



## **Changes in Physical Activity During the COVID-19 Pandemic: A Mixed Methods Assessment**

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### ABSTRACT

*International Journal of Exercise Science* 16(5): 327-341, 2023. COVID-19 was declared a global pandemic in March 2020. Resulting containment protocols altered the day-to-day lives of people around the globe, impacting typical physical activity patterns. The purpose of this mixed-method study was to understand how physical activity changes occurred during the first few months of the COVID-19 pandemic. Participants ( $n = 271$ ) completed a survey including a qualitative item asking for descriptions of how their physical activity had changed, as well as a categorical item asking whether they had become more active, stayed equally as active, or become less active during the pandemic. Qualitative responses were analyzed to identify emergent themes, and chi-squared analyses were used to compare proportional differences in themes according to self-reported physical activity classification. Analysis revealed 10 themes: (1) decreased transportation-related physical activity, (2) change in location, (3) loss of resources, (4) discrepancies between self-reported changes in activity level and description of activities, (5) increased transportation-related physical activity, (6) changes in routines, (7) adapting exercise, (8) avoiding contact, (9) changes unrelated to COVID-19, and (10) illness or injury. Significant differences existed between groups for all themes except for avoiding contact, changes unrelated to COVID-19, and injury or illness. Empowering individuals to overcome barriers may be important during a pandemic to help people maintain or increase physical activity levels. Future research should explore the continued experience of people during the COVID-19 pandemic and investigate its impact on levels of physical activity going forward.

**KEY WORDS:** Coronavirus, qualitative, international, population, survey

### INTRODUCTION

Near the end of 2019, the first cases of the novel coronavirus SARS-CoV-2 (COVID-19) were detected in China. As the number of cases in China and other countries increased, COVID-19

was declared as a pandemic by the World Health Organization (WHO) (12). To address the ongoing outbreak, public health organizations recommended measures such as isolation, quarantine, social distancing, and community containment as no specific therapeutics or vaccines existed (35). During the Spring of 2020, most countries adopted these practices, with some countries such as Italy, Japan, South Korea, and Sri Lanka as early as February (5).

The measures used to control the spread of COVID-19 caused everyday life to become more restricted. In most countries, only essential workers reported to physical locations for work while others worked from home, were furloughed, or were terminated (27). Additionally, many social activities were canceled and locations closed including concerts, bars, restaurants, and gyms (6). These changes had a cascading effect on people's daily lives, altering individual levels of physical activity. Stockwell and colleagues (32) found that in 25 studies participants reported decreases in physical activity post-COVID-19 lockdown compared to pre-COVID-19 levels.

As lockdown protocols began, researchers investigated how and why physical activity changed. In a scoping review, Caputo and Reichert (7) found that most studies focused on the relationship between social distancing and levels of physical activity. Overall, these studies have shown a reduction in physical activity (9, 15, 21) and an increase in sedentary behaviors during the pandemic (3). Some evidence suggests that participant descriptions of how their routines have changed reveal the mechanisms of such changes (14, 18). For example, Kaur and colleagues (18) conducted semi-structured interviews and found that during the initial phase of the pandemic, many individuals experienced psychological disturbances, such as reduced motivation, stress, and anxiety, as well as an overdependence on social media that may have led to a reduction in physical activity levels. Furthermore, they report that some participants who maintained their level of physical activity engaged in coping strategies such as cognitive restructuring of the situation, searching for substitutes to gym workouts, and using music as a motivational tool for exercise (18). In a second qualitative study, parents of children with Autism Spectrum Disorder reported experiencing barriers related to safety concerns, lack of opportunities such as gyms or parks, and a lack of knowledge about physical activity (14). Beyond these early reports, little evidence has been published to understand the nature of physical activity changes in the months following the declaration of COVID-19 as a global pandemic.

To help fill the gap in the literature, the purpose of this study was to understand the nature of changes in physical activity during the first several months of the COVID-19 pandemic as described by participants. Descriptions of their activity paired with self-reported changes in physical activity level will help provide context to participants' experiences during the pandemic. We anticipate that the emergent themes identified in these data may highlight mechanisms of change in physical activity levels and inform physical activity promotion efforts under strained circumstances like those experienced early in the pandemic.

## METHODS

### *Participants*

A total of 998 English-speaking participants from 35 countries around the world were recruited through Prolific (prolific.co), an online participant recruitment system (M(SD)age = 28.62 (10.24), 49.25% female) for the parent project. Most participants lived in continental Europe (52%), UK/Ireland (28%), or North America (17%). A majority of participants identified as White or Caucasian (81.8%), followed by Hispanic or Latino/a (6.9%), Asian/Pacific Islander (6.8%), "Other" (2.6%), Black or African American (1.7%), and Native American (0.2%). On average, participants rated themselves slightly above the midpoint on the MacArthur scale of subjective social status (M = 5.55, SD = 1.51 on the 1-10 scale) (1). Regarding education, 1.8% of respondents had not completed high school, 22.3% of respondents had a high school degree or equivalent, 20.5% completed some college, 6.0% had a 2-year degree, 31.1% had a Bachelor's degree, 14.4% had a Master's degree and 2.4% had a Doctoral or professional degree.

### *Protocol*

Data were collected online as part of an ongoing longitudinal international investigation of how COVID-19 affected cooperation (16, 37). All protocols received institutional approval. This research was carried out fully in accordance with the ethical standards of the International Journal of Exercise Science (23). Sociodemographic information was collected in March 2020. Participants completed a new survey for participation in the parent project once every two weeks. On July 23<sup>rd</sup>, 2020, physical activity data for this exploratory study were collected. Participants were asked to categorically identify whether they had become more active, stayed equally as active, or become less active compared to before the COVID-19 pandemic, and describe their changes in physical activity with an open response field for qualitative data collection. Specifically, participants were asked: "Next, think about your activity patterns before the Covid-19 pandemic response compared to your activity patterns now. How have your activity patterns changed? Think about the physical activity setting (in the gym, at home, outside, inside), the social context (group vs alone), the types of equipment used, the type of activities you performed, the frequency and duration of activity (how often and how long), and the intensity of the activity (how hard is the exercise)." Participants were given unlimited space in which to type their response to this qualitative item.

Responses to the open-ended item were paired with the item asking participants if they were (a) more active, (b) less active, or (c) equally active to give additional context to responses. Only participants who entered responses contextualizing their physical activity in the open-ended field were included in the initial data analysis. Responses from participants were reviewed and responses that did not include information about how physical activity levels changed were excluded from the final analysis. The remaining responses were coded into meaning units. Statement coding was reviewed to ensure accuracy and emergent coding themes were compiled. The frequency and proportion of times that themes were mentioned was calculated and reported for the total sample, as well as according to self-reported physical activity change group.

*Statistical Analysis*

One sample chi-squared tests were used to compare proportions of participants who reported becoming more active, remaining equally as active, or becoming less active. A one-way ANOVA was used to assess differences in age and self-reported SES between activity level groups. Chi-squared tests were also used to assess proportional differences between groups for sex, region of residence, educational status, race/ethnicity, and themes of physical activity change derived from the qualitative data.

**RESULTS**

Out of the 998 adults included in the parent project, 679 (68%) participants indicated categorically whether they had become more active, stayed equally as active, or become less active. Previous analyses indicated that this sample was more likely to have become less active ( $n=287$ ; 42.3%) or stay equally as active as before the pandemic ( $n = 265$ ; 39%) than to have become more active ( $n=127$ ; 18.7%) (36). From this sample, a total of  $n = 627$  (92.3%) participants responded to the qualitative item asking for descriptions of how their physical activity had changed. Responses that did not provide descriptive information about changes in behavior ( $n = 356$ ; 56.8%) were excluded. Examples of excluded responses include 'no change,' 'yes,' 'no,' as well as those left blank or containing non-sense characters (e.g., 'asoifaohkjade'). The remaining  $n = 271$  (43.2%) responses were included for the purpose of this study and were assessed for common themes then analyzed according to self-reported change in physical activity level.

Demographic characteristics of the total sample and sample subgroups are displayed in Table 1. The sample was mostly white (80.4%), young women (54.4%; mean(sd) age of 28.8(10) years) with at least some college education (77.8%), residing in Europe (55.4%). The sample included residents of 33 different countries with the United Kingdom ( $n = 67$ ), Portugal ( $n = 47$ ), and Poland ( $n = 35$ ) having the greatest representation, followed by Canada ( $n = 15$ ), Mexico ( $n = 13$ ), Spain ( $n = 13$ ), and Greece ( $n = 10$ ). The remaining nations (Australia, Austria, Belgium, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hungary, Ireland, Israel, Italy, Latvia, Netherlands, New Zealand, Norway, Scotland, Slovenia, South Korea, Sweden, Switzerland, and the United States) were represented by  $n < 10$  participants per country.

As was observed in the full study population (36), participants were more likely to report becoming less active (50.9%) than becoming more active (26.6%;  $p < .001$ ) or staying equally as active (22.5%;  $p < .001$ ). Activity subgroups did not differ in age ( $p = .95$ ), self-reported SES ( $p = .30$ ), region of residence ( $p = .99$ ), or educational status ( $p = .35$ ). Women were more likely to become less active than to remain equally as active and men were more likely to remain equally as active than to become less active ( $\chi^2(df) = 6.42(2)$ ;  $p = .04$ ; adjusted standardized residual = |2.2|). People of Hispanic descent were more likely to report becoming less active than staying equally as active or becoming more active ( $\chi^2(df) = 18.56(8)$ ;  $p = .02$ ; adjusted standardized residual = |2.0|), and individuals reporting "other" race/ethnicity were more likely to become more active than to remain equally as active or become less active ( $\chi^2(df) = 6.42(2)$ ;  $p = .04$ ;

adjusted standardized residual = |3.6|). Among reports of “other” racial/ethnic background were 1 “Mediterranean”, 1 “middle eastern”, and 5 “mixed”.

**Table 1.** Descriptive statistics for sociodemographic variables of the total sample and physical activity subgroups during the pandemic response.

Demographic variables	Total sample	More active	Equally as active	Less active
<i>n</i> (%)	271 (100)	72 (26.6) <sup>a</sup>	61 (22.5) <sup>b</sup>	138 (50.9) <sup>a,b</sup>
Age yrs, m(sd)	28.8 (10.0)	28.6 (9.9)	28.5 (9.0)	28.9 (10.6)
<i>n</i> (%) Female	147 (54.2)	37 (51.4)	26 (42.6) <sup>a</sup>	84 (60.9) <sup>a</sup>
<i>n</i> (%) Region				
Europe	151(55.4)	40 (55.6)	34 (55.7)	77 (55.8)
North America	37 (13.7)	9 (12.5)	9 (14.8)	19 (13.8)
UK/Ireland	71 (26.2)	19 (26.4)	15 (24.6)	37 (26.8)
Other	12 (4.8)	4 (5.6)	3 (4.9)	5 (3.6)
<i>n</i> (%) Educational Status				
High school/GED or less	57 (21.0)	13 (18.1)	14 (23.0)	30 (21.7)
Some college	57 (21.0)	11 (15.3)	12 (19.7)	34 (24.6)
2-yr degree	12 (4.4)	6 (8.3)	3 (4.9)	3 (2.2)
4-yr degree	93 (34.3)	27 (37.5)	24 (39.3)	42 (30.4)
Master’s degree	36 (13.3)	8 (11.1)	7 (11.5)	21 (15.2)
Doctoral degree	6 (2.2)	3 (4.2)	0 (0.0)	3 (2.2)
Professional degree	7 (2.6)	2 (2.8)	1 (1.6)	4 (2.9)
<i>n</i> (%) Race/Ethnicity				
Asian/Pacific Islander	16 (5.9)	5 (6.9)	3 (4.9)	8 (5.8)
Hispanic/Latino(a)	24 (8.9)	3 (4.2) <sup>a</sup>	4 (6.6) <sup>b</sup>	17 (12.3) <sup>a,b</sup>
White/Caucasian	218 (80.4)	55 (76.4)	54 (88.5)	109 (79.0)
Black/African American	3 (1.1)	0 (0.0)	0 (0.0)	3 (2.2)
Other	7 (2.6)	6 (8.3) <sup>a,b</sup>	0 (0.0) <sup>a</sup>	1 (0.7) <sup>b</sup>
SES self-rating, m(sd)	5.7 (1.4)	5.7 (1.7)	6.0 (1.4)	5.6 (1.3)

<sup>a,b</sup>Significant difference between groups with the same superscript letter for the respective variable.

Analysis of the open-ended responses revealed 10 themes: (1) decreased transportation-related physical activity, (2) change in location, (3) loss of resources, (4) discrepancies between self-reported changes in activity level and description of activities, (5) increased transportation-related physical activity, (6) changes in routines, (7) adapting exercise, (8) avoiding contact, (9) changes unrelated to COVID-19, and (10) illness or injury. Table 2 displays the number of responses identified for each theme and their percentage of total responses within the total sample as well as by subgroup.

**Table 2.** Emergent themes and chi-squared tests of differences between subgroups

n(%) Theme	Total sample n = 271	More active n = 72	Equally active n = 61	Less active n = 138
Decreased Transportation	79 (29.2)	3 (4.2) <sup>a</sup>	7 (11.5) <sup>b</sup>	69 (50.0) <sup>a,b</sup>
Change in Location	62 (22.9)	24 (33.3) <sup>a</sup>	18 (29.5) <sup>b</sup>	20 (14.5) <sup>a,b</sup>
Loss of Resources	45 (16.6)	4 (5.6) <sup>a</sup>	0 (0.0) <sup>b</sup>	41 (29.7) <sup>a,b</sup>
Discrepancies	35 (12.9)	7 (9.7) <sup>a</sup>	25 (41.0) <sup>a</sup>	3 (2.2) <sup>a</sup>
Increased Transportation	31 (11.4)	20 (27.8) <sup>a</sup>	8 (13.1) <sup>a</sup>	3 (2.2) <sup>a</sup>
Changes in Routines	31 (11.4)	14 (19.4) <sup>a</sup>	7 (11.5)	10 (7.2) <sup>a</sup>
Adapting Exercise	31 (11.4)	24 (33.3) <sup>a</sup>	6 (9.8) <sup>a</sup>	1 (0.7) <sup>a</sup>
Avoiding Contact	24 (8.9)	3 (4.2)	5 (8.2)	16 (11.6)
COVID-19 Unrelated	12 (4.4)	1 (1.4)	5 (8.2)	6 (4.3)
Illness/Injury	3 (1.1)	0 (0.0)	1 (1.6)	2 (1.4)

<sup>a,b</sup>Significant difference between groups with the same superscript letter for the respective variable. Themes were not mutually exclusive. Participant responses were coded for all themes to which they applied.

**Decreased Transportation-Related Activity:** The most often mentioned theme was decreased transportation-related physical activity (29.2%). We used the definition of transportation-related activity proposed by the Centers for Disease Control and Prevention: “physical activity undertaken for the purpose of getting from place to place, which may include walking, jogging, biking, or any other physically active method of getting from one place to another” (10). Some participants related the loss of transportation-related activities to changes in work-related transportation (e.g., “I’m much less active as I usually cycle to work and back but now I’m working remotely”), while others reported change related to fewer outings more generally (e.g., “I used to go out more; which made me walk more; now I’m mostly at home”). Participants who reported becoming less active were more likely to indicate decreased transportation-related activity than those who increased or maintained their physical activity ( $\chi^2(df) = 60.03(2); p < .001$ ; adjusted standardized residual = |7.7|). Indeed, reduced transportation related activity was the most frequently identified theme among those who reported becoming less active. The proportions of individuals mentioning a reduction in transportation-related activity was not significantly different between groups who increased or maintained their physical activity ( $p = .11$ ).

**Change in Location:** A change in the location where participants participated in physical activity was the second most (22.9%) frequently mentioned theme. For example, participants reported exercising at home (“...before the pandemic I used to go to the gym; but now I train at home with my dumbbells”), and outside (“Instead of going to a gym to use a treadmill I run/walk in the nearby park and forest”) instead of at a gym. Though this theme was mentioned among the three groups at relatively high rates, participants who indicated becoming less active were significantly less likely to mention this theme than those who increased or maintained their physical activity ( $\chi^2(df) = 11.48(2); p = .003$ ; adjusted standardized residual = |3.3|). Groups who became more active or remained equally as active did not significantly differ ( $p = .64$ ). A change in location was one of the two most frequently reported themes among those who became more

active and was the second most frequently reported theme among those who maintained their physical activity level.

**Loss of Resources:** Participants reported loss of access to resources needed to participate in planned physical activity (16.6%) (e.g., "I am disabled and the large part of my exercise routine was in the pool sadly I haven't been able to do this at all") and loss of opportunities to participate in exercise classes (e.g., "Both my dance and barre classes have been cancelled..."). Not surprisingly, participants who reported becoming less active were more likely to indicate a loss of resources impacting their physical activity than those who became more active or maintained their activity ( $\chi^2(df) = 35.31(2); p < .001$ ; adjusted standardized residual = |5.9|). Loss of resources was the second most frequently indicated theme among those who reported becoming less active. The proportions of individuals mentioning a loss of resources was marginally different between groups who became more active (5.6%) or remained equally as active (zero;  $p = .06$ ).

**Discrepancies in Answers:** For some of the participants, discrepancies existed between self-identified change in physical activity and qualitative descriptions of changes in physical activity (12.9%). While each group (more active, equally active, less active) had responses indicating a discrepancy between the self-reported items, most of the contradictory responses were made by participants classified as remaining equally as active during the pandemic. Participants who reported remaining equally as active were significantly more likely to make comments that contrasted with their categorical self-identification than those in either of the other groups ( $\chi^2(df) = 51.93(2); p < .001$ ; adjusted standardized residual = |7.1|). Among participants in the equally active response group, 41.0% had discrepancies between their reported levels of physical activity and descriptions of physical activity. Participants' answers describe both increases in physical activity (e.g., "I started doing individual exercises like yoga and going for runs; which I didn't before but I still play basketball with a few friends around twice per week; similar to before"), and decreases, (e.g., "I walk less; since I stay home more; and that's it. I wasn't very active before either").

Those who became more active were significantly more likely to make contrasting statements about changes in their physical activity level than those who reported becoming less active ( $\chi^2(df) = 4.44(1); p < .04$ ; adjusted standardized residual = |2.1|). Within the more active group, 9.7% of participants' responses contradicted their self-reported change in physical activity. Some participants responses indicated no change in physical activity level (e.g., "My activity pattern has not changed because I was always exercising at home and I was going for jogging on the streets") while others indicated a decrease in physical activity (e.g., "Before covid I was going to the gym and more social life. And to get to some places I had to walk; therefore, I was spending less time sitting and more time walking").

The participants indicating decreased levels of physical activity had the lowest percentage of discrepancies in answers, with only 2.2% of responses being contradictory. Among these

participants, all incidents of discrepancies indicated no change in levels of physical activity. For example, “[t]hey haven't changed much besides the time of day when I exercise; I used to do it early in the morning; now I do it throughout the day.”

**Increased Transportation-Related Activity:** In contrast to reports of reduced transportation-related physical activity, another theme was an increase in transportation-related physical activity (11.4%). Most of these responses were observed in the more active group (64.5%). For example, “[b]efore covid I only walked to the bus station for work; now I go to work by bicycle 2 times a week.” Not surprisingly, this theme was mentioned more frequently by participants in the more active group compared to the other groups ( $\chi^2(df) = 30.84(2); p < .001$ ; adjusted standardized residual = |5.1|) and was the third most frequently observed theme in the more active group. Additionally, those in the equally active group (25.8%) reported increased transportation-related physical activity more frequently than those in the less active group (9.7%;  $\chi^2(df) = 9.70(1); p = .002$ ; adjusted standardized residual = |3.1|).

**Changes in Routine:** Participants (11.4%) mentioned having more time to commit to planned physical activity due to changes in routines from quarantine and lockdowns: “During pandemic I had more time to do home workout.” Though participants did state concern about maintaining physical activity levels when returning to their old schedule (e.g., “I exercise a lot more since the all this started. Actually; I don't [know] how I'm going to handle times to exercise when I go back to work”). Participants who classified themselves as having become more active (19.4%) were more likely than those who became less active (7.2%) to mention a change in routine contributing to their changes in physical activity ( $\chi^2(df) = 6.95(2); p < .03$ ; adjusted standardized residual = |2.5|). Proportional differences between the group that maintained their physical activity and the other groups were not significant ( $p \geq .21$ ).

**Adaptation of Exercise:** The theme of adapting exercise was primarily identified in responses from the more active group (33.3%) and was one of the two most frequently identified themes in this group. Participants reported adapting their exercise programs by adjusting mode, duration, frequency, and intensity (e.g., “More cardio and less strength since COVID”). The more active group was significantly more likely to report adaptations of exercise practices than the other two groups ( $\chi^2(df) = 49.86(2); p < .001$ ; adjusted standardized residual = |6.8|). Additionally, the group that maintained their physical activity was more likely than the group that became less active to report adapting their exercise routine ( $\chi^2(df) = 10.35(1); p = .001$ ; adjusted standardized residual = |3.2|).

**Avoiding Contact:** Another emergent theme was avoiding social contact. Some individuals did not indicate the reason for doing so--simply reporting “[l]ess social contact,” for example--while others explicitly mention fear of the virus (e.g., “I started to exercise more at home. I resigned from my gym membership (gyms are opened here, but I'm too scared to come back because of covid). I walk instead of using public transport”). Though most of these responses came from



the less active group (66.7%), proportional differences between groups did not reach statistical significance ( $\chi^2(df) = 3.27(2); p = .19$ ).

**Changes Unrelated to COVID-19:** Some of the changes in reported physical activity level were unrelated to COVID-19 and the associated quarantine or lockdown protocols (4.4%). Some participants indicated that increases in physical activity came from changes in the weather that were conducive to increased activity: "Frequency changed because it is summer now; so I do jogging more often." Others indicated that other health ailments limited activity: "Since I'm not allowed to do any strenuous exercise [*sic*] any more I have to keep my blood pressure normal..." Again, proportional differences between groups did not reach statistical significance ( $\chi^2(df) = 3.62(2); p = .16$ ).

**Injury or Illness:** One participant indicated that changes in physical activity levels were caused directly by contracting COVID-19 and subsequent health complications ("[d]ue to having covid 19 and then pneumonia my activity has decreased as I have been u[na]ble to do even minimal activity") while two participants indicated illness or injury caused their change in physical activity levels. Groups did not differ according to the frequency of mentioning illness or injury as impacting their physical activity levels ( $\chi^2(df) = 1.11(2); p = .57$ ).

## DISCUSSION

In this study, we employed a mixed-method design to explore differences in physical activity level changes (increase, decrease, or maintain) during the pandemic according to descriptions of change in physical activity. We found 10 main themes which included (1) decreased transportation-related physical activity, (2) change in location, (3) loss of resources, (4) discrepancies between self-reported changes in activity level and description of activities, (5) increased transportation-related physical activity, (6) changes in routines, (7) adapting exercise, (8) avoiding contact, (9) changes unrelated to COVID-19, and (10) illness or injury. In addition, we found differences in the reported frequency of these themes between groups, specifically regarding changes in location, loss of resources, discrepancies in answers, increased transportation-related physical activity, changes in routines, and adapting exercise.

Among the subset of participants that provided qualitative responses, the majority (50.2%) reported becoming less physically active. This is consistent with previous findings (7), of samples becoming less physically active during the pandemic. Of those participants who reported becoming less physically active, the majority were female (60.9%). Differences in physical activity between men and women have been reported previously but consistent findings about the relationship between sex and pandemic-related changes in physical activity have not been found (4, 20, 33). For example, in a sample of ( $n = 2,524$ ) Italian adults, Maugeri et al. (22) found that men had a greater reduction in energy expenditure than women during the

pandemic response. In contrast, Rhodes et al. (28) found that among Canadian adults ( $n = 1,055$ ), gender did not have a significant relationship with change in physical activity. Despite the difference existing in the present sample, none of the responses of the participants indicated a sex-related reason for the changes in their activity level. For example, none of the participants indicated childbirth or pregnancy as a reason for changes in physical activity.

A significant difference did exist for those who identify as Hispanic with most reporting that they became less physically active. Previous research has shown Hispanic samples more likely to be less physically active than White Americans, though differences existed based on countries of origin rather than ethnicity (24). Similarly, a significant difference existed between groups among those who identified as other for race. However, it is difficult to draw conclusions from the ethnic differences observed in our study due to the lack of ethnic diversity in our sample.

Decreases in transportation-related physical activity were the most frequently observed theme in the responses and were reported primarily by participants who self-reported as having become less active. A likely reason for this change has to do with the location of the participant relative to essential resource facilities (e.g., grocery stores). As lockdown policies prohibited many businesses and workplaces from opening, travel for many was limited to trips to and from essential services. For those near such essential services, an increase in transportation-related physical activity may have resulted as they were able to reach these locations without using transportation services. But for others who lived farther away, essential services are only accessible by non-active transportation (i.e., automobile). Previous research into built environments and infrastructure has shown the importance of environments that allow for more access to both leisure and transportation-related physical activity (17, 31). In many areas, public transportation was halted, effectively eliminating any physical activity that resulted from traveling to and from public transportation hubs. Further, as workers were furloughed, fired, or began to work from home, these workers may have struggled to find opportunities for physical activity. Essential workers, on the other hand, might have found opportunities to increase their physical activity as they traveled to and from work. For example, reduced traffic may have encouraged some to bike or walk to work with a greater sense of safety than before lockdown. These findings support the importance of transportation-related physical activity while highlighting variables that affect transportation-related physical activity such as location, employment status, access to resources, and public policies. Future research should investigate the how the built environment impacts physical activity during periods of restricted movement or quarantining.

The themes of loss of resources and adapting exercise highlight potential differences in mindset and attitudes of participants. Excluding four responses, participants in the less active group indicated they were more likely to have experienced a loss of resources while the more active group indicated they were more likely to experience an adaptation of exercise (e.g., "The patterns haven't necessarily changed; I changed the exercises [sic] to adapt them to indoors life but I work the same muscular groups and systems") despite shared lockdown experiences.

Those who became more active may possess characteristics that made them more likely to adapt their physical activity to suit their current situation. A number of factors may contribute to this important phenomenon such as one's mindset and attitudes regarding physical activity (11), years of experience of exercising, and/or knowledge about fitness and exercise. Continued work might consider focusing on individual differences in physical activity history, perceptions of one's environment and one's sense of perceived control.

Discrepancies in participant responses highlight the need to operationally define physical activity when collecting qualitative responses on this topic. For example, the following responses came from participants who indicated that they remained equally active during the quarantine:

"Don't exercise. Have spent more time on housework and gardening activities than pre-pandemic however,"

"I don't have to walk to uni anymore. So I stopped walking at least 1h every day,"

"I used to go out more; which made me walk more; now I'm mostly at home."

It appears that these participants overlook walking and activities around the house as physical activity, likely considering only planned exercise when evaluating physical activity levels. Education about the benefits of unstructured and transportation-related activity could help individuals enhance their experiences. Previous research has identified health literacy as a gap in knowledge about health promoting behaviors among the general population (8) which has been linked to a reduced likelihood of engaging in healthy behaviors (26). Similarly, Paakkari and Okan (25) identified health literacy as one of the major issues highlighted by COVID-19 and stated that, in European countries, "nearly half of adults reported having problems with health literacy and not having relevant competencies to take care of their health and that of others." Educating individuals to increase their health literacy to facilitate physical activity should be a goal during stressful phenomena such as the current pandemic. Findings of this study suggest that it is important to provide individuals with educational resources to inform their pursuit of physical activity routines and programs in our efforts to promote physical activity.

A less frequently mentioned emergent theme was that of injury or illness affecting levels of physical activity. Logically, a reduction in physical activity would be associated with reduced incidence of injury. Interestingly, of the three responses identified for this theme, only one mentioned contracting COVID-19 and subsequent pneumonia as a reason for decreased physical activity. Given the circumstances of the pandemic, it does seem surprising that so few mentioned the pandemic in their descriptive responses. Nevertheless, practitioners should be ready to help their patients safely return to recommended levels of physical activity after recovery from injury or illness, including COVID-19. This may come with additional challenges during a pandemic as reflected by other emergent themes identified in this study.

Outside of the emergent themes found in participant responses, other topics were repeatedly mentioned by participants but without enough detail to warrant listing as a theme. For example, participants mentioned a lack of motivation or being demotivated; however, they did not specify

a cause for the loss of motivation. The loss of motivation merits further exploration of the factors at play through both quantitative and qualitative studies. Overall, it is important to understand the factors that impacted individuals and their experiences with physical activity during the pandemic. Retrospective studies designed to explore the experiences of individuals' physical activity during quarantine will be important for understanding physical activity in the years following the COVID-19 pandemic and could inform physical activity promotion efforts in the future should a similar crisis arise. Additionally, these findings support the need to provide themselves with more education about physical activity and how to empower individuals to take ownership of their physical activity and other health behaviors.

The experiences of our participants during this pandemic provide a template for future pandemics and epidemics. Prior to the COVID-19 pandemic, identification of conditions that could contribute to future pandemics were present in the literature (19, 30, 34). Factors that were present before COVID-19 have not changed. Environmental changes that enable the transmission of zoonotic diseases such as increased human-animal contact and expanding urban areas with high population density that increases the chance of human-human transmission are still present (19, 34). In the event of future pandemics, effective measures to promote physical activity will benefit the physical health and mental wellbeing of the populations affected. Creating opportunities for individuals to be healthier in similar future situations should be the intent of future research.

**Limitations:** Though this study provides valuable insight regarding the impact of the pandemic on physical activity behaviors, it does have some limitations. First, the use of Prolific as a recruitment method may have impacted the representativeness of the sample as these types of services often appeal to certain types of individuals, and limit recruitment to only those who have reliable internet access. Also, this study used an opportunistic, retrospective approach. Instead of investigating the experiences of the participants through a targeted interview process, participants responded to free-response questions. This limits how well our themes generalize outside of this sample. Additionally, as participants completed the open-ended question via an online survey, many responses contained single-word or non-descriptive answers. Similarly, many answers contained typos and grammatical errors which made it more difficult to identify intention or meaning. It was also not possible to follow up with participants to clarify responses. It is possible that we were not able to capture the full extent of changes in physical activity during the pandemic as a number of responses lacked detail or were skipped entirely. The observations of response discrepancies highlight the need to operationally define physical activity to a greater extent when collecting survey data. It is likely that a more detailed description of physical activity would have resulted in fewer discrepancies between the self-identified category of physical activity change and qualitative descriptions of change since the onset of the pandemic. Additionally, as most of the participants were from European countries, the characteristics of the lockdown in European countries may have contributed more to interpretations of these findings than those of other global regions. Finally, the study was limited by the absence of a theoretical framework specified a priori with which to analyze participant responses. The approach lacked the specification of a hypothesis with the intent to derive a

purely deductive account of how the pandemic impacted physical activity behaviors. Future analyses might consider using a theoretical framework, such as Self-Determination Theory (13), the Theory of Planned Behavior (2), or the Socio-Ecological Model (29) to analyze qualitative data relating to behavioral responses to similar unique circumstances.

**Conclusion:** The themes generated indicate that multiple factors impacted participants' physical activity levels. Participants reported experiencing similar circumstances; however, changes in physical activity differed despite these similar experiences. The responses suggest that individuals need improved education about healthy behaviors to maintain or increase physical activity levels during times when resources and normal opportunities are restricted. Further research is required to understand individuals' experiences with changes in physical activity levels during the COVID-19 pandemic as well as the potential long-term effects that the pandemic will have on physical activity level.

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