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PHYSICAL ACTIVITY, HEALTH AND EXERCISE

Relationships between changes in self-reported physical activity, sedentary behaviour and health during the coronavirus (COVID-19) pandemic in France and Switzerland

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ABSTRACT

To assess whether changes in physical activity and sedentary behaviour during the COVID-19 lockdown are associated with changes in mental and physical health. Observational longitudinal study. Participants living in France or Switzerland responded to online questionnaires measuring physical activity, physical and mental health, anxiety, and depressive symptoms. Paired sample t-tests were used to assess differences in physical activity and sedentary behaviour before and during lockdown. Multiple linear regressions were used to investigate associations between changes in physical activity and changes in mental and physical health during lockdown. 267 (wave1) and 110 participants (wave2; 2 weeks later) were recruited. Lockdown resulted in higher time spent in walking and moderate physical activity (~10min/day) and in sedentary behaviour (~75min/day), compared to pre COVID-19. Increased physical activity during leisure time from week 2 to week 4 of lockdown was associated with improved physical health (β=.24, p=.002). Additionally, an increase in sedentary behaviour during leisure time was associated with poorer physical health (β=−.35, p=.002), mental health (β=−.25, p=.003), and subjective vitality (β=−.30, p=.004). Ensuring sufficient levels of physical activity and reducing sedentary time can play a vital role in helping people to cope with a major stressful event, such as the COVID-19 pandemic.

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KEYWORDS
COVID-19 lockdown; physical activity; sedentary behaviour; physical health; mental health

Introduction

At the time of writing, over a quarter of the worldwide population is in containment to slow down the spread of the coronavirus disease 2019 (COVID-19) pandemic. This stressful context likely has detrimental effects on physical and mental health, as chronic stress is associated with neuroendocrine, metabolic, inflammatory, cardiovascular, and cognitive systems dysregulation (Juster et al., 2010). As physical activity has been shown to protect both physical and mental health (Rebar et al., 2015; Warburton et al., 2006), it could help people cope with COVID-19 related stress and mitigate its detrimental effects on health. Conversely, sedentary behaviour, defined as any waking behaviour in a reclining, sitting, or lying position that requires an energy expenditure lower than 1.5 Metabolic Equivalent Task (MET) (Sedentary Behaviour Research Network, 2012), has been shown to have a wide range of relatively independent negative health effects, including adverse metabolic conditions, depression, cognitive decline, quality of life and increased mortality (Boberska et al., 2018; Ekelund et al., 2016; Hamilton et al., 2007; Olanrewaju et al., 2020; Teychenne et al., 2010).

Unfortunately, the COVID-19 pandemic has likely affected people's usual physical activity (Staff, 2020) and sedentary levels for two reasons – a practical one and an affective one. First, the lockdown measures, including gym closures, public movement restrictions and reduced commuting, have dramatically disrupted daily routines. Second, people's stress and anxiety emerging from the risk of contracting the virus may reduce people's inclination to leave their houses to perform their usual activities. While the effects of lockdown measures on commuting behaviours seem relatively obvious (i.e., teleworking and public movement restrictions should decrease the usual time spent in physical activity or sedentary behaviour when commuting), the effects are more difficult to predict in terms of behaviour during leisure time. The increase in potential leisure time may represent an opportunity to foster the development of a more active lifestyle, but may also favour sedentary activities. Despite their potential protective role on people's health during the COVID-19 pandemic, understanding whether changes in physical activity and sedentary behaviour are associated with the COVID-19 lockdown is largely unknown. Beyond this specific major contextual change, this study will investigate whether increases in physical activity and decreases in sedentary behaviour can play a vital role in helping people to cope with major stressful events.

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Our first objective was to assess, relative to before the COVID-19 lockdown, changes in physical activity and sedentary behaviour during commuting and leisure during the COVID-19 lockdown. Our second objective was to investigate whether changes in physical activity and sedentary behaviour during a 2-week period of the lockdown were associated with changes in health indicators. We hypothesized that commuting-related physical activity and sedentary behaviour would be lower during the COVID-19 lockdown in comparison to before the lockdown period (H1). We hypothesized, that leisure time-related physical activity and sedentary behaviour would be, respectively, higher and lower during the COVID-19 lockdown in comparison to before the lockdown period (H2). Finally, we hypothesized that an increase in physical activity during a two-week lockdown would be associated with an improvement in physical and mental health (H3), while an increase in sedentary behaviour would be associated with a poorer physical and mental health (H4).

Method

Statistical power

For power calculation, our main analyses involved multiple linear regressions. Using the G*power 3 software (Faul et al., 2007), and considering a conservative medium effect-size (Cohen's d ~ .5), the typical sample size necessary to reach satisfying statistical power was N = 108 (for a power of 90% and an α-rate of .05). To compensate for potential loss in the follow-up measure, we planned to recruit at least 216 participants. However, the questionnaires remained open for 8 days and the data collection was not terminated before this period, regardless of the amount of collected data.

Participants and procedure

Participants living in France or Switzerland were recruited through social media (Facebook, Twitter, LinkedIn) and word-of-mouth and asked to respond to two short (about 15 mins) online questionnaires administered 2 weeks apart, using a secured web survey hosted by the University of Geneva, Switzerland. To be included in the study, participants had to live either in France or Switzerland. To recruit a sample as large and diverse as possible, no particular groups were targeted and no exclusion criteria were specified. As we sampled widely, we decided to measure potential confounders of the association of change in physical activity and sedentary behaviour with change in physical and mental health (i.e., gender, age, or COVID-19 symptoms).

The first questionnaire was launched on Monday, 30 March, 2 weeks after the start of the lockdown measures in France and Switzerland. The second questionnaire was launched two weeks later on Monday, 13 April (i.e., fourth week of lockdown). All questionnaires remained open for 8 days (Monday of a week to Tuesday of the following week). Participants who answered the first questionnaire and who accepted to provide their email were contacted directly via email to answer the second questionnaire. As an incentive, for each completed questionnaire, a 0.50 Euro donation was made to a study on COVID-19. Usual weekly physical activity and sedentary behaviour before the lockdown were retrospectively assessed in the first questionnaire. The first part of the questionnaire referred to the usual physical activity and sedentary behaviour before the lockdown, while the second part assessed physical activity, sedentary behaviour, and health in the last 7 days.

The restrictive measures decided by the French government and two French-speaking cantons of Switzerland (Geneva and Vaud canton) were implemented in mid-March 2020 for 8 weeks. In both France and Switzerland, schools, bars, restaurants, movie theatres, and fitness centres were closed. Teleworking was highly recommended when possible. In France, apart from essential travels (i.e., work, shops for food or medication, helping of a relative in need), people were allowed to go out for a maximum of 1 hour per day and had to stay within 1 km radius of their house. In Switzerland, people were encouraged to stay home, but did not have formal restrictions related to movement. The only restrictions were to maintain a 2-metre distance and to avoid gatherings with more than five people.

All participants signed an online informed consent form. A total of 273 participants living in France or Switzerland fully completed the first questionnaire (age = 40 ± 18 years; Body Mass Index [BMI] = 22.8 ± 3.7 kg/m^2; 68% women; 77% French). Among these 273 participants, a total of 110 participants (i.e., attrition of 60%) fully completed the second questionnaire (age = 43 ± 19 years; BMI = 23.1 ± 4.0 kg/m^2; 69% women; 76% French). The study was approved by the Ethics Committee of Geneva Canton, Switzerland (CCER2019-00065), and was promoted by the University of Geneva and the Univ. Grenoble Alpes.

Measures

Physical activity and sedentary behaviour during commuting time and leisure time were assessed using the International Physical Activity Questionnaire (IPAQ; Craig et al., 2003). Specifically, the first series of questions focused on commuting-related physical activity (i.e., walking and bicycling) and sedentary behaviour (i.e., commuting using motor vehicle). The second series of questions focused on leisure-time-related physical activity (i.e., walking, moderate physical activity, vigorous physical activity). Finally, the last two questions focused on the time spent sitting during leisure-time and working-time.

Perceived global physical and mental health were assessed using two adapted items of the Patient-Reported Outcomes Measurement Information System (PROMIS) (Hays et al., 2009): "During the last seven days, how would you rate your physical health?"; "During the last seven days, how would you rate your mental health, including mood and your ability to think?". Respondents answered each item on a scale ranging from 1 (*Poor*) to 4 (*Excellent*).

Depressive symptoms were assessed using two adapted items of PROMIS (Cella et al., 2010): "During the last seven days, you felt depressed"; "During the last seven days, you felt desperate". Respondents answered each item on a scale ranging from 1 (*Rarely*) to 4 (*Always*). The items were averaged to create an overall measure of depressive symptoms.

Anxiety was assessed using two adapted items from PROMIS (Cella et al., 2010): "During the last seven days, you felt scared"; "During the last seven days, you had difficulties focusing on anything other than your anxiety". Respondents answered each item on a scale ranging from 1 (*Rarely*) to 4 (*Always*). The items were averaged to create an overall measure of anxiety.

Subjective vitality was assessed using the following items: "At this moment, I feel alive and vital"; "At this time, I have energy and spirit". Respondents answered each item on a scale ranging from 1 (*Strongly disagree*) to 7 (*Strongly agree*) (Forestier et al., 2018; Ryan & Frederick, 1997).

The following variables were used as *potential confounders*: gender, age, BMI, country of residence (France vs. Switzerland), chronic condition (e.g., hypertension, cerebral vascular disease) (yes vs. no), and COVID-19 symptoms (yes vs. no).

Statistical analyses

To assess the influence of the lockdown on physical activity and sedentary behaviour, a series of two-tailed paired sample t-tests (before vs. during the second week of the lockdown) were conducted on physical activity and sedentary behaviour during commuting as well as on walking, moderate physical activity, vigorous physical activity, and sedentary variables during leisure time.

To investigate the associations between changes in physical activity and sedentary behaviour during the COVID-19 lockdown and changes in mental and physical health, multiple linear regressions using a residualized change scores approach were conducted (Zumbo, 1999). This approach eliminates autocorrelated errors and regression towards the mean effects, which often makes it preferable to the simple change scores approach. A positive residualized change score indicates an increase from the second week to the fourth week of the lockdown and a negative score indicates a decrease. For each health-related outcome, the main predictors of the models included the residualized change scores of the time spent in (1) physical activity (i.e., walking behaviours, moderate, and vigorous physical activity) and sedentary behaviour during leisure time, as well as (2) the time spent in physical activity and sedentary behaviour during commuting.

Statistical assumptions associated with linear regressions (normality of the residuals, homogeneity of variance, linearity, multicollinearity, and undue influence) were checked and models were adjusted when required (e.g., outlier removal). All the analyses were conducted using the R software (Team, R. C., 2019).

Results

Descriptive results are shown in Supplementary material 1. For all analyses, interaction terms with country and gender were added to assess whether we observed effects specific to participants' country of residence or gender, which was overall not the case unless otherwise indicated in the results section below (please see supplemental materials for more details).

Influence of the COVID-19 lockdown on physical activity and sedentary behaviour from before to during the lockdown

As expected (H1), the lockdown resulted in less time spent in physical activity (~ −16 min/day, $p < .001$) and sedentary behaviour (~ −28 min/day, $p < .001$) when commuting (Figure 1) – the effect on physical activity when commuting was higher in French sample in comparison to the Swiss sample. During

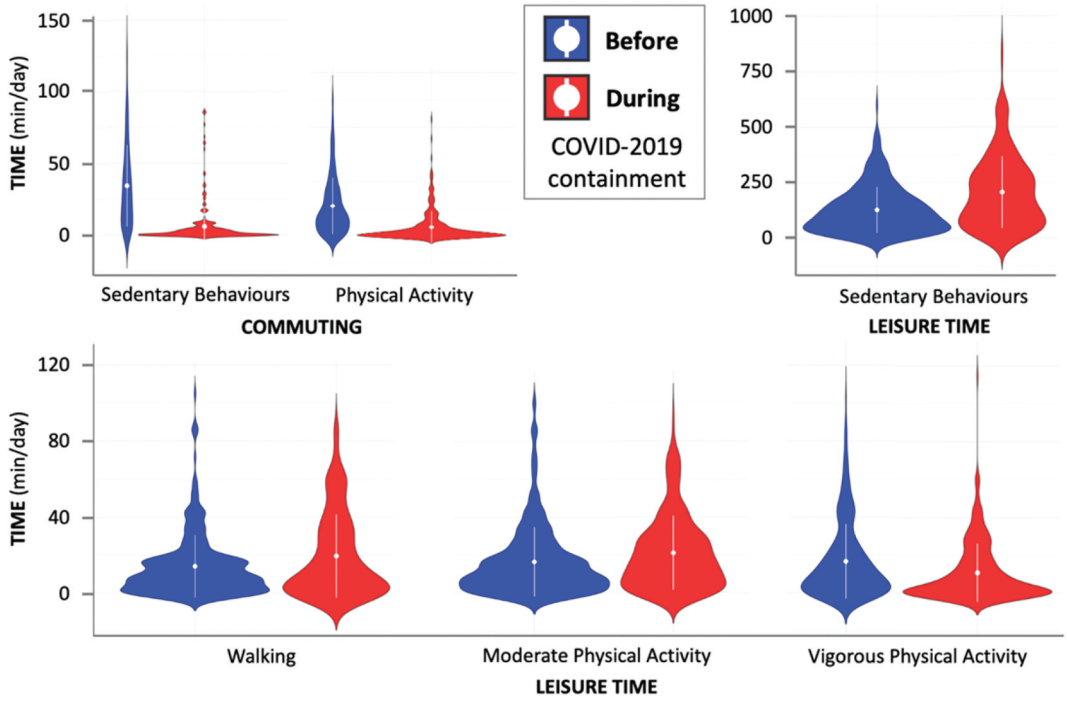

Figure 1. Influence of COVID-19 lockdown on self-reported physical activity and sedentary behaviour. *Note*. The variables were expressed in minutes per day. The white dot represents the mean. The white line represents the standard deviation. On each side of this white line is represented the kernel density plot.

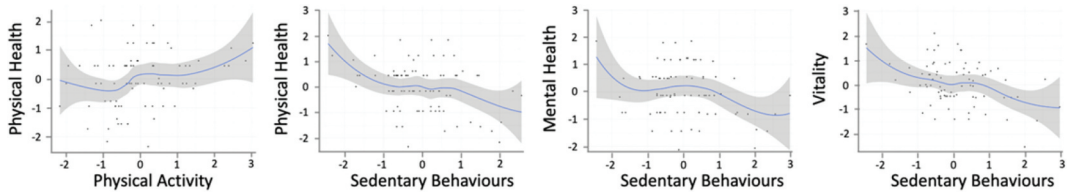

Figure 2. Associations between change in physical and sedentary behaviour and change in physical and mental health during the COVID-19 lockdown. *Note*. The variables were expressed using a residualized change scores approach. The scatterplot illustrates the raw data for all participants. The blue line represents the smooth curve fitting resulting from the locally estimated scatterplot smoothing (LOESS) method. The grey area represents the 95% confidence interval around the fixed effect.

leisure time, as expected (H2), we observed more time spent in sedentary behaviour (~ +77 min/day, $p < .001$), and walking (~ +5 min/day, $p < .001$) and moderate physical activity (~ +4 min/day, $p < .001$) – these last two associations were marginally stronger in women. By contrast, we observed less time spent doing vigorous physical activity (~ −6 min/day, $p < .001$). Full details of the analyses are available in the supplementary materials.

Associations between changes in physical activity and sedentary behaviour during the COVID-19 lockdown and changes in mental and physical health

Results of the multiple linear regressions revealed that an increase in physical activity during leisure time from week two to week four was associated with improved physical health ($\beta = .24$, $p = .002$). By contrast, increased in sedentary behaviour during leisure time was associated with poorer physical health ($\beta = -.35$, $p = .002$), mental health ($\beta = -.25$, $p = .003$), and subjective vitality ($\beta = -.30$, $p = .004$) (Figure 2). No other associations with physical activity and sedentary behaviour were found. The variance explained in the outcomes ranged from about 4% (depressive symptoms) to 17% (physical health). Consequently, these results are in line with our hypotheses 3 and 4, although consistent evidence for a protective effect of physical activity is lacking. Full details of the analyses are available in the supplementary materials.

Supplementary analyses on changes in physical activity and sedentary behaviour, and in the health-related outcomes from week two to week four of the lockdown are available in the supplementary materials.

Discussion

The first objective of this study was to investigate changes in physical activity and sedentary behaviour during commuting and leisure time from before to during COVID-19 lockdown. While the lockdown showed an adverse effect on some behaviours during leisure time, such as a decrease in vigorous physical activity and an increase in sedentary behaviour, the lockdown also showed a beneficial effect by increasing the time spent walking and doing moderate physical activity. Although the differences observed in the time spent in physically active behaviours (a few minutes a day) may seem trivial, this effect is meaningful when considering public health physical activity guidelines (WHO, 2010). For example, an increase in about 10 min a day of walking and moderate physical activity equals about 50% of the 150 min of moderate physical activity per week, while a decrease in about 6 min a day of vigorous physical activity equals about 60% of the 75 min of vigorous physical activity per week. Likewise, although no consensus exists on the definition of too much sedentary time (Stamatakis et al., 2019), the change we evidenced in sedentary behaviour during leisure time (i.e., >1 hour/day) is meaningful in view of the often targeted limit of 4–5 hours/day of sedentary time (Conroy et al., 2013; Maher & Conroy, 2016; Saidj et al., 2015). Moreover, in our sample, the self-reported time spent in sedentary behaviour was below this time limit both before (i.e., 2 hours and 9 min a day) and during (i.e., 3 hours and 25 min a day). Finally, as hypothesized (H1), the restriction of public movement imposed by the lockdown measures resulted in a decrease of both physical activity and sedentary behaviours related to commuting. Yet, these average changes should be interpreted cautiously because of their wide variability across participants, and their small size.

The second objective was to investigate the potential protective effect of physical activity behaviours on physical and mental health during the lockdown. We found evidence that increasing physical activity during leisure time was associated with better physical health, while increasing sedentary time was associated with lower physical and mental health, and vitality. Overall, as hypothesized (H2 and H3), these findings suggest that engaging in physically active behaviours and reducing sedentary behaviour during the COVID-19 lockdown improve health perception. Hence, our study provides support for the idea that the physical and mental health benefits associated with physical activity also apply in the context a major stressful event (Rebar et al., 2015; Warburton et al., 2006), and thereby confirms that physical activity can play a vital role in coping with stressors. Likewise, our study shows not only the positive effects of low level of sedentary behaviours on individuals' physical and mental health (Boberska et al., 2018; Ekelund et al., 2016; Hamilton et al., 2007; Olanrewaju et al., 2020; Teychenne et al., 2010), but also its role in helping individuals to cope with a major stressful event.

The present study has the following strengths. First, we used a questionnaire allowing a fine-grained measure of physical activity dissociating between intensities (walking, moderate, and vigorous) and the context in which physical activity occurs (during commuting or leisure time). Second, we investigated a wide range of indicators linked to both physical and mental health. Third, the longitudinal design allowed to examine the associations between changes in physical activity and sedentary behaviour and changes in health outcomes during the lockdown. However, this study includes five features that limit the conclusions that can be drawn. First, our measure of physical activity was self-reported and retrospective, which may have led

to recall bias and more prone to validity and reliability issues (Bakker et al., 2020; Scott et al., 2007). Second, physical and mental health were assessed by self-reported scales which included few items. Although this strategy allowed a short questionnaire to encourage participation, it potentially diminished reliability and limited the ability to evaluate how physical activity can influence more accurate measures of mental and physical health. Third, the sampled data has two selection biases: a selection bias due to attrition (as inevitable in longitudinal studies) and a second one due to the recruitment procedure that was done mostly online because of the COVID-19 restrictions, which have resulted in an over-recruitment of participants with particular profiles. Overall, these features limit the generalizability of the results. Fourth, a measure of stress (and not only anxiety) could have been added to examine how participants' level of stress might have moderated the effects observed. Finally, we assessed change in health over 2 weeks of the lockdown, which may not be sufficient to observe a significant influence of physical activity on health outcomes.

In conclusion, this study suggests that ensuring sufficient level of physical activity and reducing sedentary time can play a vital role in helping people to cope with a major stressful event, such as the COVID-19 pandemic. The disruption of daily routines resulting from the COVID-19 pandemic could be seen as an opportunity to implement new habits that, in the long term, may foster the development of a more active lifestyle.

Disclosure statement

The authors declare no conflict of interests.

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Ethics approval

This study was approved by the Ethics Committee of Geneva Canton, Switzerland (CCER2019-00065).

Consent to participate

All the participants agreed to participate and signed a written informed consent.

Consent for publication

All the authors listed in the by-line have agreed to the by-line order and to the submission of the manuscript in this form.

Contributors

B.C designed the study protocol and the analyses. All authors critically appraised the planned analyses. B.C., and M.P.B. drafted the manuscript. All authors critically appraised and approved the final version of the manuscript.

Data availability statement

The data that support the findings of this study will be available at https://zenodo.org/deposit/3761833

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