Changes in sleep patterns of college students in Israel during COVID-19 lockdown, a sleep diaries study.

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Abstract

Objective

To prevent and reduce the spread of COVID-19, governments around the world apply social restrictions and lockdowns. Such lockdowns significantly alter daily routine and habits. A growing body of research indicates that lockdowns affect sleep and circadian rhythms. The current study further explores that effect using sleep logs for a relatively long duration including lockdown and post-lockdown periods in Israel.

Methods

For five consecutive weeks, both during lockdown and during post-lockdown periods, from March 13th 2020 to May 12th 2020, Israeli students were asked to fill out daily sleep logs in which they report their sleep and wake times. The participants were also asked to fill out the Morningness-Eveningness Questionnaire (MEQ) in the beginning of the study.

Results

Data show increase in sleep duration and a later midsleep point during lockdown, compared to post-lockdown periods, both on workdays and on weekends. An interaction between chronotype and lockdown are also observed; Morning types sleep more both during lockdown and during post-lockdown periods. Interestingly, the midsleep point of late chronotypes is later during both workdays and weekends even during lockdown when social constraints on sleep time are in part removed.

Discussion

Overall, the current results based on detailed and relatively long-term sleep logs analysis confirm previous work using more limited measures such as one-time questionnaires. A lockdown period affects sleep-wake behavior: during lockdown people sleep duration is increased and their sleep onset is delayed. Nevertheless, the circadian preference of individuals is conserved across conditions.

1.0 Introduction

The outbreak of the global COVID-19 pandemic has altered the world in many ways with many countries imposing lockdowns and social distancing rules as a mean to prevent the spread of the disease (Coibion, Gorodnichenko, & Weber, 2020). A lockdown situation induces a considerable change in our schedules including when and where we work, study and sleep (Cellini, Canale, Mioni, & Costa, 2020). A recent meta-analysis indicates an increase in sleep duration during lockdowns with a mean increase of 26.4 ± 21.1 minutes (Stukalin, Lan, Kronfeld-Schor, Shmueli, & Einat, 2021).

One factor that may interact with the effects of lockdown on circadian sleep-wake behavior is the individual chronotype. Chronotypes describe the sleep/wake timing preference of individuals relative to the population. Regarding timing of sleep, early chronotypes prefer to wake up early in the morning and go to bed early at night, while late chronotypes prefer to wake up late in the morning (or noon) and go to sleep late at night or early morning. Most of the population is somewhere in-between (Roenneberg & Merrow, 2016). A large number of studies explored the effects of chronotypes on many behavioral and biological variables. The general findings of these studies are that people with late chronotypes tend to sleep less, perform worse in multiple tasks and be less healthy compared with individuals with early or intermediate chronotypes (Han & Chung, 2020; Hug, Winzeler, Pfaltz, Cajochen, & Bader, 2019; Makarem, Paul, Giardina, Liao, & Aggarwal, 2020; Partonen, 2015; Taylor & Hasler, 2018; Yu et al., 2015). It is suggested that late chronotype individuals need to adapt to the standard social clock, whether it is school or work hours, an adaptation that results in a constant disturbance to their innate timing preferences and many times leads to chronic sleep deprivation, which negatively affects health (Hofman, 2007). This misalignment can be easily demonstrated by the differences between sleep times and duration during work days and weekends in late chronotypes, and is described in the literature as “social jet lag” (SJL) (Wittmann, Dinich, Merrow, & Roenneberg, 2006).

We suggest that the changes to sleep patterns induced by the COVID-19 lockdowns may interact with chronotypes. Accordingly, the current study utilizes sleep diaries of college students to explore differential effects of lockdowns on individuals with different chronotypes. In the present study, Israeli students were asked to fill out daily sleep logs in which they report their sleep and wake times for five consecutive weeks that include a lockdown period and a post-lockdown period, and the results were compared between different chronotypes.

2.0 Materials And Method

2.1 Participants

Ninety one (91) undergraduate college students (74 women and 17 men, mean $\pm$ SEM for age = 25 ± 0.4 , age range 19–53) from the Tel-Aviv-Yaffo Academic College (Tel-Aviv, Israel) volunteered for this five-week long study which started on March 13th 2020 and ended on May 12th 2020. Participants filled out daily sleep logs and completed the Morningness-Eveningness questionnaire (MEQ) (Horne & Ostberg, 1976). Demographic information, including age, gender, employment status and living conditions were also collected. For analysis purposes, we considered two time periods in the study: (1) A lockdown period: March 13th to March 25th (2) a post-lockdown period: March 26th to May 12th (specific restrictions for the lockdown period are detailed below). Procedures used in this study were approved by the ethics committee at Tel-Aviv-Yaffo Academic College (protocol 2020058) and participants signed an informed consent form at the beginning of the study.

2.2 Instruments

2.2.1 Sleep logs: Participants were instructed to fill sleep logs every morning, immediately after they woke up. A daily reminder was sent at 12:00 PM using a WhatsApp group message to participants' cellular phones. In the sleep logs, participants reported the time they went to sleep and the time they woke up.

2.2.2 Morningness-Eveningness Questionnaire (MEQ): Morningness-eveningness preference was assessed with the Hebrew version of the MEQ questionnaire (Horne & Ostberg, 1976). The questionnaire includes 19 auto-evaluating questions with a total score ranging from 16 to 86. The higher the score the more morning oriented the person is. The global score was converted to a three levels scale: Morning type (50–86), intermediate type (43–49), evening type (16–42). For the analysis of chronotypes, we compared the extreme groups alone, omitting the intermediate types.

2.3 Statistical analysis

Data for each measure were averaged for each time-period (lockdown and post-lockdown) either for the entire population or separately for each gender and for workdays and weekends. A mixed ANOVA was used to test the interaction between chronotypes and lockdown with chronotype as a main factor and time-period (lockdown and post-lockdown) as repeated measure factor. Further analysis also included gender as a main factor. Data were separately analyzed for workdays and weekends. Significant results were followed by Bonferroni post-hoc analysis. Paired students' t-tests were used to compare lockdown to post lockdown times for the entire population.

3.0 Results

3.1 Analysis of the entire cohort: For the entire cohort we found a significant reduction in sleep duration from lockdown to post-lockdown period for workdays [Table 1; paired t-test $t(74) = 3.44$, $p = 0.001$] and weekends [Table 1; $t(74) = 2.47$, $p = 0.016$]. Midsleep time was later during lockdown compared with post-lockdown for workdays [Table 1, $t(74) = 6.29$, $p < 0.001$] and weekends [$t(74) = 4.51$, $p < 0.001$]. Interestingly, lockdown had no effects on social jetlag [$t(74) = 1.36$, $p = 0.18$].

Table 1
sleep measures for the entire cohort (mean $\pm$ SEM)

	Lockdown	No-lockdown	Statistics
Sleep duration – workdays (min)	474.2 $\pm$ 5.02	456.7 $\pm$ 5.82	$t(74) = 3.44$, $p = 0.001$
Sleep duration – weekends (min)	503.5 $\pm$ 5.7	489.9 $\pm$ 6.5	$t(74) = 2.47$, $p = 0.016$
Midsleep point – workdays (time)	5:39 $\pm$ 0:05	5:10 $\pm$ 0:04	$t(74) = 6.29$, $p < 0.001$
Midsleep point – weekends (time)	6:04 $\pm$ 0:05	5:41 $\pm$ 0:05	$t(74) = 4.51$, $p < 0.001$

3.2 Analysis of chronotypes: A mixed ANOVA was used to test the interaction between chronotypes and lockdown. There was a significant effect of lockdown and chronotype on sleep duration during workdays: Lockdown effect [$F(1,44) = 5.49$, $p = 0.02$]; Chronotype effect [$F(1,44) = 3.88$, $p = 0.05$; Lockdown X

Chronotype interaction [$F(1,44) = 1.481, p = 0.23$]. In general, participants slept more during lockdown compared to a post-lockdown period, and morning types slept more than evening types (Table 2). These effects were not demonstrated during weekends: Lockdown effect [$F(1,44) = 3.1, p = 0.085$]; Chronotype effect [$F(1,44) = 0.55, p = 0.046$]; Lockdown X Chronotype interaction [$F(1,44) = 0.34, p = 0.56$].

Table 2
sleep duration workdays - lockdown and
chronotype interaction

	Lockdown	Post-lockdown
Morning	480.6 ± 44.5	473.7 ± 47.5
Evening	462.9 ± 46.4	440.8 ± 54.3

Similarly, when testing the entire cohort, there was a significant correlation between sleep duration and MEQ during workdays during lockdown [$r = 0.23, p = 0.04$] and post-lockdown [$r = 0.305, p = 0.01$] but no such correlation was demonstrated during weekends [for lockdown: $r = 0.055, p = 0.63$, for post-lockdown $r = 0.15, p = 0.24$]. Early chronotype correlated with longer sleep duration on weekdays, both during lockdown and on a post-lockdown time.

3.3 Chronotypes and midsleep point: Midsleep point was later for late chronotypes compared with early chronotypes and was later during lockdown compared with post-lockdown periods (Table 3). For workdays: Lockdown effect – $F(1,44) = 28.68, p < 0.001$; chronotype effect – $F(1,44) = 22.4, p < 0.001$, interaction: $F(1,44) = 0.2, p = 0.68$. For weekends: lockdown effect – $F(1,44) = 11.87, p < 0.001$; chronotype effect – $F(1,44) = 24.05, p < 0.001$; interaction – $F(1,44) = 0.12, p = 0.73$.

Table 3
midsleep point - lockdown and chronotype
(hour:minutes)

	Lockdown	Post-lockdown
morning - workdays	5:05 ± 0:34	4:35 ± 0:25
evening-workdays	6:24 ± 0:42	5:05 ± 0:38
morning - weekends	5:23 ± 0:35	5:00 ± 0:37
evening - weekends	6:55 ± 0:45	6:28 ± 0:42

3.4 Sleep duration and gender: A mixed ANOVA was used to test the interaction between gender and lockdown on sleep duration (Table 4). For workdays, the results of the ANOVA show significant effect of lockdown [$F(1,73) = 6.2, p = 0.015$] but no effects of gender [$F(1,73) = 1.55, p = 0.22$] and no interaction [$F(1,73) = 0.07, p = 0.79$]. A different outcome was shown for weekends with no significant effect (albeit a non-significant trend) of lockdown [$F(1,73) = 2.83, p = 0.096$] but a significant effect for gender with women sleeping more than men [$F(1,73) = 6.37, p = 0.014$] and no interaction [$F(1,73) = 0.13, p = 0.72$].

Table 4
sleep duration - lockdown and gender

	Lockdown	Post-lockdown
Women – workdays	477.4 ± 42.8	459.2 ± 50.0
Men-workdays	460.3 ± 45.5	445.7 ± 52.8
Women – weekends	510.4 ± 46.2	495.7 ± 53.1
Men – weekends	473.7 ± 54.1	464.2 ± 64.9

3.5 Midsleep point and gender: Midsleep point for women was later than for men during lockdown for both workdays and weekends but this difference disappeared in the post-lockdown period. For workdays, lockdown effect $F(1,73) = 12.4$, $p < 0.001$; gender effect $F(1,73) = 0.66$, $p = 0.42$; interaction $F(1,73) = 6.04$, $p = 0.016$; post-hoc: women lockdown $\neq$ women no-lockdown ($p < 0.001$); women lockdown $\neq$ men lockdown ($p = 0.041$). For weekends, lockdown effect $F(1,73) = 4.6$, $p = 0.035$; gender effect $F(1,73) = 1.58$, $p = 0.21$; interaction $F(1,73) = 5.56$, $p = 0.021$; post-hoc: women lockdown $\neq$ women no-lockdown ($p < 0.001$); women lockdown $\neq$ men lockdown ($p = 0.024$).

4.0 Discussion

A significant number of studies regarding COVID-19 related to the effects of social restrictions and lockdowns on well-being were published since the COVID-19 pandemic interfered with the life of most people in the world. From these studies, quite a few evaluated measures related to sleep and circadian rhythms (Cellini et al., 2020; Gupta et al., 2020; Leone, Sigman, & Golombek, 2020; Ong et al., 2021; Oved et al., 2021; Robbins et al., 2021; Romero-Blanco et al., 2020; Sun et al., 2020; Trakada et al., 2020; Wright et al., 2020). However, most explored these questions using surveys and questionnaires administered once or twice. Only a few studies utilized continuous data collection whether with sleep logs (Robbins et al., 2021; Wright et al., 2020) or wearable devices (Ong et al., 2021; Oved et al., 2021; Sun et al., 2020). In the current study we used a well-practiced, albeit quite demanding, method to follow sleep in a cohort of college students- sleep logs for a relatively long period. Sleep logs have been used in sleep research as well as clinical practice for many years and are considered a highly reliable method. Yet, the use of sleep logs demands high level of cooperation from subjects and therefore many studies prefer other methods. For five consecutive weeks, which included lockdown and post-lockdown periods, students were asked to fill out daily sleep logs in which they reported their sleep and wake times. Up to now, to the best of our knowledge, sleep logs were used to investigate the effects of lockdowns on sleep-wake behavior in only two published studies (Robbins et al., 2021; Wright et al., 2020). In the first participants filled out sleep logs for one week before lockdown and three months later for another week during lockdown, and in the second, participants used a smartphone sleep app. In the current study, participants filled out sleep logs every day for five consecutive weeks, therefore allowing the exploration of continuous changes and the transitions over time in sleep timing. We suggest that the current study presents a more accurate evaluation of sleep variables compared with other studies.

Despite the differences in methodology, it appears that the current results are in agreement with recent studies using surveys and questionnaires (Blume, Schmidt, & Cajochen, 2020; Leone et al., 2020; Ong et al., 2021; Papazisis, Nikolaidis, & Trakada, 2021; Tahara et al., 2021; Wright et al., 2020) and clearly show an increase in sleep duration and later midsleep point during lockdown periods. Interestingly, both during lockdown and post-lockdown periods, individuals with early chronotypes maintained longer sleep duration compared with late chronotype during workdays. This difference between the groups disappeared during weekends. These findings may suggest that despite the lockdown, the schedules of the subjects were not completely flexible, and that they may still have reasons to wake up at specific times, possibly to attend online courses or for essential work.

Both lockdown and chronotype had significant effects on midsleep point, with later point in late chronotype individuals and later point during lockdown. Recent studies showed that in general people maintain their circadian preference during lockdowns, despite the significant change in social schedules and in light exposure (Blume et al., 2020; Leone et al., 2020; Oved et al., 2021). This suggests that even when social constraints are at least in part removed, the behavioral manifestations of chronotype are preserved.

While some studies indicated a reduction in social jetlag (SJL) during lockdown, especially in late chronotypes (Blume et al., 2020; Leone et al., 2020; Ong et al., 2021; Tahara et al., 2021; Wright et al., 2020), we did not find such an effect. Overall, the SJL found in our study was relatively small compared to other studies. This difference can be easily explained as our entire research was conducted during COVID-19 restrictions, and all our participants were students that did not have to physically attend classes during the time of the study as all courses were given online.

Our results indicate some gender differences: Women in our cohort slept more than men during workdays. This is in line with a growing body of literature that found that on average women sleep more than men (Burgard & Ailshire, 2013; Cellini et al., 2021). It was hypothesized that women sleep duration is longer as a compensation for lower sleep quality. Indeed it was found that on average, sleep quality of women is lower compared to men (Shim & Kang, 2017), and this gender difference was reported even during lockdown (Cellini et al., 2021).

Overall, our results using detailed and relatively long-term sleep logs analysis confirm previous work using more limited measures, such as one-time surveys. A lockdown period affected sleep-wake behavior: during lockdown sleep duration is increased and sleep onset is delayed. Nevertheless, the circadian preference is maintained.

Declarations

Competing interests: The authors declare no competing interests.

References

Blume, C., Schmidt, M. H., & Cajochen, C. (2020). Effects of the COVID-19 lockdown on human sleep and rest-activity rhythms. *Curr Biol.*, 30(14), R795-R797. doi: 10.1016/j.cub.2020.1006.1021. Epub 2020 Jun 1010.

Burgard, S. A., & Ailshire, J. A. (2013). Gender and Time for Sleep among U.S. Adults. *Am Sociol Rev.*, 78(1), 51–69. doi: 10.1177/0003122412472048.

Cellini, N., Canale, N., Mioni, G., & Costa, S. (2020). Changes in sleep pattern, sense of time and digital media use during COVID-19 lockdown in Italy. *J Sleep Res.*, 29(4), e13074. doi: 10.1111/jsr.13074. Epub 2020 May 13015.

Cellini, N., Conte, F., De Rosa, O., Giganti, F., Malloggi, S., Reynt, M.,... . Ficca, G. (2021). Changes in sleep timing and subjective sleep quality during the COVID-19 lockdown in Italy and Belgium: age, gender and working status as modulating factors. *Sleep Med.*, 77:112–119.(doi), 10.1016/j.sleep.2020.1011.1027. Epub 2020 Dec 1013.

Coibion, O., Gorodnichenko, Y., & Weber, M. (2020). The Cost of the Covid-19 Crisis: Lockdowns, Macroeconomic Expectations, and Consumer Spending. USA: National Bureau of Economic Research.

Gupta, R., Grover, S., Basu, A., Krishnan, V., Tripathi, A., Subramanyam, A.,... . Avasthi, A. (2020). Changes in sleep pattern and sleep quality during COVID-19 lockdown. *Indian J Psychiatry.*, 62(4), 370–378. doi: 10.4103/psychiatry.IndianJPsychiatry_4523_4120. Epub 2020 Jul 4127.

Han, C. H., & Chung, J. (2020). Late Chronotype is Associated with Adolescent Asthma: Assessment Using the Korean-Version MCTQ. *Int J Environ Res Public Health.*, 17(9), 3000. doi: 10.3390/ijerph17093000.

Hofman, W. F. (2007). Do adolescent evening types sleep less. In A. L. Bammel van, D. G. M. Beersma, H. Folgering, W. F. Hofman & G. S. F. Ruit (Eds.), *Sleep wake research in the Netherlands* (11 ed., pp. 67–70): Dutch Society Sleep wake research.

Horne, J. A., & Ostberg, O. (1976). A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. *Int J Chronobiol.*, 4(2), 97–110.

Hug, E., Winzeler, K., Pfaltz, M. C., Cajochen, C., & Bader, K. (2019). Later Chronotype Is Associated with Higher Alcohol Consumption and More Adverse Childhood Experiences in Young Healthy Women. *Clocks Sleep.*, 1(1), 126–139. doi: 10.3390/clockssleep1010012. eCollection 1012019 Mar.

Leone, M. J., Sigman, M., & Golombek, D. A. (2020). Effects of lockdown on human sleep and chronotype during the COVID-19 pandemic. *Curr Biol.*, 30(16), R930-R931. doi: 10.1016/j.cub.2020.1007.1015. Epub 2020 Jul 1018.

Makarem, N., Paul, J., Giardina, E. V., Liao, M., & Aggarwal, B. (2020). Evening chronotype is associated with poor cardiovascular health and adverse health behaviors in a diverse population of women.

Chronobiol Int., 37(5), 673–685. doi: 610.1080/07420528.07422020.01732403. Epub 07422020 Mar 07420524.

Ong, J. L., Lau, T., Massar, S. A. A., Chong, Z. T., Ng, B. K. L., Koek, D.,... . Chee, M. W. L. (2021). COVID-19-related mobility reduction: heterogenous effects on sleep and physical activity rhythms. *Sleep.*, 44(2), zsaa179. doi: 110.1093/sleep/zsaa1179.

Oved, S., Mofaz, M., Lan, A., Einat, H., Kronfeld-Schor, N., Yamin, D., & Shmueli, E. (2021). Differential effects of COVID-19 lockdowns on well-being: interaction between age, gender and chronotype. *J R Soc Interface.*, 18(179), 20210078. doi: 20210010.20211098/rsif.20212021.20210078. Epub 20212021 Jun 20210072.

Papazisis, Z., Nikolaidis, P. T., & Trakada, G. (2021). Sleep, Physical Activity, and Diet of Adults during the Second Lockdown of the COVID-19 Pandemic in Greece. *Int J Environ Res Public Health.*, 18(14), 7292. doi: 7210.3390/ijerph18147292.

Partonen, T. (2015). Chronotype and Health Outcomes. *Current Sleep Medicine Reports*, 1, 205–211.

Robbins, R., Affouf, M., Weaver, M. D., Czeisler, M., Barger, L. K., Quan, S. F., & Czeisler, C. A. (2021). Estimated Sleep Duration Before and During the COVID-19 Pandemic in Major Metropolitan Areas on Different Continents: Observational Study of Smartphone App Data. *J Med Internet Res.*, 23(2), e20546. doi: 20510.22196/20546.

Roenneberg, T., & Merrow, M. (2016). The Circadian Clock and Human Health. *Curr Biol.*, 26(10), R432-443. doi: 410.1016/j.cub.2016.1004.1011.

Romero-Blanco, C., Rodríguez-Almagro, J., Onieva-Zafra, M. D., Parra-Fernández, M. L., Prado-Laguna, M. D. C., & Hernández-Martínez, A. (2020). Sleep Pattern Changes in Nursing Students during the COVID-19 Lockdown. *Int J Environ Res Public Health.*, 17(14), 5222. doi: 5210.3390/ijerph17145222.

Shim, J., & Kang, S. W. (2017). Behavioral Factors Related to Sleep Quality and Duration in Adults. *J Lifestyle Med.*, 7(1), 18–26. doi: 10.15280/jlm.12017.15287.15281.15218. Epub 12017 Jan 15231.

Stukalin, Y., Lan, A., Kronfeld-Schor, N., Shmueli, E., & Einat, H. (2021). *Sleep duration during COVID-19 lockdown: systematic review and meta-analysis.* (rs-778956/v1). ResearchSquare.

Sun, S., Folarin, A. A., Ranjan, Y., Rashid, Z., Conde, P., Stewart, C.,... . Dobson, R. J. (2020). Using Smartphones and Wearable Devices to Monitor Behavioral Changes During COVID-19. *J Med Internet Res.*, 22(9), e19992. doi: 19910.12196/19992.

Tahara, Y., Shinto, T., Inoue, K., Roshanmehr, F., Ito, A., Michie, M., & Shibata, S. (2021). Changes in sleep phase and body weight of mobile health App users during COVID-19 mild lockdown in Japan. *Int J Obes*, 3, 1–4.

Taylor, B. J., & Hasler, B. P. (2018). Chronotype and Mental Health: Recent Advances. *Curr Psychiatry Rep.*, 20(8), 59. doi: 10.1007/s11920-11018-10925-11928.

Trakada, A., Nikolaidis, P. T., Andrade, M. D. S., Puccinelli, P. J., Economou, N. T., Steiropoulos, P.,... . Trakada, G. (2020). Sleep During "Lockdown" in the COVID-19 Pandemic. *Int J Environ Res Public Health.*, 17(23), 9094. doi: 9010.3390/ijerph17239094.

Wittmann, M., Dinich, J., Merrow, M., & Roenneberg, T. (2006). Social jetlag: misalignment of biological and social time. *Chronobiol Int.*, 23(1–2), 497–509. doi: 410.1080/07420520500545979.

Wright, K. P., Jr., Linton, S. K., Withrow, D., Casiraghi, L., Lanza, S. M., Iglesia, H.,... . Depner, C. M. (2020). Sleep in university students prior to and during COVID-19 Stay-at-Home orders. *Curr Biol.*, 30(14), R797-R798. doi: 710.1016/j.cub.2020.1006.1022. Epub 2020 Jun 1010.

Yu, J. H., Yun, C. H., Ahn, J. H., Suh, S., Cho, H. J., Lee, S. K.,... . Kim, N. H. (2015). Evening chronotype is associated with metabolic disorders and body composition in middle-aged adults. *J Clin Endocrinol Metab.*, 100(4), 1494–1502. doi: 1410.1210/jc.2014-3754. Epub 2015 Apr 1491.