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# Sleep quality, latency, and sleepiness are positively correlated with depression symptoms of Brazilians facing the pandemic-associated stressors of COVID-19

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**Abstract**

The severe acute respiratory syndrome coronavirus has implicated on mental health and psychopathological sequelae through viral infection. Suggestively, the pandemic-associated stressors (e.g., isolation, fear of illness, inadequate information and supply) may affect the sleep and feedback the depression symptoms, ultimately decreasing the immune system and offering further opportunities for severe acute respiratory syndrome coronavirus infection. Nevertheless, this association still requires investigation. Therefore, this study aimed to correlate the depression symptoms with sleep variables from subjects facing the restrictions of the ongoing pandemic in Brazil.

One hundred sixty-two volunteers (age = 31 ± 13 years; body mass = 69.8 ± 14.9 kg; height = 168 ± 9 cm) answered the Beck Depression Inventory, Pittsburgh Sleep Quality Index/Epworth Sleepiness Scale for determination of depression symptoms and sleep variables, respectively.

Significant and positive correlations were obtained between Beck score and sleep quality ($r$ = 0.53; $P$ = .000), sleep latency ($r$ = 0.29; $P$ = .000), and sleepiness ($r$ = 0.22; $P$ = .003), but not with sleep time ($r$ = –0.10; $P$ = .175).

This report concluded that Brazilians struggling with pandemic-associated stressors with high depression symptoms may have negative impacts on sleep, mainly regarding its quality, latency, and sleepiness.

**Abbreviations:** BDI = Beck Depression Inventory, CIs = confidence intervals, CNDS = Complex Network and Depression Symptoms Project, COVID-19 = severe acute respiratory syndrome coronavirus, ES = effect size, PSQI = Pittsburgh Sleep Quality Index, SD = standard deviation.

**Keywords:** COVID-19, depression, pandemic, sleep

## 1. Introduction

Initial reports have been associating the ongoing coronavirus disease (COVID-19) pandemic with implications on mental health and psychopathological sequelae through viral infection.[1] In this scenario, recent studies discussed how pandemic stressors can negatively affect sleep,[2–4] and given the well-grounded crosstalk between sleep and immunity,[5] one may hypothesize that inadequate rest could be associated with psychiatric implications such as depression.

Psychological wellbeing is associated with a good quality of sleep, which is affected by several factors, like family support, social factors, and social support,[6] aspects that has presented lots of changes during the pandemic of COVID-19.[7] In this context, sleep is one of the factors that underwent alterations due to excessive stress,[3] leading to reduction of protective aspects like brain-derived neurotrophic factor, increase of cortisol concentration and synapse downregulation, parameters observed in cases of anxiety and depression.[8]

The correlation of mental health and sleep have been shown by previous reports.[9–11] Experimental studies found association between sleep, circadian rhythm, and neurodegenerative diseases like anxiety, depression, and Alzheimer.[6] Prolonged sleep loss or long sleep duration can dysregulate the homeostatic system by the increased production of inflammatory mediators, like cytokines, chemokines, and vasoactive amines.[12] If this scenario becomes chronic, it can cause a variety of diseases, including obesity,[13] type 2 diabetes,[14] cardiovascular,[15] and neurodegenerative.[12,16]

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*The datasets generated during and/or analyzed during the current study are not publicly available but are available from the corresponding author on reasonable request.*

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Central and peripheral inflammation are factors that may explain the link between environmental stress and depression.[17] Considering the pandemic-associated stressors (e.g., isolation, fear of illness, inadequate information and supply), sleep may be impaired and feedback the depression symptoms, ultimately decreasing the immune system and offering further opportunities for COVID-19 infection. However, such association remains to be further explored. Given the emergent necessity of scientific information surrounding the pandemic outbreak, in this article, we aimed to correlate the depression symptoms with sleep variables from subjects facing the restrictions of the ongoing pandemic in Brazil.

## 2. Methods

### 2.1. Participants and design

This cross-sectional study is part of the Complex Network and Depression Symptoms project, a transversal approach that aims to associate distinct data with the depression symptoms during the current pandemic by the complex network approach. The project has been conducted since the beginning of the COVID-19 outbreak with individuals between 18 and 60 years. Our focus was to understand how symptoms of depression are affected by the ongoing pandemic and if these may modulate health parameters, and not study people already diagnosed as depressive. Thus, our exclusion criteria were 2-fold: outside the 18–60 age and diagnosed as depressive. Data were collected via validated self-applied questionnaires, which were applied remotely. This project was approved by a Research Ethics Committee (38370120.7.0000.5514) and was conducted in agreement with the ethical recommendations of the Declaration of Helsinki.

### 2.2. Depression symptoms

The Portuguese version of the Beck Depression Inventory (BDI)[18] consists of 21 items that evaluate depressive symptoms and attitudes and comprised a Likert scale of 0–3. Internal consistency for this scale ranges from 0.73 to 0.92, with a mean of 0.86. Questions are associated with sadness, pessimism, feeling of failure, lack of satisfaction, feeling of guilt, feeling of punishment, self-depreciation, self-accusations, suicidal ideation, crying/weeping attacks, irritability, social withdrawal, indecision, distortion of body image, inhibition to work, sleep disturbance, fatigability, loss of appetite, weight loss, somatic worry, and decreased libido. The severity of symptoms is classified as minimal (0–9), mild-moderate (10–18), moderate-severe (19–29), and severe (30–63).

### 2.3. Sleep variables

The validated version for the Portuguese language of the Pittsburgh Sleep Quality Index[19] consists of 19 questions divided into components, including sleep quality, latency, total sleep time, efficiency, disturbance, use of sleep medication, and daytime dysfunction. Each component is equally weighted on a 0–3 scale. Sleep quality, latency, and total time are derived from these scores and were used for the correlation analysis. Regarding sleep quality, the higher the score, the poor is the quality. The Epworth Sleepiness Scale[20] comprises 8 questions on the usual chances of having dozed off or fallen asleep while engaged in distinct activities. Each question has a 4-point scale (0–3) and the sum of scores provide the sleepiness final score.

### 2.4. Statistical analysis

Data are presented as mean and standard deviation (SD). Lilliefors' analysis confirmed the nonparametric characteristic of the data. Therefore, correlations were proceeded by the Spearman approach. Additionally, Kruskal-Wallis analysis was adopted to compare the sleep parameters (dependent variables) according to BDI classifications (factorial). When the effect was highlighted, Dunn post hoc test was applied. Confidence intervals were calculated for both SD and correlation with $\alpha = 0.05$ ($\sigma/\sqrt{n}$). Beneficial, trivial, and harmful classifications were adopted as the probability for testing the hypothesis and were obtained from the confidence interval. Effect sizes (ESs) were calculated by subtracting the mean of one group from the other and dividing the result by the mean of the SD of the respective groups. ES were classified as small if <0.5, medium if 0.5–0.8, and large if >0.8. A minimum of 5% of significance was considered in every analysis.

## 3. Results

One hundred sixty-two volunteers were eligible to this study. More than half of our sample was composed of women (women = 72%; men = 28%). The mean and SD of general characteristics, sleep variables, and depression symptoms is presented in Table 1. Significant and positive correlations were obtained between Beck score and sleep quality (Fig. 1A), sleep latency (Fig. 1B), and sleepiness (Fig. 1C). However, no significant association was visualized between Beck score and sleep time (Fig. 1D).

Figure 2 demonstrated that volunteers classified with minimal depression symptoms according to BDI presented better sleep quality (4.9 ± 2.4 a.u.) when compared with the others (mild-moderate = 7.2 ± 2.6 a.u.; moderate-severe = 7.8 ± 2.2 a.u.) (Fig. 2A). Moreover, a significant effect was also visualized for sleep latency but post hoc only indicated a difference between minimal (21 ± 19 minutes) and moderate-severe (31 ± 21 minutes) classifications ($P = .005$) (Fig. 2B). However, no differences were visualized between groups for sleepiness (minimal = 7.6 ± 4.1 a.u.; mild-moderate = 9.3 ± 5.1 a.u.; moderate-severe = 9.4 ± 4.0 a.u.) or sleep duration (minimal = 486 ± 67 minutes; mild-moderate = 483 ± 85 minutes; moderate-severe = 451 ± 86 minutes) (Fig. 2C and D). Large ES were observed for sleep quality between groups classified with minimal depression symptoms and mild-moderate or moderate-severe (Table 2).

## 4. Discussion

The results of this study must be interpreted in light of the COVID-19 pandemic-associated stressors affecting Brazilians. Our data put forward that as far as the depression symptoms increase, the sleep quality decreases. This corroborates with the positive association between Beck score and sleepiness, suggesting that subjects with high depression symptoms may struggle to stay awake or alert. Further, the positive correlation between Beck score and sleep latency indicates that the transition of full

**Table 1**

**General characteristics, sleep variables, and depression symptoms of Brazilians during the pandemic outbreak.**

| N = 162 | Mean | SD | CI |
|---|---|---|---|
| General characteristics | | | |
| Age (yr) | 31 | 13 | 11–14 |
| Body mass (kg) | 69.8 | 14.9 | 13.4–16.7 |
| Height (cm) | 168 | 9 | 8–10 |
| Sleep variables | | | |
| Sleep quality (a.u.) | 6.0 | 2.7 | 2.4–3.0 |
| Sleep total time (min) | 480 | 77 | 69–86 |
| Sleep latency (min) | 26 | 25 | 22–28 |
| Sleepiness (a.u.) | 8.4 | 4.5 | 4.1–5.0 |
| Depression symptoms (a.u.) | 11.1 | 8.1 | 7.3–9.0 |

CI = confidence interval for standard deviation, SD = standard deviation.

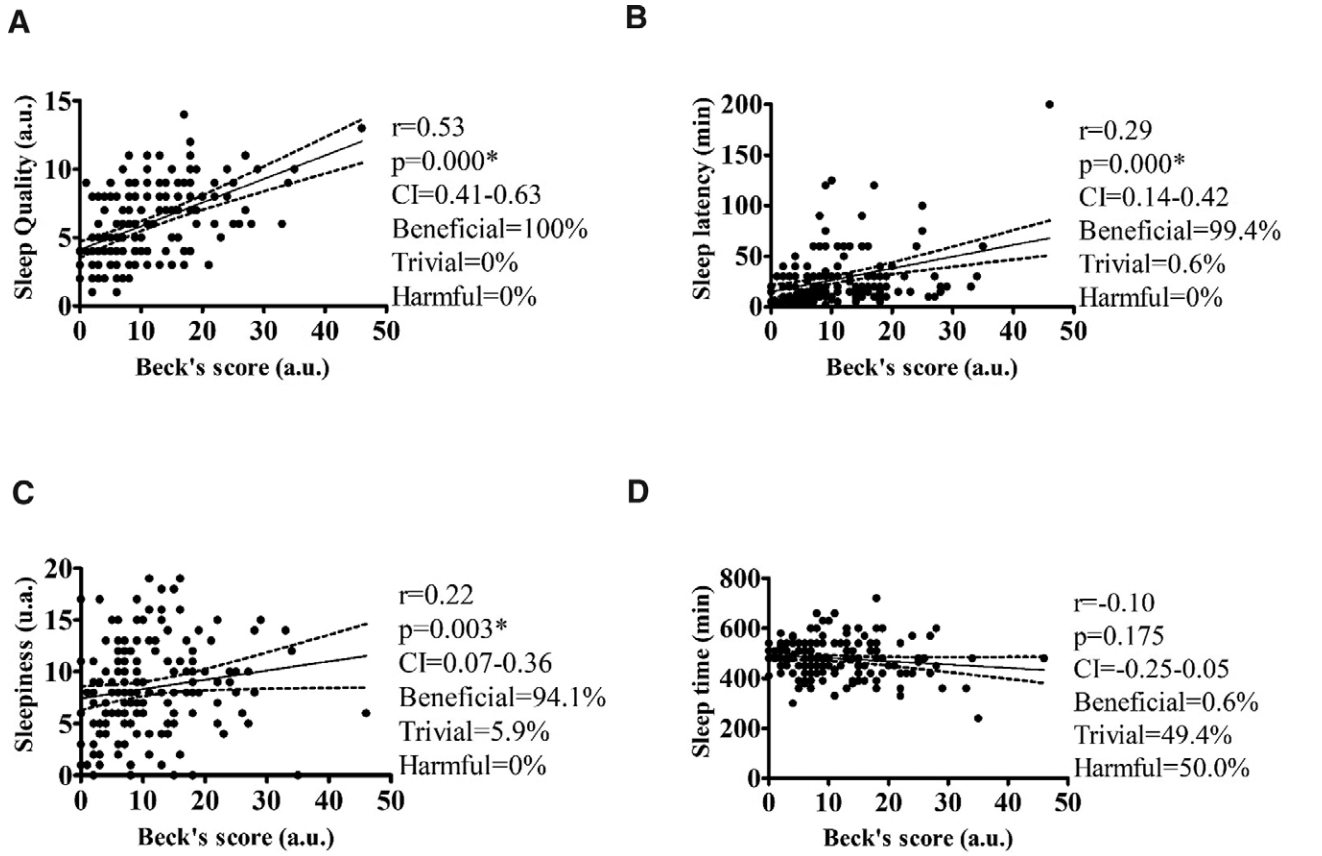


**Figure 1.** Correlation between depression score and sleep variables. Spearman analysis between the score from the Beck Depression Inventory and the sleep quality (A), sleep latency (B), sleepiness (C), and sleep time (D). Note that beneficial, trivial, and harmful classifications are associated with the probability for testing the hypothesis and were obtained from the CI. CI = confidence interval.

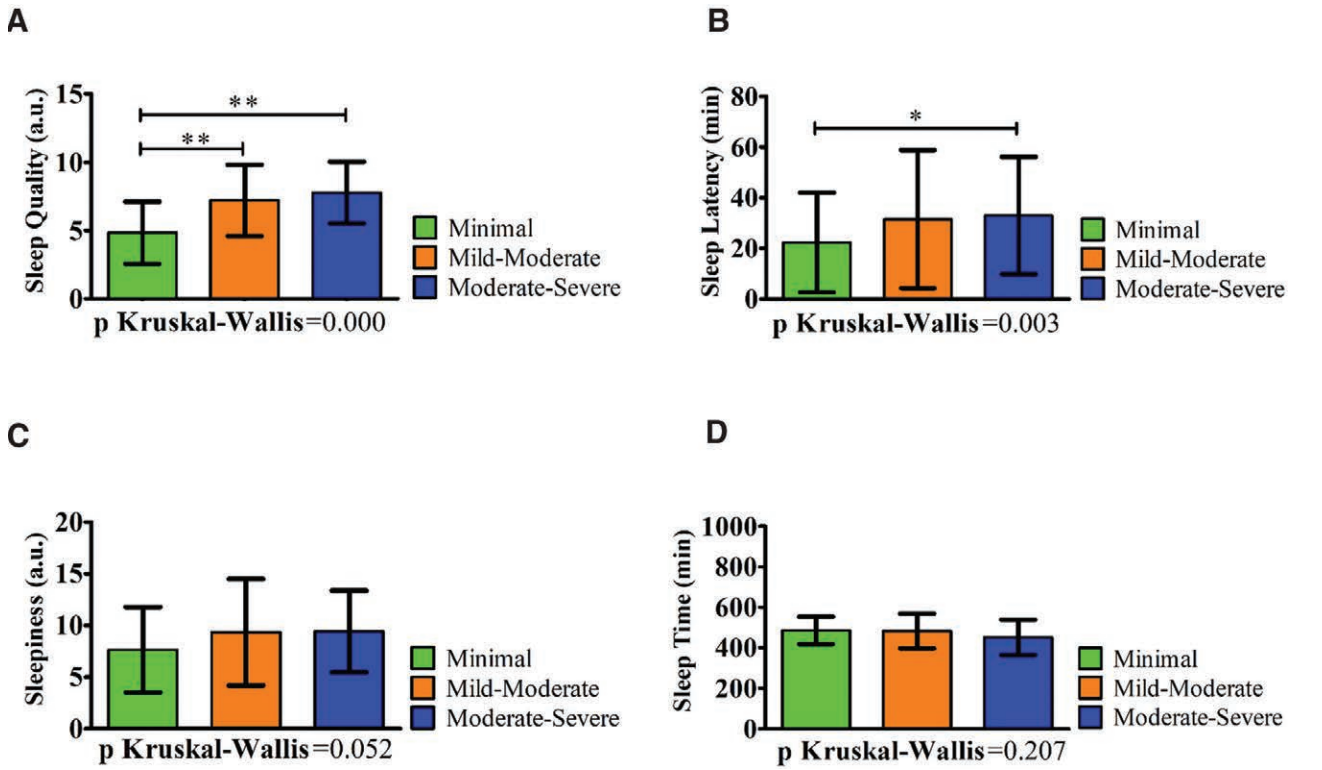


**Figure 2.** Groups were formed based on the Beck Depression Inventory classifications (minimal, n = 88; mild-moderate, n = 50; moderate-severe, n = 24). Subsequently, variations of each group were compared in terms of sleep quality (A), sleep latency (B), sleepiness (C), and sleep time (D); *$P \leq .05$; **$P \leq .01$.

**Table 2**

**Effect size of sleep variables according to severity of depression symptoms from Brazilians during the pandemic outbreak.**

| Comparison | Sleep quality | Sleep total time | Sleep latency | Sleepiness |
|---|---|---|---|---|
| Minimal vs mild-moderate | –0.967 | –0.367 | 0.040 | –0.365 |
| Minimal vs moderate-severe | –1.298 | –0.557 | 0.443 | –0.438 |
| Mild-moderate vs moderate-severe | –0.235 | –0.272 | 0.361 | –0.017 |

wakefulness to sleep may be affected by individuals with elevated depression symptoms. Last, the BDI classifications were effective to strengthen the above-mentioned outcomes.

Cytokines levels in the cerebrospinal fluid and brain immune cell functions (e.g., microglia, astrocytes, and oligodendroglia) may shed some light on the neuroinflammation in depression.[6] Sleep, on the other hand, provides metabolic clearance that, in turn, may attenuate brain inflammation.[5] Not only based on the neuroinflammation[21] perspective but considering further aspects as circadian rhythm alterations and melatonin levels,[22] the role of adequate sleep in depression is well grounded. However, the necessity of social distancing and fear of viral infection during the ongoing pandemic has precluded visits to clinics for deeper sleep analysis [23] such as polysomnographic measures. Thus, alternative methods like those adopted in this study can be valid strategies for clinicians to monitor and provide guidance for people suffering from depression in the present.

Our results sustain this possibility by demonstrating that as far as depression symptoms increase, sleep quality, sleep latency, and sleepiness are negatively affected. Moreover, the probability for testing these hypotheses was beneficial in each case, strengthen these associations. The absence of a relationship between depression symptoms and sleep time is aligned with an unanswered question surrounding adequate sleep duration for humans.[24] A recent report with 10,325 individuals concluded that for short sleepers (≤300 minutes), better cognition can be achieved by a consistent change to moderate sleep duration (300–480 minutes), but for long sleepers (≥480 minutes), it is not necessary to modify the total sleep length to improve cognition.[12] In our sample, only 1 subject (0.6%) reported sleep time below 300 minutes, while 40.2% were classified as long sleepers and the remaining 59.2% as moderate sleepers. Even so, the coefficient of variation regarding sleep duration (16%) was lower when compared with the other sleep variables (quality = 44%; latency = 95%; sleepiness = 53%). This factor suggestively precluded the association between depression symptoms and sleep time of people affected by the ongoing pandemic, but a larger sample could advance on this context.

The sleep quality of subjects classified with minimal depression symptoms was significantly lower when compared with those with mild-moderate or moderate-severe. This result is aligned with reports showing the inverse correlation between sleep quality and symptoms of anxiety and depression due to increased stress and social isolation during the COVID-19 outbreak.[2,6,11] Nevertheless, our data bring new insights surrounding the BDI relevance in the present. According to the classification shown by this scale, it was possible to discriminate and evidence individuals with good or poor sleep quality, making the evaluation of volunteers more easy and fast.

The COVID-19 pandemic has brought several changes in the routine of the world population, like the adoption of home office. Even with the restrictions decreasing, remote work is even more encouraged by the companies,[25] which can affect negatively the desk workers in lifestyle behaviors and wellbeing.[26] The increase of time at work, although at home, has caused a decrease in physical activity,[27] which directly influence in sleep quality, reducing it to levels below healthy and leading to major probability to develop neurodegenerative diseases like anxiety and depression.[28] Further, the fear of contamination has made individuals with psychiatric disorders influenced by pandemic changes not attended treatment in clinics,[29] leading to increase of the symptoms of anxiety and depression.

This increase in stress may be caused by factors like excessive exposure to screens,[30] which disrupts the secretion of melatonin by the pineal gland, increasing the incidence of depressive symptoms due to the reduction of sleep quality and making it a vicious cycle.[31] In this scenario, the circadian rhythm presents itself as a extremely important factor to regulate sleep quality, as mentioned in previous articles.[16,30,32,33] This system is composed by phases of sleep/wake cycle influenced by dark/light exposure, helping to align hormonal factors that adjust well-functioning of sleep, one of them being melatonin.[33,34] The above-mentioned information strengths the aim of this study by demonstrating that sleep quality cannot be overlooked during the current pandemic, mainly regarding its influence on the depressive symptoms.

The results of this work should be interpreted in light of its strengths and limitations. Body mass/height was reported rather than measured but such limitation did not impact our results. Furthermore, although the division between the groups has not occurred homogeneously, it has not influenced the data analysis, making possible the progress of the work. The major strength of this study was the achievement of significant correlations between depression symptoms and sleep variables employing self-applied questionnaires applied remotely through the ongoing pandemic.

In summary, this study concluded that Brazilians struggling with pandemic-associated stressors with high depression symptoms may have negative impacts on sleep, mainly regarding its quality, latency, and sleepiness. The follow-up of these subjects can provide further insights on the direct impact of COVID-19 on depression symptoms and consequently on sleep.

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## Author contributions

ALPG - conception, design, analysis, interpretation of data and wrote the manuscript

TAOC - analysis, interpretation of data and revised the manuscript.

MFRT - analysis, interpretation of data and revised the manuscript.

IGMR - conception, design, analysis, interpretation of data and revised the manuscript.

LHDM - supervision, conception, design, analysis, interpretation of data and revised the manuscript.

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