

# Impact of the COVID-19 pandemic on the wellbeing of *parkrun* participants in the United Kingdom

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## Research Article

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# Abstract

## Introduction

Lockdown restrictions imposed across the UK in response to the COVID-19 pandemic had a profound impact on many people's health and wellbeing. People were encouraged to be active, but population surveys suggest some groups found this easier than others. We explored the changes in health, wellbeing and physical activity levels among a sample in the UK who experienced the sudden loss of a weekly community-based physical activity opportunity, *parkrun*.

## Methods

A sample of UK *parkrun* participants responded to two surveys; pre-COVID-19 in January/February 2019 and during the COVID-19 pandemic in September 2020. Outcomes were happiness, life satisfaction, connections with others, physical health, mental health and physical activity. The sample was stratified by gender, age, deprivation status, physical activity and number of *parkruns* completed. Demographics were reported using descriptive statistics. Distributions between sub-groups were compared using Chi-square tests while differences in outcomes were determined using the Mann-Whitney U test. Open text responses were also analysed.

## Findings

Happiness, life satisfaction, connections with others, physical health and mental health of 450 *parkrun* participants were negatively impacted for all sub-groups, although the impact was not experienced equally. The COVID-19 pandemic negatively impacted the mental wellbeing of a greater proportion of females, younger adults, inactive people, those from higher deprivation areas, and those who had completed fewer *parkruns*.

## Conclusions

There is evidence that the wellbeing of those who were more active, and those more involved in a community-based physical activity initiative pre-pandemic, was less negatively affected during the COVID-19 lockdown.

## Declarations

### Acknowledgements

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### Ethics

Ethical approval for the original Health and Wellbeing Survey was granted by Sheffield Hallam University Research Ethics Committee on 24/07/2018 (reference number: ER7034346). Ethical approval for this secondary data analysis study was granted by the same ethics committee on 4/12/2020 (reference number ER29077901).

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The views, thoughts, and opinions expressed in the manuscript belong solely to the author/s, and do not necessarily reflect the position of parkrun, the parkrun Research Board or funders.

### Conflicts of interest

CW and MG are parkrun staff members. SH, AB, EG and HQ are members of the parkrun research board. All authors except EG are parkrun registrants/participants.

## Lay Summary

A sample of 450 UK *parkrun* participants responded to two surveys; one before the COVID-19 pandemic and one during the pandemic. Outcomes were happiness, life satisfaction, connections with others, physical health, mental health and physical activity. Physical activity fell by 6% while happiness and life satisfaction fell by 12%. People experienced the worst negative impact on their connections with others. The pandemic was found to affect more women, younger adults, those from more deprived neighbourhoods, those who were least active at *parkrun* registration and those who had completed a lower number of *parkrun* events in the 12 months prior to the close of *parkrun* events. The role that community-based physical activity initiatives will have in bringing people's mental health, connections with others, happiness and life satisfaction back to pre-COVID-19 levels in post-lockdown periods needs further investigation and ongoing monitoring.

## Introduction

In March 2020, a nationwide 'lockdown' in the United Kingdom (UK) in response to coronavirus disease 2019 (COVID-19), placed stringent restrictions on travel, social interaction, and access to public spaces with the aim of slowing the spread of the virus and protecting healthcare services. People were advised to 'stay at home', only leaving for essential reasons. The closure of 'non-essential' businesses, organisations and spaces included leisure and fitness centres, gyms, swimming pools, physical activity events and sports clubs. This had a profound impact on the quality and quantity of social interactions and individual lifestyles (Bu et al., 2020) with detrimental consequences to social isolation and loneliness (Bu et al., 2020), mental distress (Banks and Xu, 2020), happiness and life satisfaction (Krekel et al., 2020), especially among women, younger adults, people from black and minority ethnic backgrounds and those with lower household income (Fancourt et al., 2020a).

Despite the closure of sport, exercise and physical activity facilities, physical activity came into the spotlight as governments across the world encouraged people to become and stay active as an 'essential activity' for their health and wellbeing (Payne, 2020, World Health Organization, 2020). Much interest was given to population level changes in physical activity (Stockwell et al., 2021). Research from the beginning of lockdown in March 2020 suggested that higher proportions of the UK population were self-reporting meeting physical activity guidelines compared to preceding years (Smith et al., 2020a), which was supported by Google Trends data from the UK (Ding et al., 2020). Conversely, Sport England data from across the COVID-19 pandemic suggests that the lockdown restrictions had a negative impact on the type and volume of activity people were doing – especially during initial stages of the pandemic (between mid-March and mid-May) (Sport England, 2021). The proportion of the population classed as "active" dropped by 7.1% (over 3 million fewer active adults) compared to the 12 months before (Sport England, 2021).

Collectively, the available evidence into physical activity changes is difficult to compare, generalise and interpret due to methodological differences, seasonal variation in activity levels and the changing COVID-19 lockdown restrictions over place and time. Though what became clear across all the evidence was that physical activity levels differed depending on sociodemographic characteristics such as age, sex, socioeconomic status, disability status, ethnicity and pre-lockdown physical activity level (Smith et al., 2020a, Stockwell et al., 2021, Sport England, 2021, Faulkner et al., 2021). This warrants investigation due to its potential to contribute and reinforce existing health inequalities (Gidlow et al., 2006, Stringhini et al., 2010).

The COVID-19 pandemic restrictions not only meant changes in the levels and type of physical activity but also a loss of social interaction. Feeling a sense of belonging to a social group is a protective mechanism against social isolation, loneliness and poor mental health (Holmes et al., 2020). The social element of participation is likely to have been lost due to lockdown measures. It is therefore important to explore any changes in health, wellbeing and physical activity levels among those who had their community-based physical activity opportunities abruptly removed during lockdown restrictions.

We examine this issue in the context of *parkrun*, a community-based physical activity opportunity that suspended its 2,200+ worldwide events in March 2020 (over 1,000 of which take place in the UK). *parkruns* are free, weekly, 5 kilometre events where people can participate as a runner, walker or volunteer ([www.parkrun.com](http://www.parkrun.com)). In the UK, before events were closed due to the COVID-19 pandemic, around 170,000 people were taking part each week. *parkrun* has removed many of the barriers to physical activity, encouraging participation by women (Stevinson and Hickson, 2013), older people (Grunseit et al., 2018), people with long-term health conditions (Quirk and Haake, 2019), people who were previously inactive (Quirk et al., 2020) and those living in areas of high deprivation (Smith et al., 2020b). Research suggests that the health and wellbeing gains of participation are derived from the friendly, welcoming and social nature of the events (Grunseit et al., 2020). With the abrupt cancellation of *parkrun* events in March 2020, the *parkrun* population provides a unique opportunity to explore change over time in health and wellbeing among relatively active people.

In this study, we sought to understand how the health, wellbeing and physical activity level of UK *parkrun* participants changed during the COVID-19 pandemic and the extent to which people from different sub-groups differed.

## Methods

Ethical approval for the original Health and Wellbeing Survey was granted by Sheffield Hallam University Research Ethics Committee on 24/07/2018 (reference number: ER7034346). Ethical approval for this secondary data analysis study was granted by the same ethics committee on 4/12/2020 (reference number ER29077901).

### Study samples

This study uses a single sample of *parkrun* participants responding to surveys at 2 time points, described below.

#### *The Health and Wellbeing Survey* (labelled “pre-COVID”)

In 2018, *parkrun* commissioned the Advanced Wellbeing Research Centre (AWRC) at Sheffield Hallam University (UK) to conduct a study into the health and wellbeing of the UK *parkrun* community (Haake, Quirk, and Bullas 2018); including participants in England, Scotland, Wales and Northern Ireland. In the longitudinal arm of the study, new *parkrun* registrants (50,509) were emailed in January/February 2019 with an invite to complete an online survey and were followed up with the same survey 6 months later in July 2019 (receiving 567 responses). This paper only reports the data from January/February 2019 (i.e., “pre-COVID”).

The Health and Wellbeing Survey measured happiness, life satisfaction, self-reported physical activity level, motives for participation, health status, healthcare usage, mental wellbeing, perceived impact of *parkrun* and the impact of *parkrun* on social opportunities. Participants in the Health and Wellbeing Survey gave permission for their anonymised responses to be used for further research.

#### *The parkrun COVID-19 survey* (labelled “COVID”)

During the COVID-19 pandemic in September 2020, 20 months after the *parkrun* Health and Wellbeing survey was distributed, *parkrun* sent a COVID-19 survey to *parkrun* participants in the UK; including participants in England, Scotland, Wales and Northern Ireland. The online *parkrun* COVID-19 survey was sent via email to a stratified random sample balanced for gender, age and number of *parkrun* walk/runs completed in the 12 months prior to 18<sup>th</sup> March 2020. This represented 57,941 *parkrun* participants and included 2,560 respondents from the pre-COVID Health and Wellbeing Survey. The *parkrun* COVID-19 survey aimed to understand the impact of the COVID-19 pandemic on the health and wellbeing of *parkrun* participants and their thoughts about returning to *parkrun* when events were relaunched in the UK. Participants in the *parkrun* COVID-19 survey gave permission for their responses to be shared with researchers for the purposes of further research.

#### *Combined dataset used in this secondary analysis*

Responses to the Health and Wellbeing Survey and the *parkrun* COVID-19 survey were matched at the person-level using *parkrun* Athlete ID (provided to all *parkrun* registrants to identify them on the *parkrun* database and enable the collation of all their *parkrun* participation data) and date of birth across the two databases. This resulted in a combined (linked) dataset of 450 respondents who had completed both surveys and thus allowed a comparison of responses over time (before and during the pandemic).

## **Outcomes**

### ***Demographic variables***

Additional demographic variables not collected in the surveys were extracted from the *parkrun* database after the matching process:

- Gender (female and male);
- Age derived from date of birth;
- Index of multiple deprivation (IMD) derived from postcode;
- Self-reported physical activity level at *parkrun* registration;
- Number of *parkrun* events completed before *parkrun* events closed in March 2020.

### ***Health and wellbeing***

Mental wellbeing was captured using questions on happiness, life satisfaction, mental health and connections with others. The pre-COVID and COVID surveys both used the Office of National Statistics (ONS) personal wellbeing scales questions for happiness and life satisfaction: i) *Overall, how happy did you feel yesterday?* and ii) *Overall, how satisfied are you with your life nowadays?* Respondents were asked to respond on a scale of 0 to 10, where 0 is “not at all” and 10 is “completely”.

In the COVID survey, participants were asked: *How has your i) happiness, and ii) satisfaction with life iii) connections with others in your community, iv) physical health, and v) mental health been impacted by the COVID-19 pandemic?* On a 5-point Likert scale, respondents were given the options: major positive impact, moderate positive impact, no impact, moderate negative impact, major negative impact.

### ***Self-reported physical activity level***

The pre-COVID and COVID surveys both used the Milton, Bull & Bauman (2011) single item physical activity question which asked: *In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate? This may include sport, exercise, and brisk walking or cycling for recreation or to get to and from places, but should not include housework or physical activity that may be part of your job.* Respondents could answer: 0 days, 1 day, 2 days etc up to 7 days.

### ***Open text responses***

The COVID survey gave respondents the option of providing an open-text response to the question: *“Is there anything you want to add about the impact of the pandemic, and the absence of *parkrun* events on your health and wellbeing?”*

## **Data analysis**

Data was visually checked in Microsoft Excel by one researcher (SH) and analysed using frequency counts, means, standard deviations, medians, minimum and maximum and inter-quartile range. For categorical data: N and %.

### ***Stratification***

The sample was stratified by the following:

- **Gender:** female and male (Supplementary Material 1a);
- **Socioeconomic status (SES):** using the indices of multiple deprivation (IMD), classified into four quartiles (Q1, Q2, Q3, Q4) and segregated into 'Low IMD' (those in the most deprived areas; IMD Q1 and Q2) and 'High IMD' (those in the least deprived areas; IMD Q3 and Q4) (Supplementary Material 1c);
- **Age:** derived from the date of birth and segregated into 'younger adults' (less than 55 years of age; mean age 41.2) and 'older adults' (55 years or over; mean age 62.4) (Supplementary Material 1b);
- **Activity level:** derived from a physical activity question asked at *parkrun* registration and segregated into 'lower activity' (those reporting 0, 1 or 2 days per week of at least 30 minutes moderate exercise) and 'higher activity' (those reporting 3 and 4 or more days per week of at least 30 minutes moderate exercise) (Supplementary Material 1d);
- ***parkrun* engagement level:** derived from *parkrun* participation records and segregated either side of the median into 'low *parkruns*' ( $\leq 9$  *parkruns* completed in the previous 12 months; mean number of *parkruns* 3.7) and 'high *parkruns*' ( $> 9$  *parkruns* completed in the previous 12 months; mean number of *parkruns* 23.2) (Supplementary Material 1e).

The change in physical activity between the pre-COVID and COVID surveys was determined using the single item activity question with a maximum change of  $\pm 7$  days of activity per week.

Distributions between sub-groups were compared using Chi-square tests with the significance of specific categories analysed using partitioned Chi-square tests; these were calculated in Excel for Mac (v16.43). Happiness, life satisfaction and single item physical activity level were non-parametric (i.e. had medium to large values of  $Z_{skew}$  and  $Z_{kurt}$ ) and differences were determined using the Mann-Whitney U test in SPSS (v26). Effect sizes were calculated using Cohen's  $d$  using pooled standard deviation.

The open-ended survey responses were analysed in Excel using content analysis and inductive coding (O'Cathain and Thomas, 2004). One researcher (HQ), an experienced qualitative researcher, devised a coding frame inductively from the data and manually assigned codes to the verbatim responses that captured what the respondent was saying (i.e., the thematic content of the response). Content analysis stopped when the researcher had reached a point of having summarised all the responses into themes. Themes were presented as numbers and proportions. Verbatim comments were extracted to illustrate the themes.

## Findings

### Sample characteristics

Table 1 shows the demographics of the full sample; the demographics of all sub-groups are given in Supplementary Material 1. The mean age of the sample was 47.6 years with a slight skew towards younger respondents. The age range was 16 to 80 years and 55.3% were female. The proportion of the sample increased linearly with IMD quartile from 11.2% for quartile 1 (most deprived) to 35.1% for quartile 4 (least deprived). 7.4% were inactive at *parkrun* registration (i.e. reported doing less than one day of least 30 minutes of moderate exercise per week) with the mode at three days of activity per week (31.7% of the cohort).

[insert Table 1]

In the year prior to *parkrun* closing due to the COVID-19 pandemic (13 to 14 months after the pre-COVID survey), participants had done a mean of 13.3 *parkruns*, i.e. just over one per month; the distribution was highly skewed, with a median of 9 *parkruns* and an inter-quartile range of 3 to 21 *parkruns*.

### Happiness, life satisfaction and physical activity

#### Full cohort

Table 2a-2c shows happiness, life satisfaction and physical activity at the pre-COVID and at COVID surveys for the full cohort (all) and the sub-groups. Happiness fell from 7.48 before the COVID-19 pandemic to 6.60 during the COVID-19 pandemic by a mean of -0.88; similarly, life satisfaction fell from 7.48 to 6.56 by a mean of -0.92. Values of happiness and life satisfaction during the COVID-19 pandemic were significantly lower for all sub-groups compared to before the COVID-19 pandemic (Tables

2a and 2b;  $p < 0.01$  or  $p < 0.001$  with moderate to large effect sizes). The physical activity level for the full cohort fell from 3.47 to 3.22 days per week by 0.21 days per week (Table 2c;  $p < 0.05$  with a small effect size).

The following sections describe the statistically significant findings for each sub-group (Tables 2a to 2c).

*[insert Table 2a-2c]*

#### *Females vs males*

Females had higher happiness and life satisfaction before the COVID-19 pandemic than during the COVID-19 pandemic. Although the differences between genders were not significantly different between time points, the *change* in life satisfaction from before to during the COVID-19 pandemic was, i.e. for females it dropped by 1.17 while for men it dropped by 0.62 (Table 2b; effect size=0.26,  $p < 0.01$ ). There was no statistically significant difference in physical activity levels between females and males.

#### *Younger vs older*

Happiness and life satisfaction were statistically higher for the older sub-group compared to the younger sub-group both before the COVID-19 pandemic and during the COVID-19 pandemic (Tables 2a and 2b;  $p < 0.01$ ). There was no significant difference in physical activity levels between the two sub-groups at either time point (Table 2c).

#### *Low IMD (most deprived) vs high IMD (least deprived)*

Happiness and life satisfaction appeared to be lower at both time points for the low IMD group compared to the high IMD group, although this was only significant for happiness during the COVID-19 pandemic (Table 2a; 6.30 vs 7.45, effect size=0.23,  $p < 0.05$ ). There was no significant difference for physical activity levels between the two sub-groups at either time point, although the *change* in physical activity level from before to during the COVID-19 pandemic was significantly larger for the low IMD group compared to the high IMD group, i.e. the activity level of the low IMD group fell by 0.52 days per week while the high IMD group fell by 0.14 days per week (Table 2c; effect size 0.19,  $p < 0.05$ ).

#### *Low vs high activity at registration*

Happiness, life satisfaction and physical activity were lower for the low activity group compared to the high activity group before and during the COVID-19 pandemic. The *change* in activity from before to during the COVID-19 pandemic was greater for the high activity sub-group compared to the low activity group (Table 2c; -0.57 vs 0.10, effect size 0.34,  $p < 0.05$ ).

#### *Low vs high number of parkruns*

Happiness and life satisfaction tended to be higher before the COVID-19 pandemic for the low *parkruns* sub-group compared to the high *parkruns* sub-group; conversely these variables were lower for the low *parkruns* sub-group during the COVID-19 pandemic (Tables 2a and 2b). Although the differences between sub-groups were not significant, the *change* in happiness was significantly greater for the low *parkruns* sub-group with a drop of -1.10 compared to -0.70 (Table 2a; effect size 0.19,  $p < 0.05$ ).

### **Perceived impact of the COVID-19 pandemic**

Tables 3a to 3e show the perceived impact of the COVID-19 pandemic. The most reported negative impact was on connections with others (73%), while physical health had the lowest negative impact (41%) and the largest positive impact (26%). Around a third of respondents reported no impact of the COVID-19 pandemic on either their physical or mental health. The following sections describe the statistically significant findings for each sub-group.

*[insert Table 3a-3e]*

#### *Females vs males*

There was little statistical difference between females and males although there were indications that a larger proportion of females improved their connections with others during the COVID-19 pandemic (Table 3c; 17% vs 9%,  $p < 0.05$ ) and a larger proportion of females reported worse physical health (Table 3d; 46% vs 34%,  $p < 0.05$ ).

#### *Younger vs older adults*

A larger proportion of younger adults reported a major negative impact of the COVID-19 pandemic on their happiness when compared to older adults (Table 3a; 10% vs 1%,  $p < 0.01$ ). Similar differences between younger and older adults reporting a major negative impact were found for life satisfaction (Table 3b; 8% vs 2%,  $p < 0.05$ ) and mental health (Table 3e; 10% vs 1%,  $p < 0.01$ ). Overall, 66% of younger adults reported worse mental health compared to 42% of older adults (Table 3e;  $p < 0.001$ ). Conversely, a larger proportion of older adults than younger adults reported a moderately positive impact of the COVID-19 pandemic on their connections with others (Table 3c; 16% vs 10%,  $p < 0.05$ ).

A large proportion of older adults reported no impact to their physical health than younger adults (Table 3d; 39% vs 30%,  $p < 0.01$ ); this was also true for mental health (Table 3e; 52% vs 28%,  $p < 0.001$ ).

#### *Low IMD (most deprived) vs high IMD (least deprived)*

A larger proportion of those from the low IMD sub-group reported a major negative impact of the COVID-19 pandemic on their happiness when compared to the high IMD sub-group (Table 3a; 12% vs 4%,  $p < 0.05$ ). Overall, 50% of the low IMD sub-group reported worse physical health compared to 37% of the high IMD sub-group (Table 3d;  $p < 0.01$ ). Similarly, 66% of the low IMD sub-group reported worse mental health compared to 56% of the high IMD sub-group (Table 3e;  $p < 0.05$ ). Conversely, a larger proportion of the high IMD sub-group reported a moderate positive impact of the pandemic on their connections with others compared to the low IMD sub-group (Table 3c; 14% vs 8%;  $p < 0.05$ ).

A larger proportion of those from the high IMD sub-group reported no impact to their life satisfaction than those from the low IMD sub-group (Table 3b; 22% vs 14%,  $p < 0.01$ ); this was also true for physical health (Table 3d; 35% vs 26%,  $p < 0.05$ ) and mental health (Table 3e; 38% vs 28%,  $p < 0.05$ ).

#### *Low vs high activity*

A larger proportion of those who had low activity levels at registration reported a moderately negative impact of the COVID-19 pandemic on their life satisfaction when compared to those who reported higher levels of activity (Table 3b; 68% vs 56%,  $p < 0.05$ ), and also their physical health (Table 3d; 45% vs 32%,  $p < 0.01$ ). A slightly larger proportion of those from the high activity sub-group reported no impact of the COVID-19 pandemic to their life satisfaction than those from the low activity sub-group (Table 3c; 16% vs 10%,  $p < 0.05$ ).

#### *Low vs high number of parkruns*

A larger proportion of those who did a low number of *parkruns* reported a moderately negative impact of the COVID-19 pandemic on their happiness when compared to those who did a high number of *parkruns* (Table 3a; 68% vs 56%,  $p < 0.01$ ).

### **Open-text responses**

125 respondents (28% of the COVID survey sample) provided an open-text response. 80% of those providing an open text response (100 respondents) described aspects of *parkrun* that they missed. Data coding led to the generation of 11 themes that captured how people had responded to the absence of *parkrun*, to the COVID-19 pandemic and other comments about *parkrun* in relation to its anticipated return (see Supplementary Material 2 for all themes with illustrative quotes). The top 2 themes, with illustrative quotes are outlined in Table 4.

[insert Table 4]

## **Discussion**

We have been able to analyse changes in health, wellbeing and physical activity among a sample of *parkrun* participants who had completed surveys before and during the COVID-19 pandemic. Happiness and life satisfaction dropped by about 12% in the 20-month period between *parkrun* registration (pre-COVID) and during the COVID-19 pandemic. The happiness and life satisfaction scores fell by almost 1 point below the pre-COVID-19 national averages for England and Wales 2019-2020 (Office of National Statistics (ONS), 2018) though were higher than those reported in other England studies during the COVID-19 pandemic (Carson et al., 2020).

Whilst the happiness and life satisfaction among all sub-groups were impacted negatively, this was not experienced similarly across groups. Happiness levels fell more among younger, female and those from more deprived areas. Life satisfaction levels fell more among females, more deprived and lower activity level respondents. These findings are consistent with the reports of younger adults and females in the UK demonstrating worse mental health symptoms and larger deteriorations in mental health compared to older adults and males during the COVID-19 pandemic (Fancourt et al., 2020b, Pierce et al., 2020, Krekel et al., 2020). The gender differences are consistent with pre-existing health inequalities (Pierce et al., 2020) and have been attributed in part to informal caring responsibilities and childcare responsibilities held alongside working commitments by females during the COVID-19 pandemic (Mak et al., 2021).

Just over half of our sample reported a negative impact of the pandemic on mental health with 6% reporting a positive impact of the pandemic on mental health. Again, younger adults were more likely to report a negative impact of the pandemic on their mental health than older adults, which supports other findings (O'Connor et al., 2020, Office of National Statistics (ONS), 2020, Pierce et al., 2020). We did not find any differences in the mental wellbeing impact of the pandemic on people from more deprived neighbourhoods compared to those in less deprived neighbourhoods which could be attributed to higher physical activity levels (Johansson et al., 2019), though this needs investigating further.

Our data show that the greatest negative impact of the COVID-19 pandemic among our sample was on people's connections with others. Younger adults were more detrimentally impacted. Our open-text responses captured how people missed the socialisation and community *parkrun* provides, perhaps more so than the physical activity itself. This is supported by previous *parkrun* research that has highlighted that the community and social connections are both major appeal and positive outcome of *parkrun* participation (Grunseit et al., 2020). Our findings suggest that given many respondents were able to maintain their level of physical activity during the COVID-19 lockdown, physical activity on its own was not enough to support mental wellbeing, showing that the lack of social connections had the most detrimental impact. The importance of maintaining social connections during the COVID-19 pandemic has been strongly advocated as a potential buffer against negative physical and mental health outcomes (Nitschke et al., 2020). This suggests that a return to *parkrun* may mitigate some of the negative mental health effects of lockdown. Further research is needed to find out if this is the case.

Less than half of respondents reported a negative impact of the pandemic on their physical health and around a quarter reported a positive impact on the pandemic on their physical health. This may be attributed to physical activity levels and our sample's ability to roughly maintain their activity level during the pandemic (still around 3 days a week of activity). Physical activity levels fell across the whole sample by about 6%, though there was evidence that some people increased their activity level whilst others decreased, which is consistent with the existing, but somewhat mixed evidence base (Bann et al., 2020). The open-text comments suggest that people's physical activity response to the pandemic may have been influenced by motivation (i.e., having an incentive to be active alone) and opportunity (i.e., time in relation to other commitments), which varied according to living, working and caring arrangements. *parkrun* provided some people with motivation and incentive to be active and whereas others lacked sufficient incentive to remain active in the absence of *parkrun* events.

Participating in events like *parkrun*, when they return, could contribute to the enhancement of mental wellbeing, especially among younger female participants during future lockdowns, in the 'back to normal' transition and 'post-lockdown' periods (Sallis et al., 2020). Further research is needed to find out if this is the case.

## **Methodological considerations**

Findings should be interpreted in the context of the following methodological considerations. Firstly, the self-reported measures may have been biased by measurement errors and reporting biases. Secondly, the surveys were conducted at different times of the year (January/February and September) so the findings should be interpreted with consideration of potential seasonality effects. Thirdly, it is possible that those who provided a response could be different from other *parkrun* participants, and therefore caution must be taken when extrapolating these findings to a wider population. Fourthly, in our exploration of potential inequalities, it is important to note the following limitations. The socioeconomic status of respondents was not inferred from employment, income etc. but was inferred from IMD which was sourced by the postcode provided at *parkrun* registration. This gives an average for the area lived in when the respondent first registered with *parkrun*, it does not guarantee that it is specific to the person. A further limitation of our analysis is that we did not consider the impact of the COVID-19 pandemic on ethnic minority groups which have shown inequalities in physical activity levels during the COVID-19 pandemic (Bann et al., 2020). Finally, our analysis was unable to distinguish the impact of the pandemic from the impact of the lockdown policy on health and wellbeing (Foa et al., 2020).

## Conclusions

The overall wellbeing of a cohort of 450 *parkrun* participants declined during the COVID-19 pandemic. Physical activity fell by 6% while happiness and life satisfaction fell by 12%. The *parkrun* participants perceived that the most notable detrimental impact of the pandemic was on their connections with others. The pandemic was found to affect more women, younger adults, those from more deprived neighbourhoods, those who were least active at registration and those who had completed a lower number of *parkrun* events in the 12 months prior to the close of *parkrun* events. The role that community-based physical activity initiatives will have in bringing people's mental health, connections with others, happiness and life satisfaction back to pre-COVID-19 levels in post-lockdown periods needs further investigation and ongoing monitoring.

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## Tables

Table 1. Demographics (at registration) of newly registered parkrunners in pre-COVID and COVID surveys.

Age (years)		N	Mean	St Dev	Min	Median	IQR	Max	Female
		438	47.6	13.1	16.8	48.4	39.3-56.8	80.8	55.3%
Index of multiple deprivation		N	Q1	Q2	Q3	Q4			
Frequency	All	436	49	100	134	153			
Proportion	All		11.2%	22.9%	30.7%	35.1%			
Activity level at registration		N	<1	≈1	≈2	≈3	≥4		
Frequency	All	445	33	51	119	141	101		
Proportion	All		7.4%	11.5%	26.7%	31.7%	22.7%		
Number of parkruns		N	Mean	St Dev	Min	Median	IQR	Max	
	All	356	13.3	12.3	1	9	3-21	49	

Table 2. Questions on happiness, life satisfaction and physical activity pre-COVID and during the COVID-19 pandemic. Young/old defined as <55 and ≥55 years; Low/high IMD <50% and ≥50%; Low/high activity ≤ 'About 2 days per week' and ≥ 'About three days per week'; fewer/more parkruns ≤9 runs and >9 runs.

(a) Overall, how happy did you feel yesterday? (0-10)

	Happiness	All	Female	Male	Younger	Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
	n	398	216	182	276	122	132	253	178	215	157	155
Pre- COVID survey	Mean	7.48	7.56	7.38	7.26	7.98	7.45	7.49	7.25	7.68	7.61	7.46
	Standard deviation	1.52	1.46	1.59	1.52	1.41	1.42	1.58	1.63	1.40	1.55	1.57
	Effect size between sub- groups			0.12		***0.48		0.03		*0.29		0.10
COVID survey	Mean	6.60	6.57	6.62	6.29	7.28	6.30	6.79	6.37	6.79	6.52	6.75
	Standard deviation	2.20	2.26	2.12	2.28	1.82	2.32	2.08	2.31	2.09	2.15	2.09
	Effect size between sub- groups			0.02		***0.46		*0.23		0.19		0.11
Change	Mean	-0.88	-0.99	-0.76	-0.96	-0.70	-1.14	-0.69	-0.91	-0.86	-1.10	-0.70
	Standard deviation	2.13	2.21	2.04	2.25	1.84	2.28	1.99	2.06	2.20	1.92	2.27
	Effect size between sub- groups			0.11		0.12		0.21		0.02		*0.19
	Effect size pre-COVID vs COVID	***0.47	***0.52	**0.41	***0.50	**0.43	***0.60	***0.38	**0.44	***0.50	***0.58	**0.38

(b) Overall, how satisfied are you with your life nowadays? (0-10)

	Life satisfaction	All	Female	Male	Younger	Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
	n	397	216	181	276	121	131	252	178	214	157	155
Pre-COVID survey	Mean	7.48	7.63	7.31	7.28	7.95	7.35	7.55	7.32	7.62	7.57	7.47
	Standard deviation	1.76	1.74	1.78	1.79	1.62	1.90	1.71	1.79	1.74	1.88	1.65
	Effect size between sub-groups			0.18		***0.39		0.11		*0.17		0.06
COVID survey	Mean	6.56	6.46	6.69	6.37	7.01	6.35	6.70	6.33	6.76	6.54	6.73
	Standard deviation	1.83	1.90	1.73	1.89	1.58	1.97	1.71	1.90	1.75	1.82	1.84
	Effect size between sub-groups			0.13		**0.36		0.19		*0.24		0.10
Change	Mean	-0.92	-1.17	-0.62	-0.91	-0.94	-1.00	-0.85	-0.96	-0.88	-1.04	-0.74
	Standard deviation	2.12	2.17	2.02	2.23	1.84	2.52	1.88	2.10	2.15	2.11	2.23
	Effect size between sub-groups			**0.26		0.01		0.07		0.04		0.14
	Effect size pre-COVID vs COVID	***0.51	***0.64	***0.35	***0.49	***0.59	***0.52	***0.50	***0.54	***0.49	***0.56	***0.42

(c) In the past week, on how many days have you done a total of 30 minutes or more of physical activity, which was enough to raise your breathing rate? (0-7 days).

	Physical activity	All	Female	Male	Younger	Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
	n	425	232	193	297	128	141	270	191	229	171	158
Pre-COVID survey	Mean	3.47	3.36	3.61	3.49	3.42	3.49	3.43	2.60	4.22	3.43	3.48
	Stdev	1.60	1.58	1.61	1.56	1.68	1.62	1.59	1.38	1.35	1.58	1.52
	Effect size between sub-groups			0.16		0.04		0.04		***1.19		0.03
COVID survey	Mean	3.22	3.17	3.28	3.18	3.33	2.97	3.29	2.71	3.65	3.08	3.42
	Stdev	1.97	1.93	2.01	1.94	2.04	1.87	2.00	1.87	1.91	1.87	2.02
	Effect size between sub-groups			0.06		0.08		0.16		***0.50		0.17
Change	Mean	-0.21	-0.19	-0.33	-0.32	-0.09	-0.52	-0.14	0.10	-0.57	-0.36	-0.06
	Standard deviation	1.93	1.94	2.10	2.08	1.86	2.10	1.93	1.99	1.95	1.76	2.08
	Effect size between sub-groups			0.07		0.11		*0.19		**0.34		0.16
	Effect size pre-COVID vs COVID	*0.14	0.11	0.18	0.18	0.05	*0.30	0.08	0.07	***0.34	0.20	0.03

Mann-Whitney U test: \*p<0.05; \*\*p<0.01; \*\*\*p<0.001.

Effect size: Small 0-0.2; 0.2-0.5 moderate; large 0.5-0.8; very large 0.8-1.2; huge>2.0.

Table 3. Perceived change in happiness, life satisfaction, connections with others, mental health and physical activity due to the COVID-19 pandemic. Younger/older <55 and ≥55 years; Low/high IMD <50% and ≥50%; Low/high activity ≤ 'About 2 days per week' and ≥ 'About three days per week'; low/high parkruns ≤9 runs and >9 runs.

(a) How has your happiness been impacted by the COVID-19 pandemic?

Happiness	All	Female	Male	Younger	** Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
major negative impact	31	17	14	30	1	18	12	12	18	11	13
moderate negative impact	278	157	121	184	85	87	181	129	145	122	95
no impact	96	48	48	62	33	26	68	45	51	31	40
moderate positive impact	40	25	15	28	10	17	23	16	24	15	20
major positive impact	5	2	3	2	3	1	3	1	4	1	3
<b>Total</b>	<b>450</b>	<b>249</b>	<b>201</b>	<b>306</b>	<b>132</b>	<b>149</b>	<b>287</b>	<b>203</b>	<b>242</b>	<b>180</b>	<b>171</b>
major negative impact	7%	7%	7%	10%	†† 1%	12%	† 4%	6%	7%	6%	8%
moderate negative impact	62%	63%	60%	60%	64%	58%	63%	64%	60%	68%	†† 56%
no impact	21%	19%	24%	20%	25%	17%	24%	22%	21%	17%	23%
moderate positive impact	9%	10%	7%	9%	8%	11%	8%	8%	10%	8%	12%
major positive impact	1%	1%	1%	1%	2%	1%	1%	0%	2%	1%	2%
moderate or major negative	69%	70%	67%	70%	65%	70%	67%	69%	67%	74%	† 63%
no impact	21%	19%	24%	20%	25%	17%	24%	22%	21%	17%	23%
moderate or major positive	10%	11%	9%	10%	10%	12%	9%	8%	12%	9%	13%

(b) How has your overall satisfaction with your life been impacted by the COVID-19 pandemic?

Life satisfaction	All	Female	Male	Younger	Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	* High parkruns
major negative impact	27	19	8	23	3	10	15	8	18	12	11
moderate negative impact	276	148	128	186	82	98	171	137	136	110	100
no impact	88	46	42	56	30	21	63	32	55	37	33
moderate positive impact	50	31	19	37	12	19	31	22	28	20	21
major positive impact	8	5	3	4	4	1	6	3	5	1	5
<b>Total</b>	<b>449</b>	<b>249</b>	<b>200</b>	<b>306</b>	<b>131</b>	<b>149</b>	<b>286</b>	<b>202</b>	<b>242</b>	<b>180</b>	<b>170</b>
major negative impact	6%	8%	4%	8%	† 2%	7%	5%	4%	7%	7%	6%
moderate negative impact	61%	59%	64%	61%	63%	66%	60%	68%	† 56%	61%	59%
no impact	20%	18%	21%	18%	23%	14%	† 22%	16%	23%	21%	19%
moderate positive impact	11%	12%	10%	12%	9%	13%	11%	11%	12%	11%	12%
major positive impact	2%	2%	2%	1%	3%	1%	2%	1%	2%	1%	3%
moderate or major negative	67%	67%	68%	68%	65%	72%	65%	72%	64%	68%	65%
no impact	20%	18%	21%	18%	23%	14%	† 22%	16%	23%	21%	19%
moderate or major positive	13%	14%	11%	13%	12%	13%	13%	12%	14%	12%	15%

(c) How have your connections with others in your community been impacted by the COVID-19 pandemic?

Connections with others	All	Female	Male	Younger	* Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
major negative impact	90	49	41	68	19	36	51	46	42	32	36
moderate negative impact	238	127	111	166	68	76	156	108	130	100	95
no impact	60	29	31	37	22	20	37	20	39	18	24
moderate positive impact	54	39	15	29	21	12	40	23	29	23	16
major positive impact	6	3	3	5	1	3	3	4	2	5	0
<b>Total</b>	<b>448</b>	<b>247</b>	<b>201</b>	<b>305</b>	<b>131</b>	<b>147</b>	<b>287</b>	<b>201</b>	<b>242</b>	<b>178</b>	<b>171</b>
major negative impact	20%	20%	20%	22%	15%	24%	18%	23%	17%	18%	21%
moderate negative impact	53%	51%	55%	54%	52%	52%	54%	54%	54%	56%	56%
no impact	13%	12%	15%	12%	17%	14%	13%	10%	† 16%	10%	14%
moderate positive impact	12%	16%	† 7%	10%	† 16%	8%	† 14%	11%	12%	13%	9%
major positive impact	1%	1%	1%	2%	1%	2%	1%	2%	1%	3%	0%
moderate or major negative	73%	71%	76%	77%	† 66%	76%	72%	77%	71%	74%	77%
no impact	13%	12%	15%	12%	17%	14%	13%	10%	† 16%	10%	14%
moderate or major positive	13%	17%	† 9%	11%	17%	10%	15%	13%	13%	16%	9%

(d) How has your physical health been impacted by the COVID-19 pandemic?

Physical health	All	Female	Male	Younger	Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
major negative impact	13	10	3	11	2	7	6	5	8	6	6
moderate negative impact	171	105	66	120	46	68	99	92	77	72	54
no impact	147	77	70	91	52	39	101	59	87	55	63
moderate positive impact	97	47	50	68	26	29	66	38	57	36	42
major positive impact	22	10	12	16	6	6	15	9	13	11	6
<b>Total</b>	<b>450</b>	<b>249</b>	<b>201</b>	<b>306</b>	<b>132</b>	<b>149</b>	<b>287</b>	<b>203</b>	<b>242</b>	<b>180</b>	<b>171</b>
major negative impact	3%	4%	1%	4%	2%	5%	2%	2%	3%	3%	4%
moderate negative impact	38%	42%	33%	39%	35%	46%	† 34%	45%	†† 32%	40%	32%
no impact	33%	31%	35%	30%	† 39%	26%	† 35%	29%	36%	31%	37%
moderate positive impact	22%	19%	25%	22%	20%	19%	23%	19%	24%	20%	25%
major positive impact	5%	4%	6%	5%	5%	4%	5%	4%	5%	6%	4%
moderate or major negative	41%	46%	† 34%	43%	36%	50%	†† 37%	48%	† 35%	43%	35%
no impact	33%	31%	35%	30%	† 39%	26%	† 35%	29%	36%	26%	28%
moderate or major positive	26%	23%	31%	27%	24%	23%	28%	23%	29%	6%	8%

(e) How has your mental health been impacted by the COVID-19 pandemic?

Mental health	All	Female	Male	Younger	*** Older	Low IMD	High IMD	Low activity	High activity	Low parkruns	High parkruns
major negative impact	30	21	9	29	1	10	18	12	18	11	15
moderate negative impact	235	133	102	172	54	89	141	114	117	98	81
no impact	155	80	75	85	68	41	107	66	88	61	59
moderate positive impact	22	12	10	15	6	7	15	8	14	10	8
major positive impact	6	3	3	4	2	2	4	3	3	0	6
<b>Total</b>	<b>448</b>	<b>249</b>	<b>199</b>	<b>305</b>	<b>131</b>	<b>149</b>	<b>285</b>	<b>203</b>	<b>240</b>	<b>180</b>	<b>169</b>
major negative impact	7%	8%	5%	10%	†† 1%	7%	6%	6%	8%	6%	9%
moderate negative impact	52%	53%	51%	56%	†† 41%	60%	† 49%	56%	49%	54%	48%
no impact	35%	32%	38%	28%	††† 52%	28%	† 38%	33%	37%	34%	35%
moderate positive impact	5%	5%	5%	5%	5%	5%	5%	4%	6%	6%	5%
major positive impact	1%	1%	2%	1%	2%	1%	1%	1%	1%	0%	4%
moderate or major negative	59%	62%	56%	66%	††† 42%	66%	† 56%	62%	56%	61%	57%
no impact	35%	32%	38%	28%	††† 52%	28%	† 38%	33%	37%	34%	35%
moderate or major positive	6%	6%	7%	6%	6%	6%	7%	5%	7%	6%	8%

Chi-square test of differences between distributions of sub-groups: \*p<0.05; \*\*p<0.01; \*\*\*p<0.001

Partitioned Chi-square test of differences between categories of sub-groups: †p<0.05; ††p<0.0

Table 4 Top two themes generated from open text responses with illustrative quotes

	Open text response theme and example quote	Proportion reporting theme
1	<p><b>Missing the <i>parkrun</i> community and socialisation</b></p> <p><i>“There is something about being in a group of people that provides motivation, seeing everyone else get up in the morning to go for a run or a walk, no matter their ages or fitness levels. I could have easily ran the parkrun route in my local area without an organised event, but I didn't, and I believe it is because the sense of community and connectedness inspires me more than doing exercise because I 'have to' or 'should' .”</i></p>	22%
2	<p><b>Feeling little incentive/motive to continue being active in the absence of <i>parkrun</i></b></p> <p><i>“parkrun gives everyone who attends an incredible sense of belonging. Without parkrun I have ran a significant amount less times a week (sometimes none at all) as I would normally have something to work towards when looking forward to Saturday mornings. My mental health has deteriorated because of the lack of exercise and community that parkrun brings to my life. I am really looking forward to the reintroduction of the events sooner rather than later.”</i></p>	20%

## Supplementary Files

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