The COVID-19 lockdown promotes changes in sleep habits in the Croatian general population

Renata Pecotić[1,2], Ivana Pavlinac Dodig[1,2], Linda Lušić Kalcina[1,2], Sijana Demirović[3], Katarina Madirazza[1,2], Maja Valić[1,2], Zoran Đogaš[1,2]

[1]Split Sleep Medicine Center, University of Split School of Medicine, Split, Croatia

[2]Department of Neuroscience, University of Split School of Medicine, Split, Croatia

[3]Department of Neuroscience, University of Mostar School of Medicine, Mostar, Bosnia and Herzegovina

Aim To investigate the effects of the coronavirus disease 2019 (COVID-19) lockdown on sleep habits in the Croatian general population.

Methods In this cross-sectional study, 1173 respondents from the general population (809 women) completed a self-report online questionnaire that gathered demographic data and data on sleep habits and mood changes before and during the COVID-19 lockdown.

Results During the lockdown, bedtime (from 23:11 ± 1:07 to 23:49 ± 1:32 h, $P < 0.001$) and waketime were delayed (from 6:51 ± 1:09 to 7:49 ± 1:40 h, $P < 0.001$). Sleep latency increased from 10 (5-20) to 15 (10-30) minutes ($P < 0.001$). Bedtime and waketime delays were more pronounced in women and respondents younger than 30. Compared with other age groups, respondents younger than 30 more frequently reported insomnia for the first time during the lockdown and had less frequent night-time awakenings ($P < 0.001$), less common problems falling asleep ($P < 0.001$), less frequently felt calm ($P < 0.001$) and rested ($P < 0.001$), but more frequently felt sadness ($P < 0.001$) and fear ($P = 0.028$).

Conclusion The effect of the lockdown on sleep needs to be better understood. Sleep hygiene education could serve a first-line lifestyle intervention for people in lockdown experiencing sleep disruption.

Correspondence to:
Zoran Đogaš
Department of Neuroscience
University of Split School of Medicine
Šoltanska 2
21000 Split, Croatia
zdogas@gmail.com

Coronavirus disease 2019 (COVID-19) is a new communicable disease with devastating global effects. Its emergence and spread have caused confusion, anxiety, and fear among the general public (1). In Croatia, the first COVID-19 patient was recorded on February 26, 2020. The lockdown was announced on March 19 and lasted until April 27, when a gradual relaxation of restrictions began (2,3). During that period, the epidemic situation in Croatia was relatively favorable, with 2.1 deaths per 100 000 population (according to EDC Europe).

Populations exposed to restrictive measures, especially those related to the COVID-19 pandemic, suffer from negative psychological, emotional, social, and general health consequences (4-13). The increase in anxiety, stress, and depression during the lockdown might disrupt sleep quality and sleep hygiene (14,15). Furthermore, the balance between circadian rhythm and homeostatic sleep pressure might be affected by environmental factors. For example, excessive use of social media before bedtime, especially in the younger population, negatively affects sleep habits and sleep quality, and increases the risk of sleep disorders (16). As stress-related sleep problems might adversely influence health, and as there is a bidirectional relation between emotional and behavioral reactivity and sleep quality (14,17), the effects of lockdown on sleep disturbances need to be assessed. Sleep hygiene and sleep quality are growing public health issues globally, and their importance has been especially evident during the COVID-19 pandemic. Poor sleep tremendously affects human health as it may lead to reduced cognitive and psychomotor performance, emotional impairment, increased fatigue, sympathetic nervous system activation, and blood pressure rise, cortisol secretion alterations, and development of insulin resistance (18,19). Furthermore, high-quality sleep stimulates the immune system, which emphasizes the role of good sleep habits in decreasing the risk for COVID-19 infection (20-22). Therefore, overall sleep quality and sleep habits are important considerations in people who self-isolate or are in lockdown.

Although the epidemic situation during the COVID-19 lockdown in Croatia was very well controlled, strict measures and fear might have affected sleep, behavior, and mood. Considering that evidence from different populations supports the negative effects of such measures on sleep in general (23-27), this study aimed to assess the effects of the COVID-19 lockdown on sleep habits and the development of sleep disorders, especially insomnia, in the Croatian general population. During the lockdown, respondents from Zagreb experienced an earthquake

of magnitude 5.5 on the Richter scale, which might have been a confounding factor.

RESPONDENTS AND METHODS

Respondents

The study enrolled 1173 respondents (809 or 73.7% women). All respondents were adults from the general population of Croatia who had internet access. The exclusion criterion was age younger than 18.

Methods

This cross-sectional, online, questionnaire-based study was carried out from April 25, 2020 to May 5, 2020. The questionnaire was distributed to the investigators' contacts through snowball sampling by e-mails and social media (WhatsApp, Viber, Facebook, and others). The investigators' contacts were asked to share the survey with as many people as possible and to encourage their contacts to share the link further. After accepting to participate in the survey, the respondents were automatically directed to the questionnaire by clicking on the link. Because of the distribution and sampling technique, we were not able to calculate the response rate. The study protocol was approved by the Biomedical Research Ethics Committee of the University of Split, School of Medicine. All study procedures conformed to the ethical principles of the 1964 Declaration of Helsinki and its later amendments.

The online, self-report questionnaire was developed by the investigators using Google forms. The questionnaire included a brief explanation of the study aims and procedures, and three subsets of questions: personal and demographic data (17 questions), sleep habits (26 questions), and mood changes (16 questions) before and during the COVID-19 lockdown in Croatia (28). The demographic data section inquired about the respondents' general characteristics and background (birth, sex, height, weight, current residence, education, and employment status). The sleep habits section inquired about bedtime and waketime, sleep latency, naps, awakenings during the night, difficulties while falling asleep, self-reported insomnia, chronic fatigue, and other sleep-related problems such as snoring, sleep-walking, bruxism, and sleep-talking before and during the lockdown. The total sleep time was calculated as the difference between bedtime and waketime. Sleep latency was self-reported as a response to an open-ended question, expressed in minutes. The sleep habits questionnaire had been previously used in studies published by our

group (16,28,29). In the mood changes sections, the respondents self-assessed calmness, rest, contentment, anxiety, anger, fear, discouragement, and sadness before and during the lockdown on a Likert scale from 1 to 4 (1 – not at all, 2 – somewhat, 3 – moderately, 4 – very much so).

Statistical analysis

The normality of distribution was assessed with a Kolmogorov-Smirnov test and Shapiro-Wilks test. The homogeneity of variances was also assessed. When a deviation from normality was found, parametric analysis was performed if visual inspection following the assessment of the Q-Q plots and distribution plots revealed a distribution close to normal. We assumed that type-I error might be adequately controlled even in skewed populations when having a large sample size. If the same assessment revealed asymmetric data along with a significant test of normality, a Wilcoxon signed-rank test for skewed variables was used for paired samples to assess the change between before and during the COVID-19 lockdown. A *t* test for paired samples was performed when possible according to underlying assumptions. An analysis of variance (ANOVA) was performed to compare continuous variables in different age groups. When homogeneity of variances assumption was violated, a Brown-Forsythe and Welch parameter was calculated, since this parameter is not based on the assumption that all the groups were sampled from populations with equal variances. Differences among specific groups were tested with a *post-hoc* Tukey test. Logistic regression included categorical and continuous variables as predictors. When categorical variables were included in the logistic regression, the first category was used as the reference category. Statistical significance level was set at $P < 0.05$. The statistical analysis was performed with SPSS, version 14 (IBM, Armonk, NY, USA).

RESULTS

Overall, 73.7% of respondents were female, and the average age of the total sample was 42 years (Table 1). The majority of respondents had a master's degree (49.4%) or PhD (12.5%). Overall, 95.6% of respondents were adhering to the lockdown restrictions most of the time or all the time, with the majority of them working from home (41.9%) or in rotating shifts (15.4%).

Shift in sleep patterns during the COVID-19 lockdown

Bedtime was delayed from $23:11 \pm 1:07$ hours before the lockdown to $23:49 \pm 1:32$ hours during the lockdown

($P<0.001$). Waketime was also delayed from $6:51 \pm 1:09$ hours before the lockdown to $7:49 \pm 1:40$ hours during the lockdown ($P<0.001$), with the delay being even than that for bedtime. Sleep latency was increased from 10 (5-20) minutes before the lockdown to 15 (10-30) minutes during the lockdown ($P<0.001$), with a similar increase in women and men (Table 2).

Bedtime and waketime delay was more pronounced in women compared with men (Table 3) and in patients under 30 compared with other age groups. On the other hand, the delay was similar in all age-groups older than 50. Middle-aged population, aged from 30 to 50 years, mostly reported a somewhat smaller bedtime and wake-

TABLE 1. Respondents' demographic characteristics

Characteristics	N (%)
Distribution	
female	809 (73.7)
male	288 (26.3)
Age (median, IQR)	42 (32-52)
male	46 (35-55)
female	42 (31-52)
Body weight (median, IQR)	72 (63-84)
Height (median, IQR)	173 (168-179)
Body mass index (median, IQR)	23.94 (21.71-26.93)
Education	
elementary school	9 (1)
high school	206 (23.4)
college or bachelor's degree	121 (13.7)
master's degree	435 (49.4)
PhD	110 (12.5)
Restrictions	
I don't follow restrictions	5 (0.4)
I follow restrictions occasionally	46 (3.9)
I follow restrictions most of the time	473 (40.3)
I follow all the restrictions	649 (55.3)
Smoking	
no	850 (72.5)
yes	323 (27.5)

TABLE 2. Sleep latency before and during the lockdown in both sexes. Data are presented as median (interquartile range)

	Sleep latency (min)		
	before lockdown	during lockdown	P*
Total sample	10 (5-20)	15 (10-30)	<0.001
Male	10 (5-15)	15 (7.5-30)	<0.001
Female	15 (5-30)	20 (10-30)	<0.001

*Wilcoxon signed-rank test.

time delay when compared with younger respondents (Table 3).

Respondents from Zagreb, who experienced an earthquake during the lockdown, did not differ from other respondents in the frequency of night-time awakenings ($\chi^2=0.433$; $P=0.511$) and difficulties falling asleep ($\chi^2=0.213$; $P=0.644$) before the lockdown. However, during the lockdown they reported more night-time awakenings ($\chi^2=13.405$; $P<0.001$) and difficulties falling asleep ($\chi^2=8.644$; $P=0.003$). They did not report a significantly dif-

ferent shift in bedtime ($P=0.673$) and waketime ($P=0.134$) compared with other respondents.

Newly recognized insomnia patients during the COVID-19 lockdown

Overall, 169 (15.4%) respondents reported having insomnia before the lockdown, whereas 316 (28.8%) reported it during the lockdown. Therefore, 220 respondents during the lockdown self-reported insomnia for the first time. These respondents were younger than other respondents

TABLE 3. Sex differences in change in bedtime and waketime during lockdown

	Mean ± standard deviation	P*
Change in bedtime during the lockdown (bedtime after-bedtime before)		
female	0:40 ± 1:21	0.029
male	0:28 ± 1:12	
Change in waketime during the lockdown (waketime after-waketime before)		
female	0:59 ± 1:26	0.032
male	0:47 ± 1:21	
Change in bedtime during lockdown (bedtime after-bedtime before)		
up to 29 years[†]	1:00 ± 1:01	<0.001
30-39 years[‡]	0:37 ± 1:17	
40-49 years[‡]	0:39 ± 1:04	
50-59 years[§]	0:21 ± 1:04	
above 60 years[¶]	0:11 ± 1:04	
Change in waketime during lockdown (waketime after-waketime before)		
up to 29 years[†]	1:34 ± 1:11	<0.001
30-39 years[**]	1:00 ± 1:20	
40-49 years[‡]	0:55 ± 1:14	
50-59 years[††]	0:36 ± 1:17	
above 60 years[¶]	0:25 ± 1:10	

*T-test for equality of means, equal variances not assumed and ANOVA test was performed. †Significantly different to all other age groups (post-hoc Tukey test).
‡Significantly different to age group up to 29 years and above 60 years (post-hoc Tukey test).
§Significantly different to age group up to 29 years (post-hoc Tukey test).
¶Significantly different to age groups up to 29 years, 30-39 years, 40-49 years (post-hoc Tukey test).
**Significantly different to age group up to 29 years, 50-59 years, and above 60 years (post-hoc Tukey test).
††Significantly different to age group up to 29 years and 30-39 years (post-hoc Tukey test).

TABLE 4. Logistic regression of self-reported first-time insomnia during the lockdown including age and sleep patterns before the lockdown as predictors*

Variables	R²	B	P	Odds ratio	95% confidence interval for exponential value (B)	
					lower	upper
Age	7.3%	-0.018	0.007	0.982	0.970	0.995
Bedtime before lockdown		-0.123	0.121	0.884	0.757	1.033
Waketime before lockdown		0.025	0.746	1.025	0.882	1.192
Problems with night-time awakenings before lockdown*		-0.569	0.048	0.566	0.322	0.996
Frequent problems falling asleep before lockdown*		-0.991	<0.001	0.371	0.230	0.599

*Problems with night-time awakenings before lockdown and frequent problems falling asleep before lockdown coded as 0 – no and 1 – yes.

(39 [28.5-48] years vs 43 [33-54] years; *P*<0.001). Sixty-one respondents self-reported insomnia before but not during the lockdown.

Respondents with newly reported insomnia reported less frequent awakenings (12.7% vs 31.6%, *P*<0.001) and less common problems falling asleep before the lockdown (9.1% vs 19.3%, *P*<0.001) compared with respondents with no change in sleep disturbances (Figures 1 and 2). They did not report having other chronic diseases more often (19.1%) than respondents who reported no change in sleep disturbances (22.4%). Respondents with newly recognized insomnia did not significantly differ from other respondents according to sex (χ^2=2.84, *P*=0.092), education (χ^2=6.49, *P*=0.166), domestic living conditions (χ^2=5.59, *P*=0.349), or working status (χ^2=4.67, *P*<0.198).

During the lockdown, respondents with newly reported insomnia more frequently reported sadness (χ^2=24.011, *P*<0.001) and fear (χ^2=9.093, *P*=0.028), and less frequently reported feeling calm (χ^2=17.724, *P*<0.001) and rested (χ^2=15.862, *P* < 0.001) (Figure 3).

When logistic regression was performed for developing insomnia during the COVID-19 lockdown, an increased odds of developing insomnia during the lockdown was associated with younger age as well as with less common problems with night-time awakenings and less common problems falling asleep before the lockdown (Table 4).

DISCUSSION

In this study, respondents from the general population of Croatia experienced changes in sleeping patterns during the COVID-19 lockdown. Increased sleep latency and a significant delay in bedtime and waketime were reported, with the most pronounced delay in waketime and bedtime in respondents younger than 30 years. A pronounced delay in bedtime and waketime was also more evident in female respondents. An increased odds of self-reporting insomnia for the first time during the COVID-19 lockdown was associated with younger age and less common night-time awakenings, as well as with less common difficulties while falling asleep before the lockdown.

During the COVID-19 pandemic, complex demands are placed on sleep environments and social interactions, disfacilitating high-quality sleep (14). Poor sleep quality during the COVID-19 pandemic was reported worldwide (9,10,23-27). Additionally, sleep patterns shifted and sleep
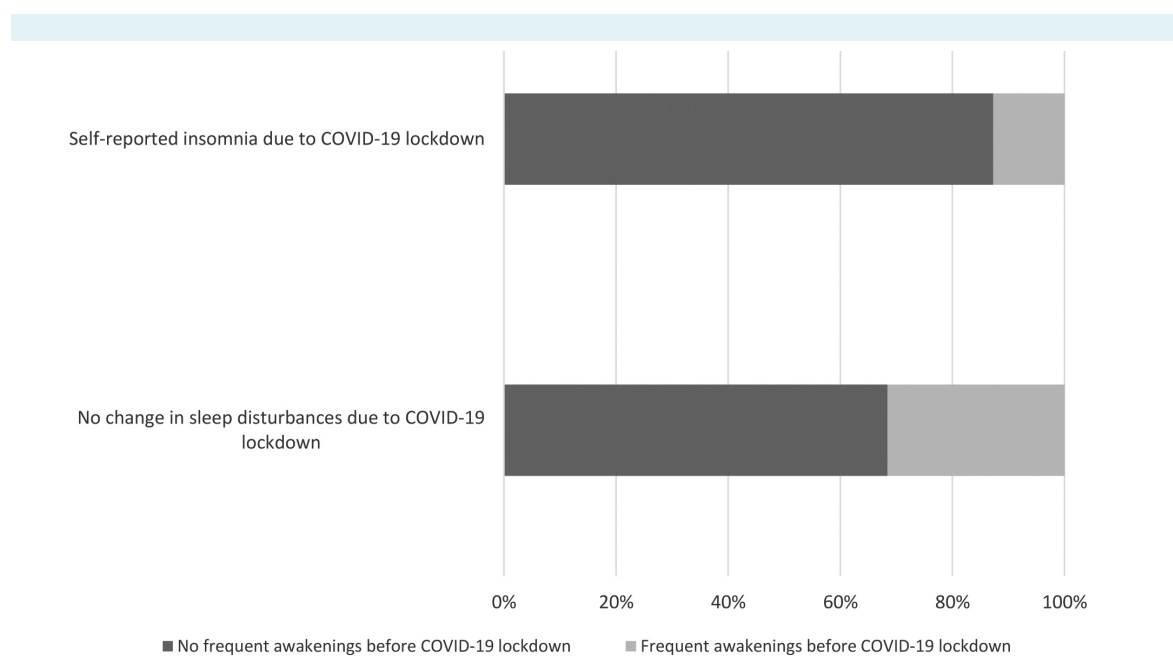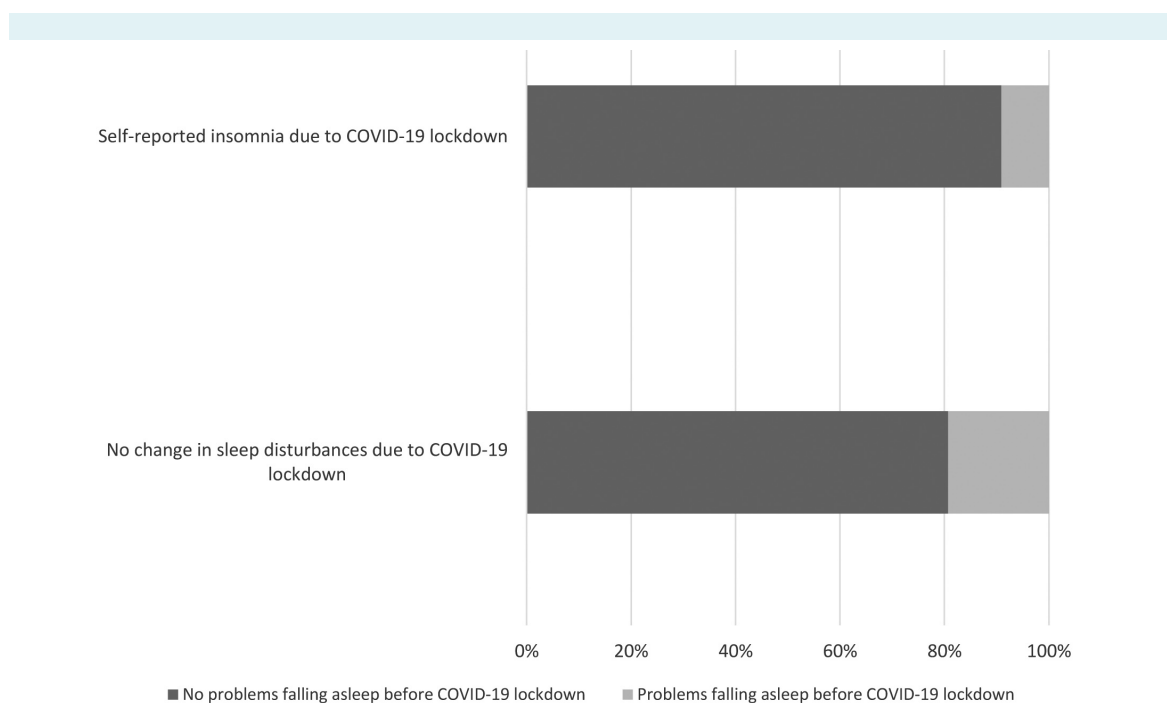

FIGURE 1. The percentage of respondents with self-reported insomnia and those without sleep disturbances due to the coronavirus disease 2019 (COVID-19) lockdown among respondents with and without frequent awakenings before the lockdown.

difficulties increased (30). A major finding of our study was a high prevalence of self-reported insomnia in the Croatian general population.

The onset of insomnia has been related to excessively stressful events (31). The vulnerability to insomnia is further promoted by a perceived intensity of stressfulness and lack of control by the respondent (32). Psychological stress during a lockdown results from social distancing with subsequent emotional behavior such as fear, depression, anxiety, and insomnia (8). Lockdown may be also perceived as a personalized traumatic event considering the reported increase in posttraumatic stress disorder (PTSD) symptoms during lockdown (4). PTSD-related sleep disturbances, such as increased awakenings and decreased slow wave sleep, are well-known (33,34) and frequently observed in insomnia sufferers (35). Furthermore, bedtime stress and worries have contributed to decreased sleep efficiency (36), especially during the COVID-19 outbreak (37). Furthermore, high levels of specific worries and loneliness related to COVID-19 have been associated with clinical levels of depression, anxiety, and PTSD symptoms (38). Having all this in mind, one might speculate that increased sleep latency reported in our study was a result of intrusive stress-related bedtime rumination during the COVID-19 lockdown.

Social distancing and overwhelming stress caused by long-term home confinement disturb a previously established positive balance between workload and home requirements, exercise and relaxation, as well as sleep and wakefulness (14). In our study, younger respondents and those with less common night-time awakenings and difficulties falling asleep before the COVID-19 lockdown had a greater risk of developing insomnia for the first time during the lockdown. This group might include those people who previously had well-established daytime and night-time routines and who successfully balanced individual, social, and environmental demands. However, this balance and routines might have been upset by lockdown-related lifestyle and emotional disturbances, which increased the risk for self-reported insomnia. Furthermore, insomnia is associated with hyperarousal and overall negative mood, with more negative feelings in the evening (39). This agrees with the more frequent reports of sadness and fear of self-reported insomnia sufferers during the lockdown.


FIGURE 2. The percentage of respondents with self-reported insomnia and those without sleep disturbances due to the coronavirus disease 2019 (COVID-19) lockdown among respondents with and without problems falling asleep before the lockdown.

Another major finding of our study was a significant delay in bedtime and waketime during the COVID-19 lockdown, which was most pronounced in respondents under 30 years of age and in women. It remains to be resolved whether the observed shift was affected by the female parental responsibilities and work schedules.

Staying indoors during the day reduces the beneficial effects of natural daytime light exposure on sleep (40), and artificial light suppresses the regular circadian rhythm (40,41). The expanding use of electronic devices that emit blue-light, particularly before bedtime, delays sleep onset, increases sleep latency, alters melatonin secretion and synthesis, and increases alertness (40,41). Therefore, the bedtime shift and prolonged sleep latency observed in our study are not surprising given the restricted opportunities for leaving home during the lockdown and an overall increase in social media use and screen exposure, probably resulting from a need for enhanced social support during the pandemic (14,42,43). The delay in bedtime and waketime during the COVID-19 lockdown was followed by an increased total sleep time, because of a longer shift in waketime rather than bedtime, indicating a pre-existing sleep deprivation, as well as sleep debt. The shift in bedtime and waketime did not differ between the respondents from Zagreb and respondents from other parts of Croatia. However, respondents from Zagreb reported more frequent night-time awakenings and difficulties falling asleep. Sleep disturbances are a pervasive hallmark of natural disaster exposure, emerging in the form of frequent trauma-related disruptive night-time behaviors and decreased sleep quality (44).
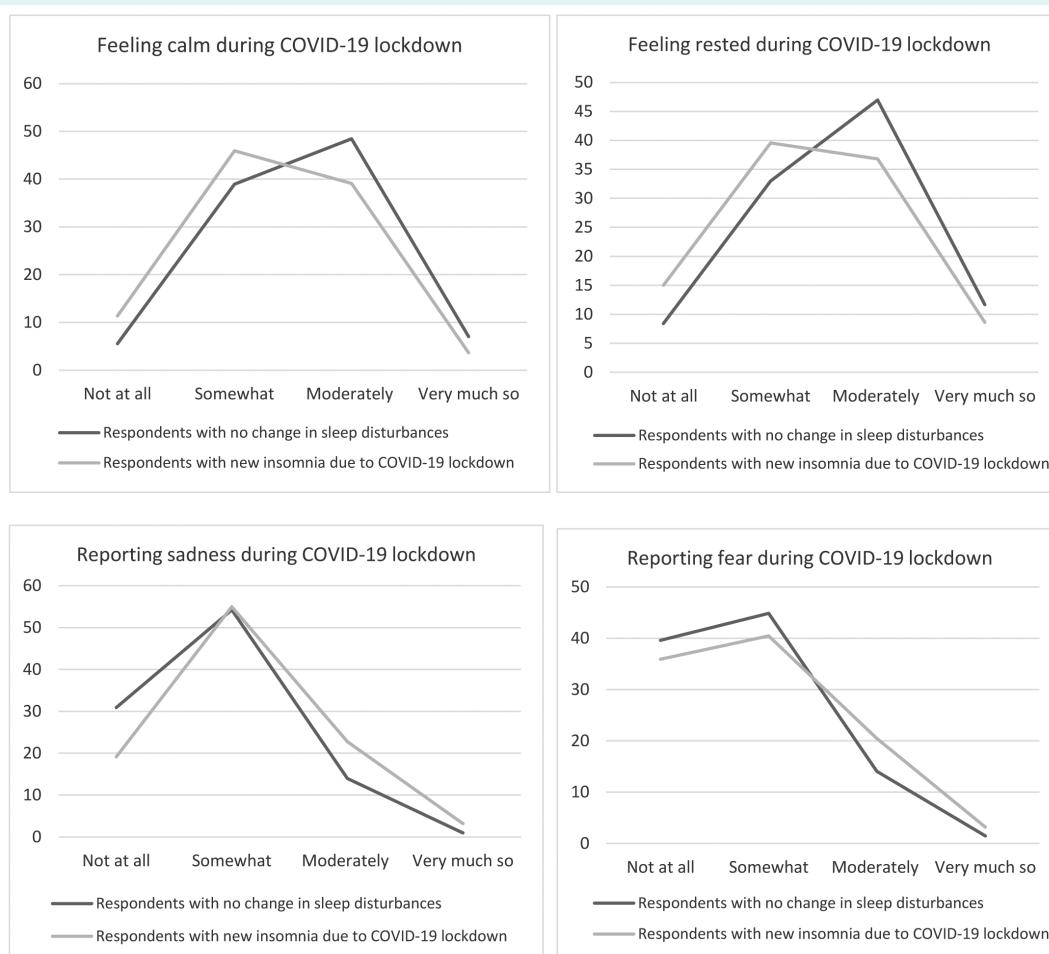
FIGURE 3. Mood assessment in respondents with self-reported first time insomnia during the coronavirus disease 2019 (COVID-19) lockdown compared with respondents with no sleep disturbances.

There are several limitations to our study. The study enrolled only the respondents with internet access. Furthermore, the use of self-report data might have been a source of bias. Given the proportion of women represented (73.7%), as well as a large proportion of highly educated respondents (61.9%), our findings might be less representative of the general population. Women were more likely to voluntarily participate in the current study, and a similar trend was observed in our previous study (16). Furthermore, this study did not assess the prevalence of respondents who tested positive for COVID-19 in the general population. Moreover, during the lockdown, the respondents experienced the spring daylight-saving time transition, which is followed by an increase in sleep latency and sleep fragmentation (45). Still, we believe that the clock change impact was not as long-lasting and strong as the impact of the lockdown itself.

The lockdown burden on sleep needs to be better understood. Sleep hygiene education could serve a first-line lifestyle intervention for people in a lockdown experiencing sleep disruption. Further studies should aim at delivering these interventions to the vulnerable population groups recognized in the current study.

References

1   Anderson RM, Heesterbeek H, Klinkenberg D, Hollingsworth TD. How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet. 2020;395:931-4. Medline:32164834 doi:10.1016/S0140-6736(20)30567-5

2   Government measures; c2022. Available from: https://www.koronavirus.hr/vladine-mjere/101. Accessed: July 30, 2022.

3   Daily new confirmed COVID-19 cases; c2022. Available from: https://ourworldindata.org/. Accessed: July 30, 2022.

4   Hawryluck L, Gold WL, Robinson S, Pogorski S, Galea S, Styra R. SARS control and psychological effects of quarantine, Toronto, Canada. Emerg Infect Dis. 2004;10:1206-12. Medline:15324539 doi:10.3201/eid1007.030703

5   Bai Y, Lin CC, Lin CY, Chen JY, Chue CM, Chou P. Survey of stress reactions among health care workers involved with the SARS outbreak. Psychiatr Serv. 2004;55:1055-7. Medline:15345768 doi:10.1176/appi.ps.55.9.1055

6   Taylor MR, Agho KE, Stevens GJ, Raphael B. Factors influencing psychological distress during a disease epidemic: data from Australia's first outbreak of equine influenza. BMC Public Health. 2008;8:347. Medline:18831770 doi:10.1186/1471-2458-8-347

7   Pellecchia U, Crestani R, Decroo T, Van den Bergh R, Al-Kourdi Y. Social consequences of ebola containment measures in Liberia. PLoS One. 2015;10:e0143036. Medline:26650630 doi:10.1371/journal.pone.0143036

8   DiGiovanni C, Conley J, Chiu D, Zaborski J. Factors influencing compliance with quarantine in Toronto during the 2003 SARS outbreak. Biosecur Bioterror. 2004;2:265-72. Published online 01 15, 2005. Medline:15650436 doi:10.1089/bsp.2004.2.265

9   Huang Y, Zhao N. Generalized anxiety disorder, depressive symptoms and sleep quality during COVID-19 outbreak in China: a web-based cross-sectional survey. Psychiatry Res. 2020;288:112954. Medline:32325383 doi:10.1016/j.psychres.2020.112954

10   Xiao H, Zhang Y, Kong D, Li S, Yang N. The effects of social support on sleep quality of medical staff treating patients with coronavirus disease 2019 (COVID-19) in January and February 2020 in China. Med Sci Monit. 2020;26:e923549. Medline:32132521 doi:10.12659/MSM.923549

11   Francisco R, Pedro M, Delvecchio E, Espada JP, Morales A, Mazzeschi C, et al. Psychological symptoms and behavioral changes in children and adolescents during the early phase of COVID-19 quarantine in three european countries. Front Psychiatry. 2020;11:570164. Medline:33343415 doi:10.3389/fpsyt.2020.570164

12   Coloma-Carmona A, Carballo JL. Predicting PTSS in general population during COVID-19 pandemic: The mediating role of health anxiety. J Affect Disord. 2021;294:329-36. Medline:34311333 doi:10.1016/j.jad.2021.07.032

13   Wielgus B, Urban W, Patriak A, Cichocki L. Examining the associations between psychological flexibility, mindfulness, psychosomatic functioning, and anxiety during the covid-19 pandemic: a path analysis. Int J Environ Res Public Health. 2020;17. Medline:33255758 doi:10.3390/ijerph17238764

14   Altena E, Baglioni C, Espie CA, Ellis J, Gavriloff D, Holzinger B, 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;•••:e13052. Medline:32246787 doi:10.1111/jsr.13052

15   Sher L. COVID-19, anxiety, sleep disturbances and suicide. Sleep Med. 2020;70:124. Medline:32408252 doi:10.1016/j.sleep.2020.04.019

16 Dogas Z, Lusic Kalcina L, Pavlinac Dodig I, Demirovic S, Madirazza K, Valic M, et al. The effect of COVID-19 lockdown on lifestyle and mood in Croatian general population: a cross-sectional study. Croat Med J. 2020;61:309-18. Medline:32881428 doi:10.3325/cmj.2020.61.309

17 Altena E, Micoulaud-Franchi JA, Geoffroy PA, Sanz-Arigita E, Bioulac S, Philip P. The bidirectional relation between emotional reactivity and sleep: from disruption to recovery. Behav Neurosci. 2016;130:336-50. Medline:26866361 doi:10.1037/bne0000128

18 Alhola P, Polo-Kantola P. Sleep deprivation: Impact on cognitive performance. Neuropsychiatr Dis Treat. 2007;3:553-67. Medline:19300585

19 Irish LA, Kline CE, Gunn HE, Buysse DJ, Hall MH. The role of sleep hygiene in promoting public health: A review of empirical evidence. Sleep Med Rev. 2015;22:23-36. Medline:25454674 doi:10.1016/j.smrv.2014.10.001

20 Gamaldo CE, Shaikh AK, McArthur JC. The sleep-immunity relationship. Neurol Clin. 2012;30:1313-43. Medline:23099140 doi:10.1016/j.ncl.2012.08.007

21 Lange T, Dimitrov S, Born J. Effects of sleep and circadian rhythm on the human immune system. Ann N Y Acad Sci. 2010;1193:48-59. Medline:20398008 doi:10.1111/j.1749-6632.2009.05300.x

22 Silva E, Ono B, Souza JC. Sleep and immunity in times of COVID-19. Rev Assoc Med Bras (1992). 2020;66Suppl 2(Suppl 2):143-7.

23 Cox RC, Olatunji BO. Sleep in a pandemic: Implications of COVID-19 for sleep through the lens of the 3P model of insomnia. Am Psychol. 2021. Medline:34138586 doi:10.1037/amp0000850

24 Casagrande M, Favieri F, Tambelli R, Forte G. The enemy who sealed the world: effects quarantine due to the COVID-19 on sleep quality, anxiety, and psychological distress in the Italian population. Sleep Med. 2020;75:12-20. Medline:32853913 doi:10.1016/j.sleep.2020.05.011

25 Blume C, Schmidt MH, Cajochen C. Effects of the COVID-19 lockdown on human sleep and rest-activity rhythms. Curr Biol. 2020;30:R795-7. Medline:32693067 doi:10.1016/j.cub.2020.06.021

26 Gao C, Scullin MK. Sleep health early in the coronavirus disease 2019 (COVID-19) outbreak in the United States: integrating longitudinal, cross-sectional, and retrospective recall data. Sleep Med. 2020;73:1-10. Medline:32745719 doi:10.1016/j.sleep.2020.06.032

27 Kokou-Kpolou CK, Megalakaki O, Laimou D, Kousouri M. Insomnia during COVID-19 pandemic and lockdown: Prevalence, severity, and associated risk factors in French population. Psychiatry Res. 2020;290:113128. Medline:32563951 doi:10.1016/j.psychres.2020.113128

28 Lusic Kalcina L, Pavlinac Dodig I, Pecotic R, Demirovic S, Valic M, Dogas Z. The construction of the Split Sleep Questionnaire on sleep habits during the COVID-19 pandemic in the general population. Croat Med J. 2022;63:299-309. Medline:35722699

29 Valic M, Pecotic R, Lusic L, Peros K, Pribudic Z, Dogas Z. The

relationship between sleep habits and academic performance in dental students in Croatia. Eur J Dent Educ. 2014;18:187-94. Medline:24479578 doi:10.1111/eje.12081

30 Leone MJ, Sigman M, Golombek DA. Effects of lockdown on human sleep and chronotype during the COVID-19 pandemic. Curr Biol. 2020;30:R930-1. Medline:32810450 doi:10.1016/j.cub.2020.07.015

31 Healey ES, Kales A, Monroe LJ, Bixler EO, Chamberlin K, Soldatos CR. Onset of insomnia: role of life-stress events. Psychosom Med. 1981;43:439-51. Published online 10 01, 1981. Medline:7313035 doi:10.1097/00006842-198110000-00007

32 Morin CM, Rodrigue S, Ivers H. Role of stress, arousal, and coping skills in primary insomnia. Psychosom Med. 2003;65:259-67. Medline:12651993 doi:10.1097/01.PSY.0000030391.09558.A3

33 Kim EJ, Dimsdale JE. The effect of psychosocial stress on sleep: a review of polysomnographic evidence. Behav Sleep Med. 2007;5:256-78. Medline:17937582 doi:10.1080/15402000701557383

34 Kobayashi I, Boarts JM, Delahanty DL. Polysomnographically measured sleep abnormalities in PTSD: a meta-analytic review. Psychophysiology. 2007;44:660-9. Medline:17521374 doi:10.1111/j.1469-8986.2007.537.x

35 Pigeon WR, Perlis ML. Sleep homeostasis in primary insomnia. Sleep Med Rev. 2006;10:247-54. Medline:16563817 doi:10.1016/j.smrv.2005.09.002

36 Akerstedt T, Kecklund G, Axelsson J. Impaired sleep after bedtime stress and worries. Biol Psychol. 2007;76:170-3. Medline:17884278 doi:10.1016/j.biopsycho.2007.07.010

37 Lin LY, Wang J, Ou-Yang XY, Miao Q, Chen R, Liang FX, et al. The immediate impact of the 2019 novel coronavirus (COVID-19) outbreak on subjective sleep status. Sleep Med. 2021;77:348-54. Medline:32593614 doi:10.1016/j.sleep.2020.05.018

38 Liu CH, Zhang E, Wong GTF, Hyun S, Hahm HC. Factors associated with depression, anxiety, and PTSD symptomatology during the COVID-19 pandemic: Clinical implications for U.S. young adult mental health. Psychiatry Res. 2020;290:113172. Medline:32512357 doi:10.1016/j.psychres.2020.113172

39 Buysse DJ, Thompson W, Scott J, Franzen PL, Germain A, Hall M, et al. Daytime symptoms in primary insomnia: A prospective analysis using ecological momentary assessment. Sleep Med. 2007;8:198-208. Medline:17368098 doi:10.1016/j.sleep.2006.10.006

40 Potter GD, Skene DJ, Arendt J, Cade JE, Grant PJ, Hardie LJ. Circadian rhythm and sleep disruption: causes, metabolic consequences, and countermeasures. Endocr Rev. 2016;37:584-608. Medline:27763782 doi:10.1210/er.2016-1083

41 Chang AM, Aeschbach D, Duffy JF, Czeisler CA. Evening use of light-emitting eReaders negatively affects sleep, circadian timing, and next-morning alertness. Proc Natl Acad Sci U S A. 2015;112:1232-7. Medline:25535358 doi:10.1073/pnas.1418490112

42 Cellini N, Canale N, Mioni G, Costa S. Changes in sleep pattern,

sense of time and digital media use during COVID-19 lockdown in Italy. J Sleep Res. 2020;29. Medline:32410272 doi:10.1111/jsr.13074

43 Chesterman A, de Battista M, Causse E. Effects of social position and household affordances on COVID-19 lockdown resilience and coping. J Environ Psychol. 2021;78:101687. Medline:34584327 doi:10.1016/j.jenvp.2021.101687

44 Tempesta D, Curcio G, De Gennaro L, Ferrara M. Long-term impact of earthquakes on sleep quality. PLoS One. 2013;8:e55936. Medline:23418478 doi:10.1371/journal.pone.0055936

45 Harrison Y. The impact of daylight saving time on sleep and related behaviours. Sleep Med Rev. 2013;17:285-92. Medline:23477947 doi:10.1016/j.smrv.2012.10.001