.2 (0.84)	0.057
<b><i>ESS</i></b>	6.23 (2.64)	5.75 (2.99)	-0.48 (2.33)	0.127
<b><i>SATED</i></b>	7.25 (1.95)	7.70 (1.99)	0.45 (2.44)	0.110
ESS, Modified Epworth Sleepiness Scale; PSQI, Pittsburgh Sleep Quality Index; SATED, Satisfaction Alertness Timing Efficiency Duration; SD, standard deviation.				

<b>Table 3.</b> COVID-19 outbreak and mood.				
	<b>Pre-COVID-19</b>	<b>COVID-19</b>		
	n = 71	n = 71	<b>Change</b>	<b>p-value</b>
	<i>Mean (SD)</i>	<i>Mean (SD)</i>	<i>Mean (SD)</i>	
<b>POMS</b>	107 (17.5)	113 (17.3)	6.27 (14.92)	0.002
Tension	5.46 (4.35)	7.37 (4.16)	1.9 (4.38)	0.001
Depression	3.79 (4.52)	4.96 (3.99)	1.17 (4.15)	0.017
Anger	5.14 (6.39)	7.21 (5.87)	2.07 (5.88)	0.002
Vigor	12.5 (5.25)	11.8 (5.31)	-0.63 (5.65)	0.388
Fatigue	4.76 (3.61)	5.25 (3.92)	0.49 (3.39)	0.110
Positive subscale	12.5 (5.25)	11.8 (5.31)	-0.63 (5.65)	0.388
Negative subscale	19.2 (16.3)	24.8 (15.2)	5.63 (13.88)	0.001
POMS, Profile of Mood States; SD, standard deviation.				

**Table 4.** Correlations between sleep quality and mood.

POMS								
	<i>Tension</i>	<i>Depression</i>	<i>Anger</i>	<i>Vigor</i>	<i>Fatigue</i>	<i>Positive</i>	<i>Negative</i>	<i>Total Score</i>
<b>PSQI</b>								
<i>Total score</i>	0.44***	0.38**	0.31**	-0.39***	0.46***	-0.39***	0.47***	0.55***
<i>Subjective sleep quality</i>	0.41***	0.31**	0.34**	-0.31**	0.42***	-0.31**	0.44***	0.49***
<i>Sleep latency</i>	0.21	0.12	0.18	-0.38**	0.20	-0.38**	0.21	0.31**
<i>Sleep duration</i>	0.29*	0.33**	0.17	-0.09	0.25*	-0.09	0.30*	0.33**
<i>Sleep efficiency</i>	0.16	0.14	0.02	-0.10	0.18	-0.10	0.17	0.17
<i>Sleep disturbance</i>	0.26*	0.15	-0.01	-0.05	0.23	-0.05	0.18	0.17
<i>Sleep medication intake</i>	0.21	0.29*	0.15	-0.09	0.13	-0.09	0.26*	0.24*
<i>Daytime dysfunction</i>	0.27*	0.34**	0.30**	-0.47***	0.48***	-0.47***	0.39***	0.49***
*p<0.05, **p<0.01, ***p<0.001. PSQI, Pittsburgh Sleep Quality Index.								

## Figures



**Figure 1**

Flow chart. ESS, Modified Epworth Sleepiness Scale; POMS, Profile of Mood States; PSQI, Pittsburgh Sleep Quality Index; SATED, Satisfaction Alertness Timing Efficiency Duration.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [TableS1.xlsx](#)