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Commentary

A tale of two pandemics: How will COVID-19 and global trends in physical inactivity and sedentary behavior affect one another?

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The world is experiencing an extraordinary, life-altering challenge due to the COVID-19 pandemic.[1] Many countries have become accustomed to a *new normal* – "social distancing"[2] and "shelter in place"[3] are now a part of everyday vernacular and life. It is hard to predict exactly when the COVID-19 pandemic will subside, and communities will return to normal function; it appears it may be some time before that occurs. One thing that we do not currently know is what lasting effects the COVID-19 pandemic will have on behavior patterns once life begins to *return to normal*.

While of a different nature, the world has been living with another pandemic for a number of years – physical inactivity (PI) and sedentary behavior (SB).[4–6] According to the World Health Organization, 31% of individuals 15 years or older are physically inactive and approximately 3.2 million deaths per year are attributed to this unhealthy lifestyle behavior. Ding et al.[7] et al. reported PI conservatively cost healthcare systems around the world $53.8 billion dollars in 2013. Moreover, deaths attributable to PI cost another $13.7 billion in productivity losses and resulted in 13.4 million disability-adjusted life-years globally. Although PI was defined as a pandemic in 2012,[5] and leading organizations have recognized this crisis and have been championing efforts to increase physical activity (PA),[8,9] insufficient PA trends continue to persist.[10,11] At the current trajectory, Guthold et al.[10] reports the 2025 global PA goal of reducing insufficient PA by 10% will not be met. In this context, all data convincingly indicates the PI pandemic will persist long after we recover from the COVID-19 pandemic - the health and economic impacts of the PI pandemic, for which no end is in sight, will continue to be severe. It is important to note that the aforementioned statistics focus on PI in the context of not meeting recommended PA guidelines (e.g., 150 min or more of moderate intensity PA per week).[12] Increased sitting time/SB, independent of leisure time PA, has also been convincingly shown to be a significant predictor of adverse health outcomes.[13,14] It has been estimated that each additional hour of sitting time results in an increase of $126 in annual healthcare costs in older adults.[15] In fact, the 2018 US Physical Activity Guidelines recognize the detrimental impact of prolonged sitting time and note any reduction in SB and increase in physical movement, even below recommended goals, have significant health benefits, and, as such, support the overarching message of *sitting less and moving more*.[12] Importantly, comparing both adherence to the US Physical Activity Guidelines and sedentary time between 2007–2008 and 2015–2016, Du et al.[11] reported no change in adherence to the PA guidelines but a significant increase in SB. These findings collectively foretell a concerning future where people continue to move less overall and will experience a poorer health trajectory as a result. Perhaps it would be more appropriate at this time to rename the *PI pandemic* to the *sedentarism*[16] *pandemic*.

As noted at the outset of this commentary, the lasting effects of the COVID-19 pandemic will not be fully realized for some time. Given the change in daily life for people around the world as a result of COVID-19, we hypothesize this health crisis has the potential to further impact and accelerate the physical PI/SB pandemic we have been confronted with, and failing to address, for a number of years. Many opportunities to be physically active have been suspended, including outpatient cardiac rehabilitation, school-based physical education and athletic programs, fitness centers and public parks; the infrastructure to be physically active, which was not being utilized by a majority of the global population prior to COVID-19,[8] has been significantly diminished. This is compounded by directives to shelter in place and practice social distancing. There is a significant concern that these factors come together to increase the risk of social isolation, which has been shown to negatively impact mental health, PA patterns and sedentary time across the lifespan as well as increase mortality risk in the elderly.[17] In 100,839 male and female Brazilian adolescents, Werneck et al.[18] noted higher levels of physical activity and decreased sitting time were associated with lower social isolation. In another Brazilian adolescent cohort, Pinto et al.[19] found PA and not participating in physical education classes increased loneliness. For adolescents, social interactions and friendships significantly influence PA behaviors,[20,21] a factor that has assuredly been negatively impacted by shelter in place and social distancing mandates as a result of COVID-19. The influence of social isolation and unhealthy lifestyle choices within a family unit has also been studied. Thompson et al.[22] found a significant correlation between social isolation and an unhealthier lifestyle in parents with adolescent children, which also negatively influenced lifestyle behaviors of their adolescent children. Robins et al.[23] found higher levels of household PA to be associated with lower levels of social isolation in community-dwelling older adults. Schrempft et al.[24] likewise reported time spent in SB was significantly higher and time spent participating in moderate- to vigorous-intensity PA was significantly lower in men and women aged 50 to 81 years who reported being socially isolated compared to those who reported not being isolated.

The question must be asked – is COVID-19 making the world move even less than before? Given the significant blow COVID-19 has

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delivered to the ability for people to leave their homes and engage in regular activities (e.g., school, work, fitness facilities) and utilize community resources (e.g., parks, playgrounds, walking trails), the answer to this question is most certainly yes. If the answer to the first question is yes, the next question becomes will these increased SB persist and become the new societal norms? We are not aware of any available literature that has assessed the lasting effect of pandemics on PA and SB. However, previous research has assessed the lasting impact of natural disasters on PA. Following the 2011 earthquake and tsunami that devastated East Japan, Okazaki et al.[25] reported a lasting significant decrease in PA in children and adolescents over three years following the disaster. Similar research must be conducted after we recover from the COVID-19 pandemic to determine the lasting impact this global crisis may have on PA patterns and sedentary time.

There are efforts to help individuals be physically active during COVID-19 that should be applauded. The American College of Sports Medicine has released information on how to remain active during COVID-19.[26] Numerous fitness centers have also been posting free online workout routines to help people remain active at home.[27,28] Leading health and wellness journalists have also been stressing the importance of continuing to move during COVID-19,[29] noting recent research that taking as little as 4000 steps per day at any pace, which you can do around your house, significantly improves long-term health.[30] Lastly, world renowned exercise and physical activity scholars are also beginning to publish on this topic.[31] While these are certainly positive efforts that must continue, concern remains that individuals who were not previously engaged in a regular exercise routine and led a sedentary lifestyle will not be likely to increase their daily PA during COVID-19 and, in fact, may be moving even less. Bauer et al.[32] highlighted US Centers for Disease Control and Prevention strategies to combat PI including: "1) epidemiology and surveillance to monitor trends and inform programs; 2) environmental approaches that promote health and support healthy behaviors; 3) health system interventions to improve the effective use of clinical and other preventive services; and 4) community resources linked to clinical services that sustain improved management of chronic conditions. Establishment of community conditions to support healthy behaviors and promote effective management of chronic conditions will deliver healthier students to schools, healthier workers to employers and businesses, and a healthier population to the healthcare system." As allowable, components of these strategies should be employed during the COVID-19 pandemic, promoting PA and sitting less while abiding by shelter in place and social distancing recommendations. Once the COVID-19 pandemic has subsided, these strategies should be employed with a renewed vigor to increase PA and decrease SB.[33]

To this point, we have discussed the potential detrimental impacts of the COVID-19 pandemic on PA behaviors and SB. It is important to note that we may also be at risk for a viscous cycle where current and potentially accelerated PI patterns and sedentary behaviors may worsen the impact of future pandemics. Not surprisingly, individuals infected with COVID-19 are much more likely to be hospitalized and have poorer health outcomes if underlying medical conditions, such as one or more chronic disease diagnoses, are present.[34] Moreover, the evidence linking a significantly higher increased risk for chronic disease if you are physically inactive and lead a sedentary lifestyle is beyond dispute.[32,35,36] The intersection between current risks for health complications and mortality rates associated with COVID-19 and the current state of PI and SB cannot be ignored. If the prevalence of chronic conditions brought about by unhealthy lifestyles were lower, would the catastrophic effects of the COVID-19 pandemic be lessened?

In conclusion, we are currently confronted with two pandemics occurring at the same time. The world will recover from the COVID-19 pandemic and so-called normal activities will resume. However, the PI/SB pandemic will continue and, more troublingly, we may be at risk for this pandemic to worsen as a result of COVID-19. As a global society, we simply cannot let this happen. Aggressive efforts need to be taken to get people physically moving again after COVID-19 – at an absolute minimum we need to *hold the line*. However, we should take this opportunity to learn valuable lessons from the COVID-19 pandemic; in particular, how aggressively the world altered societal norms to decrease the spread of this viral infection. Perhaps the world will realize a similar aggressiveness is needed to treat the PI/SB pandemic, improving health outcomes under normal conditions and improving humankind's resiliency during future pandemics.

Statement of conflict of interest

None of the authors have any conflicts of interests with regard to this publication.

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