

## Targeting sedentary behavior as a feasible health strategy during COVID-19

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### Abstract

Sedentary behavior is associated with poor physical and mental health. Targeting sedentary behavior is a simple strategy that may help counter physical and mental health concerns associated with COVID-19-related social restrictions. Of course, traditional strategies such as achieving optimal exercise and physical activity levels are also important and should be recommended. However, even under normal circumstances, the difficulty in promoting lasting exercise habits at multiple levels (e.g. individual, environment, policy) are well documented, and chances of maintaining or improving these factors is now even lower. Thus, relative to other lifestyle behaviors – sedentary behavior may be more amenable to change. Moreover, reducing sedentary behavior may be less susceptible to influence from factors associated with health disparities such as age, race, and socio-economic status compared to exercise or physical activity. Sedentary behavior is a feasible health strategy that should be targeted during COVID-19.

### Keywords

Sedentary behavior, COVID-19, Physical health, Mental health, Lifestyle behaviors, Socioecological model

### INTRODUCTION

Humanity is facing unprecedented challenges as the coronavirus (COVID-19) pandemic has infected over 11 million individuals worldwide and impacted (e.g., financially and mentally) many more [1, 2]. It now appears unlikely that the virus and the resulting social restrictions (e.g., social distancing, self-isolation, and remote working/learning) will subside in the short term, forcing humans to adapt to a new way of living and interacting with each other. While social restrictions are critical strategies to combat the spread of the virus, they also promote negative lifestyle behaviors, such as physical inactivity and sedentary behavior. These behaviors are associated with poor cardiometabolic and mental health [3, 4] and with COVID-19 severity [5]. Thus, behavioral strategies are necessary to offset the negative health consequences of COVID-19-related social restrictions while minimizing the likelihood of severe COVID-19 outcomes [6]. In this commentary, we argue that sedentary behavior is an achievable target for behavior change during COVID-19.

### Implications

**Practice:** Community- and home-based efforts to reduce sedentary behavior are practical strategies to promote health during COVID-19.

**Policy:** Policymakers should consider promoting strategies to interrupt sedentary behavior—such as by making safe, open outdoor spaces available for socially distant physical activity—as a means to encourage healthy lifestyle behaviors while not compromising the social restrictions necessary to curb the spread of COVID-19.

**Research:** Future research is needed to better understand and modify determinants of key lifestyle behaviors (e.g., sedentary behavior) during COVID-19, including at individual, environmental, and policy levels.

Healthy behaviors, such as structured exercise to combat physical inactivity, should be promoted as part of a balanced lifestyle. However, even during normal times, it is challenging to promote lasting healthy exercise habits [7]. When considering the many determinants and barriers to exercise (e.g., access to safe, open spaces), the complexity and difficulty of promoting exercise in the midst of COVID-19-related social restrictions are even more readily apparent. A useful framework for contextualizing the determinants of and barriers to behavior change is the socioecological model, which recognizes that individuals exist within the context of their environment [8]. Specifically, behavior change is likely to be restricted if the physical and sociocultural environments do not support behavior change. Intraindividual (e.g., self-efficacy and enjoyment), interindividual (e.g., social support), physical environment (e.g., home and neighborhood), and policy-level (e.g., government guidelines) determinants are unique factors that must be considered in the context of promoting exercise. The determinants of exercise are indeed traditionally dependent on factors higher in the socioecological model (e.g., policy/environment). However, it is particularly

important to consider the socioecological framework now as the supportive influences of exercise (e.g., economic and infrastructural resources) have been directly, negatively affected by social restrictions associated with COVID-19. Mixed evidence has pointed to both increases and decreases in exercise in the wake of COVID-19 [3, 9, 10] (although some COVID-19-related policies/recommendations may actually decrease sedentary behavior, such as the removal of chairs or benches in workplaces and public places [11, 12]). However, for individuals in lower socioeconomic status (SES) segments of the population, the chances of improving already low levels of exercise are now even less [13]. Additionally, these individuals are more likely to contract COVID-19, as well as suffer more severe outcomes, compared to higher SES individuals and are arguably most in need of healthy behavior adoption [14–17].

Compared to exercise, sedentary behavior, defined as any waking activity in a seated or reclining position ( $\leq 1.5$  metabolic equivalents) [18], may be less susceptible to factors associated with health disparities, such as race and SES. For example, low-income individuals are less likely to be able to afford home exercise equipment or have access to high-quality parks and recreation facilities [13]. Not only is sedentary behavior an independent risk factor for cardiometabolic diseases [19, 20] but it can also be safely modulated during the pandemic to a greater extent than exercise. For example, interrupting sedentary behavior with a simple low-intensity physical activity (e.g., standing calf raises) at home or work does not risk compromising social distancing to the same degree as visiting a gym or a park to engage in traditional exercise [21]. Reducing sedentary behavior is a realistic and feasible target that may confer physical and mental health benefits, including in adults, adolescents, and children [22–27]. Thus, while exercise is a potent health-promoting behavior and should continue to be encouraged, a particular emphasis should be placed on reducing sedentary behavior. This commentary will further outline the connections between sedentary behavior and physical and mental health and, through the lens of a socioecological model of behavior change, provide recommendations for reducing sedentary behavior during COVID-19.

### COVID-19 and increased sedentary behavior

Available evidence indicates that increased sedentary behavior has been an unintended consequence of the social restrictions needed to combat the spread of COVID-19 [28–30]. Remote working, social distancing, and self-isolating at home have interrupted normal daily routines. For example, leisurely walking in public places and movement around a typical office or workspace have largely been abated as a result of the decreased human contact needed to contain COVID-19 [31, 32]. Moreover, it is likely that COVID-19 has indirectly caused already low exercise levels to decrease even further, particularly amongst individuals in lower SES populations, racial minorities, and other at-risk segments of the population [33]. Thus, it is plausible that sedentary behavior has been increased at the expense of both traditional moderate-vigorous-intensity physical activity (e.g., formal exercise), as well as low-intensity physical activity that normally accompanies daily work, recreational, and social routines. Of concern, the lack of moderate-vigorous physical activity and increased sedentary behavior are independent risk factors for cardiometabolic diseases, which are associated with more severe COVID-19 outcomes [34, 35].

### Sedentary behavior and physical health

Strong longitudinal associations exist between sedentary behavior, cardiometabolic disease risk, and all-cause mortality [19]. For example, sitting  $\geq 6$  hr per day is associated with a 1.28-fold increase in all-cause mortality compared to those that sat  $< 3$  hr per day [36]. Sedentary behavior negatively impacts health by decreasing vascular function, energy expenditure, and glucose/insulin regulation—all of which are strongly associated with cardiometabolic disease risk [27, 37, 38]. Importantly, the presence of cardiometabolic disease risk factors (e.g., insulin resistance and hypertension) and overt cardiometabolic disease (e.g., obesity, coronary artery disease, and diabetes) have been associated with more severe COVID-19 outcomes, such as hospitalization, intubation, and death [5, 39, 40]. For instance, data from the Centers of Disease Control indicated that considerable proportions of underlying cardiometabolic conditions were present among COVID-19 hospitalizations in March 2020, including hypertension

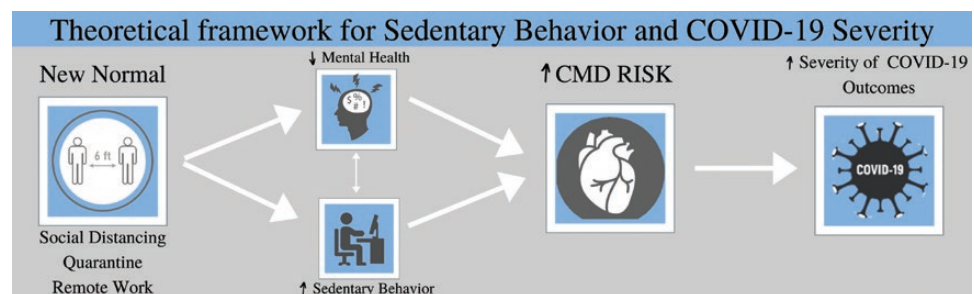


Fig 1 | Theoretical framework for sedentary behavior and COVID-19 severity.

(49.7%), obesity (48.3%), diabetes (28.3%), and cardiovascular disease (27.8%) [41]. As such, increased sedentary behavior as a result of COVID-19 threatens cardiometabolic health, which is concerning in and of itself yet is doubly troublesome given the links between poor cardiometabolic health and severe COVID-19 outcomes (Fig. 1).

**Sedentary behavior and mental health**

Increased sedentary behavior and physical inactivity have both been implicated in poor mental health outcomes, including stress, anxiety, and depression [33, 42–45]. Additionally, increases in stress, anxiety, depression, frustration, anger, loss of freedom, inadequate information, financial struggle, and uncertainty regarding the future have been reported in past epidemics, as well as in COVID-19 [46–52]. It is important to note that mental stress directly confers cardiometabolic risk via sympathetic overactivation and also interacts in a bidirectional manner with poor lifestyle factors known to increase cardiometabolic risk [48, 53]. Regarding the latter point, COVID-19 may promulgate harmful cycles in which elevated mental stress exacerbates poor lifestyle behaviors, which, in turn, may lead to even greater stress [48]. This is especially concerning since both mental stress and other negative lifestyle factors associated with mental stress, such as sedentary behavior, increase cardiometabolic disease risk and may, thus, elevate the likelihood for negative COVID-19 outcomes [38, 54] (Fig. 1).

**Recommendations and considerations**

In the context of mitigating vascular and metabolic dysfunction associated with sedentarism, strategies

to interrupt sedentary behavior should be emphasized, particularly those that can be implemented in the home or neighborhoods. Effective sedentary behavior interruption strategies include fidgeting, bodyweight or resistance band exercises, standing, and walking [23,24,55–57]. Though specific guidelines for limiting sedentary behavior are currently lacking, current evidence, including from our group’s recent meta-analysis, indicates that the most extensively reported and efficacious strategies seem to be standing and walking 2–5 min every 20–30 min (Table 1) [23,24,55–57]. While strategies designed to interrupt sedentary behavior for the purpose of improving mental health have been less extensively studied, available evidence does suggest the possibility that such strategies may indeed benefit mental health [22, 44].

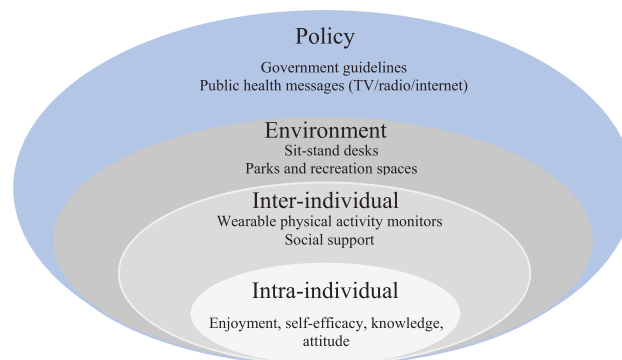
Linking back to the socioecological model of behavior change, we recommend that reducing sedentary behavior be considered and promoted within the context of each level of the socioecological model (Fig. 2). At the policy level, international research efforts, such as the Collaborative Outcomes Study on Health and Function During Infection Times are needed to better understand the social and behavioral determinants of negative health outcomes during COVID-19, which, in turn, can help shape appropriate, preventive health-promoting policies [58]. As an example, municipalities should consider implementing measures to promote breaking up sedentary behavior while maintaining safe social distancing. One option could be to prohibit automobile traffic in urban neighborhoods on select days or weekends to better enable easily accessible socially distant time spent outdoors, as has already been demonstrated in cities such as Oakland, CA, Boston, MA, and New York, NY [59]. Such policies may not only encourage traditional recreation and moderate-vigorous physical activity but could also facilitate true sedentary behavior interruption strategies, such as an easily accessible 5 min walk outdoors between video (e.g., Zoom) meetings.

At the level of the physical environment, stand-up desks could be implemented for employees who have returned to traditional work environments.

**Table 1** | Best evidence for breaking up sedentary behavior in the context of feasibility and reducing cardiometabolic disease risk

Best evidence for sitting interruption [55]

Frequency	Every 20–30 min
Intensity	Light
Time	2–5 min
Type	Walking and standing



**Fig 2** | Socioecological model of behavior change for sedentary behavior.

Similarly, employers could offer financial assistance to incorporate stand-up desks and/or wearable physical activity monitors at employees' homes for remote workers. Moreover, such action need not be viewed as altruistic as sedentary behavior and cardiometabolic conditions are known to reduce worker productivity and increase employer costs [60, 61].

The individual-level determinants of sedentary behavior are arguably most important to consider in that they are closely related to an individual's locus of control. Unlike exercise, sedentary behavior does not rely on difficult-to-modify determinants higher up in the socioecological model. At the interindividual level, social support to reduce sedentary behavior may include encouraging colleagues to take standing-up or stretching breaks during work-related video meetings or challenging family and friends to friendly step-count competitions via wearable or smart-phone-based physical activity monitors. Technological strategies, such as physical activity monitors, are particularly attractive as they can be implemented/modulated at multiple levels of the socioecological model and have been shown to successfully (a) increase cognitive/emotional constructs related to motivation and positive behavior change, (b) reduce sedentary behavior, and (c) improve health [62–65].

At the intraindividual level, it is critical to consider the factor of enjoyment. Individuals will be more likely to adhere to behavior change if a particular activity is enjoyable [66]. If simply standing or doing repetitive resistance exercises is perceived as a mundane task, continued adherence will be compromised [67]. Health promotion efforts should encourage individuals to seek out creative strategies to interrupt sedentary behaviors that are enjoyable to them—whether that be spending a few minutes gardening throughout the day, dancing along to one's favorite music, or playing with children or pets.

## CONCLUSION

The COVID-19 pandemic is a rapidly changing global health crisis that will likely continue into 2021 and perhaps beyond. Efforts to contain the virus are centered on drastic social restrictions, which threaten cardiometabolic and mental health [35, 68]. Not only are decrements in health concerning in and of themselves, but cardiometabolic diseases and their risk factors predispose individuals to severe COVID-19 outcomes [5, 34]. Behavioral strategies, such as moderate-vigorous physical activity, provide potent protective effects against cardiometabolic disease risk, and such behaviors should of course be encouraged and promoted during COVID-19. However, even under normal circumstances, the difficulty in

promoting healthy physical activity habits are well documented [69]. The chances of maintaining or improving exercise levels during the COVID-19 pandemic is now even more challenging, which is especially true for those segments of the population that are most physically and financially vulnerable. Considering a socioecological model of behavior change in which determinants of behavior change are considered at multiple levels (e.g., individual, environment, and policy), we posit that reducing sedentary behavior is a particularly important behavioral target. Reducing sedentary behavior is a simple strategy that may be more amenable to change compared to increasing exercise, which relies to a greater extent on higher-level environmental and policy-related determinants. Simple, enjoyable low-intensity sedentary behavior interruption strategies should be encouraged by policymakers, health care providers, academic institutions, and other work, social, and family networks to reduce sedentary behavior and promote health in the face of COVID-19.

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