Report

Türk Fen ve Sağlık Dergisi
Turkish Journal of Science and Health

Volume 2
Number 1
Year 2021
Pages 84-91

ISSN: 2717-7173 https://dergipark.org.tr/tr/pub/tfsd

Received: 11.08.2020 *Accepted:* 01.01.2021

COVID-19 Pandemisinin Türk İnsanlarının Sirkadiyen Ritmine ve Yaşam Kalitesine Etkisi

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ÖZET:
Amaç: Çalışmanın amacı COVID-19 pandemisinin Türkiye'de yaşayan insanların yaşam kalitesine ve uyku profillerine olan etkisini anlamaktır. **Gereç ve Yöntem:** COVID-19 virüsü 2019 yılının Aralık ayında Çin'de raporlanmış ve pandemiye sebep olmuştur. Uluslararası sağlık örgütünün 21 Aralık 2020 haftalık raporuna göre dünya çapında 75 milyondan fazla kişiye COVID-19 teşhisi konulurken, Türkiye için bu rakam 2 milyon 'dur. Bu salgın sırasında insanların günlük yaşamlarında meydana gelen değişiklikler, uyku zamanlarını da değiştirmiştir. Uyku insan hayatının en önemli parçalarından biridir ve sirkadiyen ritim adı verilen mekanizma tarafından kontrol edilmektedir. Bu çalışmada, 1230 birey gönüllü olarak bir ankete katılıp yaşam kaliteleri ve uyuma-uyanma zamanlarının pandemi öncesi ve sonrası durumlarını değerlendirmişlerdir. **Bulgular:** Anket sonuçları analiz edildiğinde, katılımcıların yüzde 65'i yaşam kalitelerinin önemli ölçüde düştüğünü belirtmiştir. Karantina süreci ve kuralları sebebiyle katılımcıların yüzde 82'si fiziksel aktivitelerinde azalma olduğunu bildirmiştir. Uyuma-uyanma zamanları ise COVID-19 öncesi döneme göre daha geniş bir zamana yayılmıştır. Buna ek olarak, iş günleri ve iş olmayan günler arasındaki fark incelendiğinde, bu farkın pandemi sürecinde neredeyse ortadan kalktığı gözlenmiştir. Bu sonuç da evden okuma ve evden çalışma süreçlerinin katılımcıların uyku düzenlerini duvar saatine göre değil, bireysel vücut saatlerine göre düzenlediklerini göstermektedir. **Sonuç:** COVID-19 ile yaşam kalitesi düşmesine rağmen, karantina süreci bireylerin günlük yaşamlarını kendi vücut saatlerine göre ayarlayabilmelerine olanak sağlamıştır. Bu görece küçük çaplı anket bile toplumun biyolojik saatinin ve yaşam kalitesinin pandemi sebebiyle değiştiğini ve otoritelerin normale dönüş sürecinde bunu göz önünde bulundurmaları gerektiğini belirtmeye yetmiştir.
Anahtar Kelimeler: *Sirkadiyen ritim, uyku, COVID-19*

Effects of COVID-19 on circadian clock and life quality of the Turkish people

ABSTRACT:
Purpose: Understand the effects of COVID-19 pandemic on life quality and sleeping profile of Turkish people. **Material and Methods:** A pandemic causing virus COVID-19 was first reported China, on December 2019. According to the WHO COVID-19 21 December 2020 weekly report, over 75-million COVID-19 cases were diagnosed worldwide, and 2 million cases were reported from Turkey. During this outbreak, sleeping schedules of people altered due to the dramatic changes in their daily lives. Sleep is one of the most important components of our lives, and it is regulated by a tightly controlled mechanism called circadian clock. In this study, 1230 people participated to a survey about their wellbeing and sleep-wake times before and during the pandemic. **Results:** When the survey results were analyzed, 65 percent of participants indicated that their life quality significantly went down. As the results of quarantine rules, physical activities of 82 percent of the participants reduced significantly. Sleep-wake times are now spread to a wider window compared to before COVID-19. Additionally, workdays versus work-free days difference has gotten smaller with increased working from home situations. These results indicate that, working and studying from home allowed people to plan their sleep according to their body clock, instead of the clock on the wall. **Conclusion:** Although the life quality is reduced, quarantine let people to plan their daily lives based on their chronotype (their own body clock). This relatively small-scale survey indicated that people and the public authorities should consider society's changed biological clocks and wellbeing during their 'back to normal' processes.
Keywords: *Circadian clocks, sleep, COVID-19*

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INTRODUCTION

There have been many coronaviruses which are infectious to animals. The SARS (SARS-CoV) and MERS (MERS-CoV) coronavirus outbreaks showed that coronaviruses can be highly pathogenic to humans, as well as animals (Cui et al., 2019). Both SARS and MERS outbreaks were originated from bats and had some intermediate hosts. In the case of SARS-CoV, the host was market civets, and it was camels for MERS-CoV (Cui et al., 2019). While excessive research is still being conducted by the scientists, genomic sequencing studies indicate bat as the natural host of the COVID-19 (Guo et al., 2020). Although there is no known cure for this infection, affected countries are trying to prevent the spread of the virus by suggesting a list of actions for prevention, such as staying at home, working from home, avoiding unnecessary large gatherings, and most importantly, social distancing and wearing a mask. Many countries have been affected by COVID-19 pandemic for months now, and it had many social and economic consequences for the world. Besides these negative effects, it made a huge impact on people's psychology by changing their daily routines. One of the most important biological processes that regulate our daily lives is circadian clock (Roenneberg and Merrow, 2016).

Circadian clock is a complex system regulating many physiological and behavioral processes in the body (Takahashi, 2016). As a feature of being a complex system, it has both internal (coming from inside of the body) and external (coming from outside of the body) regulators. Sleep (Touitou et al., 2017), glucose and energy metabolisms (Poggiogalle, Jamshed and Peterson, 2018), immune system and stress response (Baxter and Ray, 2019), lipid metabolism (Gooley, 2016) and more are regulated by circadian clock. SCN (suprachiasmatic nucleus) region of the brain is located in the hypothalamus and it is considered as the circadian center of the body (Mohawk et al., 2013). SCN expresses circadian rhythms starting from early embryonic stages (Landgraf et al., 2015). Even SCN is a strong autonomous cycler, light is sensed through the eyes and it entrains the molecular circadian clock in the SCN. Food timing also regulates the clock in the peripheral organs like liver, kidney and adipose tissue (McHill et al., 2017) (Oosterman et al., 2015). Which in turn sends feedback signals to the central clock in the SCN. Similar to food and light, social interactions also affect the body's circadian clock. When the synchrony between the internal and external cues is disrupted, diseases start to appear (Mohawk et al., 2013). Forcing people to work at night disharmonize the synchrony of the circadian clock. This conflict messes the circadian clock of the body, and many systems that regulates (Joseph Bass, 2010). As a result, circadian clock is both endogenous and entrainable system. In society, people are forced to live with fixed time schedules, totally disregarding their internal circadian clock and chronotype. Contrary to the general sense about the circadian clock that everyone needs to sleep and wake up around the same time, the sleep timing in circadian clock can vary between people. Chronotype assesses people's morningness or eveningness. Some people have a tendency to go to bed earlier than the others (the early chronotypes versus the late chronotypes) (Horne and Ostberg, 1976). There have been several genes discovered causing sleep timing or duration changes in humans (Sehgal and Mignot, 2011). With expanded knowledge on genetics of sleep (Hirano et al., 2018) (Pellegrino et al., 2014), we now know that timing and duration of sleep is heterogenous in the society, and that may not match with the fixed working hours (i.e. 9.00 AM-5.00 PM) all the time.

With the COVID-19 pandemic, people started studying/working from home, which actually means they can freely choose their study/work times based on their internal circadian clock regulation. In the current study, 1230 people from Turkey attended an online survey which provided valuable information about how COVID-19 has affected the general wellbeing and sleeping-wake up times of the people.

MATERIAL and METHODS

The survey is prepared in Google Docs in Turkish and the link is provided to the participants through social media. Survey data is collected from April 17 2020 to April 22 2020 when stay at home orders are in place. Every participant agreed to participate in this study before they answered any questions. All 1230 participants' answers about their genders, COVID-19 statuses, life qualities, physical activities, screen

times, sleep quality and daytime naps were analyzed with Graphpad Prism 8 software. Survey answers provided by 1230 participants are firstly divided into two categories based on their employment status before the analysis of their sleeping times. While 1029 people were employed, 201 people were not. Sleeping-wake up times of the participants in each group were plotted as a scatter plot in Graphpad Prism 8 software.

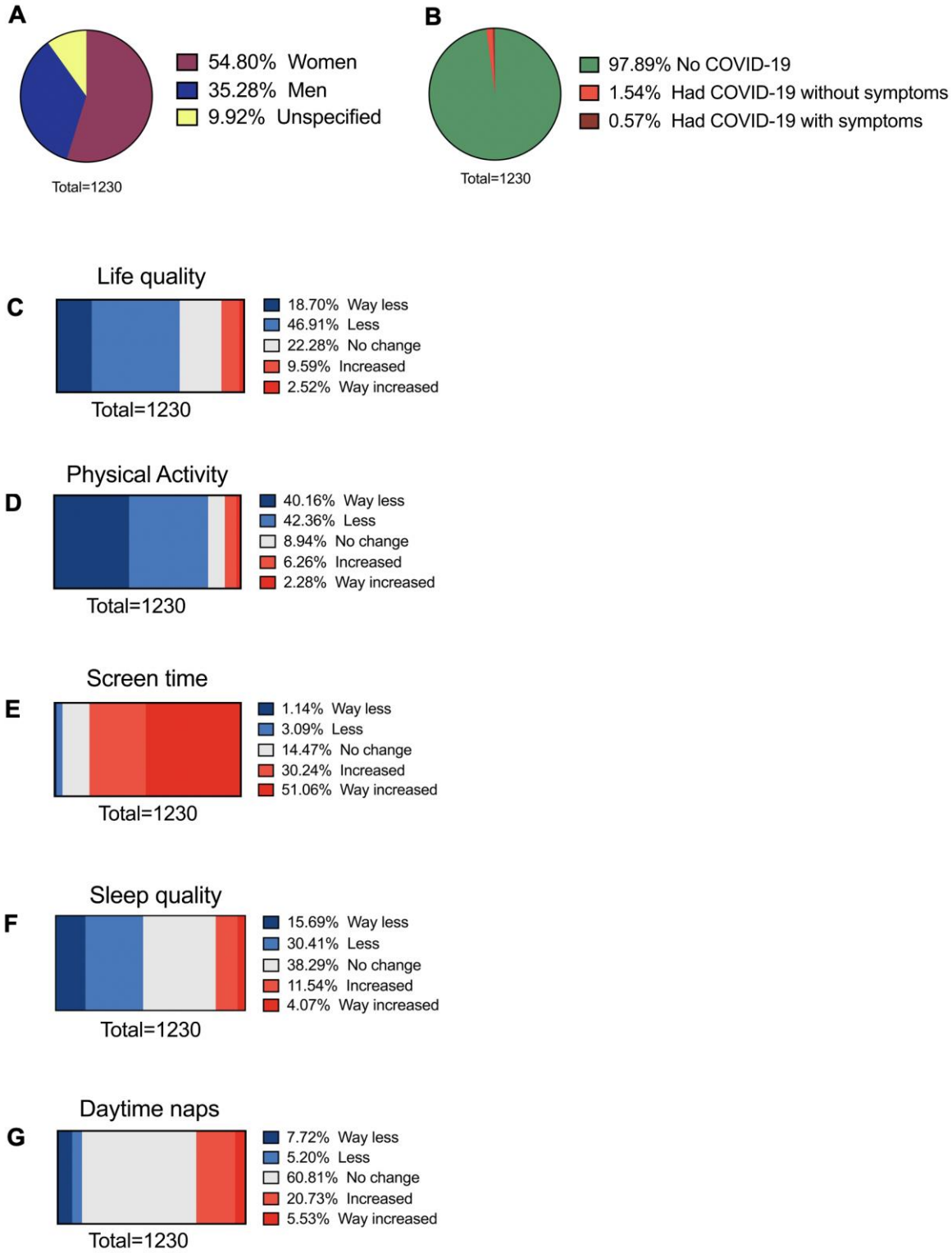

Figure 1. Effects of COVID-19 on general wellbeing of the participants. (A) Genders of the participants indicated by themselves. (B) COVID-19 disease situations of the participants based on their knowledge. Effects of COVID-19 on (C) life quality, (D) physical activity, (E) screen time, (F) sleep quality and (G) daytime naps of the participants.

RESULTS

1. The effects of COVID-19 on people's general wellbeing

1230 survey participants volunteered to answer survey questions. The questions were about their life qualities, screen times, physical activities, sleep quality, and sleep-wake up times. While 54.8% of participants were women, 35.3% were men and 9.9% did not specify their gender (Figure 1A). According to the answers, even 97.89% of the participants has not had COVID-19 (based on their knowledge), pandemic significantly affected a big portion of the participants' lives (Figure 1B). As seen from Figure 1C, 65.61% of all attendees indicated that their life quality less or way less went down with COVID-19 pandemic. As the pandemic kept everyone in their homes and induced working/studying from home, 82.52% of all attendees reported that they were performing fewer physical activities as a result of the pandemic (Figure 1D). In Figure 1E, it is clear that online studying and meetings increased people's screen time significantly. It is also important to note that blue light from cell phones, TVs, tablets, or computer screens can affect the sleep. The participants answered a question about their sleep quality. While 46.1% of them reported reduced sleep quality, only 15.61% of the participants realized an improvement in their sleep quality (Figure 1F). These results clarified that people either have more daytime naps (26.26%) or their daytime nap habits have not changed by COVID-19 pandemic (60.81%) (Figure 1G). All participants are divided into two groups -employed and unemployed- and further analyses are performed according to their answers.

2. COVID-19 changed sleeping-wake up profiles of employed people-especially in the workdays

In this part, we focused on the impact of COVID-19 on the sleeping-wake up profiles of people who were working before the COVID-19. 1029 participants indicated that they were employed before the COVID-19. In this section, the effects of COVID-19 on employed people's sleep-wake up time profiles are analyzed. 52.67% of the employed participants were women, 37.03% were men and 10.3% did not specify their gender (Figure 2A). Over 97% of the employed participants have not had COVID-19 based on their knowledge (Figure 2B). In Figure 2C, 85.23% of the participants in this group are daytime workers, while 11.86% of the participants are working in shifts. Figure 2D shows the effect of COVID-19 on people's employment status. It is important to highlight that 26.92% of the attendees lost their jobs as a result of COVID-19.

In Figure 3, effect of COVID-19 on sleeping and wake up times of employed participants in workdays (when they need to wake up at a specific time) and work-free days (when they wake up according to their chronotype) were analyzed. Figure 3A-left shows the effect of COVID-19 on sleeping times of the people in the workdays. Before COVID-19 pandemic, people sleep between 22:00 and 01:00 (3-hour window). While after COVID-19, the range is much wider, and it is shifted from 23:00 to 04:00 (5-hour window). Figure 3A-right indicates the wake-up times of the same people before and after COVID-19, on workdays. While most of the participants' wake up time in workdays tend to be in a 3-hour window interval before COVID-19, this time interval became wider after COVID-19, and turned out to be a bell-shaped curve with 7-hour window. Work-free days were also analyzed in the study to show the effect of COVID-19 on chronotype of the participants. Figure 3B left and right graphs showed sleeping and wake up times in work-free days, respectively. As COVID-19 changed the sleeping and wake up times profiles in workdays, it only shifted the profiles 1-2 h on work-free days. In conclusion, although there are differences in sleeping and wake up times in the workdays before and after COVID-19, the actual chronotype of people (work-free days phenotype) has not much affected by the pandemic.

In Figure 3C and 3D, the difference between workdays versus work-free days were analyzed before and after COVID-19 pandemic. Figure 3C-left and right mention the working day versus work-free day differences in sleeping time and wake up time before COVID-19. Figure 3D outlines the same, just after COVID-19. These results delineate that before COVID-19, participants were forced to live with fixed time schedules due to fixed 'work hours' even it is different than their internal circadian clock (work-free days profiles) (Figure 3C). On the other hand,

Figure 3D-left shows that sleeping times in workdays and work-free days are strongly overlapping each other after the COVID-19. Similarly, wake up time profiles of workdays and work-free days are more overlapping to each other after COVID-19, compared to before COVID-19 profiles. These indicate that, while there is a big difference between workdays and work-free days before COVID-19, the difference is almost disappeared when people started working/studying from home.

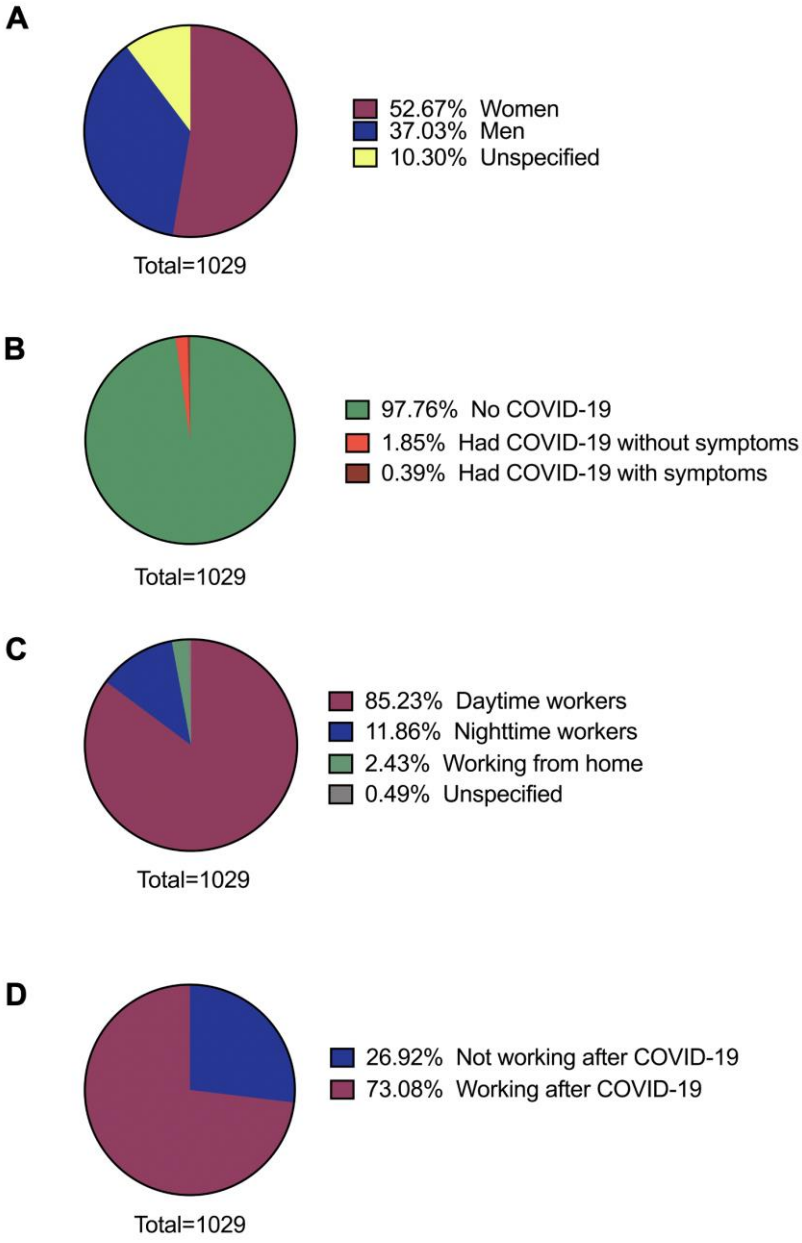

Figure 2. (A) Gender, (B) COVID-19 disease situations of the employed participants. (C) Shifts of the employed participants. (D) Employment status of the participants after the COVID-19.

3. Even unemployed participants' sleeping-wake up times are affected by COVID-19

The second group of participants in this study were the ones who were not employed before COVID-19. This population was not obligated to work or study in their daily routine. The majority of the participants in this group (65.67% in 201 people) were female, and 98.51% of them have not had COVID-19 based on their knowledge (Figure 4A). Figure 4B shows a 2-hour shift in the sleeping and wake up time is detected due to COVID-19. Before COVID-19, there might be working spouses or children seeking education in the household who need help of unemployed spouses/parents in the mornings. The

reason of the chronotype change of unemployed participants might be affected by the disappeared morning needs of the household during the pandemic.

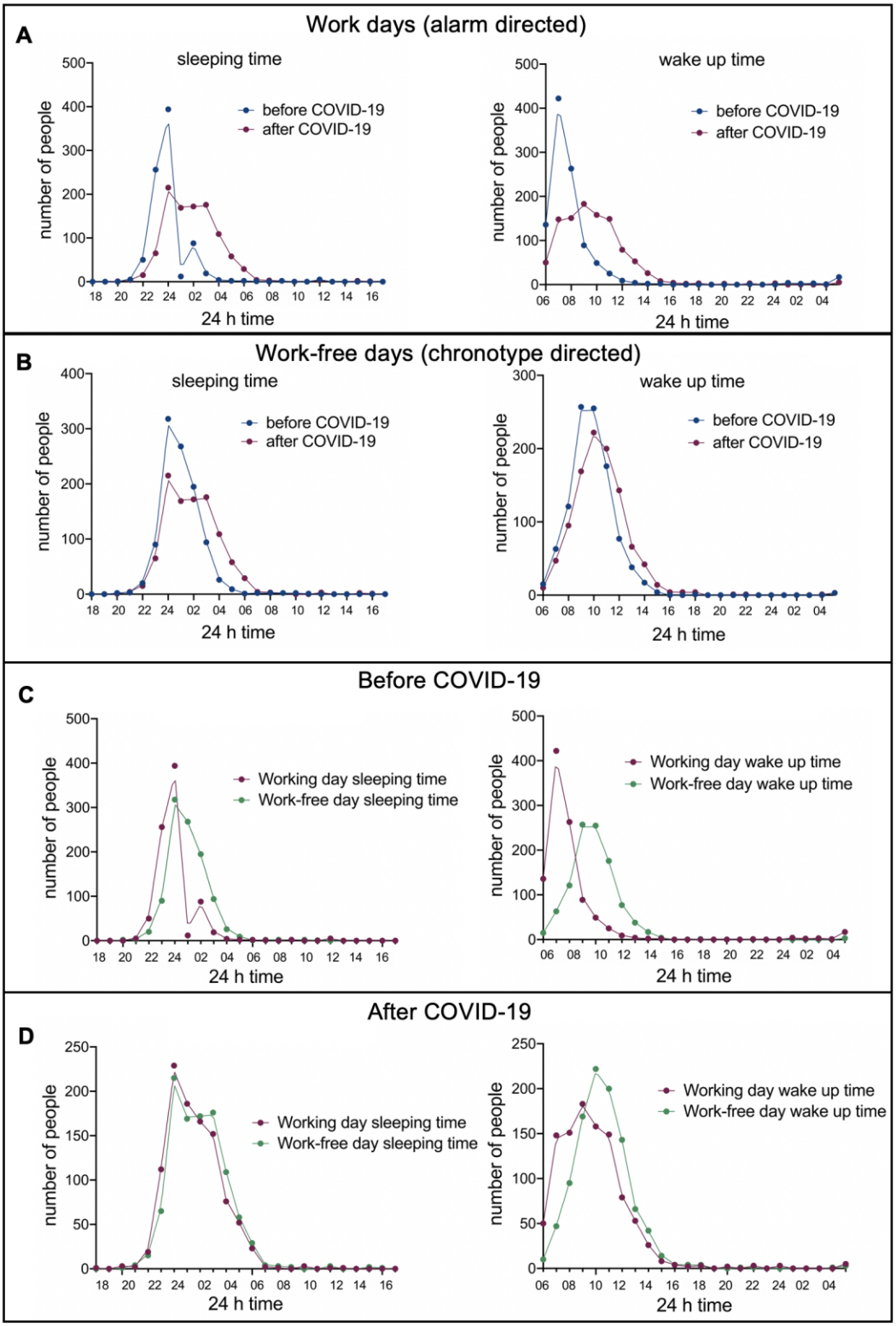

Figure 3. Effects of COVID-19 on sleeping and wake up times of employed participants. (A) Sleeping (left) and wake up (right) times of employed people in the workdays before (blue) and after (red) COVID-19. (B) Sleeping (left) and wake up (right) times of employed people in the work-free days before (blue) and after (red) COVID-19. (C) Profiles of participant's sleeping (left) and wake up (right) times in workdays (red) and work-free (green) days before COVID-19. (D) Profiles of participant's sleeping (left) and wake up (right) times in workdays (red) and work-free (green) days after COVID-19.

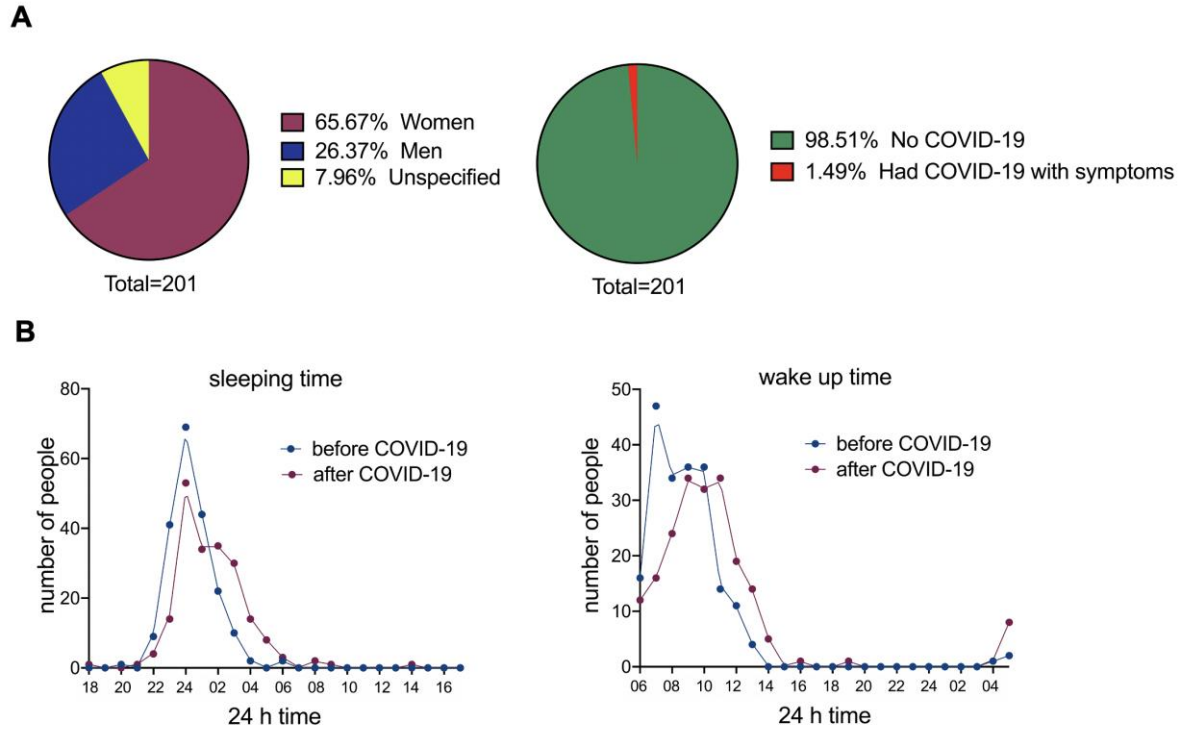

Figure 4. Effects of COVID-19 on unemployed participants' sleeping and wake up times. (A) Genders of unemployed participants. (B) COVID-19 situations of the unemployed participants. (B) Sleeping times of unemployed participants before (blue) and after (red) COVID-19. (C) Wake up times of unemployed participants before (blue) and after (red) COVID-19.

DISCUSSION

A pandemic such as COVID-19 was the first time and ever seen situation for most of world's population. As seen from the Figure 1, life quality of most of the participants was reduced. As a result of stay-at-home orders, physical activity of most of the people have significantly got lower. In order to stop the spread of the virus, people are encouraged to work or study from home. In other words, they started working and living with their own chronotype (Horne and Ostberg, 1976). They have started living with the cues of their internal circadian clock, not by the time schedule their job requires. As seen from the sleep-wake up time difference between workdays (alarm directed) and work-free days (chronotype directed), it can clearly be concluded that participants' designated work hours do not always match with their chronotype (Roenneberg *et al.*, 2019). Consistently with the previous results, people's sleep schedule is different on work-free days compared to workdays (Roepke and Duffy, 2010). When sleeping-wake up times on workdays and work-free days are compared before and after COVID-19, there is less difference between them after COVID-19. One can conclude that COVID-19 pandemic gave people freedom to live with their own circadian rhythm -chronotype-. Two independent studies from Germany and Argentina also reached to the similar conclusions (Leone, Sigman and Golombek, 2020) (Staller and Randler, 2020) (Roepke and Duffy, 2010). It has been proven that people are more productive when they work according to their chronotype (Ujma *et al.*, 2020). Due to the facts, employers might want to reconsider calling employees to the office with fixed hours since letting people work with their own schedule can increase the productivity when the pandemic is over.

CONCLUSION

In addition to increasing knowledge about the mechanism of action, epidemiology, treatment and prevention of the COVID-19; its effects on people's general wellbeing -like their life qualities, screen times, physical activities, sleep quality and daytime naps- should not be undervalued. Even a small-scale survey has proved that the life quality of most of the participants have significantly reduced. As the main focus of the survey, sleeping-wake up times of the

people before and during the pandemic is analyzed. With the COVID-19, the difference between the sleep timing in workdays and work-free days has almost disappeared. As a conclusion, people have started adjusting their work times according to their chronotype. It has been shown that people who are thought to have higher IQs are actually just have the freedom to work according to their own chronotype (Ujma *et al.*, 2020). In order to increase the productivity and prevent sleep problems during the recovery from COVID-19 pandemic, both employees and employers should be aware of the importance of chronotype-directed sleep.

Conflict of Interest: No conflict of interest to report.

REFERENCES

Baxter, M. and Ray, D. W. (2019). Circadian rhythms in innate immunity and stress responses. Immunology, 161(4):261-267. https://dx.doi.org/10.1111/imm.13166

Cui, J., Li, F. and Shi, Z. L. (2019). Origin and evolution of pathogenic coronaviruses. Nature Reviews Microbiology, 17(3):181-192. https://dx.doi.org/10.1038/s41579-018-0118-9

Gooley, J. J. (2016). Circadian regulation of lipid metabolism. Proceedings of the Nutrition Society, 75(4):440-450. https://dx.doi.org/10.1017/S0029665116000288

Guo, Y. R. *et al.* (2020). The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak- A n update on the status. Military Medical Research, 7(1):11. https://dx.doi.org/10.1186/s40779-020-00240-0

Hirano, A. *et al.* (2018). DEC2 modulates orexin expression and regulates sleep. Proceedings of the National Academy of Sciences of the United States of America, 115(13):3434-3439. https://dx.doi.org/10.1073/pnas.1801693115

Horne, J. A. and Ostberg, O. (1976). A self assessment questionnaire to determine Morningness Eveningness in human circadian rhythms, International Journal of Chronobiology, 4(2):97-110.

Joseph Bass, J. S. T. (2010). Circadian Integration of Metabolism and Energetics. Science, 330(6009), 1349–1354. https://dx.doi.org/10.1126/science.1195027

Landgraf, D. *et al.* (2015). Embryonic development and maternal regulation of murine circadian clock function. Chronobiology International, 32(3):416-27. https://dx.doi.org/10.3109/07420528.2014.986576

Leone, M. J., Sigman, M. and Golombek, D. A. (2020). Effects of lockdown on human sleep and chronotype during the COVID-19 pandemic. Current Biology, 30(16):R930-R931. https://dx.doi.org/10.1016/j.cub.2020.07.015

McHill, A. W. *et al.* (2017). Later circadian timing of food intake is associated with increased body fat. American Journal of Clinical Nutrition, 106(5):1213-1219. https://dx.doi.org/10.3945/ajcn.117.161588

Mohawk, J. A., Green, C. B. and Takahashi, J. S. (2013). Central and peripheral circadian clocks in mammal. Annual Review in Neuroscience. 35:445-462. https://dx.doi.org/10.1146/annurev-neuro-060909-153128

Oosterman, J. E. *et al.* (2015). Impact of nutrients on circadian rhythmicity. American Journal of Physiology - Regulatory Integrative and Comparative Physiology, 308(5):R337-50. https://dx.doi.org/10.1152/ajpregu.00322.2014

Pellegrino, R. *et al.* (2014). A Novel BHLHE41 Variant is Associated with Short Sleep and Resistance to Sleep Deprivation in Humans. Sleep, 37(8):1327-36. https://dx.doi.org/10.5665/sleep.3924

Poggiogalle, E., Jamshed, H. and Peterson, C. M. (2018). Circadian regulation of glucose, lipid, and energy metabolism in humans. Metabolism: Clinical and Experimental, 84:11-27. https://dx.doi.org/10.1016/j.metabol.2017.11.017

Roenneberg, T. *et al.* (2019). Chronotype and social jetlag: A (self-) critical review. Biology, 8(3):54. https://dx.doi.org/10.3390/biology8030054

Roenneberg, T. and Merrow, M. (2016). The circadian clock and human health. Current Biology, 26(10):R432-43. https://dx.doi.org/10.1016/j.cub.2016.04.011

Roepke, S. E. and Duffy, J. F. (2010). Differential impact of chronotype on weekday and weekend sleep timing and duration, Nature and Science of Sleep, 2010(2):213-220. https://dx.doi.org/10.2147/NSS.S12572

Sehgal, A. and Mignot, E. (2011). Genetics of sleep and sleep disorders. Cell, 146(2):194-207. https://dx.doi.org/10.1016/j.cell.2011.07.004

Staller, N. and Randler, C. (2020). Changes in sleep schedule and chronotype due to COVID-19 restrictions and home office. Somnologie, 1-7. https://dx.doi.org/10.1007/s11818-020-00277-2

Takahashi, J. S. (2016). Transcriptional architecture of the mammalian circadian clock, Nature Publishing Group, 18(3):164-179. https://dx.doi.org/10.1038/nrg.2016.150

Touitou, Y., Reinberg, A. and Touitou, D. (2017). Association between light at night, melatonin secretion, sleep deprivation, and the internal clock: Health impacts and mechanisms of circadian disruption, Life Sciences, 173:94-106. https://dx.doi.org/10.1016/j.lfs.2017.02.008

Ujma, P. P. *et al.* (2020). The relationship between chronotype and intelligence: the importance of work timing. Scientific Reports, 10(1):7105. https://dx.doi.org/10.1038/s41598-020-62917-9