Are exergames an option to cope with sleep disorders during the COVID-19 outbreak?

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ABSTRACT

During the COVID-19 pandemic, factors related to the isolation and quarantine period increased psychobiological distress in the general population around the world, increasing anxiety, emotional stress, and depression, as well as worsening of the quality of sleep. Seeking alternatives to provide support for the implementation of some interventions for well-being and health under pandemic conditions, exergames (active video games) seem to be a feasible alternative to keep people physically active and to positively impact sleep health. In this overview article, we discussed the feasibility of exergames as an option to cope with sleep disorders and improve sleep quality during the COVID-19 outbreak through increasing physical exercise and physical fitness levels.

Keywords: Sleep; Exercise; Coronavirus; Video Games.
INTRODUCTION

Coronavirus disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), has caused an unprecedented health, social, and economic worldwide crisis and infected, and victimized millions of people. The COVID-19 pandemic has produced lockdowns, quarantines, and social distancing and isolation, which has increased health problems, such as stress, depression, anxiety, and sleep disturbances.

Previous studies have demonstrated that sleep quality of the population has been impaired throughout the pandemic. For example, a study conducted in China with 7,236 participants showed that 18% of them reported poor sleep quality. Salehinejad et al. (2020) showed that quantitative participants showed that 18% of them reported poor sleep quality of the population has been impaired throughout the pandemic. For example, a study conducted in China with 7,236 participants showed that 18% of them reported poor sleep quality. Salehinejad et al. (2020) showed that quantitative participants showed that 18% of them reported poor sleep quality. Salehinejad et al. (2020) showed that quantitative participants showed that 18% of them reported poor sleep quality.

Generally, factors related to isolation, quarantine, anxiety, stress, and economic losses and increased levels of physical inactivity could partly explain the impairment of sleep quality in the general population. A review study conducted by Altena et al. (2019) postulated that sleep disorders might be related to COVID-19 home confinement due to bright light exposure (e.g., smartphone, tablet or laptop) decreasing melatonin release during the night; low levels of physical exercise and social activity (inability to visit friends and family or attend cultural and leisure events); and time pressures of home office, childcare, and household requirements affecting sleep negatively.

Alternatively, physical exercise is recognized as a non-pharmacological tool that positively impacts sleep quality. However, the COVID-19 outbreak imposed quarantine, isolation, and social distancing, as well as the closures of physical exercise facilities and prohibition from circulating among people, which prevented people from performing physical exercise in indoor and/or outdoor environments depending on the region and country. Thus, staying at home to prevent the spread of COVID-19 infection is a new reality, and it is necessary to maintain or increase physical exercise levels to improve or maintain health. In this sense, home-based physical exercise seems to be an effective method to stay active; however, feelings of tiredness, lack of energy, lack of motivation, lack of skills, lack of resources, and fear of injury might be some barriers to people attempting to adopt an active lifestyle. In the current manuscript, we presented exergames (also known as active video games or exergaming) as a possible home-based physical exercise strategy to increase physical exercise levels, mitigating health problems (such as sleep disturbances) due to the COVID-19 outbreak.

Physical exercise as an intervention to improve sleep quantity and quality

The literature has solid evidence that physical exercise improve sleep quantity and quality. For example, Kelley and Kelley (2017) conducted a systematic review and meta-analysis that showed the positive impacts of physical exercise on the apnea-hypopnea index, overall sleep quality, global score, subjective sleep, and sleep latency. Briefly, the beneficial short- and long-term effects of physical exercise on sleep architecture may be explained by bidirectional and interactive pathways incorporating circadian rhythm, metabolic, immune, thermoregulatory, vascular, mood, and endocrine effects.

There are some theories to explain the short- and long-term influence of physical exercise on sleep. The thermoregulation theory is grounded on evidence linking the preoptic area of the anterior hypothalamus to sleep regulation and core temperature downregulation. The theories of body restoration and energy conservation are based on the homeostatic mechanisms regulating sleep, of which total sleep time and slow-wave sleep quality increase with energy expenditure. Here, falling asleep is facilitated by two factors: physiological strains and decrease in body energy caused by physical training, which increases the need for rest and consequently sleep. For this reason, regular physical exercise might promote relaxation and energy expenditure that benefits sleep. Also, regular physical exercise has been associated with improved variables related to sleep, including sleep quality, sleep latency, wake time after sleep onset, and sleep disturbances. By contrast, increased sedentary behavior has been associated with worse sleep outcomes, such as insomnia, sleep disturbances, and insufficient sleep. Therefore, the scientific literature brings evidence that supports the benefits of regular physical exercise as a non-pharmacologic strategy to improve sleep quantity and quality.

In this sense, preventive measures adopted to mitigate COVID-19 transmission included the shutting down of physical exercise facilities (e.g., gyms, swimming pools, and fitness centers) and restriction of outdoor and indoor activities, which may increase physical inactivity and sedentary behavior. To cope with this situation, previous studies have proposed home-based physical exercise programs through feasible and alternative strategies, such as practicing kettlebell training or interval training (e.g., high intensity interval training: 1-4 minute bouts of vigorous exercise interspersed with periods of passive or active recovery). However, for some persons, especially for those that are not experienced with physical exercise training, these strategies could not be easy to implement, since there is a need to control the variables related to training, such as intensity and/or guidance from a specialized professional. Thus, a feasible and possible alternative could be exergames.

Exergames as a strategy to increase levels of physical exercise and quality of sleep during the COVID-19 outbreak

Nowadays, new ways of technology are being created as options for health promotion. Among these options, traditional video games are one of the most popular forms of leisure time. In addition, initiatives in social media (e.g., #PlayApartTogether) promote playing video games for socialization and stress reduction during the COVID-19 pandemic. However, a great amount of time is spent playing video games via online streaming in...
consoles, which stimulates sedentary behavior. Technology has been looked upon with a certain villainy and has been responsible for declining levels of physical exercise among people around the world. Unlike traditional video games, exergames stimulate the player by moving their whole body, resulting in higher motor activation, and responses of physiological variables (e.g., heart rate, oxygen uptake and energy expenditure) as compared to traditional video games that use joysticks.

Many previous studies have shown that the most common exergames elicit a physical exercise intensity corresponding from light to moderate. For example, Viana et al. (2018) investigated the responses of heart rate and oxygen uptake during an exergame session. The authors found that exergames can be classified as light to moderate exercise and concluded that exergames could be an interesting alternative to traditional forms of physical exercise. Notably, these authors investigated an exergame that involved callisthenic physical exercise, which is a traditional mode of physical exercise performed by physical exercise practitioners and prescribed by coaches. Viana et al. (2017) and Morais et al. (2021) investigated the acute effects of the exergame Zumba Fitness on anxiety in women. The authors found that this exergame had an anxiolytic effect and attributed this effect to the moderate intensity of physical exercise evoked by the exergame session.

Given that most studies that have investigated the effect of physical exercise on sleep have applied traditional forms of moderate-intensity physical exercise, it is reasonable to assume that exergames can evoke effects similar to traditional forms of physical exercise on sleep and may be used to manage sleep disorders, especially among those that are physically inactive and that are not attracted to performing traditional forms of physical exercise.

Indeed, the main advantage of exergames compared with traditional forms of physical exercise is that exergames are considered more enjoyable. In practical terms, this finding is relevant because more than a quarter of all adults around the world are physically inactive, and one of the barriers to becoming physically inactive pointed out by people is “finding physical activity unattractive.” Therefore, exergames present the potential to attract inactive people to a physical exercise program.

To the best of our knowledge, only one study has investigated the effect of exergames on sleep. Yunus et al. (2020) investigated the effects of the exergame Kinect Sports for Xbox 360 Kinect on sleep and emotional well-being among students. The participants were submitted to 30 minutes of intervention, three times per week for 6 weeks. The authors found improvement in sleep using the Functional Outcome Sleep Questionnaire-30 in the exergame group but not in the control group. The authors concluded that exergames are feasible to manage sleep conditions.

Limitations of exergames use and practical recommendations during the COVID-19 outbreak

Some limitations and practical recommendations must be considered about the feasibility of using exergames to cope with sleep disturbances during the COVID-19 outbreak. First, this intervention (exergames) implies the use of a specific console and accessories (to motion capture and control) connected to a TV. These electronic devices may not be accessible or available for everyone, especially those living in low- and middle-income wage brackets, as the costs of the equipment might be prohibitive for some people. Finally, exergames can be difficult to use among older people or those who are not familiar with recent technology. In these cases, more traditional home-based physical exercise programs should be encouraged.

As mentioned above, exergames are considered more fun than traditional forms of physical exercise and a potential tool to increase adherence to regular physical exercise. Considering sustaining motivation to continue playing exergames, different games might be used in a single or multiplayer mode. Thus, multiplayer/single player preferences can increase the level of game enjoyment.

Albeit speculative, it is reasonable to assume that it would be important to select games that induce moderate intensity levels. Considering that the literature does not provide an ideal duration of an exergame session and that exergames elicit a physical exercise intensity similar to that elicited by traditional forms of physical exercise, we recommended to remain active during the COVID-19 outbreak following the World Health Organization 2020 guidelines on physical activity and sedentary behavior (e.g., 150-300 minutes of moderate-intensity aerobic physical activity or 75-150 minutes of vigorous-intensity activity per week).

The time of day/night which exergames will be undertaken should be considered because late-night physical exercise results in a body temperature increase, increase in blood pressure and heart rate levels, and sympathetic nervous system activation, all of which impair sleep quality. Other studies conducted within non-athletic participants have not observed any adverse effects or disturbed nocturnal sleep after the physical exercise session, which may be involved with improving sleep quality when performed 2-4 hours before bedtime. On the other hand, disturbed nocturnal sleep was observed after high-intensity physical exercise performed 1 hour before bedtime.

The ratio between physical exercise timing and sleep shall be modulated by chronotype. The chronotype is individual and reflects circadian variations of physiological and psychological variables during the day and this human predisposition to perform better physical or cognitive tasks during morningness or evenningness is supposedly determined by the central circadian clock located in the suprachiasmatic nuclei of the hypothalamus. Considering that there is no consensus about physical exercise timing and sleep, chronotype status might be used to identify the ideal period for exercise based on innate circadian rhythmicity, using self-assessment questionnaires, such as the morningness–eveningness questionnaire.

Another limitation is that the blue light emission of a TV can disrupt the natural sleep-wake cycles of the brain, especially when people engage in exergames before bedtime. However, some practical recommendations to minimize the
effects of blue light exposure during an exergame session is the player use amber-tinted glasses to avoid excessive blue light exposure at night in order to cancel out the melanin-suppressing effect of the bright light and change some settings manually on the TV to reduce brightness and contrast or turn on a blue light filter to mitigate sleep disturbances due to excessive or inadequate lighting.

CONCLUSION

Exergames can be an interesting alternative and attractive tool in times of the COVID-19 pandemic, with lockdowns, quarantines, and social distancing and isolation, to cope with sleep disturbances. In addition, the benefits of the practice of exergames could be innumerable, mainly for populations at risk of getting coronavirus infections, such as children who are still unable to attend school and do group physical exercise programs safely and elderly people who, in general, had lower levels of physical activity, even before the pandemic, and in many cases, already live in a situation of social isolation. Finally, exergames can be played at home with relative safety and could help improve and maintain physical exercise levels, as well as improve the quality of sleep.

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REFERENCES

1. Cespedes MS, Souza JCRP. Coronavirus: a clinical update of COVID-19. Rev Assoc Med Bras. 2020;66(2):116-23.
2. Gao J, Zheng P, Jia Y, Chen H, Mao Y, Chen S, et al. Mental health problems and social media exposure during COVID-19 outbreak. PLoS One. 2020;15(4):e0231924.
3. Puccinelli PJ, Costa TS, Seffrin A, Lira CAB, Vancini RL, Knechtke B, et al. Physical activity levels and mental health during the COVID-19 pandemic: preliminary results of a comparative study between convenience samples from Brazil and Switzerland. Medicina. 2021;57(1):48.
4. Puccinelli PJ, Costa TS, Seffrin A, Lira CAB, Vancini RL, Nikolaidis PT, et al. Reduced level of physical activity during COVID-19 pandemic is associated with depression and anxiety levels: an internet-based survey. BMC Public Health. 2021 Mar;21:425.
5. Morin CM, Carrier J, Bastien C, Godbout R. Sleep and circadian rhythm between the pre-pandemic and the COVID-19 pandemic. Can J Public Health. 2020 Apr;91(2):96-9.
6. McGinty D, Szymbiaski R. Keeping cool: a hypothesis about the mechanisms and functions of slow-wave sleep. Trends Neurosci. 1990 Dec;13(12):480-7.
7. Flausino NH, Prado JMP, Queiroz SS, Tufik S, Mello MT. Physical exercise performed before bedtime improves the sleep pattern of healthy young good sleepers. Psychophysiology. 2012 Feb;49(2):186-92.
8. Montgomery J, John T, Paxton SJ. Energy expenditure and total sleep time: effect of physical exercise. Sleep. 1982;5(2):159-69.
9. Youngstedt SD. Effects of exercise on sleep. Curr Sports Med Rep. 2005 Apr;24(1):35-65.
10. Griffiths M. Video games and health. BMJ. 2005 Jul;331:122-3. DOI: https://doi.org/10.1136/bmj.331.7509.122
11. 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 Aug;29(4):e13052.
12. Tremblay MS, Aubert S, Barnes JD, Saunders TJ, Casar J, Latimer-Cheung AE, et al. Sedentary behavior research network (SBRN)–terminology consensus project process and outcome. Int J Behav Nutr Phys Act. 2017 Jun;14(1):75.
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36. Guthold R, Stevens GA, Riley LM, Bull FC. Worldwide trends in insufficient physical activity from 2001 to 2016: a pooled analysis of 358 population-based surveys with 1.9 million participants. Lancet Glob Health. 2018 Oct;6(10):e1077-e86.

37. Yuanus FW, Tan XZ, Romli MH. Investigating the feasibility of exergame on sleep and emotion among university students. Games Health J. 2020;9(6):415-24.

38. Boulos MNK. Xbox 360 Kinect exergames for health. Games Health J. 2012 Oct;1(5):326-30.

39. Viana RB, Alves CL, Vieira CA, Vancini RL, Campos MH, Gentil P, et al. Anxiolytic effects of a single session of the exergame Zumba® Fitness on healthy young women. Games Health J. 2017;6(6):565-70.

40. Chan G, Arya A, Orji R, Zhao Z. Motivational strategies and approaches for single and multi-player exergames: a social perspective. PeerJ Computer Sci. 2019 Nov;5:e230.

41. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, et al. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. Br J Sports Med. 2020 Dec;54(24):1451-62.

42. Glavin EE, Ceneus M, Chanowitz M, Kantillerakis J, Mendelow E, Mosquera J, et al. Relationships between sleep, exercise timing, and chronotype in young adults. J Health Psychol. 2020 Jun 04; [Epub ahead of print]. DOI: https://doi.org/10.1177/1359105320926530

43. Myllymäki T, Kyröläinen H, Savolainen K, Hokka L, Jakonen R, Juuti T, et al. Effects of vigorous late-night exercise on sleep quality and cardiac autonomic activity. J Sleep Res. 2011 Mar;20(1 Pt 2):146-53.

44. Larsen P, Marino F, Melehan K, Guelfi KJ, Duffield R. Evening high-intensity interval exercise does not disrupt sleep or alter energy intake despite changes in acylated ghrelin in middle-aged men. J Exp Physiol. 2019 Jun;104(6):826-36.

45. Oda S, Shirakawa K. Sleep onset is disrupted following pre-sleep exercise that causes large physiological excitement at bedtime. Eur J Appl Physiol. 2014 Sep;114(9):1789-99.

46. Vitale JA, Weydahl A. Chronotype, physical activity, and sport performance: a systematic review. Sports Med. 2017 Sep;47(9):1859-68.

47. Nováková M, Sládek M, Sumová A. Human chronotype is determined in bodily cells under real-life conditions. Chronobiol Int. 2013;30:607-17.

48. Horne JA, Östberg O. A self-assessment questionnaire to determine morningness-eveningness in human circadian rhythms. Int J Chronobiol. 1976;4(2):97-110.

49. Duffy JF, Czeisler CA. Effect of light on human circadian physiology. Sleep Med Clin. 2009;4(2):165-77.

50. Sasseville A, Paquet N, Sévigny J, Hébert M. Blue blocker glasses impede the capacity of bright light to suppress melatonin production. J Pineal Res. 2006 Aug;41(1):73-8.

51. Kayumov L, Casper RF, Hawa RJ, Perelman B, Chung SA, Sokalsky S, et al. Blocking low-wavelength light prevents nocturnal melatonin suppression with no adverse effect on performance during simulated shift work. J Clin Endocrinol Metab. 2015 May;99(5):2753-61.