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Strategies to combat the increase of sedentary behavior after COVID-19 pandemic: an opinion article

Estratégias para combater o aumento do comportamento sedentário após a pandemia do COVID-19: um artigo de opinião

Estrategias para combatir el aumento del comportamiento sedentario después de la pandemia de COVID-19: un artículo de opinión

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Thalles Guilarducci Costa
ORCID: https://orcid.org/0000-0003-2542-8903
Universidade Federal de Goiás, Brazil
E-mail: profthallesgc@gmail.com
Carlos Ramos-Urrea
ORCID: https://orcid.org/0000-0001-8381-850X
Instituto Universitário Vive Sano, Brazil
E-mail: carlosramos2690@gmail.com
Douglas Assis Teles dos Santos
ORCID: https://orcid.org/0000-0002-7664-5468
Universidade do Estado da Bahia, Brazil
E-mail: datsantos@uneb.br
Thatiane Lopes Valentim Di Paschoale Ostolin
ORCID: https://orcid.org/0000-0002-8492-2840
Universidade Federal de São Paulo, Brazil
E-mail: thatiane.ostolin@unifesp.br
Claudio Andre Barbosa de Lira
ORCID: https://orcid.org/0000-0001-5749-6877
Universidade Federal de Goiás, Brazil
E-mail: andre.claudio@gmail.com

Abstract
In the current COVID-19 pandemic, physical activity has been decreasing. In contrast, sedentary behavior largely increased due to social isolation. This scenario led to a significant worsening of population physical and mental health. With the increasing vaccination rate, many countries are coming back to normal life, but the fear of COVID-19 and crowding places can limit the physical activity practice in traditional exercise facilities, such as gyms. Given that physical activity is a nonpharmacological tool to enhance health and prevent a multitude of non-communicable diseases, it is important to achieve recommended levels of physical activity after the COVID-19 pandemic. In this opinion article, we aimed to alert about the deleterious effects of sedentary behavior associated with physical inactivity due to COVID-19 pandemic and post-pandemic scenarios. Moreover, we provide alternative strategies (exergames and high-intensity interval exercise) for individuals to maintain their activity in their homes or outdoors, avoiding traditional exercise facilities for practicing physical activity where there is potential crowding.
Keywords: Sedentary behavior; COVID-19; Physical exercise; Health.

Resumo
Na atual pandemia de COVID-19, a atividade física vem diminuindo. Em contrapartida, o comportamento sedentário aumentou bastante devido ao isolamento social. Este cenário levou a um agravamento da saúde física e mental. Com o aumento da taxa de vacinação, muitos países estão voltando à vida normal, mas o medo da COVID-19 e de lugares aglomerados podem limitar a prática de atividade física em instalações de exercício, tais como academias. Dado que a atividade física é uma ferramenta não farmacológica para melhorar a saúde e prevenir uma infinidade de doenças não transmissíveis, é importante manter os níveis recomendados de atividade física após a pandemia da COVID-19. Neste artigo de opinião, nós objetivamos alertar sobre os efeitos deletérios do comportamento sedentário associado à inatividade física decorrente dos cenários de pandemia e pós-pandemia da COVID-19. Além disso, fornecemos estratégias alternativas (exergames e exercícios intervalados de alta intensidade) para que os indivíduos mantenham sua atividade em suas casas ou ao ar livre, evitando locais tradicionais de prática de atividade física onde haja potencial aglomeração.
Palavras-chave: Comportamento sedentário; COVID-19; Exercício físico; Saúde.

Resumen
En la actual pandemia de COVID-19, la actividad física ha ido disminuyendo. Por otro lado, el sedentarismo ha aumentado significativamente debido al aislamiento social. Este escenario llevó a un empeoramiento de la salud física y mental. Con el aumento de la tasa de vacunación, muchos países están volviendo a la vida normal, pero los temores de la presencia de COVID-19 y los lugares concurridos pueden limitar la actividad física en instalaciones donde realizamos actividad física como los gimnasios. Dado que la actividad física es una herramienta no farmacológica para mejorar la salud y prevenir multitud de enfermedades no transmisibles, es importante mantener los niveles recomendados de actividad física tras la pandemia de COVID-19. En este artículo de opinión pretendemos advertir sobre los efectos deletéreos del sedentarismo asociado a la inactividad física derivados de los escenarios de pandemia y pospandemia del COVID-19. Además, brindamos estrategias alternativas (exergames y ejercicios intervalados de alta intensidad) para que las personas mantengan su actividad en el hogar o al aire libre, evitando los lugares tradicionales de actividad física donde existe la posibilidad de aglomeración.
Palabras clave: Conducta sedentaria; COVID-19; Ejercicio físico; Salud.

1. Introduction

The COVID-19 pandemic has globally affected the health and lifestyle of the population. Worldwide, as of April 11, 2022, more than 497 million people have been diagnosed with COVID-19, and about 6 million have died (WHO, 2022). Since the declaration of pandemic status by the World Health Organization, many countries have started community containment to reduce personal interactions, such as school closures, home-working, cancellation of public meetings, and restriction of access to public transport and commercial establishments. Social distancing aimed to reduce infection and mortality, and prevent healthcare system collapse (Mahase, 2020). Some countries adopted a lockdown procedure (e.g. mandatory social distancing with arrests or fines for those for violating the restrictions (Sjödin *et al.*, 2020). On April 7th, 2020, three billion people were confined to their homes worldwide, and more than 130 countries had applied restrictive measures to combat the pandemic (UNICEF, 2020).

Although community containment contributes to flattening the epidemiological curve of COVID-19 infection, hence controlling the spread of the disease (Patrick et *al.*, 2020; Taghrir *et al.*, 2020), it seems to have a collateral effect on physical activity level, with increased sedentary behavior (Venkatesh & Edirappuli, 2020). Data from Fitbit™ (Fitbit, 2020), a wearable technology that tracks physical activity levels, showed the impact of COVID-19 on the global step count. In Europe, there has been a decrease in activity levels of 7% in Germany and 38% in Italy (the most affected country on the continent). In America, this decline reached over 50% (Evidation, 2020). Apple also monitored mobility trends, recording a 41% decline in mobility in the UK (Apple, 2020). Conversely, SteamTM, a personal computer gaming marketplace, has hit a record number of users, with 22 million players logging in (Steam, 2020). Moreover, Netflix™ gained 15.8 million members in the first trimester of 2020, increasing two times more than expected (Netflix, 2020). Additionally, as a result of the global pandemic, the number of people working remotely has increased, in addition to people who stopped working, which can lead to poor mental health and distress (Zhang *et al.*, 2020).

A study from the University of Cambridge (Meyer *et al.*, 2020) evaluated 3,052 adults in April 2020, focusing on registered sitting time, screen time, whether or not they met physical activity guidelines, and mental health during the COVID-19 quarantine. A large increase in sitting time and screen time were found in addition to a high rate of decreasing physical activity among participants who were active before the pandemic. Poor mental health was associated with increased sitting and screen time and a decline in physical activity level. Children were also affected by confinement. Pietrobelli *et al.* (2020) found decreased time spent doing sports activities but increased screen time among children during Italy's lockdown. It is important to highlight that video games are being played at record levels during containment (King *et al.*, 2020).

Even considering the vaccination of the population and the decrease in the number of cases and deaths due to COVID-19, the disease continues to alarm the population, mainly due to uncertainty and fear (Mertens *et al.*, 2020; Yalçın *et al.*, 2022).

In this context, it is reasonable to assume that many people will remain at home and with low levels of physical activity. Therefore, the current opinion article discusses the possible deleterious effects of increasing sedentary behavior on health-related outcomes, as well as highlights potential promising strategies to increase physical activity and decrease sedentary behavior in the post-pandemic scenario.

2. Health-Related Outcomes due to Sedentary Behavior

Sedentary behavior encompasses all behavior characterized by low energy expenditure [e.g. <1.5 metabolic equivalents (METS)], while sitting or reclining, for example, watching television, working on a computer, or reading (Tremblay *et al.,* 2017). This is a different concept from being physically inactive, which refers to a person who does not meet the physical activity recommendations, such as 150 min of moderate- to vigorous-intensity physical activity per week, or 75 min of vigorous physical activity per week, for adults (Tremblay *et al.,* 2017). Despite being a relatively new topic of research, sedentary behavior is prospectively associated with an increased risk of all-cause mortality, cardiovascular disease, and type 2 diabetes (Katzmarzyk *et al.,* 2019).

A sedentary lifestyle is also strongly linked to depressive symptomatology and psychological distress (Hoare *et al.,* 2016; Liu *et al.,* 2016), as well as the severity of depressive symptoms, illness duration, and high doses of antipsychotic medication in people with severe mental illness (Bort-Roig *et al.,* 2019). Pinto Pereira *et al.* (2012) investigated 7,660 subjects in a 40-year follow-up study and found an association between screen time and sitting work, and poorer cardiovascular biomarkers (e.g. low-density cholesterol levels and blood pressure). Balboa-Castillo *et al.* (2011) reported an association between more hours spent sitting and poor health-related quality of life in older adults.

Although the dose-response relationship seems to be non-linear, screen time higher than 2 h/day is associated with a high risk of depression (Liu *et al.,* 2016). In recent systematic reviews, screen time was associated with depression risk, especially in women (Wang *et al.,* 2019), while sitting time was moderately associated with anxiety risk (Teychenne *et al.,* 2015), despite inconsistent and heterogeneous study results. According to Ellingson *et al.* (2018), changes in sedentary behavior were also related to mood disturbance, stress, and sleep in young adults. Therefore, it is clear that sedentary behavior impairs health-related outcomes.

During social isolation imposed by the pandemic, the population's physical activity level decreased, while sedentary behavior increased (Czenczek-Lewandowska *et al.,* 2021; Karageorghis *et al.,* 2021). This is a worrying fact since significant 4–17% reductions in the risk of mortality from all causes were found when replacing 30 min/day of sedentary behavior with mild physical activity and replacing 60 min/day with physical activity reduces the risk by up to 18% (Matthews *et al.,* 2016). Walmsley *et al.* (2021) showed that reallocating time from sedentary behavior to other behaviors, such as moderate-to-vigorous physical activity, light physical activity, or sleep was associated with a lower risk of incident cardiovascular disease. Therefore, it is important to tackle the increases in sedentary behavior seen during the quarantine period. Briefly, these positive results are explained because sedentary behavior decreases the use of glucose by the muscles, increasing insulin resistance and causing muscle atrophy (Zhang *et al.,* 2007). The increase in the level of physical activity due to the substitution of sedentary behavior prevents these deleterious effects.

The decreases in social interaction produced by social distancing may harm mental and physical health (Benke *et al.,* 2020; Brooks *et al.,* 2020; Croezen *et al.,* 2015; Lee & Kim, 2019; Rodriguez-Ayllon *et al.,* 2019). This effect has already been described in the literature, which describes the mental health consequences seen in previous quarantines, such as higher risks of depression (Courtin & Knapp, 2017), emotional disturbance (Yoon *et al.,* 2016), stress (Digiovanni *et al.,* 2004), low mood (Lee *et al.,* 2005), irritability (Lee *et al.,* 2005), or insomnia (Lee *et al.,* 2005), as well as an association with higher rates of

suicide in the elderly population (Yip *et al.*, 2010). Sepúlveda-Loyola *et al.* (2020) showed a negative effect on mental health in the general population during social isolation due to COVID-19, describing higher levels of anxiety and depression, as well as poorer sleep quality. Recently, Puccinelli *et al.* (2021) showed that the COVID-19 pandemic caused a negative impact on physical activity levels, and subjects who reduced their level of physical activity had the highest levels of mood disorders. Despite reduction in infection rate due to vaccination campaign, it was demonstrated that being exposed to COVID-19 has also the power to enhance fear of COVID-19 (Tsang *et al.*, 2021), which can lead to workplace phobia (Malik *et al.*, 2021) and higher self-isolation (Blake *et al.*, 2021). Thus, it is reasonable to assume that some people will maintain reduced physical activity level due to fear of attending exercise facilities. Therefore, the use of potential and promising behavior-change strategies must be established and recommended to increase physical activity levels without leaving home, decrease sitting and screen time, and tackle sedentary behavior.

3. Possible Strategies to Decrease Sedentary Behavior and Increase Physical Activity Post-COVID-19 Pandemic

Several studies have proposed interventions to increase physical activity while decreasing the number and duration of sedentary periods. Sedentary behavior can be reduced by limiting TV viewing, computer and internet use (using proper software to reduce electronic media use), and increasing steps per day (Todd *et al.*, 2008). Two meta-analyses have investigated the outcomes of reducing screen time. Liu *et al.* (2016) showed that this strategy can be useful for reducing sedentary behavior; however, screen time must be replaced with physical activity; otherwise, it may be substituted with another sedentary activity. Blackburn *et al.* (2020), in a meta-analysis including 126 studies, found that behavior-change interventions may reduce daily sedentary time. The interventions worked by reducing sitting time in the workplace, for example by adding standing tables, or behavioral changes, such as education about the benefits of reducing sitting and monitoring sedentary behavior through activity trackers.

Replacing sitting with standing can also be a useful strategy to improve health; replacing 1 hour of sitting with 1 hour of standing is associated with an increase in fat-free mass and a decrease in fat mass, beyond a decrease in waist circumference (Danquah *et al.*, 2018). However, it should be noted that superior effects are noticed when sitting is replaced with walking or moderate-to-vigorous physical activity (Henson *et al.*, 2018; Winkler *et al.*, 2018). Additionally, enhanced movement time and standing time to the detriment of sitting time can lead to lower blood pressure, fasting triglycerides, and cholesterol (Winkler *et al.*, 2018). These interventions decreased sedentary behavior, but only in the long run. Since we need quick results considering the post-pandemic context, the use of strategies like replacing non-active video games with active video games (exergames) (Ni Mhurchu *et al.*, 2008) is potentially promising for encouraging and promoting the necessary behavior changes. Indeed, exergames can also be an interesting strategy for reducing sedentary behavior and have the benefit of improving mental health (Morais *et al.*, 2021; Viana *et al.*, 2017; Viana & de Lira, 2020; Viana *et al.*, 2021).

Another strategy is to use home-based training (Guadalupe-Grau *et al.*, 2020), such as home-based resistance exercise (Zimerer *et al.*, 2021), and high-intensity interval exercise (Souza *et al.*, 2020). These kinds of exercises are useful for improving cardiorespiratory fitness, muscle strength, body composition, and mental health. Furthermore, home-based training has been shown to be safe and feasible for clinical and non-clinical populations (Guadalupe-Grau *et al.*, 2020; Myers *et al.*, 2015; Schaun *et al.*, 2018). Table 1 provides further health benefits and protocol about the above-mentioned strategies.

Table 1. Strategies to reduce sedentary behavior and enhance physical activity.

Strategies	Protocols	Potential health outcomes
Exergaming	≥ 2 days per week, 150 minutes per week (dance steps, postural control, coordination, walk training, and Zumba Fitness)	↑ Cardiorespiratory fitness ↓ Anxiety and depression ↑ Enjoyment ↑ Postural balance ↑ Cognitive function ↑ Quality of life ↓ Cardiometabolic risks
Home-based training	Warm-up exercises (breathing, knee raise, leg raise, leg swings, side lunges, arm circles, side walking squat) 1 set of 15 repetitions of each. Resistance exercises with body weight or extra weight such as a gallon of water (squats, row, lunges, chest press, squat jumps, biceps curl) 3 sets of 10 to 15 repetitions. Cooldown exercises (ankle dorsiflexion, lumbar stretch, lumbar rotation, hamstrings stretching, hip flexors stretching, chest stretch, back stretch) 1 set counting till 10 maintaining the position. All this protocol 2 to 3 days per week in a combination with aerobic training.	↑ Muscle function ↑ Cardiorespiratory fitness ↓ Anxiety and depression ↓ Cardiometabolic risks ↑ Quality of life Glycemic control
High-intensity interval training	Sprint interval training (SIT): short bouts (30s) of "all-outs" efforts with long recovery (2min), 4 to 6 bouts Tabata protocol: 7 to 8 20-s bouts of high-effort cycling with 10s recovery. Cycling can be replaced by calisthenics exercises, such as jumping jacks, mountain climbers, burpees, squats, and thrusts) All these protocols 2 to 3 days per week.	↑ Cardiorespiratory fitness ↓ Cardiometabolic risks ↓ anxiety and depression
Replacing sitting	Reallocating 60 minutes of sitting time per day for standing, light stepping, or walking. Interrupt sitting time every 60 minutes. Replace regular workstations withstand up workstations.	↓ Cardiometabolic risks

↑: improvement; ↓: reduction. Source: Authors.

For those cities/countries in which resistance exercise facilities are now open, it is recommended to decrease exercise intensity avoid the discomfort caused by using a mask. Recently, Shaw *et al.* (2021) conducted a systematic review and meta-analysis to investigate the impact of wearing a mask during exercise. The authors found that exercise performance was not impacted; however, wearing a mask during exercise increased ratings of perceived exertion and dyspnea. Therefore, wearing a mask during exercise can cause discomfort. Recently, Gentil *et al.* (2021) proposed some practical recommendations for the use of resistance training in COVID-19 survivors, which include reduced training volume (3–6 sets per muscle group per week), preferential performance of multi-joint exercises, exercise sessions no longer than 4 min, low number of repetitions (≤6), long intervals between sets (≥3 min), and controlled movement speed (2 s in both concentric and eccentric phases). It is noteworthy that an exercise science professional should be consulted (especially for those who are less experienced or want to start a physical activity program). In addition, for those who have any pre-existing condition (for example, diabetes or cardiovascular disease), it is recommended to consult a physician to investigate possible contraindications.

Finally, the use of mobile health technologies can track the time spent engaging in sedentary behavior and provide alerts from biological sensors, offering data for monitoring health-related outcomes (Lee *et al.*, 2019).

4. Final Considerations

Given that sedentary behavior has a deleterious effect on several health outcomes, it can have a relevant impact on the healthcare system during both the COVID-19 pandemic and in the post-COVID-19 period. Health professionals and the population must be aware of feasible and low-cost possibilities for combating sedentary behavior due to pandemics. Therefore, it is our opinion that home-based exercise (including calisthenics exercise, high-intensity interval training, and exergames) can be a useful strategy for tackling sedentary behavior.

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