

1 **Relationships Between Changes in Self-Reported Physical Activity, Sedentary**
2 **Behaviours and Health During the Coronavirus (COVID-19) Pandemic in France and**
3 **Switzerland**

4

5 Running head: COVID-19 AND PHYSICAL ACTIVITY

6

7 Boris Cheval^{1,2,*}, Hamsini Sivaramakrishnan³, Silvio Maltagliati⁴, Layan Fessler⁴, Cyril

8 Forestier⁴, Philippe Sarrazin⁴, Dan Orsholits⁵, Aina Chalabaev⁴, David Sander^{1,2}, Nikos

9 Ntoumanis³, & Matthieu P. Boisgontier⁶

10 ¹Swiss Center for Affective Sciences, University of Geneva, Geneva, Switzerland

11 ²Laboratory for the Study of Emotion Elicitation and Expression (E3Lab), Department of
12 Psychology, University of Geneva, Geneva, Switzerland

13 ³Physical Activity and Well-Being Research Group, Department of Psychology, Curtin
14 University, Perth, Australia

15 ⁴Univ. Grenoble-Alpes, SENS, F-38000 Grenoble, France

16 ⁵Swiss NCCR “LIVES – Overcoming Vulnerability: Life Course Perspectives”, University of
17 Geneva, Switzerland

18 ⁶School of Rehabilitation Sciences, Faculty of Health Sciences, University of Ottawa, Ottawa,
19 Canada

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28 All authors have read and approved this version of the manuscript.

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30 The authors can be reached on Twitter @chevalboris @MattBoisgontier

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32 *Corresponding author: Campus, Biotech, Chemin des mines 9, 1202, Genève, Switzerland;
33 boris.cheval@unige.ch; @ChevalBoris (B. Cheval).

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35 **Statement of contribution**

36 **What is already known on this subject?**

- 37 • Stressful contexts may have detrimental effect on physical and mental health.
- 38 • Physical activity protects both physical and mental health, while sedentary behaviours
- 39 have detrimental effects.
- 40 • Whether physical activity can have beneficial effects on people's physical and mental
- 41 health during the COVID-19 pandemic has not been examined.

42

43 **What this study adds?**

- 44 • COVID-19 lockdown was associated with lower leisure-related vigorous physical
- 45 activity and higher leisure-related sedentary activity.
- 46 • COVID-19 lockdown was associated with higher leisure-related walking and
- 47 moderate physical activity.
- 48 • During the COVID-19 lockdown, increase in leisure-related physical activity was
- 49 associated with increase physical health, while increase in leisure-related sedentary
- 50 activity was associated with decrease physical health, mental health, and subjective
- 51 vitality.

52 **Abstract**

53 **Objective.** To assess whether changes in physical activity and sedentary behaviours during the
54 COVID-19 lockdown are associated with changes in mental and physical health.

55 **Design.** Observational longitudinal study.

56 **Method.** Participants living in France or Switzerland responded to online questionnaires.
57 Paired sample t-tests were used to assess differences in physical activity and sedentary
58 behaviours before and during lockdown. Multiple linear regressions were used to investigate
59 the associations between changes in physical activity and changes in mental and physical health
60 during lockdown.

61 **Results.** A total of 267 (wave1) and 110 participants (wave2) were recruited. Lockdown
62 resulted in higher time spent in walking and moderate physical activity (~10min/day) and in
63 sedentary behaviours (~75min/day), compared to pre COVID-19. An increased physical
64 activity during leisure time from week 2 to week 4 of lockdown was associated with increased
65 physical health ($\beta=.24$, $p=.002$). Additionally, an increase in sedentary behaviours during
66 leisure time was associated with a decrease in physical health ($\beta=-.35$, $p=.002$), mental health
67 ($\beta=-.25$, $p=.003$), and subjective vitality ($\beta=-.30$, $p=.004$).

68 **Conclusions.** Changes in physical activity and sedentary behaviours during lockdown are
69 associated with changes in physical and mental health. Ensuring sufficient levels of physical
70 activity and reducing sedentary time during lockdown could benefit individuals' health.

71 *Keywords:* COVID-19 lockdown, physical activity, sedentary behaviours, physical
72 health, mental health

73 **Relationships Between Changes in Self-Reported Physical Activity, Sedentary**
74 **Behaviours and Health During the Coronavirus (COVID-19) Pandemic in France and**
75 **Switzerland**

76 At the time of writing, over a quarter of the worldwide population is in containment to
77 slow down the spread of the coronavirus disease 2019 (COVID-19) pandemic. This stressful
78 context probably has detrimental effects on physical and mental health, as chronic stress is
79 associated with neuroendocrine, metabolic, inflammatory, cardiovascular, and cognitive
80 systems dysregulation (Juster, McEwen, & Lupien, 2010). As physical activity usually protects
81 both physical and mental health (Rebar et al., 2015; Warburton, Nicol, & Bredin, 2006), it could
82 help people cope with COVID-19 related stress and mitigate its detrimental effects on health.
83 Conversely, increased time spent in sedentary behaviours may have negative health effects
84 (Boberska et al., 2018; Ekelund et al., 2016).

85 Unfortunately, the COVID-19 pandemic has likely affected people's usual physical
86 activity (Fitbit Staff, 2020) and sedentary levels for two reasons – a practical one and an
87 affective one. First, the lockdown measures, including gym closures, public movement
88 restrictions and reduced commuting, have dramatically disrupted daily routines. Second,
89 people's stress and anxiety emerging from the risk of contracting the virus may reduce people's
90 inclination to leave their houses to perform their usual activities. While the effects of lockdown
91 measures on transportation behaviours seem relatively obvious (i.e., teleworking and public
92 movement restrictions should decrease the usual time spent in physical activity or sedentary
93 behaviours when commuting), the effects are more difficult to predict in terms of leisure time
94 behaviours. The increase in potential leisure time may represent an opportunity to foster the
95 development of a more active lifestyle, but may also favour sedentary activities. Given their
96 potential role on people's health during the COVID-19 pandemic, understanding whether

97 changes in physical activity and sedentary behaviours associated with the COVID-19 lockdown
98 is warranted.

99 Our first objective was to assess changes in physical activity and sedentary behaviours
100 during transportation and leisure time from before to during COVID-19 lockdown. Our second
101 objective was to investigate whether changes in physical activity and sedentary behaviours
102 during a two-week period of the lockdown were associated with changes in health indicators.
103 We hypothesized a lower time spent in both physical activity and sedentary behaviours for
104 transportation during than before the lockdown period (H1). We hypothesized a higher time
105 spent in both physical activity and sedentary behaviours during leisure time during than before
106 the lockdown period (H2). Finally, we hypothesized that an increase in physical activity during
107 a two-week lockdown is associated with an increase in physical and mental health (H3), while
108 an increase in sedentary behaviours is associated with a decrease in physical and mental
109 health (H4).

110 **Method**

111 **Participants and Procedure**

112 Participants living in France or Switzerland were recruited through social media and
113 word-of-mouth to respond to two short (about 15 mins) online questionnaires two weeks apart.
114 The first questionnaire was launched on Monday March 30, 2 weeks after the start of the
115 lockdown restrictive measures in France and in Switzerland. The second questionnaire was
116 launched on Monday April 13. As an incentive, for each completed questionnaire, a 0.50 euros
117 donation was made by the Swiss National Science Foundation to a study on COVID-19. Usual
118 weekly physical activity and sedentary behaviours before the lockdown were retrospectively
119 assessed in the first questionnaire. Both questionnaires assessed physical activity, sedentary
120 behaviours, and health in the last seven days.

121 All participants signed an online informed consent form. A total of 273 participants
122 living in France or Switzerland fully completed the first questionnaire (age = 40 ± 18 years;
123 Body Mass Index [BMI] = 22.8 ± 3.7 kg/m²; 68% women; 77% French). A total of 110
124 participants fully completed the second questionnaire (age = 43 ± 19 years; BMI = 23.1 ± 4.0
125 kg/m²; 69% women; 76% French).

126 **Measures**

127 *Physical activity and sedentary behaviours* during transportation time and leisure time
128 were assessed using the International Physical Activity Questionnaire (IPAQ; Craig et al.,
129 2003).

130 *Perceived global physical and mental health* were assessed using two adapted items of
131 the PROMIS (Hays, Bjorner, Revicki, Spritzer, & Cella, 2009): “During the last seven days,
132 how would you rate your physical health (*mental health, including mood and your ability to*
133 *think*)? Respondents answered each item on a scale ranging from 1 (*Poor*) to 4 (*Excellent*).

134 *Depressive symptoms* were assessed using two adapted items of Patient-Reported
135 Outcomes Measurement Information System (PROMIS) (Cella et al., 2010): “During the last
136 seven days, you felt depressed (*desperate*)”. Respondents answered each item on a scale
137 ranging from 1 (*Rarely*) to 4 (*Always*).

138 *Anxiety* was assessed using two adapted items from PROMIS (Cella et al., 2010):
139 “During the last seven days, you felt scared (*you had difficulty focusing on anything other than*
140 *your anxiety*)”. Respondents answered each item on a scale ranging from 1 (*Rarely*) to 4
141 (*Always*).

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

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

149 **Statistical Analyses**

150 To assess the influence of the lockdown on physical activity and sedentary behaviours,
151 series of two-tailed paired sample t-tests (before vs. during the second week of the lockdown)
152 were conducted on physical activity and sedentary behaviours during transportation as well as
153 on walking, moderate physical activity, vigorous physical activity, and sedentary variables
154 during leisure time.

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

166 For all analyses, interaction terms with country and gender were added to assess whether
167 we observed effects specific to participants' country of residence or gender, which was overall
168 not the case unless otherwise indicated in the text below (refer to supplemental materials for
169 more details). Statistical assumptions associated with linear regressions (normality of the

170 residuals, homogeneity of variance, linearity, multicollinearity, and undue influence) were
171 checked and models were adjusted when required (e.g., outlier removal).

172 **Results**

173 **Influence of the COVID-19 Lockdown on Physical Activity and Sedentary Behaviours** 174 **from Before to During COVID-19**

175 As expected (H1), the lockdown resulted in lower time spent in physical activity (-15
176 min/day, $p < .001$) and sedentary behaviours (-29 min/day, $p < .001$) when commuting (Figure
177 1) – the effect on physical activity when commuting was higher in French than in Switzerland
178 inhabitants ($p = 0.15$). During leisure time, as expected (H2), we observed more time spent on
179 sedentary behaviours (+76 min/ day, $p < .001$), and on walking (+5 min/day, $p < .001$) and
180 moderate physical activity (+4 min/day, $p < .001$) – these last two associations were marginally
181 stronger in women. By contrast, we observed less time spent doing vigorous physical activity
182 (-6 min/day, $p < .001$). Full details of the analyses are available in the supplementary materials.

183 **Associations Between Changes in Physical Activity and Sedentary Behaviours During the** 184 **COVID-19 Lockdown and Changes in Mental and Physical Health**

185 Results of the multiple linear regression revealed that an increase in physical activity
186 during leisure time from week 2 to week 4 was associated with an increased physical health (β
187 = .24, $p = .002$). By contrast, an increase in sedentary behaviours during leisure time was
188 associated with a decrease in physical health ($\beta = -.35$, $p = .002$), mental health ($\beta = -.25$, $p =$
189 $.003$), and subjective vitality ($\beta = -.30$, $p = .004$) (Figure 2). No other associations with physical
190 activity and sedentary behaviours were found. The variance explained in the outcomes ranged
191 from about 4% (depressive symptoms) to 17% (physical health). Consequently, these results
192 are in line with our hypotheses 3 and 4, although consistent evidence for a protective effect of
193 physical activity is lacking. Full details of the analyses are available in the supplementary
194 materials.

219 physically active behaviours and reducing sedentary behaviours during the COVID-19
220 lockdown improve health perception.

221 The present study has the following strengths. First, we used a questionnaire allowing a
222 fine-grained measure of physical activity dissociating between intensities (walking, moderate,
223 and vigorous) and the context of physical activity (during transportation or leisure time).
224 Second, we investigated a wide range of indicators linked to both physical and mental health.
225 Third, the longitudinal design allowed to examine the associations between changes in physical
226 activity and sedentary behaviours and changes in health outcomes during the lockdown.
227 However, this study includes three features that limit the conclusions that can be drawn. First,
228 although our measure of physical activity was self-reported and retrospective, which may have
229 led to recall bias. Second, physical and mental health were assessed by self-reported scales
230 which included few items. Although this strategy allowed a short questionnaire to encourage
231 participation, it potentially diminished reliability and limited the ability to evaluate how
232 physical activity can influence more accurate measures of mental and physical health. Finally,
233 we assessed change in health over two weeks of the lockdown, which may not be sufficient to
234 observe a significant influence of physical activity on health outcomes.

235 In conclusion, the disruption of daily routines resulting from the COVID-19 pandemic
236 could be seen as an opportunity to implement new habits that, in the long term, may foster the
237 development of a more active lifestyle.

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241

242 **Competing interests**

243 The authors declare no conflict of interests.

244

245 **Ethical approval**

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

248

249 **Consent to participate**

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

251

252 **Consent for publication**

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

255

256 **Contributors**

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

260

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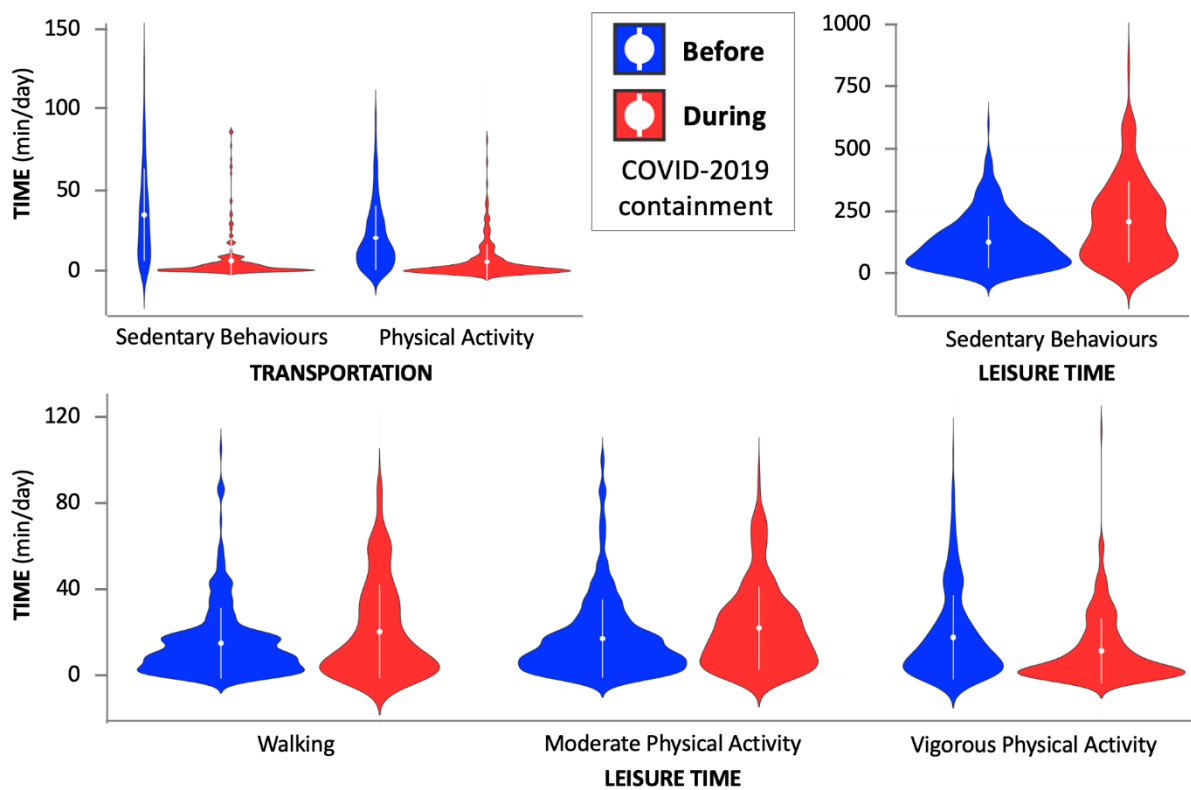
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312

313 **Figure 1**

314 *Influence of COVID-19 lockdown on self-reported physical activity and sedentary behaviours*



315

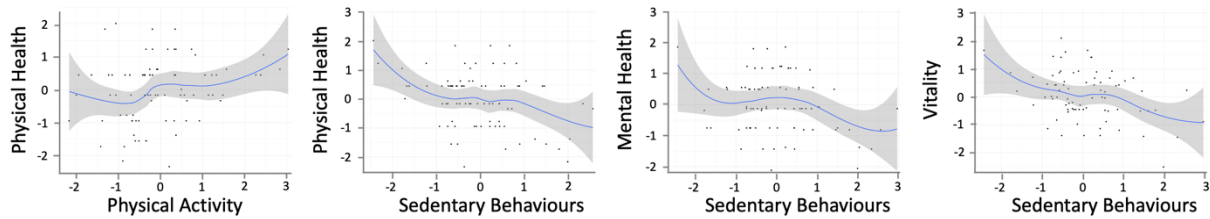
316 *Note.* The variables were expressed in minutes per day. The white dot represents the

317 mean. The white line represents the standard deviation. On each side of this white line is

318 represented the kernel density plot.

319 **Figure 2**

320 *Associations between change in physical and sedentary behaviours and change in physical*
 321 *and mental health during the COVID-19 lockdown*



322

323 *Note.* The variables were expressed using a residualized change scores approach. The
 324 scatterplot illustrates the raw data for all participants. The blue line represents the smooth
 325 curve fitting resulting from the locally estimated scatterplot smoothing (LOESS) method.
 326 The grey area represents the 95% confidence interval around the fixed effect.