

Stress, physical activity, and screen-related sedentary behaviour within the first month of the COVID-19 pandemic

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Abstract

This study investigated how stress, physical activity and sedentary behaviours, of a small sample of Canadians, changed within the first month (i.e. March/April) of the COVID-19 pandemic and the reasons/barriers associated with such changes. Individuals who regularly wear activity trackers were recruited via social media. Participants ($N = 121$) completed fillable calendars (March/April 2020) with their step counts and answered an online survey. Separate paired-sample t -tests, one-way ANOVAs and bivariate chi-squares were conducted, in addition to qualitative analysis. Daily ($p < .001$) and work ($p = .003$) stress increased, physical activity (measured by step count) decreased ($p = .0014$), and screen-related sedentary behaviour increased ($p < .001$) as a result of COVID-19. A decrease in physical activity, as a result of the pandemic, was also associated with a larger increase in work stress, compared with those who self-reported their physical activity to have been maintained or increased ($p = .005$). The most common reasons/barriers to changes in physical activity behaviours were access/equipment, time and motivation. Findings provide initial evidence of the impact of the COVID-19 pandemic on the health of some Canadians and highlight the need for continued monitoring of the health of Canadians throughout the pandemic.

KEYWORDS

COVID-19, pandemic, physical activity, sedentary behaviour, stress, wearable activity trackers

INTRODUCTION

On 11 March 2020, the World Health Organization (WHO) declared the novel coronavirus (SARS-CoV-2), which causes COVID-19, to be a global pandemic (WHO, 2020). By late-March, all provinces and territories in Canada had declared a state of emergency or a public health emergency (Dawson, 2020). Subsequently, various federal and provincial public safety measures were enacted in order to limit the spread of the COVID-19. Canadians were asked to practise physical distancing (i.e. remain at least 2 m (6 feet) away from others), to self-isolate and only leave their homes for essential errands and to quarantine if they had been exposed to the virus or returned from international travel (Government of Canada, 2020; Ontario Government, 2020). Other measures included the closure of non-essential businesses (e.g. gyms/recreation centres and non-grocery stores), as well as the closure of public spaces (e.g. parks and hiking trails; Ontario Government, 2020). With over 9,000 confirmed COVID-19 cases in Canada by the end of March 2020 and over 90,000 cases by the start of June 2020, the COVID-19 pandemic has resulted in substantial lifestyle changes for many Canadians, especially in regard to stress and mental health (Statistics Canada, 2020c), physical activity (Ontario Government, 2020) and screen-related sedentary behaviour (Statistics Canada, 2020b).

Specifically, more than half of Canadians who filled out Statistics Canada's (2020a) survey 'Impacts of COVID-19 on Canadians: Your mental health' between 24 April and 11 May 2020 reported poorer mental health since the onset of physical distancing/self-isolating associated with the pandemic. Moreover, nearly all participants (88%) reported at least one symptom of anxiety (e.g. depression, grief, panic) in the two weeks prior to completing the survey (Stats Canada, 2020a). One means of combatting poor mental health, especially during the COVID-19 pandemic, could be through physical activity (Kar et al., 2020; Kecmanovic, 2020; Statistics Canada, 2020c). Yet, lack of access to public spaces such as parks and hiking trails, as well as temporary closures of gyms/recreation centres, has had inevitable implications for physical activity. Despite the known benefits of physical activity for both physical and mental health, <1 in 5 Canadian adults met the current guidelines of 150 min per week of moderate- to vigorous-intensity aerobic exercise (Canadian Society for Exercise Physiology, 2020; Statistics Canada, 2019) prior to COVID-19 pandemic. Thus, the potential for even lower physical activity adherence rates (and its associated mental and physical health implications) as a result of a significant and substantial increase in barriers to physical activity during the pandemic is a probable reality (Chen et al., 2020). For example, a recent study by Rhodes et al. (2020) reported a significant decrease in self-reported perceived moderate-to-vigorous physical activity as a result of pandemic-related restrictions among a sample of just over one thousand Canadian adults. Moreover, using objectively measured physical activity data collected through a national physical activity promotion application, moderate-to-vigorous physical activity dropped significantly as a result of the onset of the pandemic, yet seemed to rebound 6 weeks later (Di Sebastiano et al., 2020). Lastly, the Canadian Perspectives Survey Series March/April (Statistics Canada, 2020b), which collected data from 29 March to 3 April 2020, reported that 63% and 68% of Canadians were spending more time on the Internet and watching TV, respectively, compared with before the pandemic.

As a result, a call to action by Sallis et al. (2020) urged researchers to investigate the associations between physical activity and COVID-19 parameters, including the need to develop methods for measuring physical activity during the pandemic and to identify factors that influence physical

activity during such unprecedented times. Therefore, the purpose of this study was to investigate how stress, physical activity and screen-related sedentary behaviour changed within the first month of the COVID-19 pandemic (March/April 2020). Two research questions (RQs) were specifically developed:

RQ #1: How did stress, physical activity (objectively and subjectively measured) and screen-related sedentary behaviour levels change during the initial month of the COVID-19 pandemic (March/April 2020)?

RQ #2: What were the main reasons/barriers to the change in physical activity behaviour?

MATERIALS AND METHODS

Procedure and participants

The study was listed in the International Network of COVID-19 and Physical Activity Research (INCPAR) Repository (as suggested by Sallis et al., 2020) yet not registered. Upon receiving University of Windsor Research Ethics Board Clearance (REB# 20–069), participants (18 years of age and older) were recruited during the month of April (2020) via a social media advertisement posted on Facebook, Instagram and Twitter, asking those who regularly wear activity trackers to contact the research team via email. The social media advertisement was originally shared by the researchers on their personal pages, and they encouraged friends/followers, community organisations and the university to repost and share the advertisement as well. Upon contact, an information letter, a survey link and fillable calendar of the month of March were emailed to prospective participants. If after two days the survey had not been completed and/or the calendar not returned, a reminder email went out to the participants. In total, 167 potential participants emailed the research team. Upon completion of the survey and return of the calendar, participants had a chance to win a \$25 grocery/gas gift card (1 in 50 chance).

Measures

Step count

Objective physical activity was measured using daily step count (i.e. steps/day), as recorded from their wearable activity tracker (such as those made by Apple, Fitbit, Samsung and Garmin) that was collected via a fillable calendar. Mobile phones with step counts were not accepted as activity trackers. Participants were asked to go to the application or online portal associated with their activity tracker to retroactively record their step counts for each day of March in the fillable calendar. Although the WHO (2020) declared COVID-19 a pandemic on 11 March, 'pre' and 'post' pandemic average step counts were determined for each participant based on the date each individual began physical distancing/self-isolating (or in some cases, quarantining) as a result of the pandemic ($M = 16$ March 2020, $SD = 4.7$ days, range = 13–31 days).

Wearable activity trackers have become popular because of their functionality and potential to provide individualized feedback when paired with a smartphone (An et al., 2017). Numerous devices and models exist (e.g. Apple Watch, Fitbit, Samsung and Garmin), all with varying capabilities and functionalities, and although differences in validity exist between devices for measuring step count

under different/various conditions (An et al., 2017; Bunn et al., 2018; Case et al., 2015; Kooiman et al., 2015; Storm et al., 2015), the purpose of comparison was not between devices, but rather within people (over time). An assessment of 10 different consumer activity trackers suggested high reliability for test–retest reliability (Kooiman et al., 2015), and given the difficulties/challenges of assessing physical activity in free-living individuals, the use of activity trackers was deemed appropriate for use in the current study.

Survey

Participants were also asked to complete a survey administered via Qualtrics XM (Provo, UT), which took approximately 20–25 min. All participants provided informed consent upon beginning the survey. Most questions were generally taken and/or adapted from validated and/or national surveys. The survey asked about physical activity behaviours, barriers and changes that occurred as a result of the COVID-19 pandemic, in addition to questions specific to COVID-19, stress/coping, lifestyle behaviours and demographics (e.g. gender, age, employment status and country). As previously mentioned, participants identified the day they began physical distancing/self-isolating as a result of the pandemic (including an option that they had not begun doing so) and this day (specific to each participant) was used to determine pre- and post-COVID-19 comparisons across all variables. Participants also confirmed they usually wear their activity tracking device at least 10 hr/day.

Daily stress was asked using two separate questions (i.e. pre- and post-COVID-19) 'Thinking about the amount of stress in your life, would you say that most days were/are?' with responses graded from 1 (not at all stressful) to 5 (extremely stressful; Statistics Canada, 2020d). Work stress was asked using two separate questions (i.e. pre- and post-COVID-19) 'Would you say that most days at work were/are' with response options ranging from 1 (not at all stressful) to 5 (extremely stressful) (Statistics Canada, 2020d).

Subjective physical activity time (minutes/week) was measured using the question 'Prior to the COVID-19 pandemic [or "In the past 7 days"], how many times did you participate in moderate or vigorous physical activity? Please note, moderate or vigorous physical activity causes and increase in breathing and heart rate' with response options of 1–7 days/week (Sampasa-Kanyinga & Chuput, 2017; Statistics Canada, 2020d). This question was followed up with 'On days that you were active, what was the average amount of time (in minutes) per day that you participated in moderate or vigorous physical activity?' (Sampasa-Kanyinga & Chuput, 2017; Statistics Canada, 2020d). Responses were multiplied to calculate a weekly physical activity time (minutes/week).

Physical activity behaviour change as a result of the COVID-19 pandemic was asked with a newly developed question: 'Since the COVID-19 pandemic, do you think that your physical activity has' with response options of 'decreased a lot', 'decreased a little', 'stayed the same', 'increased a little' and 'increased a lot'. Responses were collapsed into 'decreased', 'stayed the same' and 'increased'. In order to assess reasons/barriers to the change in physical activity, participants were qualitatively asked: 'If there has been a change in your physical activity behaviour, why?' to which they responded open-endedly.

Pre- and post-COVID-19 screen-related sedentary behaviour was measured with two questions (pertaining to weekdays and weekends): 'On a school or workday [or "On a day that was not school or a workday"], how much of your free time do you spend watching TV or a screen on any electronic device while sitting or lying down' (Statistics Canada, 2020d). Response options included '2 hr or less per day', 'more than 2 hr but less than 4 hr', '4 hr to less than 6 hr', '6 hr to less than 8 hr', '8 hr or more per day' and 'was not at school or work'. Data were transformed into a continuous variable:

'60 min (2 hr or less per day)', '180 min (more than 2 hr but less than 4 hr)', '300 min (4 hr to less than 6 hr)', '420 min (6 hr to less than 8 hr)' and '540 min (8 hr or more per day)' and then prorated (by 5 or 2 days) and divided by 7 to capture pre- and post-COVID-19 average daily sedentary time (minutes/day).

Data analysis

Minimal step count data were missing (5%; 197 data points out of a possible 3,751); as such, the average daily step counts were calculated using the step count divided by the total number of days with data. Separate paired-sample *t*-tests were conducted to determine whether there were statistically significant differences between pre- and post-COVID-19 stress (daily and work), objective step count (steps/day), subjective physical activity (minutes/week) and screen-related sedentary time (minutes/day) changes. Effect sizes were measured using Cohen's *d*. Four separate one-way ANOVAs, with the Tukey post hoc testing, were conducted to determine whether there was a statistically significant difference between those that decreased, maintained or increased their physical activity and stress (daily and work), objective step count (steps/day) and sedentary time (minutes/day). Effect sizes were measured using omega-squared. Bivariate chi-square analyses were used to test the association between reasons/barriers to physical activity changes themes and physical activity changes categories (decreased, maintained and increased). Effect sizes were measured using Cramer's *V*. All statistical procedures were completed using the Minitab 17 computer software (Minitab, State College, PA, USA), with a level of significance set at $p < .05$. Moreover, given the current study's focus on health-related outcomes, no corrections for multiple comparisons were completed, as suggested by Althouse (2016) and Rothman (1990).

Qualitative data were analysed using a thematic analysis (Braun & Clarke, 2006). After a familiarization period, two of the authors (SJW and PC) discussed possible themes within the data set and a codebook was mutually agreed upon. The coding of themes was then completed independently with each comment potentially being coded into different themes (thus potentially overlapping). Once all data were coded, the coders met to discuss any differences and agree upon final themes (similar to Santarossa et al., 2019).

RESULTS

Among the 167 participants who responded to the advertisement, 142 completed the survey and 132 provided valid pedometer data, resulting in a final data set of 132 participants (107 women, 23 men and 1 cis) from Canada ($n = 121$), the United Kingdom ($n = 8$), the United States ($n = 2$) and New Zealand ($n = 1$). Due to the small number of international participants ($n = 11$), they were removed from the current analysis to focus only on Canadian participants ($N = 121$). Table 1 describes the participant demographics, in which the majority of the sample was Caucasian ($n = 115$; 88%), female ($n = 96$; 80%), with a mean age of 36.2 years (± 13.12 ; ranged from 18 to 77 years). Most participants lived in Ontario ($n = 115$; 95%) and had a university certificate, diploma or degree at the bachelor's level or above ($n = 86$; 72%). Prior to COVID-19, the majority of participants worked outside the home (i.e. 68% versus 26% other/student/retired/unemployed and 6% working inside the home), whereas post-COVID-19, the majority were other/student/retired/unemployed (45%) compared with working from inside the home (40%) or working outside the home (15%).

TABLE 1 Participant demographics ($N = 121$)

Characteristic	Frequency	%
Gender		
Male	23	19
Female	96	80
Cis	1	1
Age (years)	36.2 ± 13.12 ^a	18–77 ^b
Province		
British Columbia	1	0.8
Alberta	2	1.7
Ontario	115	95
Quebec	2	1.7
New Brunswick	1	0.8
Ethnicity		
Caucasian	104	88
South Asian	1	0.9
Chinese	2	1.5
Filipino	1	0.9
Latin American	1	0.9
Arab	1	0.9
West Asian	1	0.9
Other/mixed	7	6
Education		
High school or equivalent	9	7
College, cegep or other non-university certificate or diploma	20	17
University certificate or diploma below bachelor level	5	4
University certificate, diploma or degree at bachelor level or above	86	72

^aMean and standard deviation.

^bRange.

RQ#1: Changes in stress, physical activity (objectively and subjectively measured) and screen-related sedentary behaviour during the first month (i.e. March/April 2020) of the COVID-19 pandemic

Pre- and post-COVID-19 differences between daily stress, work stress, daily step count, self-reported physical activity time (minutes/week) and sedentary time (minutes/week) are presented in Table 2. Most notably, step count significantly decreased over the month ($p = .004$), yet self-reported physical activity time was maintained ($p = .450$). Furthermore, an equal number of participants reported an increase ($n = 55$; 45%) or decrease ($n = 55$; 45%) in physical activity, with the remaining participants reporting no change ($n = 11$; 10%).

As such, Table 3 breaks down stress (daily and work), step count and screen-related sedentary behaviour by those reporting that their physical activity increased, maintained or decreased. Daily step

TABLE 2 Stress, physical activity and screen-related sedentary behaviour pre- and post-COVID-19 pandemic

	Pre	Post			Cohen's <i>d</i>
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>t</i> (<i>df</i>)	<i>p</i>	
Stress					
Daily stress (1–5) ^a	2.8 (0.9)	3.4 (0.9)	<i>t</i> (117) = –6.28	<.001	0.74
Work stress (1–5) ^a	2.7 (0.8)	3.1 (1.3)	<i>t</i> (108) = –3.03	.003	0.37
Physical activity					
Step count (steps/day)	9,509 (3,390)	8,497 (3,620)	<i>t</i> (107) = 2.92	.0014	0.29
Subjective physical activity (min/week)	289.1 (213.8)	272.5 (205.9)	<i>t</i> (115) = –13.02	.45	0.08
Screen-related sedentary behaviour					
Sedentary time (min/day)	181.9 (117.9)	299.6 (136.6)	<i>t</i> (117) = –11.41	<.001	0.92

^aHigher numbers indicate greater amounts of stress

count decreased more in those who reported decreasing their PA ($M = -2,038$, $SD = 3,755$) compared with those who reported increasing PA ($M = -134$, $SD = 3,406$), $F(2,107) = 4.00$, $p = .021$. Moreover, the change in screen-related sedentary behaviour was greater for those who decreased their PA behaviour ($M = 154.0$ min/day, $SD = 108.1$) compared with those who reported increasing PA ($M = 85.1$ min/day, $SD = 107.9$), $F(2,117) = 5.57$, $p = .005$. Lastly, no differences in physical activity behaviour were observed for those who experienced changes in daily stress, yet the change in work stress was greater for those who decreased their PA behaviour ($M = 0.8$, $SD = 1.0$) compared with those who reported no change ($M = -0.6$, $SD = 1.5$) or increasing PA ($M = 0.2$, $SD = 1.4$), $F(2,106) = 5.66$, $p = .005$.

RQ #2: Main reasons/barriers to changes in physical activity behaviour

Qualitatively, eight themes emerged as to why participants had a change in their physical activity behaviour including the following: access/equipment, incidental movement, motivation, time, coping, change in physical activity type, being sick/quarantined and to compensate for increased food consumption. Descriptively, Table 4 includes the frequency of the themes, with access/equipment ($n = 57$), time ($n = 47$) and motivation ($n = 33$) cited most frequently. Access/equipment, the most cited reason for a change in physical activity ($n = 57$ times), was more frequently mentioned for those decreasing their physical activity (72%, $n = 41$) than those who increased (25%, $n = 14$), $p < .001$. Participants mentioned 'I do not have access to my typical gyms and do not own weights to simulate previous exercise habits' (male, 29 years), 'Gym closing, inadequate exercise equipment' (female, 27 years) and 'I don't work out nearly as long or hard because I'm not at the gym. The weather has not been the best so it's hard to go for a run outside or even a walk' (female, 23 years). Oppositely, for those who increased their physical activity, access/equipment was noted as 'I bought a bike, so I bike a couple hours when the weather is good' (female, 30 years) and 'My CrossFit membership [previously] allowed only 13 classes per month, now I have access 6x [times] a week at home via online classes so I can participate more' (male, 35 years).

TABLE 3 Stress, step count and screen-related sedentary behaviour among participants reporting their physical activity decreased, stayed the same or increased as a result of the COVID-19 pandemic

	Decrease (<i>n</i> = 55)	Stay the same (<i>n</i> = 11)	Increase (<i>n</i> = 55)			
	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>M</i> (<i>SD</i>)	<i>F</i>	<i>p</i>	ω^2
Stress						
Change in daily stress (1–5) ^a	0.8 (0.9)	0.6 (1.4)	0.5 (1.2)	<i>F</i> (2, 115) = 1.51	.225	0.009
Change in work stress (1–5) ^a	0.8 (1.0) ^A	−0.6 (1.5) ^B	0.2 (1.4) ^B	<i>F</i> (2, 106) = 5.66	.005	0.079
Step count						
Pre-COVID–19 steps/day	9,446 (3,407)	8,657 (2,793)	9,397 (3,458)	<i>F</i> (2, 118) = 0.26	.773	0.012
Post-COVID–19 steps/day	7,623 (3,594)	8,558 (3,682)	9,414 (3,477)	<i>F</i> (2, 105) = 3.08	.05	0.037
Change in steps/days	−2038 (3,755) ^A	−99 (2,481)	−134 (3,406) ^B	<i>F</i> (2, 107) = 4.00	.021	0.053
Screen-related sedentary behaviour						
Pre-COVID–19 screen-related sedentary behaviour time (min/week)	163.2 (104.3)	201.8 (129.9)	196.2 (127.3)	<i>F</i> (2, 115) = 1.23	.297	0.004
Post-COVID–19 screen-related sedentary behaviour time (min/week)	317.1 (136.2)	304.7 (146.5)	281.3 (135.2)	<i>F</i> (2, 115) = 0.93	.398	−0.001
Change in sedentary behaviour time	154.0 (108.1) ^A	102.9 (107.1)	85.1 (107.9) ^B	<i>F</i> (2, 115) = 5.57	.005	0.072

Note: Post hoc Tukey test suggests that A ≠ B.

^aHigher numbers indicate greater amounts of stress.

The second most commonly cited barrier/reason to a change in physical activity was time (*n* = 47) and was cited more frequently among those increasing their physical activity (79%, *n* = 37) as opposed to decreasing physical activity (21%, *n* = 10); for example 'I have so much more time throughout the day to be active in ways I enjoy without feeling rushed or having other commitments to fill my time' (female, 25 years), 'I have more time to exercise now. My classes at the fitness centre have discontinued so now I am exercising at home more. I am trying to get my husband out walking more. I have less things to do in my day, so I have more time' (female, 61 years) and 'I have time since I am working from home, I don't have to worry about getting sweaty, I ride the stationary bike while doing zoom calls when no video is required I feel like I need it to create some routine and control in my day' (female, 49 years). However, time was also noted by those who decreased their physical activity. For example, participants stated 'Not enough time, gym is closed, not a lot of outdoor space, and no

TABLE 4 Barriers/reasons to a change in physical activity since the COVID-19 pandemic

	Decrease (<i>n</i> = 55)		Stay the same (<i>n</i> = 11)		Increase (<i>n</i> = 55)		χ^2	<i>p</i>	Cramer's <i>V</i>
	%	(<i>n</i>)	%	(<i>n</i>)	%	(<i>n</i>)			
Access/equipment (<i>n</i> = 57)	72%	(41)	3%	(2)	25%	(14)	χ^2 (2, <i>N</i> = 121) = 30.661	<.001	0.253
Incidental movement (<i>n</i> = 21)	62%	(13)	5%	(1)	33%	(7)	χ^2 (2, <i>N</i> = 121) = 2.858	.24	0.024
Motivation (<i>n</i> = 33)	55%	(18)	3%	(1)	42%	(14)	χ^2 (2, <i>N</i> = 121) = 2.750	.253	0.025
Time (<i>n</i> = 47)	21%	(10)	0%	(0)	79%	(37)	χ^2 (2, <i>N</i> = 121) = 35.583	<.001	0.026
Coping (<i>n</i> = 12)	33%	(4)	0%	(0)	67%	(8)	χ^2 (2, <i>N</i> = 121) = 2.960	.228	0.027
Change in PA type (<i>n</i> = 24)	21%	(5)	17%	(4)	62%	(15)	χ^2 (2, <i>N</i> = 121) = 7.796	.02	0.028
Being sick/quarantine (<i>n</i> = 5)	100	(5%)	0%	(0)	0%	(0)	χ^2 (2, <i>N</i> = 121) = 6.259	^a	0.029
Compensate for increased food consumption (<i>n</i> = 2)	0%	(0)	0%	(0)	100%	(2)	χ^2 (2, <i>N</i> = 120) = 2.486	^a	0.030

^aCould not be calculated due to the small cell size.

childcare' (female, 38 years), 'Change to home workouts, less time management, more time spent taking care of family' (male, 23 years) and 'Not as much free time' (female, 40 years).

The third most commonly cited barrier/reason to a change in physical activity was motivation ($n = 33$) yet was not significantly different those who decreased, maintained or increased their physical activity. Participants mentioned 'Inability to go to the gym, lack of desired equipment, slightly less motivation' (female, 27 years), 'Gym has been closed and I find it hard to work out alone' (female, 31 years) and 'No gym classes so must work out at home to videos. Not as motivating as being in a group class' (female, 52 years). Opposingly, other participants mentioned an increase in motivation such that the 'Gym is no longer open so forced to do things at home - might as well exercise with my family to promote good health (physical and mental). Knowing I can help them keeps me motivated, in addition to having more time to work out as I am no longer working due to COVID-19 (just online school rather than both)' (female, 25 years) and 'I have more time to exercise as I'm not at work. My partner is also home, so I have someone to exercise with' (male, 47 years).

DISCUSSION

The purpose of this study was to examine how stress, physical activity and screen-related sedentary behaviour of Canadians changed within the first month (March/April 2020) of the COVID-19 pandemic. Overall, the current findings provide initial support for the importance of promoting and facilitating physical activity and limiting screen-related sedentary behaviour during the COVID-19 pandemic. This study also follows a call to action by Sallis et al. (2020) to explore the effects of the COVID-19 pandemic on physical activity, with the aim to help inform public policy surrounding the current, and future, pandemic(s).

According to Statistics Canada (2020a, 2020c), the COVID-19 pandemic is associated with increases in stress and anxiety, as well as worsening mental health for Canadians, especially for women. Also, as many Canadians are working the frontlines, adapting to new ways of working, and/or having other significant changes in their day to day life, the COVID-19 pandemic has inherently introduced new stressors to the lives of Canadians (Jones, 2020). Overall, the findings of this study support those of Statistics Canada (2020a, 2020c), as participants reported significantly higher daily and work stress as a result of COVID-19. In addition, when grouping participants based on their self-reported ratings of physical activity (i.e. decrease, maintain and increase), there were no differences between groups in regard to the change in daily stress as a result of the COVID-19 pandemic. However, compared with participants who self-reported their physical activity to have maintained or increased within the first month of the pandemic, those who self-reported a decrease in their physical activity had a significantly greater change (increase) in their work stress. Despite significant increases in both daily and work stress across participants, it appears as though greater work-related increases in stress (e.g. working the frontline, change of work environment, working remotely, financial worries) had more significant impacts on participants' abilities to maintain their pre-COVID-19 levels of physical activity as a result of the pandemic. These findings align with research by Stults-Kolehmainen and Sinha (2014) and Weinstein et al. (2017) who suggested that higher stress (in this case work stress) is associated with decreases in physical activity. However, this study provides additional insight that it is particularly work stress at the onset of COVID-19 pandemic that interfered with participants' abilities to maintain their physical activity.

Within the first month of the COVID-19 pandemic, significant decreases in participants' step count were observed. Specifically, prior to the COVID-19 pandemic, participants in the current study, most of whom are women, were accumulating more steps per day (i.e. just over 9,500 steps/day) compared

with Canadian women (i.e. 8,400 steps/day) in Colley et al.'s (2011) nationally representative study. However, as a result of the pandemic, average step count in the current study dropped to just under 8,500 steps/day, much closer to the national average previously determined by Colley et al. (2011). In addition, the current findings support those of Pépin et al. (2020) who examined physical activity during the COVID-19 pandemic across multiple countries (including Canada) and reported a decrease in step count relative to the severity of isolation and quarantine orders throughout the COVID-19 pandemic. However, when participants in the current study were asked to subjectively report the number of physical activity minutes they accrued pre and post the COVID-19 pandemic, no statistical differences were reported. Although such contradictory results could be partially related to recall bias and participants inaccurately reporting their physical activity behaviour from the previous month, it appears as though the discrepancy may also be reflective of participants' reduction in incidental physical activity and non-purposeful activity (e.g. chores, basic hygiene, walking to work; Tremblay et al., 2007) caused by the public safety measures and restrictions put in place to limit the spread of COVID-19 among Canadians. For example, although there was no evidence of statistical differences in the number of self-reported physical activity minutes pre- and post-COVID-19 pandemic, many participants did note that working from home, leaving the home only for essential errands and/or having no access to recreation centres/public places decreased the amount of low-intensity or incidental physical activity they typically accrued throughout the day prior to the COVID-19 pandemic. As incidental physical activity contributes more to total energy expenditure in some people than dedicated periods of physical activity (McGuire & Ross, 2011; Tremblay et al., 2007), the results of the current study highlight the potential damaging and adverse effects that the COVID-19 pandemic is having on the physical health of Canadians, even if they have maintained pre-COVID-19 pandemic intentional physical activity levels.

Results of the current study also demonstrated that screen-related sedentary behaviour levels increased significantly for all participants, with those who reported decreasing their levels of physical activity observing greater increases in sedentary behaviour. These findings are consistent with results from the Canadian Perspectives Survey Series (March/April) released by Statistics Canada (2020b), which evaluated levels of screen-related sedentary behaviour during the COVID-19 pandemic. As screen-related sedentary behaviour is associated with adverse health outcomes (Tremblay et al., 2010; Warren et al., 2010), public awareness surrounding the risks associated with sedentary behaviour, especially during the current pandemic, is warranted. The current findings stress the importance and necessity of public health interventions to address screen-related sedentary behaviour during a global pandemic. Public health interventions are especially important when, as in the current pandemic, it is uncertain how long stay at home orders and closures will last and, as a consequence, how long the increase in screen-related sedentary behaviour will persist.

Access to equipment, time and motivation were the three most common reasons/barriers participants used to explain changes in their physical activity behaviour. For participants who reported a decrease in physical activity, access to equipment was the most cited reason/barrier. This finding emphasizes the important role of gyms and fitness trainers continuing to offer their services during the pandemic and identifies a key opportunity for those individuals working in the health and fitness industry. Moreover, some participants who identified access/equipment as a reason/barrier to the increase in their levels of physical activity noted that they were able to purchase additional equipment to allow them to continue to exercise from home or were able to continue paying for a gym membership that switched to providing online workouts that could be performed with limited equipment. It should be noted that most participants in the current study were most likely of moderate- to higher socioeconomic status (i.e. 72% of participants had a university certificate, diploma or degree at the bachelor level or above, and all had already purchased wearable activity trackers), which may have provided them means to purchase new

gym equipment or access paid-for online fitness classes, affording them the opportunity to continue their fitness regimen at home (Pampel et al., 2010). The ability to continue a gym membership virtually or to purchase new gym equipment is not available for many Canadians and highlights the potential financial implications of the COVID-19 pandemic even further. Time was the second most cited reason/barrier to changes in physical activity and mainly acted as a facilitator for participants who reported increasing their physical activity behaviour. For example, many participants reported that working from home allowed them more flexibility and opportunity to exercise. This finding is unsurprising as lack of time is often noted as a barrier to physical activity (Godin et al., 1994; Hoare et al., 2017).

Limitations

Despite the need for research examining associations between the COVID-19 pandemic and numerous health outcomes (e.g. stress, physical activity and sedentary behaviour) and this study's contribution to the Sallis et al. (2020) call to action, it is not without its limitations. First, the study had a small sample size ($N = 121$) with the majority of participants being educated, younger adult women living in Ontario, which could be attributed to the nature of data collection of using wearable activity trackers. As such, the results are not generalizable to the Canadian population, but could provide some evidence for how the pandemic is affecting educated, younger adult women living in Ontario.

Users of wearable activity trackers are most often women in their 30s who have pursued higher education (Friel & Garber, 2020). Along those lines, not all participants wore the same brand/type of activity tracker, so it is possible that comparisons between people may not be entirely accurate. Yet, there is evidence supporting validity and inter-device reliability of step counts between different types of wearable activity tracker devices (Evenson et al., 2015). Third, research by Friel and Garber (2020) suggested that individuals wearing activity trackers report greater levels of physical activity compared with those no longer wearing an activity tracker. Therefore, it is likely that our sample population engaged in more physical activity prior to the COVID-19 pandemic than the general population and our findings may not translate to those who do not regularly wear an activity tracker.

Additionally, correcting (or not) for multiple comparisons is a subject of great debate among researchers, especially for those conducting health-related research. The current study did not correct for multiple comparisons (Althouse, 2016; Rothman, 1990), but acknowledge that not all researchers hold the same views regarding this subject.

Also, although participants confirmed typically wearing their activity tracker 10 + hours/day, it would have been beneficial to include the device wear time as a covariate in the quantitative analyses. Finally, participants responded subjectively about their levels of stress, physical activity screen-related sedentary behaviour alongside the objective wearable activity tracker data, with self-report data being subject to recall and social desirability bias (Prince et al., 2008; van de Mortel, 2008). It should also be noted that the transformation of sedentary behaviour from a categorical to continuous variable may have influenced the current results. However, data collection occurred in a timely manner and used reliable and valid survey questions to mitigate such biases as much as possible.

CONCLUSION

This study responded to the call to action by Sallis et al. (2020) by examining how stress, physical activity and screen-related sedentary behaviour changed with the first month of the COVID-19 pandemic for Canadians. Current findings provide initial evidence that daily stress and work stress

have increased, that physical activity levels (as measured by step count) have significantly declined as a result of the pandemic, and that screen-related sedentary behaviour has also increased. The study also suggested a decrease in physical activity, as a result of the pandemic, is associated with a larger increase in work stress, compared with those who self-reported their physical activity to have been maintained or increased. Lastly, these findings were contextualized with reasons/barriers to changes in physical activity. Overall, such findings emphasized the importance of promoting and facilitating physical activity and limiting screen-related sedentary behaviour during a pandemic. However, more research is needed to examine the ongoing impact of the COVID-19 pandemic on stress, physical activity (especially using objective measures) and sedentary behaviours, especially as restrictions are lifted and/or Canadians adapt to the pandemic in the long term.

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CONFLICT OF INTEREST

The authors declare that they have no competing interests.

ETHICAL STATEMENT

The University of Windsor Research Ethics Board cleared this project (REB# 20–069).

DATA AVAILABILITY STATEMENT

The dataset is available by contacting Dr. Sarah Woodruff (woodruff@uwindsor.ca).

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