the british psychological society
promoting excellence in psychology

British Journal of Health Psychology (2021), 26, 588–605

www.wileyonlinelibrary.com

Special Section Article

Determinants of physical activity among adults in the United Kingdom during the COVID-19 pandemic: The DUK-COVID study

John C. Spence*[1], Ryan E. Rhodes[2], Ashley McCurdy[1], Amie Mangan[1], Debbie Hopkins[3] and W. Kerry Mummery[1]

[1]Faculty of Kinesiology, Sport, and Recreation, University of Alberta, Edmonton, Alberta, Canada
[2]School of Exercise Science, Physical & Health Education, University of Victoria, British Columbia, Canada
[3]School of Geography and the Environment, University of Oxford, UK

Objectives. This study examined the impact of the COVID-19 lockdown on the physical activity (PA) of UK adults and potential motivational determinants of such behaviour.

Design and methods. A survey was conducted with 1,521 UK adults recruited through Prolific.co in early June 2020. Along with demographic information, questions assessed current PA, changes in PA modalities (i.e., overall, around the home, for transport, in the workplace, in the local neighbourhood, at recreation/sport facilities) related to the lockdown, and beliefs about capabilities, opportunities, and motivations according to the COM-B model. A series of logistic regressions were constructed to examine associations between shifts in the PA modalities and the COM-B components.

Results. The majority of respondents (57%) had either maintained or increased their levels of PA during the COVID-19 lockdown. However, the proportion meeting PA guidelines (31%) was low and engagement in sedentary-related behaviour for both work and leisure increased substantially during the lockdown. The components of the COM-B model were associated with shifts in PA. In particular, physical opportunity (odds ratios ranging from 1.14 to 1.20) and reflective motivation (odds ratios ranging from 1.11 to 1.25) appeared to be the most consistent predictors of behaviour.

Conclusions. If UK adults believed they had the physical opportunity and were motivated, they were more likely to have maintained or increased their PA during the COVID-19 lockdown. However, the majority of adults are not meeting the UK guidelines on PA and the prevalence of PA is substantially lower than national surveys prior to the pandemic.

Statement of contribution

What is already known on this subject?

- The COVID-19 pandemic has significantly disrupted the daily routines of citizens globally.
- Engagement in physical activity appears to have declined as a result of the requirement to self-isolate and stay in place.

DOI:10.1111/bjhp.12497

- The COM-B model of behaviour change is a useful framework for identifying the correlates and determinants of behaviour.

What does this study add?

- Though most UK adults maintained or increased their engagement in physical activity during the COVID-19 pandemic, the majority did not meet recommended guidelines.
- Reflective processes and physical opportunity were the primary predictors of change in physical activity.

The outbreak of coronavirus disease (COVID-19), transmitted by the novel human coronavirus SARS-CoV-2, has had a profound impact globally. Its high rate of infection and potential for significant morbidity and mortality led the World Health Organization (2020) to declare the COVID-19 outbreak as a pandemic on 11 March 2020. Because of its transmission from person to person (Kampf, Todt, Pfaender, & Steinmann, 2020), many countries imposed some sort of social distancing protocol and/or requirement for self-isolation. In the United Kingdom, for instance, national and devolved governments imposed a lockdown in late March that required residents to remain at home unless shopping for basic necessities, attending to medical issues, engaging in one form of exercise a day (e.g., a run, walk, or cycle), or if employed in an essential job (Michie et al., 2020; National Health Service, 2020).

One of the unintended consequences of such lockdowns is that people may engage in less physical activity (PA) and more sedentary behaviour because their movement is restricted (Musselwhite, Avineri, & Susilo, 2020). According to a report from Google Mobility (2020), as of 23 June 23 substantial decreases occurred in access to services such as retail and recreation (−48%), supermarket and pharmacy (−10%), public transport (−48%), and workplaces (−51%) during the virus outbreak in the United Kingdom. Given that physical inactivity is one of the major risk factors for chronic disease and all-cause mortality (Lee, Shiroma, Lobelo, Puska, & Blair, 2012), such restrictions on mobility may have detrimental health impacts in the long run. For instance, during the week of 22 March 2020, FitBit users recorded significant decreases in daily step counts compared to the same period in the previous year (FitBit Staff, 2020). Countries at the epicentre of the pandemic in March, such as Spain (−38%) and Italy (−25%), showed the largest differences. Though other countries, such as the United States (−12%) and United Kingdom (−8%), were more modest in their step-count declines, these are still important public health impacts in relation to the already low levels of population PA observed globally (Guthold, Stevens, Riley, & Bull, 2018; Hallal et al., 2012). Other research, from Australia (Phillipou et al., 2020), Canada (Moore et al., 2020), France (Goethals et al., 2020), Kuwait (Husain, & Ashkanani, 2020), United States (Duncan, Avery, Seto, & Tsang, 2020), and the United Kingdom (Robinson et al., 2020) support the idea that PA decreased during the pandemic (Tison et al., 2020).

However, other research suggests that the pattern of behaviour may be more complex. Cheval et al. (2020) noted an increase of approximately 10 min in walking and moderate PA and an increase of approximately 75 min of sedentary behaviour among adults in France and Switzerland. Lopez-Bueno et al. (2020) found the proportion of individuals not meeting public health guidelines for activity increased during the first week of confinement (52.2%) compared to pre-confinement levels (35.1%), but declined during the second (40.3%) and third (26.2%) weeks of confinement. According to a study in the United States, PA was reduced by 32% among previously active participants but remained

unchanged among previously inactive participants (Meyer et al., 2020). During the month of April, Sport England (2020) reported a slight increase in the proportion of people claiming to be doing more PA than usual (34% vs. 31%). However, by the last week of April, motivation for PA seemed to be on the decline.

An examination of the factors that facilitate PA during quarantine and lockdown periods may assist in the development of strategic initiatives aimed at offsetting negative consequences (Arden & Chilcot, 2020; Holmes et al., 2020). Some studies have considered relationships between PA and primarily demographic factors including age, income, gender, education, ethnicity, body mass index, work status, marital status, owning a garden, having a dog, having school aged children, availability of home equipment, PA app use, social distancing practices, physical and mental health condition, infection status, and previous activity level (Alomari, Khabour, & Alzoubi, 2020; de la Cámara, Jiménez-Fuente, & Pardos-Sevilla, 2020; Ingram, Maciejewski, & Hand, 2020; Meyer et al., 2020; Rhodes, Liu, Lithopoulos, Zhang, & Garcia-Barrera, 2020; Robinson et al., 2020; Rogers et al., 2020; Smith et al., 2020; Yang & Koenigstorfer, 2020). Relatively few studies have considered psychological correlates of PA such as activity extraversion, neuroticism, habit, exercise identity, goal striving, strategic planning, attitudes, and perceptions of COVID related risks (Alomari et al., 2020; Chirico et al., 2020; Kushal, Keith, Aguiñaga, & Hagger, 2020;; Rhodes et al., 2020; Rogers et al., 2020). For instance, Chirico et al. (2020) tested an integrated model of PA based on the theory of planned behaviour and self-determination theory and found that intention to engage in PA varied as a function of attitudes, subjective norms, perceived behavioural control, and autonomous motivation. Though identification of correlates and determinants of PA during this period is a necessary first step, further research is needed to develop an understanding of behaviour rooted in broad yet cohesive theoretical perspectives that consider interconnected individual and contextual factors (Gibson Miller et al., 2020).

The capabilities, opportunities, motivations, behaviour (COM-B) model is derived from a systematic overview of behavioural frameworks and provides a coherent and broad account of behavioural factors explicitly linked with a comprehensive set of intervention and policy categories (Michie, van Stralen, & West, 2011). The model has been well supported by the National Institute for Clinical Excellence in the United Kingdom as a key theoretical framework for understanding health-related behaviour and, more recently, the British Psychological Society Behavioural Science and Disease Prevention Taskforce has adopted the model in an effort to influence behaviours that will curb the spread of COVID-19 (Gibson Miller et al., 2020). The COM-B model posits that behaviour is underpinned by three overarching constructs: capability, opportunity, and motivation (Michie, Atkins, & West, 2014; Michie et al., 2011). Capability refers to both the psychological (e.g., knowledge, reasoning, attention) and physical (e.g., strength, skills, stamina) capacity to perform a behaviour. Opportunity is conceptualized as encompassing both the social (e.g., cultural and linguistic factors that shape our thinking, interpersonal factors) and physical (e.g., environment, resources) contexts that constrain or enable a behaviour. With respect to motivation, behaviour is proposed to be driven by reflective processes, whereby individuals consciously assess options and make decisions, as well as automatic processes, which are shaped by emotional reactions, habits, desires, and impulses. These interacting constructs have been conceptualized within a broader framework, the Behaviour Change Wheel, which serves as a blueprint for linking an analysis of COM-B components with relevant intervention functions and policy categories (Michie et al., 2011, 2014). The model has been employed to describe, explain, and predict PA (Ellis, Pears, & Sutton, 2019; Howlett, Schulz, Trivedi, Troop, & Chater, 2019; Wilkie,

Townshend, Thompson, & Ling, 2018). For instance, Howlett et al. found that capability and motivation were the key drivers of PA among a sample of healthy adults with motivation being a 'strong' mediator for capability on behaviour.

Therefore, employing the COM-B model, we conducted a survey of current PA, changes in PA modalities (i.e., overall, around the home, for transport, in the workplace, in the local neighbourhood, at recreation/sport facilities) related to the lockdown, and potential motivational determinants of such behaviour among adults residing in the United Kingdom. The first objective was to document the prevalence of PA and shifts in PA modalities. We hypothesized that current PA would be lower than pre-COVID national norms and that shifts in PA would be associated with current PA. The second objective was to investigate whether components of the COM-B model predicted shifts in PA modalities during the lockdown. We hypothesized that PA would be influenced by a combination of motivation, capability, and opportunity. In particular, in light of the restrictions on outdoor activities, opportunity would be a consistent predictor of PA and changes in PA modalities. Identification and prioritization of those factors found to be most relevant may be used to guide the selection of appropriate public health approaches to foster and support PA during pandemics in line with evidence-based practice (Michie et al., 2011).

Methods

Design

This study employed an online survey in a cross-sectional design.

Sampling and participants

Participants were recruited through Prolific (http://www.prolific.co), which is a crowdsourcing behavioural research platform. As of 24 January 24, 83,077 individuals were listed as being active on the site in the past 90 days; most of whom were from the United Kingdom (UK), United States (US), Canada, Australia, and New Zealand. For sampling, a researcher can either request representative samples (for the United Kingdom and United States only; based on sex, age, and ethnicity), custom samples (screening for more than 100 variables), or open samples with no restrictions. The participants are paid by the hour at a 'fair working wage'. The process involves creating a study portal on the platform with information about the project, identification of the audience (i.e., representative, custom sample, open), the wage (per hour), and a link to the survey. Prolific compares favourably with other crowdsourcing platforms such as Mechanical Turk and CrowdFlower. For instance, Prolific participants were more naïve and less dishonest than those on Mechanical Turk and they produced data quality that was higher than those on the other two platforms (Peer, Brandimarte, Samat, & Acquisti, 2017). For this study, a representative sample of adults in the United Kingdom (N = 1,521) were recruited on 1 June 2020.

Measures

Data were collected and managed using the REDCap electronic data capture tool hosted at the primary author's university. This is a secure web-based application designed to support data capture for research studies and provides: an intuitive interface for validated

data entry; audit trails for tracking data manipulation and export procedures; automated export procedures for seamless data downloads to common statistical packages; and procedures for importing data from external sources (Obeid et al., 2013). Specifically, a survey was constructed in REDCap assessing demographics (e.g., age, sex, household income), self-rated health, perceived risk for COVID-19, PA beliefs and motives, COM-B beliefs, boredom, exercise schema, travel behaviour, PA (current, typical, longest distances walked or run), and changes in PA modalities. For the purposes of this paper, we focused on COM-B beliefs, PA (both current and typical), and changes in PA modalities.

Demographics

Based on the English Housing Survey (2018), the following demographic information was collected: sex (options: female, male), age, marital status (options: single, that is never married and never registered in a civil partnership; married and living with husband/wife; separated, but still legally married; divorced; widowed; in a registered civil partnership; separated, but still legally in a civil partnership; formerly in a civil partnership which is now legally dissolved; surviving partner from a civil partnership), highest level of education attained (options: degree level qualification [or equivalent]; At school part-time, A-Levels or Higher; ONC/National Level BTEC; O Level or GCSE equivalent [Grade A-C] or O Grade/CSE equivalent [Grade 1] or Standard Grade level 1-3; a part-time course at university, or college, including day release and block release; other qualifications [including foreign qualifications below degree level], no formal qualification), current household income from all sources (options: Up to £5,199, £5,200 to £10,399, £10,400 to £15,599, £15,600 to £20,799, £20,800 to £25,999, £26,000 to £31,199, £31,200 to £36,399, £36,400 to £51,999, £52,000 and above, don't know/prefer not to answer), ethnicity (Asian or Asian British; Black, African, Black British or Caribbean; Mixed or multiple ethnic groups; White; Another ethnic group), employment status (Working: 30 hrs a week or more; Working: <30 hrs a week; Government Training Scheme; Not working because of long-term sickness or disability; Registered unemployed; Not registered unemployed but seeking work; At home/not seeking work (including looking after the home or family); Retired (including retired early); Full-time student; Other), housing (A house or a bungalow; A self-contained flat, maisonette or apartment; A room or rooms [e.g., bedsit or flatlet]; Other), number of people in the household, and the number of automobiles available to the household. In addition, two questions were asked about perceived safety within the respondents neighbourhood during the day and at night (response options: 1 [very safe] to 6 [never walk outside along]) and one question on dog ownership (response options: yes, no).

Physical activity

Three different sets of questions were asked about typical pre-COVID PA, current PA, and shifts in PA modalities. A two-item measure assessed typical PA (Johansson & Westerterp, 2008), that is, 'In the three months prior to the COVID-19 outbreak and the subsequent government-ordered lockdown (i.e., mid-March, 2020), describe your physical activity at work (even work at home, sick leave at home and studying, for instance in a university)' (response options; 1 [Very light, e.g., sitting at the computer most of the day or sitting at a desk] to 4 [Heavy, e.g., heavy industrial work, construction work or farming]) and 'Describe your physical activity at leisure time. If the activities vary between summer and winter, try to give a mean estimate' (response options: 1 [Very light: almost no activity at

all] to 5 [Very active: strenuous activities several times a week]). The two scores were then converted to a physical activity level (PAL). In terms of validity, the scores from the questionnaire have been highly correlated (r = .89) with energy expenditure as estimated with doubly labelled water (Johansson & Westerterp, 2008).

Current PA was assessed with a single item, that is, 'In the past week, on how many days have you done a total of 30 min or more of physical activity, which was enough to raise your breathing rate? This may include sport, exercise and brisk walking or cycling (including using a wheel chair) for recreation or to get to and from places' (Milton, Clemes, & Bull, 2012). The scale has demonstrated good validity in comparison to accelerometers (r = .46 to .57). Because the UK guidelines on PA for adults recommend at least 150 min of moderate PA per week, or 75 min of vigorous PA per week, or an equivalent combination of both (UK Medical Officers, 2019), a PA status variable was then created by dichotomizing the current PA scale at 5 or more days which would be equivalent to achieving at least 150 min of moderate PA per week.

For each of six modes of PA (i.e., overall, around the home, for transport, in the workplace, in the local neighbourhood, at recreation/sport facilities), participants were asked 'In comparison to your usual/typical level of physical activity prior to the COVID-19 outbreak and the government-ordered lockdown (i.e., mid-March, 2020), how would you rate your current level of physical activity' (response options: much less, somewhat less, about the same, somewhat more, much more). Similarly, four other items asked about sitting, screen-based activities for leisure and work, and time spent outdoors relative to usual behaviour prior to the onset of COVID-19 (response options: much less, somewhat less, about the same, somewhat more, much more).

COM-B beliefs

Perceived capability, opportunity, and motivation for PA (COM-B beliefs) were measured with a 6-item scale adapted from Keyworth, Epton, Goldthorpe, Calam, and Armitage (2020). Questions asked about perceived physical opportunity, social opportunity, reflective motivation, automatic motivation, physical capability, and psychological capability for the various modes of PA (i.e., in general, around the home, in the workplace, in the local neighbourhood, at recreation/sport facilities) (response options: 0 [strongly disagree] to 10 [strongly agree]). Specifically, respondents were asked to 'Please rate your ability and willingness to engage in physical activity in various contexts during the COVID-19 outbreak and the government-ordered lockdown (i.e., mid-March, 2020)'. This was followed by each of the COM-B beliefs in relation to each of the modes of PA. For example, 'I had the PHYSICAL opportunity (e.g., sufficient time, equipment, access to places to play) to engage in physical activity around my home'. For psychological capability, we differentiated between knowledge and cognitive processing capacity (e.g., reasoning, attention). Because of this we added a seventh question specifically about knowledge using the same response options.

Procedures

The survey was constructed in REDCap and a 'study' was posted on Prolific.co. Potential participants who met the screening criteria (i.e., be from the United Kingdom, adults 18 years and older, and speak English) were informed about the study, the wage (i.e., £8.00/hr), the task that they would be doing (i.e., completing a survey about physical activity), the amount of time required (approximately 20 min), and then they were invited

to engage in the survey via a link to the REDCap site. Once on that site, they first completed an informed consent and then were exposed to the survey.

Data analysis

After generating descriptive statistics and checking normality of the distributions, two primary sets of analyses were conducted in line with our objectives. First, frequencies were generated for PA status, PA modalities, sedentary-related behaviours, and time spent outdoors. Cross-tabulations were then constructed for PA status by each of the PA modalities. A one-way ANOVA was then performed to test if current PA (days) varied by change in overall PA. Second, logistic regressions were performed in which the modes of relative PA (e.g., overall, around the home, at work) were each regressed on demographic variables (i.e., sex, age, household income, employment, ethnicity, and location of residence), typical pre-COVID PA (PAL), and the COM-B beliefs. The response options for the PA modalities were dichotomized into less and same/more. In addition, for the purpose of these analyses, employment (working/in school vs. other), ethnicity (white vs. other), and location of residence (city vs. other) were each dichotomized. All analyses were completed in SPSS 26. Finally, given the large sample size and number of analyses conducted, alpha of $p < .01$ was adopted. Regardless, we were sufficiently powered to detect small- to medium-sized effects and associations in the mean comparisons and cross-tabulations and medium-sized associations in the logistic regressions (Cohen, 1992).

Results

As presented in Table 1, a majority of respondents ranged in age from 30 to 64 years, reported a household income of <£31,200, were white (86%), resided in a town, village, or hamlet (67%), employed or in school (68%), and female (51%). For current PA, 31% of respondents engaged in 30 min of moderate PA on five or more days in the previous week. The mean number of days of doing current PA for at least 30 min was 3.14 ($SD = 2.33$) and the mean PAL for typical PA was 1.69 ($SD = 0.17$).

Objective 1: Prevalence of PA

In relation to the COVID-19 lockdown (see Table 2), the majority of respondents reported engaging in less PA for travelling to and from work/school (58%), in the workplace (55%), and at recreation/sports facilities (54%). They reported engaging in the same or more PA around the home (81%), in the local neighbourhood (63%), and overall (57%). In the latter case, 43% reported less PA, 32% the same, and 25% more PA. Those respondents who reported doing less overall PA engaged in fewer days of current PA ($M = 2.32$) than those who reported doing the same or more ($M = 3.76$), $F(1,1437) = 150.08$, $p < .001$, $\eta^2 = .095$. Furthermore, small- to medium-sized associations were noted between meeting PA guidelines and shifts in overall PA (Cramer's V = .274, $p < .0001$), PA around the home (Cramer's V = .174, $p < .0001$), PA for transport (Cramer's V = .083, $p < .01$), and PA in the neighbourhood (Cramer's V = .240, $p < .0001$). As for sedentary-related behaviours, the vast majority of respondents reported the same or more of sitting or reclining (89%), use of screen-based devices for leisure (94.5%), and use of screen-based devices for work/school (84%). Finally, a balance existed between the proportion reporting spending less (42%) and more (39%) time outdoors.

Table 1. Demographics of the sample

Variable	Categories	Frequency	%
Sex	Female	769	51.4
	Male	728	48.6
Age (years)	18–29	296	19.7
	30–49	536	35.6
	50–64	498	33.1
	65–79	168	11.2
	80+	8	0.5
Employment	Other (e.g., unemployed, retired)	484	32.2
	Working/school	1,019	67.8
Ethnicity	Other (e.g., Asian British, Black British, Caribbean, mixed)	217	14.4
	White	1,287	85.6
Household income	Up to £5,199	50	3.5
	£5,200 to £10,399	96	6.8
	£10,400 to £15,599	134	9.5
	£15,600 to £20,799	134	9.5
	£20,800 to £25,999	175	12.4
	£26,000 to £31,199	154	10.9
	£31,200 to £36,399	139	9.8
	£36,400 to £51,999	255	18.1
	£52,000 and above	275	19.5
Location of residence	Town, village, or hamlet	1,009	67.0
	City	497	33.0
Physical activity	5 or more days in the past week	441	30.5

Objective 2: Associations between COM-B components and PA modalities

Before proceeding with the logistic regressions of the COM-B predictors within the six modalities of PA, an examination of the descriptive statistics revealed a correlation of $r = .71$ between physical opportunities and social opportunities for PA at recreation/sports facilities. Because logistic regression is sensitive to high correlations among predictor variables (Tabachnick & Fidell, 2007), and because physical opportunity was the primary restriction imposed in the COVID lockdown, social opportunity was dropped from the analysis for PA at recreation/sports facilities.

The full models with all predictors against constant-only models were significant for each of the PA modalities. This indicated that the COM-B predictors, as a set, reliably distinguished between less and same/more PA. The variance in PA status accounted for is small ranging from Nagelkerke $R^2 = .14$ (at recreation/sports facilities) to .25 (in the neighbourhood). Classification was unimpressive to impressive with overall success rates ranging from 63% (recreation/sport facilities) to 80% (around the home). However, a significant Hosmer–Lemeshow test suggested a less than exactly correct model for PA at home, $\chi^2 = 36.67, p < .001$. Attempts to enhance the goodness of fit were unsuccessful, so the model was left as is.

Table 3 shows regression coefficients, Wald statistics, odds ratios (ORs), and 99% confidence intervals for ORs for each of the COM-B predictors within the six modalities of PA. According to the Wald criterion, capability was associated with two PA modalities (overall, at home), opportunity was associated with five modalities (overall, transport, at

Table 2. Proportion of respondents reporting change in physical activity and sedentary-related behaviour in relation to the COVID-19 lockdown

Behaviour	Modality	Less (%)	Same (%)	More (%)
Physical activity	Overall	43.4	31.6	25.0
	Around the home	19.2	45.3	35.4
	Travelling to and from work/school	58.1	38.3	3.6
	In the workplace	55.0	41.0	4.0
	In the local neighbourhood	36.7	25.4	37.9
	At recreation or sports facilities	54.3	41.1	4.6
Sedentary-related behaviour	Sitting or reclining	11.1	38.8	50.1
	Use of screen-based devices for leisure	5.5	31.8	62.8
	Use of screen-based devices for work/school	16.1	46.8	37.1
Other	Time spent outdoors	42.2	18.5	39.3

work, in the neighbourhood, at recreation/sport facilities), and motivation was associated with five modalities (overall, at home, transport, at work, in the neighbourhood). Reflective motivation (ORs ranging from 1.11 to 1.25) and physical opportunity (ORs ranging from 1.14 to 1.20) appeared to be the most consistent and strongest predictors of these behaviours. Neither knowledge nor social opportunity was associated with any of the behaviours. Overall PA was the only modality to be associated with all three of the COM-B variables.

Discussion

The first objective of this study was to document the prevalence of PA and shifts in PA modalities among UK adults during the COVID-19 lockdown. We found that the majority of respondents had either maintained or increased their levels of overall PA during the lockdown. In particular, levels of PA around the home and in the neighbourhood were maintained or higher. However, as hypothesized, the proportion meeting PA guidelines was low and engagement in sedentary-related behaviour for both work and leisure increased substantially during this period. Specifically, 31% of adults achieved at least 150 min of moderate PA in the past week. This is very similar to a report from Sport England (2020) in which 32% of English adults met these aerobic guidelines as of the last week in April 2020. In contrast, 63–66% of UK adults met the same guidelines between 2008 and 2018 (Scholes & Mindell, 2020; Sport England, 2018). Thus, the proportion of adults meeting these guidelines is substantially lower in the context of the COVID pandemic. This is confirmed by the finding that 43% of our respondents reported doing less overall PA at the beginning of June 2020 in comparison to the weeks prior to the lockdown in mid-March 2020. Other studies reported similar shifts in PA among UK adults during April 2020 (Rogers et al., 2020; Sport England, 2020) and decreases in the proportion meeting guidelines in the United States (Meyer et al., 2020).

The second objective was to investigate the usefulness of the COM-B model (Michie et al., 2011) in predicting shifts in PA modalities during the lockdown. As hypothesized, the components of the model were associated with shifts in PA. In particular, physical opportunity and reflective motivation appeared to be the most consistent predictors of behaviour. If people perceived they had the physical opportunity and were motivated, they were more likely to have maintained or increased overall PA, PA for transport, PA at work, and PA in the neighbourhood. Physical opportunity was the sole predictor of PA at recreation/sports facilities. Interestingly, automatic motivation was negatively associated with both PA for transport and PA at work and not associated with the other PA modalities. Though automatic processes can be influential on PA (Di Maio, Keller, Hohl, Schwarzer, & Knoll, 2020; Kaushal, Rhodes, Meldrum, & Spence, 2017; Rebar et al., 2016), and habit and conscious intentions typically contribute about equal variance to PA under ordinary circumstances (Gardner, de Bruijn, & Lally, 2011; Rebar et al., 2016), it seems that the radically different context presented during the lockdown required more conscious decision making and interrupted routines. From a habit conceptualization, this is entirely sensible as habits are behavioural responses brought about by cues (Gardner, & Rebar, 2019; Rhodes, & Rebar, 2018). COVID restrictions have dramatically disrupted routines, which provide the cues for automatic behavioural instigations (e.g., active transport, exercise schedules at gyms). Thus, many individuals will be entirely reliant on reflective processes to maintain or enact new patterns of PA.

Table 3. Logistic regression analysis of change in physical activity modalities in relation to the COVID-19 lockdown as a function of capability, opportunity, and motivation (COM-B) components

Behaviour	COM-B Factors	Item	*B*	Wald statistic	OR	99% CI
General physical activity (*N* = 1,375)	Capability	Physical	–.09*	6.83	0.92	0.84, 1.00
		Psychological	.07	4.54	1.08	0.99, 1.18
		Knowledge	–.07	3.58	0.93	0.85, 1.03
	Opportunity	Physical	.18**	45.22	1.20	1.12, 1.30
		Social	–.01	0.16	0.99	0.94, 1.05
	Motivation	Reflective	.22**	58.32	1.25	1.16, 1.35
		Automatic	.02	0.42	1.02	0.95, 1.09
Physical activity around the home (*N* = 1,333)	Capability	Physical	–.04	1.19	0.96	0.88, 1.06
		Psychological	.11*	9.01	1.11	1.02, 1.22
		Knowledge	–.06	2.57	0.94	0.85, 1.04
	Opportunity	Physical	.08	6.32	1.09	1.00, 1.19
		Social	.03	1.18	1.03	0.96, 1.11
	Motivation	Reflective	.20**	33.17	1.22	1.12, 1.34
		Automatic	.08	5.96	1.08	1.00, 1.18
Physical activity for transport (*N* = 1,352)	Capability	Physical	–.03	1.37	0.97	0.90, 1.04
		Psychological	.01	0.06	1.01	0.94, 1.08
		Knowledge	.02	0.42	1.02	0.97, 1.07
	Opportunity	Physical	.15**	26.05	1.16	1.08, 1.25
		Social	.03	0.66	1.03	0.94, 1.12
	Motivation	Reflective	.12*	9.89	1.12	1.02, 1.23
		Automatic	–.12**	13.81	0.89	0.82, 0.96
Physical activity at work (*N* = 1,329)	Capability	Physical	–.02	0.28	0.99	0.92, 1.06
		Psychological	.04	2.05	1.04	0.97, 1.13
		Knowledge	–.03	1.64	0.97	0.90, 1.04
	Opportunity	Physical	.18**	25.04	1.20	1.09, 1.31
		Social	.06	2.62	1.06	0.97, 1.17
	Motivation	Reflective	.11**	7.65	1.11	1.01, 1.23

Continued

Table 3. (*Continued*)

Behaviour	COM-B Factors	Item	*B*	Wald statistic	OR	99% CI
		Automatic	–.07*	4.05	0.94	0.86, 1.02
Physical activity in the neighbourhood (*N* = 1,337)	Capability	Physical	–.04	2.01	0.96	0.89, 1.04
		Psychological	.06	3.44	1.06	0.98, 1.14
		Knowledge	–.05	2.73	0.95	0.88, 1.03
	Opportunity	Physical	.14***	21.18	1.15	1.06, 1.24
		Social	.04	2.84	1.05	0.98, 1.12
	Motivation	Reflective	.20**	43.54	1.22	1.13, 1.32
		Automatic	–.00	.01	1.00	0.92, 1.08
Physical activity at recreation facilities (*N* = 1,337)	Capability	Physical	.01	0.04	1.01	0.94, 1.07
		Psychological	.05	3.15	1.05	0.98, 1.12
		Knowledge	–.04	2.41	0.96	0.91,1.02
	Opportunity[a]	Physical	.16**	29.55	1.17	1.09, 1.26
	Motivation	Reflective	–.07	5.94	0.93	0.86, 1.00
		Automatic	–.02	0.59	0.98	0.90, 1.06

Notes. CI = confidence interval; OR = odds ratio.
All analyses adjusted for sex, age, ethnicity, household income, employment status, community size, and typical physical activity level (PAL).
[a]Social opportunity was excluded from the analysis because of multicollinearity with physical opportunity.; *$p < .01$.; **$p < .001$.

Similarly, capability played a limited role for overall PA and PA at home. The negative association with overall PA suggests that those who perceived themselves most capable for PA, and were perhaps more physically active pre-COVID, were more likely to report doing less PA during the lockdown. Regardless, capability often has a less predictive effect on PA after accounting for motivation (Williams, & Rhodes, 2016). Though the COM-B model presents a relatively novel depiction of the capability construct, our findings support the notion that motivation supersedes capability. Furthermore, COVID-19 restrictions did not likely affect capability as much as opportunity (i.e., it did not alter knowledge about PA or PA skills) so it was to be expected that this played a lessened role under the pandemic restriction circumstances compared to opportunity.

The most surprising finding of the study was the low prediction of social opportunity for any of the PA modalities (cf. Howlett et al., 2019). It seems that aspects of the social environment (e.g., norms, social cues, social support from family and friends) were not influential on PA during the lockdown. Though social opportunity is intuitively important (McNeill, Kreuter, & Subramanian, 2006), it rarely is a strong predictor of PA in population studies (Rhodes, & Nigg, 2011). For instance, small to null results are often noted for subjective norms (Hagger, Chatzisarantis, & Biddle, 2002), relatedness in self-determination theory (Teixeira, Carraça, Markland, Silva, & Ryan, 2012), and social network analyses (Hunter et al., 2019; Stearns et al., 2019) in relation to PA. Furthermore, social impact on PA may operate indirectly through motivation, capability, and physical opportunity. For instance, both subjective norms (Fishbein, & Ajzen, 2010) and relatedness (Deci & Ryan, 1985) are conceived as having indirect effects on behaviour through motivation. Similarly, Bandura (1986) suggests that social support largely manifests through self-efficacy and outcome expectations. Thus, the direct effects of social influences proposed in the COM-B model may not be the most accurate representation of social influences on PA. The restrictions on mobility due to the lockdown may have been more overtly physical (e.g., do not go outside, maintain physical distance from other people) and their effects were reflected in the physical opportunity component of the COM-B. Thus, the more subtle influences of the social environment on PA were not evident.

Strengths of this study include the large representative sample and the theory-informed survey tool. However, this study is not without some limitations that should be acknowledged. First, in conducting the survey at the beginning of June 2020, we may have missed the most critical phase of the COVID lockdown with regard to requirements to self-isolate and restrict outdoor activities. However, lockdown restrictions were still in place in early June, with the 'social bubble' and opening of non-essential shops announced in mid-June, and our findings are consistent with other studies conducted earlier in the pandemic. Second, self-report measures are susceptible to bias and respondents may over report engagement in positive health behaviour such as PA. Where possible, we employed tools with demonstrated psychometric properties including validated measures of both current PA and the COM-B beliefs. Though our measure of shifts in PA modalities has not been validated, a similar type of scale was recently used with children in Canada (Moore et al., 2020). Third, on a related point, we asked people to reflect back on past behaviours and compare to present which can produce biases based on how people wish to project past and present. Fourth, though the sample is deemed to be representative of the UK adult population based on sex, age, and ethnicity it may not be representative in all respects. For instance, the type of person who would be willing to participate in a crowdsourcing research platform such as Prolific may not be typical of the population. Fifth, a difference of opinion exists in the literature on how to measure the COM-B constructs. We used a tool adapted from Keyworth et al. (2020) that taps directly into the

six subdomains or components (e.g., physical ability, reflective motivation) of the three primary constructs of the model (i.e., capability, opportunity, motivation). The authors describe it as a 'generic' measure. Whereas Howlett et al. (2019) maintain that the constructs represent latent variables that 'require an operationalisation resulting in a measurement model' (p. 1379) with multiple indicators for each construct. This is an issue that requires further exploration. Finally, the cross-sectional nature of our design prevents any claims about causation.

In summary, this was the first peer-reviewed study to document associations between PA and shifts in PA during the COVID-19 pandemic and components of the COM-B model (Michie et al., 2011). If UK adults believed they had the physical opportunity and were motivated, they were more likely to have maintained or increased their PA during the lockdown. However, the majority of adults are not meeting the UK guidelines on PA and the prevalence of PA is substantially lower than national surveys prior to the pandemic (e.g., Scholes & Mindell, 2020). If the coronavirus continues to be an issue in the future, it will be critically important to identify ways to foster motivation for PA and to facilitate the opportunities for people to be physical active while adhering to public health protocol.

Acknowledgements

This study was funded by a Provost Research Allowance to JCS and start-up funds for KM.

Conflicts of interest

All authors declare no conflict of interest.

Author contributions

John C Spence, PhD (Conceptualization; Data curation; Formal analysis; Funding acquisition; Investigation; Methodology; Project administration; Supervision; Writing – original draft; Writing – review & editing) Ryan E. Rhodes (Conceptualization; Methodology; Writing – original draft; Writing – review & editing) Ashley McCurdy (Writing – original draft; Writing – review & editing) Amie Mangan (Data curation; Writing – review & editing) Debbie Hopkins (Conceptualization; Methodology; Writing – review & editing) W. Kerry Mummery (Conceptualization; Funding acquisition; Methodology; Writing – review & editing).

Data Availability Statement

The data that support the findings of this study are available from the corresponding author upon request.

References

Alomari, M. A., Khabour, O. F., & Alzoubi, K. H. (2020). Changes in physical activity and sedentary behavior amid confinement: The BKSQ-COVID-19 project. *Risk Management and Healthcare Policy*, *13*, 1757–1764. https://doi.org/10.2147/RMHP.S268320

Arden, M. A., & Chilcot, J. (2020). Health psychology and the coronavirus (COVID-19) global pandemic: A call for research. *The British Journal of Health Psychology*, *25*(2), 231–232. https://doi.org/10.1111/bjhp.12414

Bandura, A. (1986). *Social foundations of thought and action: A social-cognitive theory*. Englewood Cliffs, NJ: Prentice-Hall.

Cheval, B., Sivaramakrishnan, H., Maltagliati, S., Fessler, L., Forestier, C., Sarrazin, P., & … Boisgontier, M. P. (2020). Relationships between changes in self-reported physical activity and sedentary behaviours and health during the Coronavirus (COVID-19) pandemic in France and Switzerland. *SportRxiv*. https://osf.io/preprints/sportrxiv/ydv84/

Chirico, A., Lucidi, F., Galli, F., Giancamilli, F., Vitale, J., Borghi, S., … Codella, R. (2020). COVID-19 outbreak and physical activity in the Italian population: A cross-sectional analysis of the underlying psychosocial mechanisms. *Frontiers in Psychology*, *11*, 2100. https://doi.org/10.3389/fpsyg.2020.02100

Cohen, J. (1992). A power primer. *Psychological Bulletin*, *112*, 155–159. https://doi.org/10.1037/0033-2909.112.1.155

de la Cámara, M. Á., Jiménez-Fuente, A., & Pardos-Sevilla, A. I. (2020). Confinement time due to the COVID-19 disease: An opportunity to promote and engage people in regular physical exercise? [Letter to the editor]. *Translational Sports Medicine*, https://onlinelibrary.wiley.com/doi/full/10.1002/tsm2.170

Deci, E. L., & Ryan, R. M. (1985). *Intrinsic motivation and self-determination in human behavior*. New York, NY: Plenum Press.

Di Maio, S., Keller, J., Hohl, D. H., Schwarzer, R., & Knoll, N. (2020). Habits and self-efficacy moderate the effects of intentions and planning on physical activity. *British Journal of Health Psychology*, https://doi.org/10.1111/bjhp.12452

Duncan, G. E., Avery, A. R., Seto, E., & Tsang, S. (2020). Perceived change in physical activity levels and mental health during COVID-19: Findings among adult twin pairs. *PLoS One*, *15*(8), e0237695. https://doi.org/10.1371/journal.pone.0237695

Ellis, K., Pears, S., & Sutton, S. (2019). Behavioural analysis of postnatal physical activity in the UK according to the COM-B model: A multi-methods study. *British Medical Journal Open*, *9*, e028682. https://doi.org/10.1136/bmjopen-2018-028682

England Housing Survey. (2018). *Questionnaire Documentation Year 11 (2018–19)*. V4: November 2018. Retreived from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/859768/EHS_questionnaire_documentation_year_11_18-19.pdf

Fishbein, M., & Ajzen, I. (2010). *Predicting and changing behavior: The reasoned action approach*. New York, NY: Psychology Press.

FitBit Staff. (2020, March 23). *The impact of Coronavirus on global activity*. Retrieved from https://blog.fitbit.com/covid-19-global-activity/

Gardner, B., de Bruijn, G. J., & Lally, P. (2011). A systematic review and meta-analysis of applications of the Self-Report Habit Index to nutrition and physical activity behaviors. *Annals of Behavioral Medicine*, *42*, 174–187. https://doi.org/10.1007/s12160-011-9282-0

Gardner, B., & Rebar, A. L. (2019). *Habit formation and behavior change. Oxford Research Encyclopedia of Psychology*. New York NY: Oxford University Press. https://doi.org/10.1093/acrefore/9780190236557.013.129

Gibson Miller, J., Hartman, T. K., Levita, L., Martinez, A. P., Mason, L., McBride, O., … Bentall, R. P. (2020). Capability, opportunity, and motivation to enact hygienic practices in the early stages of the COVID-19 outbreak in the United Kingdom. *British Journal of Health Psychology*, *25*(4), 856–864. https://doi.org/10.1111/bjhp.12426

Goethals, L., Barth, N., Guyot, J., Hupin, D., Celarier, T., & Bongue, B. (2020). Impact of home quarantine on physical activity among older adults living at home during the COVID-19 pandemic: Qualitative interview study. *Journal of Medical Internet Research Aging*, *3*(1), e19007. https://doi.org/10.2196/19007

Google. (2020, June 23). *COVID-19 Community mobility report: United Kingdom*. Retrieved from https://www.gstatic.com/covid19/mobility/2020-06-23_GB_Mobility_Report_en-GB.pdf

Guthold, R., Stevens, G., Riley, L., & Bull, F. (2018). Worldwide trends in insufficient physical activity from 2001 to 2016: A pooled analysis of 358 population-based surveys with 1.9 million participants. *Lancet*, *6*, e1077–1086. https://doi.org/10.1016/S2214-109X(18)30357-7

Hagger, M. S., Chatzisarantis, N. L. D., & Biddle, S. J. H. (2002). A meta-analytic review of the theories of reasoned action and planned behavior in physical activity: Predictive validity and the contribution of additional variables. *Journal of Sport and Exercise Psychology*, *24*, 3–32. https://doi.org/10.1123/jsep.24.1.3

Hallal, P. C., Andersen, L. B., Bull, F. C., Guthold, R., Haskell, W., & Ekelund, U. (2012). Global physical activity levels: Surveillance progress, pitfalls, and prospects. *Lancet*, *380*, 247–257. https://doi.org/10.1016/S0140-6736(12)60646-1

Holmes, E. A., O'Connor, R. C., Perry, V. H., Tracey, I., Wessely, S., Arseneault, L., . . . Bullmore, E. D. (2020). Multidisciplinary research priorities for the COVID-19 pandemic: A call for action for mental health science. *The Lancet Psychiatry*, 7, 547–560. https://doi.org/10.1016/S2215-0366(20)30168-1

Howlett, N., Schulz, J., Trivedi, D., Troop, N., & Chater, A. (2019). A prospective study exploring the construct and predictive validity of the COM-B model for physical activity. *Journal of Health Psychology*, *24*, 1378–1391. https://doi.org/10.1177/1359105317739098

Hunter, R. F., de la Haye, K., Murray, J. M., Badham, J., Valente, T. W., Clarke, M., & Kee, F. (2019). Social network interventions for health behaviours and outcomes: A systematic review and meta-analysis. *PLoS Medicine*, *16*(9), e1002890. https://doi.org/10.1371/journal.pmed.1002890

Husain, W., & Ashkanani, F. (2020). Does COVID-19 change dietary habits and lifestyle behaviours in Kuwait: A community-based cross-sectional study. *Environmental Health and Preventive Medicine*, *25*(1), 1–13. https://doi.org/10.1186/s12199-020-00901-5

Ingram, J., Maciejewski, G., & Hand, C. J. (2020). Changes in diet, sleep, and physical activity are associated with differences in negative mood during COVID-19 lockdown. *Frontiers in Psychology*, *11*, 2328. https://doi.org/10.3389/fpsyg.2020.588604

Johansson, G., & Westerterp, K. R. (2008). Assessment of the physical activity level with two questions: Validation with doubly labeled water. *International Journal of Obesity*, *32*, 1031–1033. https://doi.org/10.1038/ijo.2008.42

Kampf, G., Todt, D., Pfaender, S., & Steinmann, E. (2020). Persistence of coronaviruses on inanimate surfaces and their inactivation with biocidal agents. *The Journal of Hospital Infection*, *104*, 246–251. https://doi.org/10.1016/j.jhin.2020.01.022

Kaushal, N., Keith, N., Aguiñaga, S., & Hagger, M. S. (2020). Social cognition and socioecological predictors of home-based physical activity intentions, planning, and habits during the COVID-19 pandemic. *Behavioral Sciences*, *10*, 133. https://doi.org/10.3390/bs10090133

Kaushal, N., Rhodes, R. E., Meldrum, J. T., & Spence, J. C. (2017). The role of habit in different phases of exercise. *British Journal of Health Psychology*, *22*, 429–448. https://doi.org/10.1111/bjhp.12237

Keyworth, C., Epton, T., Goldthorpe, J., Calam, R., & Armitage, C. J. (2020). Acceptability, reliability, and validity of a brief measure of capabilities, opportunities, and motivations ("COM-B"). *British Journal of Health Psychology*, *25*, 474–501. https://doi.org/10.1111/bjhp.12417

Lee, I.-M., Shiroma, E. J., Lobelo, F., Puska, P., Blair, S. N., & Lancet Physical Activity Series Working Group. (2012). Effect of physical inactivity on major non-communicable diseases worldwide: an analysis of burden of disease and life expectancy. *The Lancet*, *380*(9838), 219–229. https://doi.org/10.1016/S0140-6736(12)61031-9

López-Bueno, R., Calatayud, J., Casaña, J., Casajús, J. A., Smith, L., Tully, M. A., . . . López-Sánchez, G. F. (2020). COVID-19 confinement and health risk behaviors in Spain. *Frontiers in Psychology*, *11*, 1–13. https://doi.org/10.3389/fpsyg.2020.01426

McNeill, L. H., Kreuter, M. W., & Subramanian, S. V. (2006). Social environment and physical activity: A review of concepts and evidence. *Social Science and Medicine*, *63*, 1011–1022. https://doi.org/10.1016/j.socscimed.2006.03.012

Meyer, J., McDowell, C., Lansing, J., Brower, C., Smith, L., Tully, M. A., & Herring, M. (2020). Changes in physical activity and sedentary behavior in response to COVID-19 and their associations with mental health in 3,052 US adults. *International Journal of Environmental Research and Public Health*, *17*, 6469. https://doi.org/10.3390/ijerph17186469

Michie, S. F., Atkins, L., & West, R. (2014). *The behaviour change wheel: A guide to designing interventions*. London, UK: Silverback Publishing.

Michie, S., van Stralen, M. M., & West, R. (2011). The behaviour change wheel: A new method for characterising and designing behaviour change interventions. *Implementation Science*, *6*(1), 42. https://doi.org/10.1186/1748-5908-6-4

Michie, S., West, R., Brooke Rogers, M., Bonell, C., Rubin, G. J., & Amlot, R. (2020). Reducing SARS-CoV-2 transmission in the UK: A behavioural science approach to identifying options for increasing adherence to social distancing and shielding vulnerable people. *British Journal of Health Psychology*, *25*, 945–956. https://doi.org/10.1111/bjhp.12428

Milton, K., Clemes, S., & Bull, F. (2012). Can a single question provide an accurate measure of physical activity? *British Journal of Sports Medicine*, *47*, 44–48. https://doi.org/10.1136/bjsports-2011-090899

Moore, S. A., Faulkner, G., Rhodes, R. E., Brussoni, M., Chulak-Bozzer, T., Ferguson, L. J., … Tremblay, M. S. (2020). Impact of the COVID-19 virus outbreak on movement and play behaviours of Canadian children and youth: A national survey. *International Journal of Behavioral Nutrition and Physical Activity*, *17*, 85. https://doi.org/10.1186/s12966-020-00987-8

Musselwhite, C., Avineri, E., & Susilo, Y. (2020). Editorial JTH 16 –the coronavirus disease cOVID-19 and implications for transport and health. *Journal of Transport and Health*, *16*, 100853. https://doi.org/10.1186/s12966-020-00987-8

National Health Service. (2020). *Coronavirus (COVID-19): Staying at home and away from other people (social distancing)*. Retrieved from https://www.gov.uk/government/publications/full-guidance-on-staying-at-home-and-away-from-others/full-guidance-on-staying-at-home-and-away-from-others

Obeid, J. S., McGraw, C. A., Minor, B. L., Conde, J. G., Pawluk, R., Lin, M., … Harris, P. A. (2013). Procurement of shared data instruments for Research Electronic Data Capture (REDCap). *Journal of Biomedical Informatics*, *46*(2), 259–265. https://doi.org/10.1016/j.jbi.2012.10.006

Peer, E., Brandimarte, L., Samat, S., & Acquisti, A. (2017). Beyond the Turk: Alternative platforms for crowdsourcing behavioral research. *Journal of Experimental Social Psychology*, *70*, 153–163. https://doi.org/10.1016/j.jesp.2017.01.006

Phillipou, A., Meyer, D., Neill, E., Tan, E. J., Toh, W. L., Van Rheenen, T. E., & Rossell, S. L. (2020). Eating and exercise behaviors in eating disorders and the general population during the COVID-19 pandemic in Australia: Initial results from the COLLATE project. *International Journal of Eating Disorders*, *3*, 1158–1165. https://doi.org/10.1002/eat.23317

Rebar, A., Dimmock, J. A., Jackson, B., Rhodes, R. E., Kates, A., Starling, J., & Vandelanotte, C. (2016). A systematic review of the effects of non-conscious regulatory processes in physical activity. *Health Psychology Review*, *10*, 395–407. https://doi.org/10.1080/17437199.2016.1183505

Rhodes, R. E., Liu, S., Lithopoulos, A., Zhang, C. Q., & Garcia-Barrera, M. A. (2020). Correlates of perceived physical activity transitions during the COVID-19 pandemic among Canadian Adults. *Applied Psychology: Health and Well-Being*, https://doi.org/10.1111/aphw.12236

Rhodes, R. E., & Nigg, C. R. (2011). Advancing physical activity theory: A review and future directions. *Exercise and Sports Sciences Reviews*, *39*, 113–119. https://doi.org/10.1097/JES.0b013e31821b94c8

Rhodes, R. E., & Rebar, A. (2018). Physical activity habit: Complexities and controversies. In B. Verplanken (Ed.), *The psychology of habit* (pp. 91–109). Cham, Switzerland: Springer.

Robinson, E., Boyland, E., Chisholm, A., Harrold, J., Maloney, N. G., Marty, L., … Hardman, C. A. (2020). Obesity, eating behavior and physical activity during COVID-19 lockdown: A study of UK adults. *Appetite*, *156*, 104853, https://doi.org/10.1016/j.appet.2020.104853

Rogers, N. T., Waterlow, N. R., Brindle, H., Enria, L., Eggo, R. M., Lees, S., & Roberts, C. H. (2020). Behavioral change towards reduced intensity physical activity is disproportionately prevalent among adults with serious health issues or self-perception of high risk during the UK COVID-19 lockdown. *Frontiers in Public Health*, *8*, Article 575091. https://doi.org/10.3389/fpubh.2020.575091

Scholes, S., & Mindell, J. (2020). Inequalities in participation and time spent in moderate-to-vigorous physical activity: A pooled analysis of the cross-sectional health surveys for England 2008, 2012, and 2016. *BMC Public Health*, *20*, 361. https://doi.org/10.1186/s12889-020-08479-x

Smith, L., Jacob, L., Butler, L., Schuch, F., Barnett, Y., Grabovac, I., . . . Tully, M. A. (2020). Prevalence and correlates of physical activity in a sample of UK adults observing social distancing during the COVID-19 pandemic. *BMJ Open Sport and Exercise Medicine*, *6*(1), e000850. https://doi.org/10.1136/bmjsem-2020-000850

Sport England. (2018). *Active Lives Adult Survey: May 17/18 report*. Retrieved from https://sportengland-production-files.s3.eu-west-2.amazonaws.com/s3fs-public/active-lives-adult-may-17-18-report.pdf

Sport England. (2020) *COVID-19 Briefing: Exploring attitudes and behaviours in England during the COVID-19 pandemic*. Retrieved from https://indd.adobe.com/view/793b48d5-bbcd-4de3-a50f-11d241a506b3

Stearns, J. A., Veugelers, P., Godley, J., Ekwaro, P. J., Wu, B., Bastian, K., & Spence, J. C. (2019). Associations of friendship and children's physical activity during and outside of school: A social network study. *SSM – Population Health*, 7, 100308. https://doi.org/10.1016/j.ssmph.2018.10.008

Tabachnick, B., & Fidell, L. S. (2007). *Using multivariate statistics* (Vol. 5). Boston, MA: Pearson.

Teixeira, P. J., Carraça, E. V., Markland, D., Silva, M. N., & Ryan, R. M. (2012). Exercise, physical activity, and self-determination theory: A systematic review. *International Journal of Behavioral Nutrition and Physical Activity*, *9*, 78. https://doi.org/10.1186/1479-5868-9-78

Tison, G. H., Avram, R., Kuhar, P., Abreau, S., Marcus, G. M., Pletcher, M. J., & Olgin, J. E. (2020). Worldwide Effect of COVID-19 on physical activity: A descriptive study. *Annals of Internal Medicine*, *173*, 767–770. https://doi.org/10.7326/M20-2665

UK Chief Medical Officers. (2019). *UK Chief Medical Officers' Physical Activity Guidelines*. Retrieved from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/832868/uk-chief-medical-officers-physical-activity-guidelines.pdf

Wilkie, S., Townshend, T., Thompson, E., & Ling, J. (2018). Restructuring the built environment to change adult health behaviors: A scoping review integrated with behavior change frameworks. *Cities & Health*, *2*(2), 198–211. https://doi.org/10.1080/23748834.2019.1574954

Williams, D. M., & Rhodes, R. E. (2016). Reviving the critical distinction between perceived capability and motivation: A res ponse to commentaries. *Health Psychology Review*, *10*, 144–147. https://doi.org/10.1080/17437199.2016.1171729

World Health Organization. (2020, March 11). *WHO Director-General's opening remarks at the media briefing on COVID-19 – March 11*. Retrieved from https://www.who.int/docs/default-source/coronaviruse/transcripts/who-audio-emergencies-coronavirus-press-conference-11may2020.pdf?sfvrsn=4f78bd0_0

Yang, Y., & Koenigstorfer, J. (2020). Determinants of physical activity maintenance during the Covid-19 pandemic: a focus on fitness apps. *Translational Behavioral Medicine*, *10*, 835–842. https://doi.org/10.1093/tbm/ibaa086

Received 3 July 2020; revised version received 1 December 2020