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

Ana Luíza Paula Garbuio, UG*, Talita Albertin Oliveira Carvalhal, UG*, Mariana Fatima Ribeiro Tomcix, UG*, Ivan Gustavo Masseli dos Reis, PhD®, Leonardo Henrique Dalcheco Messias, PhD®*

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 have 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,\(^3^3\) 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.\(^12,16\)
Central and peripheral inflammation are factors that may explain the link between environmental stress and depression. 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) 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-deprecation, self-accusations, suicidal ideation, crying/wearing, attacks of irritability, social withdrawal, indecision, distortion of body image, inhibition to work, sleep disturbance, fatigue, 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 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 poorer is the quality. The Epworth Sleepiness Scale 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). Lilliefer’s 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 α = 0.05 (0/1/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. ESs 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 |
|---|

| N = 162 | Mean | SD | CI |
|---|

| General characteristics | 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 ≤ .05; **P ≤ .01.
The relationship between depression symptoms and sleep time is latency, and sleepiness are negatively affected. Moreover, as far as depression symptoms increase, sleep quality, sleep time of people affected by the ongoing pandemic, but a larger sample could advance on this context.

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 |

This increase in stress may be caused by factors like excessive exposure to screens, 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. In this scenario, the circadian rhythm presents itself as an extremely important factor to regulate sleep quality, as mentioned in previous articles. 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. The above-mentioned information strengthens 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.

**Acknowledgments**

We would like to thank the volunteers for their participation in the procedures. Also, we thank the Programa de Iniciação Científica, Iniciação Tecnológica e Extensão (PICITEx) for allowing the accomplishment of this project, the Postgraduate Program in Health Sciences of the São Francisco University, the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES), and the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq - process 408680/2021-0).

**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.
References

[1] Mazza MG, De Lorenzo R, Conte C, et al. Anxiety and depression in COVID-19 survivors: role of inflammatory and clinical predictors. Brain Behav Immun. 2020;89:594–600.

[2] Cheng P, Casement MD, Kalmbach DA, et al. Digital cognitive behavioral therapy for insomnia promotes later health resilience during the coronavirus disease 19 (COVID-19) pandemic. Sleep. 2021;44:e255.8.

[3] Liu Z, Tang H, Jin Q, et al. Sleep of preschoolers during the coronavirus disease 2019 (COVID-19) outbreak. J Sleep Res. 2021;30:e13142.

[4] Pinto J, van Zeller M, Amorim P, et al. Sleep quality in times of COVID-19 pandemic. Sleep Med. 2020;74:81–5.

[5] Besedovsky L, Lange T, Haack M. The sleep-immune crosstalk in health and disease. Physiol Rev. 2019;99:1325–80.

[6] Xiao H, Zhang Y, Kong D, et al. Social capital and sleep quality in individuals who self-isolated for 14 days during the coronavirus disease 2019 (COVID-19) outbreak in January 2020 in China. Med Sci Monit. 2020;26:e923921.

[7] Cogliandro A, Barone M, Persichetti P. COVID-19 pandemic and the social effects on clinic and scientific research: the “human factor”. Eur J Plast Surg. 2020;1:2.

[8] Monteiro BC, Monteiro S, Candida M, et al. Relationship between brain-derived neurotrophic factor (Bdnf) and sleep on depression: a critical review. Clin Pract Epidemiol Ment Health. 2017;13:213–9.

[9] Espie CA, Emsley R, Kyle SD, et al. Effect of digital cognitive behavioral therapy for insomnia on health, psychological well-being, and sleep-related quality of life: a randomized clinical trial. JAMA Psychiatry. 2019;76:21–30.

[10] Freeman D, Sheaves B, Goodwin GM, et al. The effects of improving sleep on mental health (OASIS): a randomised controlled trial with mediation analysis. Lancet Psychiatry. 2017;4:749–58.

[11] Friedrich A, Classen M, Schlarb AA. Sleep better, feel better? Effects of a CBT-I and HT-I sleep training on mental health, quality of life and stress coping in university students: a randomized pilot controlled trial. BMC Psychiatry. 2018;18:268.

[12] Hua J, Sun H, Shen Y. Improvement in sleep duration was associated with higher cognitive function: a new association. Aging (Albany NY). 2020;12:20623–44.

[13] Brady EM, Bodicoat DH, Hall AP, et al. Sleep duration, obesity and insulin resistance in a multi-ethnic UK population at high risk of diabetes. Diabetes Res Clin Pract. 2018;139:195–202.

[14] Fredheim JM, Rollheim J, Omland T, et al. Type 2 diabetes and pre-diabetes are associated with obstructive sleep apnea in extremely obese subjects: a cross-sectional study. Cardiovasc Diabetol. 2011;10:84.

[15] Morris CJ, Purvis TE, Hu K, et al. Circadian misalignment increases cardiovascular disease risk factors in humans. Proc Natl Acad Sci U S A. 2016;113:E1402–11.

[16] Chen JC, Espeland MA, Brunner RL, et al. Sleep duration, cognitive decline, and dementia risk in older women. Alzheimers Dement. 2016;12:21–33.

[17] Nettes MA, Pariante CM. Is there neuroinflammation in depression? Understanding the link between the brain and the peripheral immune system in depression. Int Rev Neurobiol. 2020;152:23–40.

[18] Gorenstein C, Andrade L. Validation of a Portuguese version of the Beck Depression Inventory and the State-Trait Anxiety Inventory in Brazilian subjects. Braz J Med Biol Res. 1996;29:453–7.

[19] Bertolazi AN, Fagundes SC, Hoff LS, et al. Validation of the Brazilian Portuguese version of the Pittsburgh Sleep Quality Index. Sleep Med. 2011;12:70–5.

[20] Johns MW. Sleepiness in different situations measured by the Epworth Sleepiness Scale. Sleep. 1994;17:703–10.

[21] Bishir M, Bhat A, Essa MM, et al. Sleep deprivation and neurological disorders. Biomed Res Int. 2020;2020:5764017.

[22] Pandi-Perumal SR, Monti JM, Burman D, et al. Clarifying the role of sleep in depression: a narrative review. Psychiatry Res. 2020;291:113239.

[23] Ramar K. The COVID-19 pandemic: reflections for the field of sleep medicine. J Clin Sleep Med. 2020;16:993–6.

[24] Watson NF. Sleep duration: a consensus conference. J Clin Sleep Med. 2015;11:7–8.

[25] Bloom N. How working from home works out. Institute for Economic Policy Research (SIEPR). Policy Brief. 2020:1–9.

[26] Barone Gibbs B, Kline CE, Huber KA, et al. Covid-19 shelter-at-home and work, lifestyle and well-being in desk workers. Occup Med (Lond). 2021;71:86–94.

[27] Hall G, Laddu DR, Phillips SA, et al. A tale of two pandemics: how will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another? Prog Cardiovasc Dis. 2021;64:108–10.

[28] Altena E, Baglioni C, Espie CA, et al. Dealing with sleep problems during home confinement due to the COVID-19 outbreak: practical recommendations from a task force of the European CBT-I Academy. J Sleep Res. 2020;29:e13052.

[29] Bres Bullrich M, Fridman S, Mandzia JL, et al. COVID-19: stroke and disease. J Plast Surg. 2020;1:2.

[30] Dong L, Gumport NB, Martinez AJ, et al. Is improving sleep and circadian and sleep/wake timing. Sci Rep. 2017;7:3216.

[31] Chojnacki C, Wałęcka-Kapica E, Klupinska G, et al. Effects of fluoxetine and melatonin on mood, sleep quality and body mass index in postmenopausal women. J Physiol Pharmacol. 2015;66:665–71.

[32] Hershner S, O’Brien LM. The impact of a randomized sleep education intervention for college students. J Clin Sleep Med. 2018;14:337–47.

[33] Chojnacki C, Wałęcka-Kapica E, Klupinska G, et al. Effects of fluoxetine and melatonin on mood, sleep quality and body mass index in postmenopausal women. J Physiol Pharmacol. 2015;66;665–71.

[34] Hershner S, O’Brien LM. The impact of a randomized sleep education intervention for college students. J Clin Sleep Med. 2018;14:337–47.

[35] Dong L, Gumport NB, Martinez AJ, et al. Is improving sleep and circadian problems in adolescence a pathway to improved health? A mediation analysis. J Consult Clin Psychol. 2019;87:757–71.

[36] Phillips AJK, Clerx WM, O’Brien CS, et al. Irregular sleep/wake patterns are associated with poorer academic performance and delayed circadian and sleep/wake timing. Sci Rep. 2017;7:3216.

[37] Sletten TL, Magee M, Murray JM, et al. Efficacy of melatonin with behavioural sleep-wake scheduling for delayed sleep-wake phase disorder: a double-blind, randomised clinical trial. PLoS Med. 2018;15:e1002587.