NIHR | National Institute for Health and Care Research

Journals Library

Check for updates

Public Health Research

Volume 12 • Issue 16 • December 2024

ISSN 2050-439X

Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: Identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6)

Chief Investigator: Russell Jago

DOI 10.3310/ANBR6914

Public Health Research

ISSN 2050-439X (Online)

A list of Journals Library editors can be found on the NIHR Journals Library website

Public Health Research (PHR) was launched in 2013 and is indexed by Europe PMC, NCBI Bookshelf, DOAJ, INAHTA, Ulrichsweb™ (ProQuest LLC, Ann Arbor, MI, USA) and MEDLINE.

This journal is a member of and subscribes to the principles of the Committee on Publication Ethics (COPE) (www.publicationethics.org/).

Editorial contact: journals.library@nihr.ac.uk

The full PHR archive is freely available to view online at www.journalslibrary.nihr.ac.uk/phr.

Criteria for inclusion in the *Public Health Research* journal

Manuscripts are published in *Public Health Research* (PHR) if (1) they have resulted from work for the PHR programme, and (2) they are of a sufficiently high scientific quality as assessed by the reviewers and editors.

Reviews in *Public Health Research* are termed 'systematic' when the account of the search appraisal and synthesis methods (to minimise biases and random errors) would, in theory, permit the replication of the review by others.

PHR programme

The Public Health Research (PHR) programme, part of the National Institute for Health and Care Research (NIHR), is the leading UK funder of public health research, evaluating public health interventions, providing new knowledge on the benefits, costs, acceptability and wider impacts of non-NHS interventions intended to improve the health of the public and reduce inequalities in health. The scope of the programme is multi-disciplinary and broad, covering a range of interventions that improve public health.

For more information about the PHR programme please visit the website: https://www.nihr.ac.uk/explore-nihr/funding-programmes/public-health-research.htm

This issue

The research reported in this issue of the journal was funded by the PHR programme as award number NIHR131847. The contractual start date was in April 2021. The draft manuscript began editorial review in June 2023 and was accepted for publication in March 2024. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PHR editors and production house have tried to ensure the accuracy of the authors' manuscript and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article.

This issue presents independent research funded by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, the PHR programme or the Department of Health and Social Care. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, the PHR programme or the Department of Health and Social Care.

This issue was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Published by the NIHR Journals Library (www.journalslibrary.nihr.ac.uk), produced by Newgen Digitalworks Pvt Ltd, Chennai, India (www.newgen.co).

List of contents

NIHR | National Institute for Health and Care Research

Public Health Research

Check for updates

Synopsis

Assessing the impact of COVID-19 on the physical activity of 10–11-year-old children and their parents: Active-6 a mixed-methods study

Russell Jago,[1,2,3*] Danielle House,[1] Ruth Salway,[1] Robert Walker,[1] Lydia Emm-Collison,[1] Kate Sansum,[1] Katie Breheny,[2,3] Sarah Churchward,[4] Joanna G Williams,[2,5] William Hollingworth[2,3] and Frank de Vocht[2,3]

[1]Centre for Exercise, Nutrition & Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[2]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK
[4]Independent Public Member of the Project Team
[5]Communities and Public Health, Bristol City Council, Bristol, UK

[*]**Corresponding author** russ.jago@bristol.ac.uk

Published November 2024
DOI: 10.3310/WYHT5821

Abstract

Background: Physical activity is essential for long-term health, yet data from before the COVID-19 pandemic showed only 41% of 10- to 11-year-olds met the UK government's physical activity recommendations. Children's physical activity was limited during the national COVID-19 lockdowns. It is important to measure children's physical activity in the recovery period to assess the short- and medium-term impact of the lockdowns.

Objectives: To use mixed-methods to assess the impact of the COVID-19 pandemic on moderate-to-vigorous physical activity of year 6 children in the short-term (2021) and medium-term (2022) recovery periods by comparing these with data sampled from the same schools in 2017/18.

Methods: Quantitative and qualitative data were collected in two waves: wave 1 (May–December 2021), when lockdowns had finished but some COVID-19 mitigation policies were still in place, and wave 2 (January–July 2022), when most restrictions had been removed. These were compared with baseline data from similar year 6 children and parents/carers in the same schools collected between March 2017 and June 2018 (wave 0).

Results: In wave 1, average child accelerometer-measured weekday moderate-to-vigorous physical activity was 7–8 minutes lower than pre-pandemic while sedentary time was higher by almost 30 minutes. Child moderate-to-vigorous physical activity had recovered to pre-pandemic levels in wave 2, although sedentary time remained elevated. Across our studies, we found a new normal for child physical activity, characterised as more dependent on structured activities such as active clubs. Physical activity inequalities appear to be widening among girls and low socioeconomic position families, as they face unique barriers to participating in the new normal.

Limitations: Our sample includes more households with higher educational qualifications and predominantly female parents. Undertaking this research in schools while COVID-19 disruptions were ongoing created challenges to data collection which may have limited schools' and families' participation.

Conclusions: COVID-19 lockdowns negatively impacted child physical activity. It took almost a year of no restrictions for this to recover, and sedentary time remains high. Despite this recovery, 59% of children do not meet activity guidelines. There is a new normal to child physical activity that relies on structured activities, and some children and families may face challenges to taking part in the new normal. Strategies are needed to increase child physical activity for all.

This synopsis should be referenced as follows:
Jago R, House D, Salway R, Walker R, Emm-Collison L, Sansum K, *et al*. Assessing the impact of COVID-19 on the physical activity of 10–11-year-old children and their parents: Active-6 a mixed-methods study. *Public Health Res* 2024;**12**(16):1–29. https://doi.org/10.3310/WYHT5821

Future work:

- Develop new ways to work in partnership with schools to design bespoke physical activity programmes that can be delivered at the school site.
- Develop new ways to help girls and children from lower-income households to be physically active.
- Find the most effective means of maximising existing school resources such as extended school provision (after-school clubs) and physical resources (equipment) to promote physical activity outside of curriculum time.

Funding: This synopsis presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research as award number NIHR131847.
A plain language summary of this research article is available on the NIHR Journals Library Website https://doi.org/10.3310/WYHT5821.

SYNOPSIS

Introduction

This synopsis details the work of the Active-6 study. Active-6 is a repeated cross-sectional natural experiment, which explores child and parent/carer physical activity pre and post SARS-CoV-2 coronavirus disease (COVID-19) national lockdowns. Full details of the proposed study, including rationale, research design and analysis plans are available in the protocol which is available on the NIHR website.[1]

Rationale for research and background

Physical activity is associated with many health benefits for children and adults, including reduced risk of obesity and improved cardiovascular health, health-related quality of life and cognitive and mental health.[2,3] Physical activity tends to track from childhood into adulthood, so ensuring that children engage in regular physical activity is essential for their current and future health.[4,5] The UK Chief Medical Officers recommend that all children and young people should accumulate an average of an hour or more of moderate to vigorous intensity physical activity (MVPA) per day. This is physical activity that raises the heart rate and makes children slightly hot, slightly sweaty and slightly out of breath. However, longitudinal data collected pre-pandemic between 2012 and 2018 observed that MVPA decreases by 2.2 minutes per weekday per year throughout primary school and that, by the age of 11 years, only 41% of children met the hour per day recommendation, down from 61% at age 6 years.[6] On average, girls participate in less physical activity than boys,[7,8] and differences in physical activity patterns by family socioeconomic position have also been identified.[9]

The COVID-19 pandemic and the associated social changes had a marked impact on physical activity patterns for adults and children around the world, as various lockdowns and social distancing measures were enacted throughout 2020–2. In England, national lockdowns occurred in March–May 2020, November 2020 and January–March 2021, including school closures and restrictions on access to leisure and sports centres and playgrounds. From March 2021, various social distancing measures remained and responded to fluctuating levels of COVID-19 and emerging variants, until February 2022 when all legal COVID-19 restrictions in England were lifted. The timeline in *Figure 1* outlines these changes. These restrictions likely impacted physical activity among parents and children during their enforcement, but the extent to which the pandemic and restrictions had a longer-term effect on parent/carer and children's physical activity is unclear. Evaluating these effects is therefore warranted to provide evidence to inform policy and practice to ensure that any adverse effects on physical activity are addressed on a population level.

The Active-6 study sought to measure the impact of the pandemic on accelerometer-measured physical activity among year 6 children (aged 10–11 years) and their parents/carers in England following the final lockdown (January–March 2021). Using a baseline dataset collected in 2017/18, we sought to measure MVPA among year 6 children from the same schools to identify changes in the short-term period after the final lockdown had been lifted (May–December 2021), and if that change was maintained in the medium term (January–July 2022), indicating a more lasting change in activity levels. We also collected questionnaire data from both children and their parents/carers related to the type of activities in which they engage, health-related quality of life, household finances and well-being. We undertook qualitative data collection with parents, children and school staff to explain changes observed in quantitative analyses. Data related to school curriculum and extracurricular physical activity provision were collected from school staff, as well as an audit of school facilities. Our findings were then combined to provide rapid feedback to local and national policy-makers so that any negative impacts could be considered and addressed.

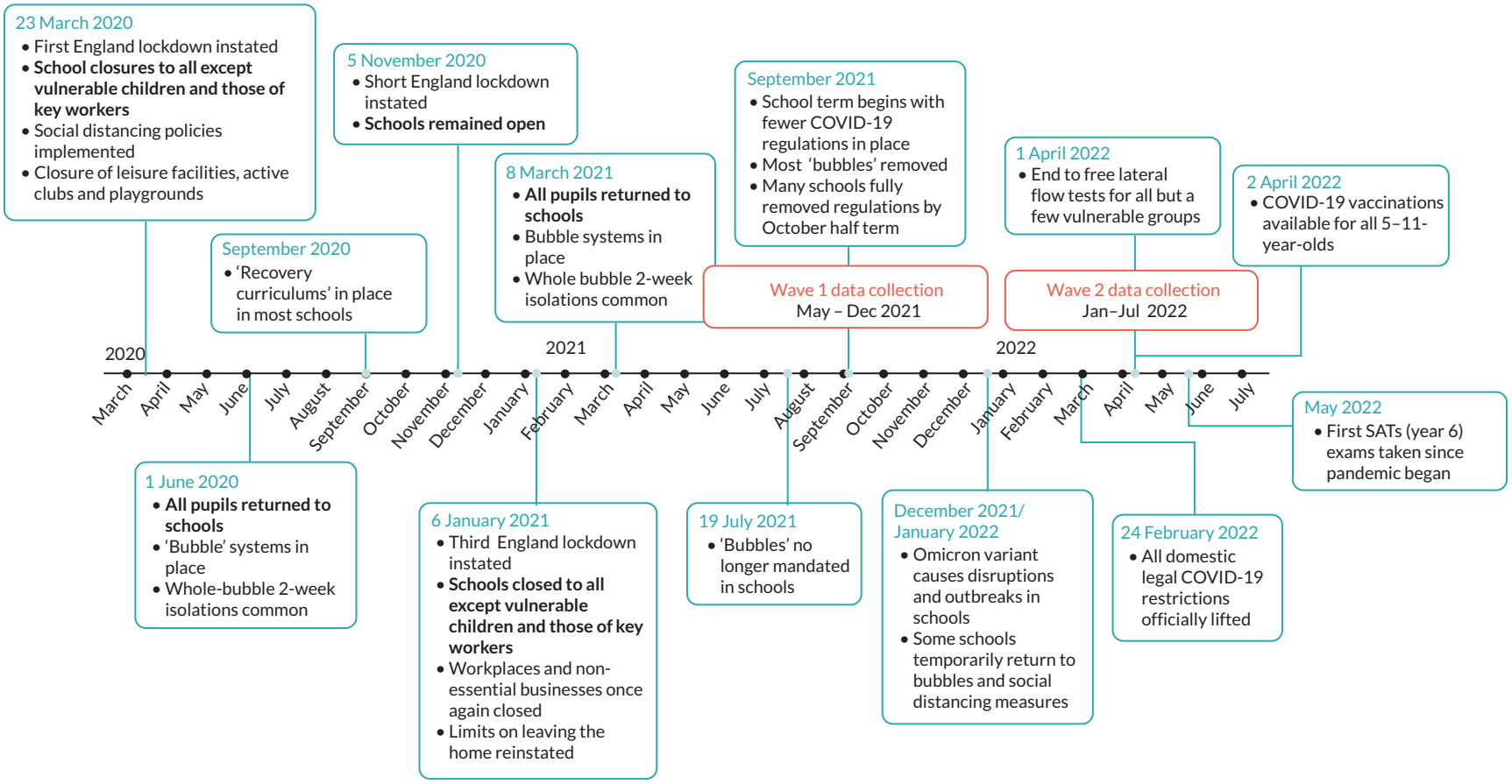

FIGURE 1 Timeline of COVID-19 policies in England. SATs, standard assessment tasks.

This synopsis should be referenced as follows: Jago R, House D, Salway R, Walker R, Emm-Collison L, Sansum K, *et al.* Assessing the impact of COVID-19 on the physical activity of 10–11-year-old children and their parents: Active-6 a mixed-methods study. *Public Health Res* 2024;12(16):1–29. https://doi.org/10.3310/WYHT5821

Objectives

The Active-6 study had seven interlinked objectives, reproduced from the study protocol:[1]

1. To assess the short-term effect of the COVID-19 pandemic on the weekday MVPA of year 6 children by comparing data from 2021 (wave 1) to data sampled from the same schools in 2017/18 (wave 0). Assess whether effects differ by socioeconomic position and/or gender.
2. To determine if there are differences between the physical activity and sedentary behaviour of year 6 children and their parents when compared with data sampled from the same schools in 2017/18 (wave 0) for the following secondary outcomes in 2021 (wave 1):
   A. parent accelerometer-measured weekday minutes of weekday MVPA
   B. child accelerometer-measured weekend minutes of MVPA
   C. parent accelerometer-measured weekend minutes of MVPA
   D. child accelerometer-measured weekday sedentary minutes
   E. child accelerometer-measured weekend sedentary minutes
   F. parent accelerometer-measured weekday sedentary minutes
   G. parent accelerometer-measured weekend sedentary minutes.
3. To assess the medium-term effects of the COVID-19 pandemic on the primary and secondary outcomes listed in objectives 1 and 2 with data sampled from the same schools in 2022 (wave 2).
4. To examine the extent to which differences in total volume of physical activity and sedentary time in both 2021 (wave 1) and 2022 (wave 2) are explained by the variation in the frequency that the child is active, child physical activity enjoyment and motivation, mode of travel to school, child screen time, after-school club attendance, parent physical activity motivation and self-efficacy.
5. To examine the specific impact of school walking, cycling and play provision, curriculum physical activity, school grounds and school physical activity policies on differences in physical activity.
6. To produce rapid interim reports from the project to UK policy-makers to inform the development of effective strategies to increase physical activity in groups who may have been disproportionately affected by changes due to COVID-19.
7. To understand the implications of COVID-19 on the time and resources allocated to physical activity by schools and households by addressing four subaims:
   A. To describe the implications of COVID-19 on household finances and spending on extracurricular physical activities.
   B. To describe changes in the allocation of school budgets to physical activity before and after COVID-19 and explore the reallocation of time between academic activities and physical activity.
   C. To assess the economic implications and affordability of potential mitigation strategies for schools and families.
   D. To explore the associations between measures of health-related quality of life and capabilities in children and adults and examine the possible impact of inequalities.
8. To use qualitative methods to further explore changes in physical activity during COVID-19, including factors that influenced activity during this time, and potential solutions to mitigate long-term negative impact on physical activity.

Methods for data collection and analysis

Detailed methods are provided in the study protocol.[1] Specific study methods and analyses are published in detail elsewhere, summarised in the overview of synopsis papers (*Table 1*) and signposted in the relevant discussion sections.

Mixed-methods data were collected in two waves. Wave 1 quantitative data collection took place between May 2021 to December 2021 when lockdowns had finished but some COVID-19 mitigation policies were still in place in schools and across society and provided data on the short-term impacts of the COVID-19 lockdowns on physical activity and associated behaviours. Wave 2 took place between January and July 2022 when most restrictions had been removed, to provide data on the medium-term impact (*Figure 1*). Wave 1 qualitative data was collected between August and December 2021 and wave 2 between February and July 2022 and provided insights and explanation into any observed changes in MVPA.

To provide baseline comparator accelerometer and questionnaire data, all participants were recruited from schools in the wider Bristol area (England) that had previously participated in B-Proact1v, a longitudinal cohort study. Both waves of Active-6 quantitative data (wave 1

TABLE 1 Active-6 study papers and status

Paper no.	Title	Objective	Authors	Year	Journal	DOI
P1	Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lock-downs: a natural experiment	1, 2 and 5	Salway R, Foster C, de Vocht F, Tibbetts B, Emm-Collison L, House D, *et al.*[10]	2022	*Int J Behav Nutr Phys Act*	https://doi.org/10.1186/s12966-022-01290-4
P2	A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021	5, 7	Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al.*[11]	2022	*Int J Behav Nutr Phys Act*	https://doi.org/10.1186/s12966-022-01356-3
P3	Screen-viewing behaviours of children before and after the 2020–1 COVID-19 lockdowns in the UK: a mixed methods study	4, 5 and 7	Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al.*[12]	2023	*BMC Public Health*	https://doi.org/10.1186/s12889-023-14976-6
P4	Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment	3, 5	Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al.*[13]	2023	*Int J Behav Nutr Phys Act*	https://doi.org/10.1186/s12966-023-01441-1
P5	The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK	7	Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al.*[14]	2023	*BMC Public Health*	https://doi.org/10.1186/s12889-023-16021-y
P6	Comparison of children's physical activity profiles before and after COVID-19 lockdowns: a latent profile analysis	4	Salway R, de Vocht F, Emm-Collison L, Sansum K, House D, Walker R, *et al.*[15]	2023	*PLOS ONE*	https://doi.org/10.1371/journal.pone.0289344
P7	The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice	4, 5, 6 and 7	Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al.*[16]	2023	*Int J Behav Nutr Phys Act*	https://doi.org/10.1186/s12966-023-01499-x
P8	The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis	6 and 7	House D, Walker R, Salway R, Emm-Collison L, Breheny K, Sansum K, *et al.*[17]	2023	*Public Health Res*	https://doi.org/10.3310/KLML4701
P9	Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed methods study from a self-determination theory perspective	4	Emm-Collison L, Walker R, Salway R, House D, Sansum K, Breheny K, *et al.*[18]	2023	*Public Health Res*	https://doi.org/10.3310/KPKW8220
P10	School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis	4	Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al.*[19]		*Public Health Res*	https://doi.org/10.3310/WQJK9893
P11	Quality of life, capability wellbeing, financial strain and physical activity in the short and medium term COVID 19 post-lockdown phases in the UK: a repeated cross-sectional study	5, 6	Breheny K, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al.*[20]		*Public Health Res*	https://doi.org/10.3310/LYJG6305

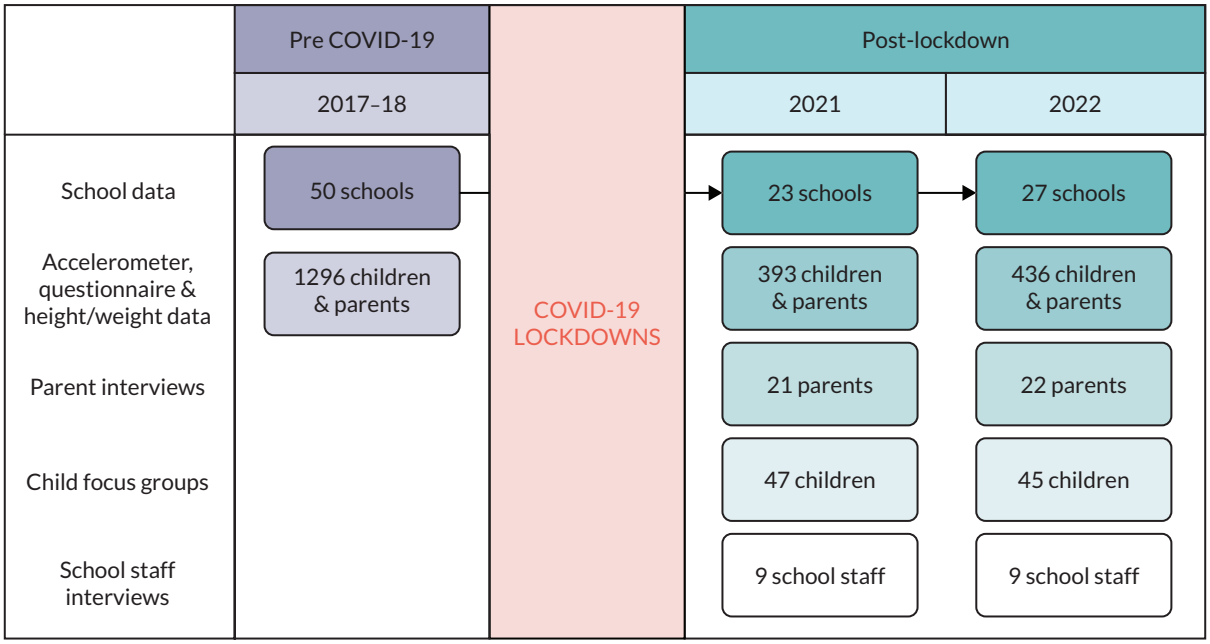

FIGURE 2 Data collected across all waves.

n = 393; wave 2 *n* = 436) were compared with data from similar year 6 children and parents/carers from the third phase of the B-Proact1V study between March 2017 and June 2018, which we will refer to as wave 0 (*n* = 1296).[6] Participants at wave 0 provided written consent/assent, and online consent/assent was provided at waves 1 and 2. *Figure 2* provides summary of data collection waves and participants, and *Appendix 1* contains details on recruitment and consent processes.

The study has three main components, summarised in *Figure 3*, and further detailed in *Appendix 2*.

Quantitative component

At each time point, participating children and a parent or carer wore a waist-worn ActiGraph wGT3X-BT accelerometer (Actigraph LLC, Pensacola, FL, USA). Participants were asked to wear accelerometers during waking hours for five consecutive days in wave 0, including two weekend days, and for seven consecutive days in waves 1 and 2. Analysis of weekday accelerometer data was restricted to participants who provided at least two valid weekdays of data, and weekend accelerometer data for those who provided at least one valid weekend day of data, defined as at least 500 minutes of data, after excluding intervals of ≥ 60 minutes of zero counts allowing up to 2 minutes of interruptions. Further details have been reported elsewhere.[1,10] In all waves, child height and weight data were collected where possible however, particularly in wave 1, this was limited due to COVID-19 social distancing measures and remote data collection in many schools.

As well as accelerometer data and child measurement data, we collected questionnaire data from parents/carers and children that included demographic data, parent/carer characteristics, mode of travel to and from school, types of physical activity they participate in, parent/carer expenditure on child clubs (waves 1 and 2 only), parent/carer and child screen viewing, and motivation, perceived physical activity ability and health aspiration scales. To capture the school physical activity environment and how this may have changed across the study due to fluctuating social distancing restrictions, we collected data on school physical activity policies, use of physical activity in the curriculum, active after-school club provision and spend (waves 1 and 2 only) and the school built environment. A detailed table of variables collected can be found in *Appendix 3*.

Health economics component

Parent/carer and child questionnaires at waves 1 and 2 included questions to measure family economic situation and well-being. Parents were asked to report their health-related quality of life and capability well-being using validated questionnaires: the EuroQol 5-dimension (EQ-5D-5L) questionnaire and ICEpop CAPability measure for Adults (ICECAP-A). Children were asked to self-report their health-related quality of life using the Child Health Utility 9 Dimension (CHU9D) questionnaire, and the impact of COVID-19 on their capability well-being was

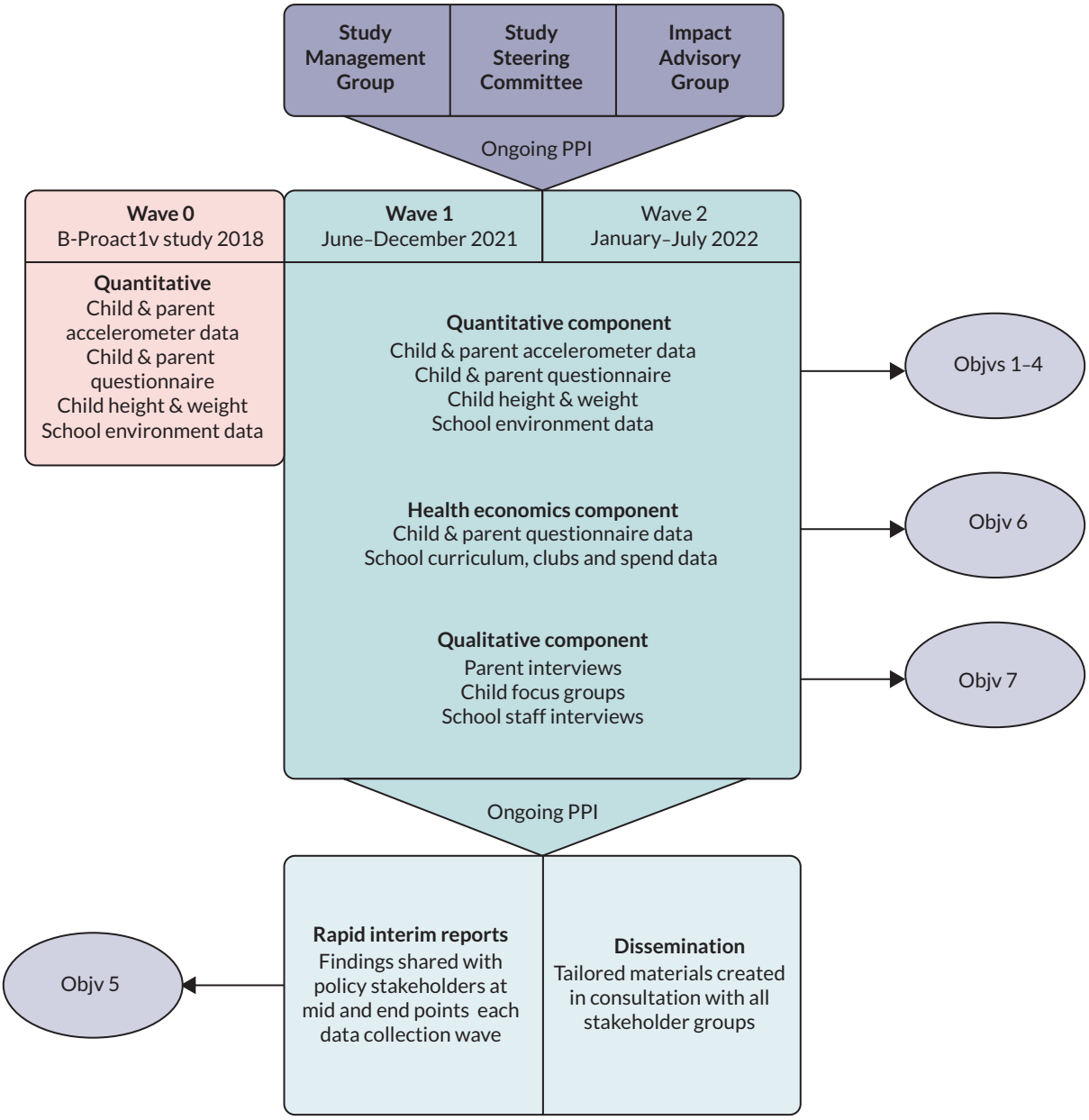

FIGURE 3 Diagram of study components. Objv, objective; PPI, patient and public involvement.

assessed using questions employed in the Birmingham CONTRAST study (Short and long term impacts of Covid-19 on Older childreN's healTh-Related behAviours, learning and wellbeing Study), which examined the impact of COVID-19 in children and young people.[21] Data on parent spending on after-school physical activity provision and other extra-curricular activities (e.g. community activities and academic tutoring) were collected using a questionnaire used in a previous study.[22] The Family Economic Strain Scale (FESS)[23] was used to collect data on household finances. A detailed table of variables collected can be found in *Appendix 3*.

Qualitative component

Each wave of data collection consisted of in-depth semistructured interviews with parents/carers and school staff, and focus groups with year 6 children to identify the perceived impacts of the pandemic on child and parent physical activity. The parent interviews and focus groups in wave 1 covered changes in physical activity and screen time, with a focus on during lockdowns and when schools reopened. The school staff interviews explored the different approaches schools have taken to promote physical activity before and after the COVID-19 lockdowns and school closures, and the opportunities and challenges

of those. In wave 2, qualitative research built upon wave 1 quantitative and qualitative findings where parents and school staff were asked about lasting changes in physical activity, screen time and the school environment. All topic guides can be found in *Report Supplementary Material 1*.

Oversight and management

The Active-6 study had three oversight and management groups. A study management group consisting of all co-applicants, study research staff and a parent/carer member met monthly to discuss progress, study design, problems and solutions and ethical issues. An independent study steering committee, consisting of an independent chair plus three independent members, including a parent/carer representative, met on four occasions throughout the study to offer guidance. And an impact advisory group of key stakeholders in policy and practice met six times over the study to disseminate rapid interim findings and to provide guidance and insight from the field.

Overview of papers synthesised in synopsis

Table 1 provides details of all papers that have been published from the Active-6 study, how they link to study objectives and publication status at time of publication.

Principal findings

Child physical activity and screen viewing in the short-term recovery phase of the COVID-19 pandemic

This section summarises wave 1 child accelerometer data (Paper 1), wave 1 qualitative data (Paper 2) and wave 1 screen-viewing data (Paper 3). Full details of the methods and findings can be found in those papers (*Table 1*) and cover objectives 1, 2, 4, 5 and 7.

March 2020 to April 2021: periods of lockdowns and restrictions (Paper 2)

Parents' and children's initial response to the first COVID-19 lockdown was characterised by feelings of novelty as families' usual responsibilities for work and school subsided. This led to increased motivation for well-being and physical activities both among families and within schools. However, this novelty was short lived. The reinstatement of lockdowns and restrictions in winter 2020–21 caused many to feel frustrated, turning the initial feelings of novelty into tedium and low motivation. As the restrictions were prolonged, academic and vocational responsibilities and pressures gradually returned, creating a period that was described as the most challenging and inactive of the pandemic. The extent that children could access physical activity facilities in their local and home environment influenced their physical activity. In particular, greater access to green space and facilities within the home was an important factor that participants linked to more rural communities and greater economic affluence. Children without access to facilities quickly began to dislike the limited physical activities available to them, especially in the later stages of the lockdowns, which led to disengagement from physical activity. Life under COVID-19 lockdowns and restrictions also led to an increased importance of the parent in their child's physical activity, as children were no longer able to be active through social activities and having fun with friends. The school day, where children were previously active during breaktimes and physical education (PE) lessons, at after-school clubs and with active travel, was for most pupils conducted in isolation within the home. Consequently, parental encouragement and availability to support their child's physical activity became more influential during this period. Increased screen-viewing behaviour was also suggested during periods of COVID-19 lockdown and restrictions, with a sense that screen-viewing behaviour was unavoidable during these periods. Many aspects of children's lives transitioned to screen-viewing activities, as families were unable to leave their homes for large periods of the day, and these became children's medium of entertainment, education, socialising, childcare and forms of physical activity.

April 2021 to December 2021: the short-term recovery phase following lockdowns and restrictions (Papers 1 and 2)

Accelerometer-measured children's physical activity found that children's daily MVPA was on average around 7–8 minutes lower in the short term after the COVID-19 lockdowns than before the pandemic, on both weekdays and weekends (Paper 1). This 8-minute difference is broadly comparable to the decline that would have previously been expected to occur over a 3-year period during primary school; that is, their activity levels were those we would have expected of 13- to 14-year-olds. In addition, sedentary time was higher than pre-pandemic by 15–25 minutes per day (Paper 1). Although both girls and children from lower socioeconomic backgrounds were less likely to engage in MVPA both before and after lockdowns, there was no evidence that the 8-minute drop differed between groups (Paper 1). Qualitative analysis explored the reasons for this drop in MVPA (Paper 2). Children experienced emotional overwhelm and physical fatigue during the return to a lifestyle which more closely represented that of a pre-pandemic normality, particularly during the return to school in September 2021. This transition was more physically and emotionally demanding than the secluded and sedentary lockdown

lifestyle. Apprehension and worry about COVID-19 were apparent in many children who also found it emotionally challenging when the number of people they interacted with on a daily basis greatly increased. These feelings of emotional overwhelm and fatigue at times manifested as social conflict and/or withdrawal, which impacted active play, led to some avoidance of active clubs and reduced enjoyment of physical activities.

Child screen viewing (Paper 3)

The reported reliance on screen viewing during lockdowns and the observed rise in sedentary time post-lockdown reflect a change in behaviour. We asked parents about their child's screen viewing and they reported that, by December 2021, total leisure screen viewing was higher by 11% on weekdays compared with pre-COVID and by 8% at weekends. This difference equates to roughly 12–15 minutes per day and was larger among girls and children from lower socioeconomic backgrounds. We also saw a change in the types of screen viewing that children engaged in, with a shift in the balance between TV and non-TV screen viewing. There was a sharp rise of 70–80% in the time spent watching TV (including on-demand and streaming services), compared with before the pandemic. Described as an 'addiction' by participants, qualitative data also suggested screen-viewing behaviours increased in the period immediately post-lockdowns compared with pre-COVID-19. This stemmed from the increased exposure to and unavoidable screen viewing during periods of lockdown that led to habitualisation. This drew children away from activities they had previously enjoyed, such as active play. However, age-related and/or societal changes may also have contributed to these changes. Due to increased levels of habitualised screen viewing, parents played a key role in setting limitations on their child's screen-viewing behaviour when they struggled to self-regulate. Organising activities outside the home was one means of breaking habitualised screen-viewing behaviour; however, many parents were not able to support the associated financial and time costs of these activities.

Child physical activity in the medium-term recovery period of the COVID-19 pandemic

This section summarises the change over time across all waves for child accelerometer data (Paper 4) and wave 2 qualitative data (Paper 5). Full details of the methods and findings can be found in those papers (*Table 1*) and cover objectives 3, 5 and 7.

Accelerometer-measured child physical activity (Paper 4)

Quantitative analysis found that after the short-term drop of 8 minutes seen in 2021, by 2022, children's MVPA was on average similar to pre-pandemic times. However, the difference in MVPA between what we would have predicted based on pre-pandemic data and what we observed post-lockdown varied substantially over the full year June 2021–July 2022. The pre- and post-lockdown gap in MVPA was widest during the winter months when MVPA is typically lower, and only returned to pre-pandemic levels by May/June 2022. Moreover, this recovery was susceptible to COVID-19 outbreaks in this age group, such as those in December/January 2021/22 and again in February/March 2022. Thus, although children's MVPA returned to pre-pandemic levels a year after lockdowns were ended, this recovery was precarious and sensitive to temporary disruptions in physical activity provision. Finally, despite the recovery in average MVPA in the medium-term, average weekday sedentary time remained higher than pre-pandemic by 13 minutes per day on average, and the majority of 10- to 11-year-old children (59%) still did not meet physical activity recommendations.

The 'new normal' for child physical activity (Paper 5)

In 2022, a 'new normal' for children's physical activity was suggested to have emerged, characterised by an increased dependence on structured and organised physical activity, such as active clubs, and a decrease in unstructured and spontaneous physical activities. This change in activity patterns stemmed from the continuation of habits formed under COVID-19 lockdowns and restrictions. Time spent within the home post-lockdown continued to reflect the lifestyle of lockdown, such as increased screen time, and activities outside the home needed to be planned and prebooked, negatively impacting spontaneous physical activity opportunities. Lockdown habits within the wider context of health, including those related to sleep patterns and diet, were also suggested to have continued and negatively impacted physical activity. However, although many children had returned to pre-pandemic levels of physical activity, a differential impact was suggested among girls and children with lower socioeconomic position, who may be at risk of lower physical activity levels in the wake of the pandemic. These were suggested to stem from the complex, multifaceted barriers (outlined below) to attending organised activities, which have become the new normal for children's physical activity.

Qualitative results highlighted the impact of missed developmental experiences among children. A key aspect of this related to interrupted social skills development, particularly in terms of children's social confidence and ability to connect and harmoniously interact with others and may have discouraged active play. Children's resilience skills, described as a crucial emotional skill for children, were also interrupted, with some reporting difficulties

coping with physical discomfort brought on by physical activity. In addition, physical skills among children were also interrupted, reflected in decreases in time-based school athletics competitions and children's swimming capabilities. As a result, a persisting sense of tiredness and fatigue among children discouraged them from physical activity. A perceived lasting impact of the pandemic on the mental health of children and their parents was also discussed, such as an increased requirement for and use of mental health support in schools. Families who were experiencing mental health challenges were thought to face elevated barriers to engaging their child in physical activity. For example, encouraging children to leave the home could require significant effort by the parent when children were uncooperative. Mental health challenges were seen as reciprocal with sedentary behaviours, which negatively impacted mental health and led to increased sedentary behaviours.

Understanding the new normal: child activity profiles and active club participation

This section summarises the findings of further analysis of child accelerometer data from all waves to explore child activity profiles (Paper 6), and qualitative, questionnaire, and cost data from waves 1 and 2 on active clubs (Paper 7). Full details of the methods and findings can be found in those papers (*Table 1*) and covers objectives 4, 5, 6 and 7.

The analysis in the previous section gives a picture of average MVPA change over time, and qualitative insights into why these changes took place (Papers 4 and 5). However, it was important to go beyond these analyses to explore the impact of the COVID-19 lockdowns on child physical activity in more detail. Specifically, we wanted to explore changes in typical patterns of child activity since the lockdowns to understand how physical activity has changed for different kinds of children, and movement between these groups (Paper 6). Additionally, recognising the importance of structured physical activity in the post-lockdown new normal, we wanted to look at changes to active club participation, cost and location (Paper 7).

Identifying children's activity profiles (Paper 6)

We undertook analyses to explore the complex association between physical activity and sedentary time, to see whether there are specific groups of children who are most likely to be inactive post-lockdown, beyond the average patterns. We identified six 'activity profiles' for children that reflected different patterns of MVPA and sedentary time, ranging from a *highly active* profile, with high MVPA and low sedentary time especially at weekends, to a *sedentary and inactive* profile, with very low levels of MVPA and high sedentary time. We found that the profiles themselves had changed before and after COVID-19 lockdowns, with a pre-pandemic group, characterised by higher MVPA, replaced by a group characterised by a mix of MVPA and light activity, a pattern similar to that seen among younger children pre COVID-19. The proportions of children in each profile also changed, with more children in the least active profiles and fewer in the most active profiles, especially in the short-term recovery phase. In particular, by 2022, the largest profile was the *sedentary and inactive*, with over one-quarter (27%) of children in this group compared with 19% pre-pandemic. We also found that gender and socioeconomic gaps had widened. Only 18% of the most active profiles were girls compared with 30% before COVID-19, while in the least active profiles, the proportion of girls increased from 69% to 74%. We also saw socioeconomic differences, with the existing gap in the *inactive* profile widening from 63% from households with lower educational qualifications to 84%, and a new emerging socioeconomic disparity in the most active group, with fewer children from households with lower educational qualifications. These findings indicate changes in post-lockdown children's physical activity, in terms of who is being active and how, and it is important to understand these further to develop new strategies to increase children's physical activity and tackle inequalities.

The role of active clubs (Paper 7)

As qualitative analysis suggested a shift in child activity from unstructured play towards more structured physical activities, we undertook analysis on the role of school- and community-based active clubs in the post-lockdown 'new normal'. This took a mixed-methods approach, combining quantitative data from children on club attendance, from parents on expenditure on clubs and from schools on active club provision, with qualitative data from all three groups. While total active club participation among children was similar before and after lockdowns, there was a rise in participation in school-based active clubs (43% of children participated in at least one school-based club in wave 0 compared to 50% in wave 2) and a corresponding drop in community-based active clubs (80% of children participated in at least one community-based club in wave 0 and 74% in wave 2). Qualitative analysis highlighted that the increased cost of living and fallout of the COVID-19 pandemic were mechanisms behind this possible shift from community- to school-based active clubs. It found that community-based active clubs were seen as a luxury that many were unable to afford due to their increased cost and requirement for parent time and support; 45% of parents said their child would attend more community clubs if they were cheaper. These findings were echoed in

our cost analysis, with median costs per session of £6.67 for community-based active clubs and £3.88 for school-based active clubs, with 50% of school-based active clubs free to attend. Lower participation in community clubs created challenges to organising competitions and offered less opportunity for club-based friendships that had previously motivated children to attend, affecting the quality of experience of attending these clubs. Adults were also volunteering less at community-based active clubs due to decreased availability and increased work pressures. Subsequently, children from families with lower educational qualifications, and/or those experiencing increased economic strain, were particularly impacted and participated in fewer active clubs.

Despite increasing active club provision, many schools were struggling to meet the increased demand for active clubs. School-based active club provision largely relied on school staff volunteering their time, which has become more challenging due to an increasingly pressured school environment. As a result, many schools tried to ensure that as many children as possible had some access to active clubs by rotating children through waiting lists or with different children attending on different days. We found that those children attending school-based active clubs were attending fewer clubs per week than before the pandemic, with those attending on three or more days decreasing from 19% in wave 0 to 10% in wave 2, which could be a result of such policies. Funding sources, such as the PE and Sport Premium, were a key component of affordable school-based active club provision, with 62% partially or wholly subsidised to parents.

Gender differences continued in the medium-term post-lockdown, with similar percentages of girls and boys participating in school-based active clubs but fewer girls participating in community-based active clubs. Parents of girls reported a larger total expenditure on community-based active clubs than parents of boys (median average £12 for boys and £15 for girls), despite girls attending fewer clubs. This may be attributed to the gendered nature of club attendance and the associated costs, as clubs boys typically attend such as football and rugby are cheaper to run than those typically attended by girls, such as gymnastics. As discussed above, cost is a key barrier to active club participation in the context of the cost-of-living crisis and fallout of the COVID-19 pandemic, so may contribute to the gendered patterns in MVPA.

The role of schools

This section summarises qualitative data on changes to the school physical activity environment (Paper 8) and any school-level variation in MVPA outcomes (Paper 10). Full details of the methods and findings can be found in those papers (*Table 1*) and cover objectives 4, 6 and 7.

The primary school environment is a significant context for child physical activity. The structured nature of a school day regulates obesogenic behaviours[24–28] and, for some children, school days are where they have greatest opportunity to engage in diverse physical activities, with around 15% of the total variability in child MVPA attributable to school-level factors.[29] In 2020 and 2021, English schools closed to most children on several occasions to mitigate the spread of COVID-19. When schools reopened, COVID-19 social distancing policies were in place for several months, which impacted schools' physical activity environments, such as policies on sanitation of equipment, how much space children had access to, how active play could be supported and active travel.

Changes to the school physical activity environment (Paper 8)

We undertook analysis of all qualitative data across both waves to understand the changes to school physical activity environments that took place, how these were experienced by staff and pupils and if/how these were retained. Returning to the 'in-person' school rhythm in September 2020 was seen to increase child physical activity after the first lockdown and school closure. During this first term children's well-being activities, including physical activity, were prioritised through recovery curriculums which were implemented to even out the detrimental physical, social and emotional impacts of lockdown. However, by September 2021, after another school closure and ongoing issues with pupils following guidance to self-isolate following infection with COVID-19, school staff described exceptional pressure to 'catch up' on lost learning. PE competed with core subjects for time, staffing issues (including ongoing COVID-19 infection and self-isolation) led to insufficient playground support staff and extracurricular clubs were reliant on scarce teaching staff time. Schools reported an uneven impact of lockdowns and COVID-19 measures on schools and their pupils, with the post-lockdown physical activity environment characterised by variation. COVID-19 social distancing policies have been retained to varying degrees within schools, at times in the interests of pupils and at others in the interests of the over-pressured school. School physical activity culture has also been impacted, with some schools unable to prioritise physical activity due to the post-lockdown pressures described above, while others strengthened their physical activity culture having understood its benefits to pupils through the pandemic. Importantly the pandemic, school closures and ongoing disruptions have had an uneven impact on children's

physical activity. School staff observed that children who were already inclined to physical activity have returned to their activities. Conversely, staff described greater challenges in getting less active children active post lockdowns, creating greater polarisation between active and inactive children.

Between-school differences in MVPA (Paper 10)

Exploring post-lockdown changes in the between-school differences in MVPA can help to determine quantitatively if the role that schools play has changed since the pandemic and can identify which school-level factors, such as environment, policies or sociodemographics, are associated with MVPA. Understanding these school factors is essential in understanding first why changes to children's physical activity took place; second, which environmental and school factors impact on child physical activity post-COVID-19 lockdowns; and third, the opportunity to influence these to promote physical activity in schools going forward.

The quantitative data showed that while schools differed from each other in terms of average child MVPA, they all showed the same overall pattern of a drop in average MVPA in 2021 followed by a recovery in 2022. A reduction in the proportion of school-level variation in 2021 suggested that, in the short term, difference in physical activity between children was mainly due to unobserved individual factors, with the importance of schools re-established by 2022. Important school-level factors both pre and post lockdowns were the existence of a cycle training policy, the proportion of children in the year using active travel to school, and the average number of active after-school clubs attended in the year group, all of which had a positive association with MVPA, and whether PE lessons were often compromised due to lack of space. These factors increased in importance post lockdowns, accounting for nearly three-quarters (72%) of the school-level variation in 2022, compared with 22% pre COVID-19 (corresponding to 9% and 3% of the total variation in MVPA). Moreover, the relative importance of these factors has changed, with high average club attendance and compromised PE space becoming important in 2022, and active travel less of a contributor. Thus, while schools remain important, we have seen a change in the way in which schools affect children's physical activity, with the increased role of active after-school clubs supporting other Active-6 findings.

Parent/carer physical activity and household well-being across the pandemic

This section summarises the parent accelerometer data across both waves (Paper 4), questionnaire and interview data on parents' physical activity motivation across both waves (Paper 9) and household health, well-being and financial strain data across both waves (Paper 11). Full details of the methods and findings can be found in those papers (*Table 1*) and cover objectives 3, 4, 6 and 7.

We collected data on parent/carer physical activity, including accelerometer-measured MVPA, to provide information on household contexts. Health-related quality-of-life measures added to our evidence base for any changes in physical activity behaviour post lockdowns and allowed us to examine any associations with household finances and inequalities. The financial strain measure was included to understand the financial impact of COVID-19 on families, and which would potentially build into the narrative around solutions to increase physical activity (if needed) which must be mindful of the economic climate. We were also interested in the impact of the lockdowns on parent/carer motivation for physical activity.

Parent/carer physical activity and motivation (Papers 4 and 9)

Parent/carer physical activity has followed a very different pattern to children over the course of the pandemic (Paper 4). In the short-term post lockdown, there was no difference in MVPA on either weekdays or weekends, compared to pre-pandemic. However, by 2022 parents' weekend MVPA was higher than before the lockdowns by 8 minutes. There was no difference in sedentary time at either point post lockdown.

To understand this observed pattern in MVPA, we undertook a mixed-methods analysis to explore how the lockdowns impacted parent/carer physical activity motivation (Paper 9). Framed within self-determination theory, the findings suggest that autonomous motivation, especially enjoyment and the importance for mental and physical well-being, was a key driver in keeping parents active during lockdowns, and remains important for physical activity post lockdown, with introjected regulation potentially playing an increased role. Interviews with parents highlighted the important role that motivation played in their physical activity engagement throughout the COVID-19 lockdowns and in the months following the easing of restrictions, offering explanation for the continuity of parent/carer MVPA we observed.

The qualitative findings also provide valuable insight into how the lockdowns impacted on parent/carer motivation through supporting, or thwarting, the basic psychological needs of autonomy, competence and relatedness. Whereas discussions of the lockdown impact on autonomy and competence were mixed and in many cases positive,

crucially there appear to be enduring negative impacts on aspects of relatedness, particularly feeling connected to others, that must be addressed to support parent/carer motivation to be physically active and to maintain their well-being.

Health-related quality of life, capability well-being and family financial strain (Paper 11)

Given the observed changes in child physical activity, we explored whether there were related changes in parent/carer and child health-related quality of life, capability well-being and family financial strain in the short and medium terms after the COVID-19 lockdowns. We found no differences between the short- and medium-term (waves 1 and 2) adult or child health-related quality of life or capability well-being measures on average. However, family financial strain was slightly worse in wave 2 compared with wave 1. When health-related quality of life and capability well-being were explored alongside family financial strain, children in families experiencing most financial strain had notably poorer health-related quality of life, and parents' health-related quality of life and capability well-being decreased as financial strain worsened. This finding is of interest in the context of the 'new normal' for children's physical activity, as some families may be less able to participate in organised active clubs due to financial strain.

Discussion

Contribution to existing knowledge

The findings of Active-6 make several valuable contributions to existing knowledge, providing layered and multiperspective insight into how the COVID-19 lockdowns impacted child and parent/carer physical activity in the short and medium terms (*Figure 4*).

It was expected that prolonged lockdowns would have a negative impact on child and adult physical activity, and studies undertaken during the lockdowns have evidenced this,[30–33] but of greater importance is how behaviour was impacted in the longer term once lockdowns and restrictions were removed, as society recovered from the pandemic. Active-6 has found that it has taken a year since lockdowns were lifted for children's MVPA to recover to pre-pandemic levels, and weekday sedentary behaviour remains elevated. But the fluctuations in MVPA we observed over the course of the study suggest that the recovery in children's MVPA may be susceptible to temporary disruptions to physical activity provision, such as school closures. To our knowledge, this is the first peer-reviewed research to explore this in a UK context. Our data are broadly consistent with Sport England's 2022 Active Lives Survey, which suggested that average activity levels had returned to pre-pandemic levels among children.[7] However, our study provides novel insight into the short- and medium-term impact of the lockdowns and restrictions in England using accelerometer-measured physical activity, rather than relying on self-report methods, such as those in the Active Lives survey.

Despite an overall recovery in levels of physical activity among children to their pre-pandemic levels, we found that still only 41% of children were meeting physical activity guidelines, and that the way in which children are active has changed. We have termed this the 'new normal' for children's physical activity, characterised by a reliance on structured activities such as active clubs. This finding contributes to existing knowledge by providing unique insight into post-lockdown physical activity patterns among children in the UK. In our evaluation of the current status of active club participation among children, financial pressures were driving a shift from community-based to school-based clubs where children are physically active. Furthermore, schools were at times struggling to meet this increased demand, and the quality of community clubs may also be impacted by lower attendance. These findings add novel and timely insight into the post-lockdown challenges to children's participation in physical activity and provide specific recommendations to address disparities and promote physical activity.

We have found that the post-lockdown school environment is highly pressured, impacting the extent to which schools can support and encourage child physical activity. Research shows schools are important contexts for child physical activity,[27,34] so strategies sensitive to the post-lockdown school environment are needed to support schools to enable child physical activity and future research is needed to further explore the impact of post-lockdown changes on physical activity environments in schools, particularly over the longer-term, as schools continue to adapt post lockdowns.[35] However, our analysis highlights the importance of relatively simple changes, such as ensuring that PE is prioritised even when space is an issue, a cycle training scheme, a strong active club environment and, to a lesser extent, encouraging active travel to school where possible, which could potentially reduce post-lockdown differences between schools.

Across the range of our studies and analyses we found that the detrimental impact of the COVID-19 lockdowns has been worse for those least active, girls and lower socioeconomic families, evidencing a widening of socioeconomic inequalities. Socioeconomic health inequalities is a key public health issue in the

UK; 35.6% of premature deaths are attributable to socioeconomic inequality[36] We know that physical activity is a habit established in childhood for life and that it is beneficial for lifelong physical and mental health life.[2–5] Therefore, supporting more children from lower socioeconomic households to meet physical activity guidelines can therefore help address socioeconomic health inequalities. The Active-6 project provides unique insight into the post-lockdown challenges facing children from lower socioeconomic households, which has been identified in Sport England's Active Lives Survey 2022.[7] Namely, cost-related barriers are creating challenges to participating in the new normal for children's physical activity, which is exacerbating pre-existing disparities. However, due to sampling limitations, we feel that further research is warranted that explores physical activity among children from lower socioeconomic households.

We observed gender disparities in physical activity, with girls being less active than boys. Before the pandemic, there was clear evidence that girls participated in less physical activity than boys in the UK,[8] which has continued following the pandemic.[7] Our results suggest that extended interruptions to physical activity during periods of lockdowns and restrictions impacted girls' perceptions of self and physical activity. Recent reports echo the challenges of these negative perceptions among girls.[37] Subsequently, when combined with increased costs for girls community-based active clubs, these may be barriers to participation in the physical activity new normal for children. Thus, there is a need to promote physical activity among girls, and perhaps especially girls from lower socioeconomic groups.

Take home messages

- After a short-term drop, average children's physical activity recovered to pre-pandemic levels, but this recovery took nearly a year after the lockdowns and may be susceptible to future disruptions to physical activity, such as school closures and stay-at-home orders.
- Most children are more sedentary than before the pandemic and 59% of 10- to 11-year-old children do not meet physical activity guidelines. There is a pressing need to promote and support physical activity in children.
- Some groups have been more adversely impacted, particularly families with lower socioeconomic position, girls and children who were less active before the pandemic. Our findings suggest a widening gap and growing inequalities.
- Strategies to support child physical activity must recognise how it has changed, with the 'new normal' suggesting there should be a stronger focus on access to structured activities, especially for those groups who typically engage in less activity.

Strengths and weaknesses of the study

The key strength of this study is that child physical activity post-COVID-19 lockdowns was measured through independent data collection and analysis methods (quantitative and qualitative) and then combined into one narrative that provides nuance and depth to our understanding. Collecting accelerometer-measured physical activity was a particular strength, as other major studies rely on self-report data, which are subject to social desirability and recall bias.[7] Additionally, this study used baseline data collected before the pandemic, rather than

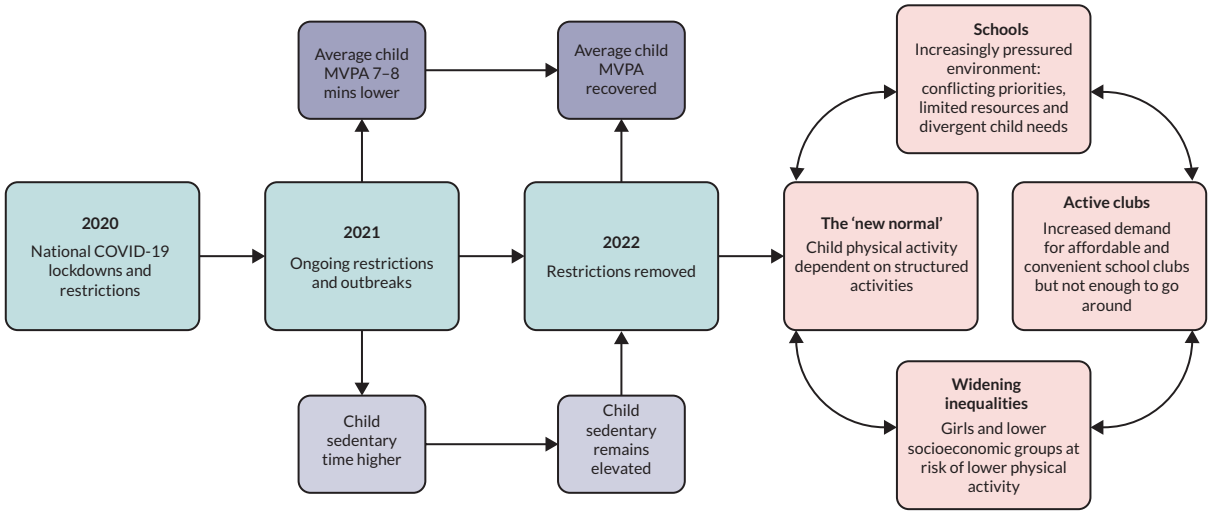

FIGURE 4 Summary of Active-6 key findings. MVPA, moderate to vigorous intensity physical activity.

relying on recall, and the collection of two additional post-lockdown waves of data, to measure change over time. These data came from the same schools and the same-aged children, which reduced school-level variability in estimates. Active-6 collected data in the post-lockdown recovery phase of the pandemic to focus on the longer-term impacts of COVID-19 and implications for policy and practice beyond immediate restrictions. We applied novel statistical techniques to model change over time and account for important factors that influence differences, such as seasonality. Our qualitative data gathered multiple perspectives of parents, children and school staff to triangulate perspectives. Again, two waves of this data enabled us to note and observe any changes over time and provide explanation for the device-measured changes we observed. Lastly, our mixed-methods design means accelerometer and questionnaire data are supported and enhanced by the qualitative study, and vice versa.

This study does, however, have weaknesses. The natural experiment design means that it is possible that observed differences are due to factors that have changed between 2017/18 and 2021/22 other than COVID-19 and associated lockdowns. Our sample is biased towards households with higher educational qualifications, with only 40% of our families from non-graduate households. Therefore, we can generalise to some extent but not explore socioeconomic factors in detail. Finally, the adult sample of our study is not typical of adults as a whole. These are specifically parents/carers of 10- to 11-year-old children between the ages of 35–49 years and, importantly, 75% of our adult sample is female, so these data mainly represent the experiences of mothers. These sample biases must be considered when interpreting the study findings and suggest that future research to target low socioeconomic families and fathers could be warranted.

Challenges faced and limitations

The major challenge this study faced was undertaking participant recruitment and data collection through primary schools during the COVID-19 pandemic, when social distancing restrictions and case numbers fluctuated. Protocols had to be flexible to both virtual and in-person study briefings and data collection, with child height and weight data, particularly in wave 1, at times not possible to collect due to social distancing guidelines. The purpose of this study was to provide rapid insight on the impact of the pandemic on child physical activity and, as such, recruitment and data collection began as soon as possible. This prevented taking time for deeper school community engagement, and this, combined with an uneven impact of the pandemic, may have limited participation of schools and families.

Patient and public involvement

Engaging members of the wider communities of Active-6 has been of central importance to this study. We embedded patient and public involvement (PPI) at every step to improve the study outcomes and created dissemination materials that were useful and relevant to each audience. PPI, therefore, took place throughout the study, but was of particular importance in designing the specifics of data collection and creating resources to share our findings. PPI input has been invaluable, improving data collection protocols and materials and the content, design and channels for dissemination. This section on PPI, therefore, can be read and understood in conjunction with the following section on dissemination. Below we outline PPI undertaken with key stakeholder groups.

Parents

Parent members have sat on the study oversight groups – the study management group and study steering committee – and have shaped and steered the day-to-day management of the study, provided feedback on draft materials including interview guides, protocols and school feedback materials and contributed to publications.

Schools and children

We have worked closely with school staff and children to provide two-way dialogue on data collection processes and study findings. We ran two PPI sessions with children, which explored reflections on wave 1 data collection processes to build upon in wave 2 and provided feedback on several relevant dissemination materials. Year 6 teachers and senior leadership team staff were consulted on data collection processes and all school or classroom-focused materials we have produced.

Policy

At the outset of the study, an impact advisory group (IAG) was established, drawing advisors from a variety of local and national organisations working to promote children's physical activity, including Department for Health and Social Care, Office for Health Improvement and Disparities, Sport England, Public Health Scotland, Active Scotland and Public Health Wales. Support from many of these organisations was established during the grant application process and the aim of this group was to share rapid findings for feedback and dialogue between the Active-6 team and policy colleagues as the study developed and the findings emerged. Members of the IAG advised the study team on relevant dissemination materials and channels, both in the IAG meetings and through targeted conversations with members about dissemination in their particular field. Several suggestions

for dissemination materials and channels emerged from these conversations.

Practitioners

Senior staff from local club providers and national charity and third-sector organisations such as Wesport, Active Gloucestershire, Bristol Sport Foundation and the Youth Sport Trust sat on the IAG and contributed the perspective of child sport and physical activity providers on the data collection, interim findings and dissemination materials. A PPI session was run with on-the-ground club provider staff to review and improve the specific dissemination materials tailored to the practitioner audience. We additionally had a representative from the local authority public health team as co-applicant on the study and who sat on the study management group, providing a unique and valuable perspective on study decision-making.

Dissemination

Providing rapid feedback to policy and practitioner colleagues was a study objective, which we did through our IAG at mid and end points of each data collection wave. This took the study findings directly to those they impact upon in a timely manner and provided dialogue on the data collection and analysis while it was taking place.

Beyond this, our dissemination strategy aimed to share relevant and useful materials in a variety of formats to all study stakeholder groups. The key stakeholder groups identified for our study were policy, schools, active club and sports commissioners and providers, parents and children and academics. With their input, we designed tailored materials for each of these stakeholder groups and identified channels for dissemination.

Two outputs have been central to our dissemination plan and are designed for all stakeholder groups and to encourage engagement with further study resources. These are the 'Active-6 hub' and a study animation. We worked with Actify, a social enterprise that hosts an online platform of physical activity digital content, to produce these. The animation provides a very general overview of the study and findings, and then signposts to the hub, which is designed for different stakeholder groups to easily navigate to relevant study materials that provide further findings or offer recommendations to increase child physical activity.

Below, we outline the additional specific materials and resources produced to disseminate Active-6 findings to each stakeholder group and the channels through which we did this, and how the animation and hub was shared with these groups.

Policy

We worked with PolicyBristol to produce a policy briefing that identifies key findings from the study and a list of policy recommendations that can support children's physical activity. The briefing was disseminated to a comprehensive list of contacts and stakeholders beyond the members of our IAG, including Members of Parliament, Peers and Councillors who sit on relevant all-party parliamentary groups or with relevant portfolios. Additionally, PPI and consultation with IAG members told us policy colleagues were keen for a slide deck of study findings. Both the policy briefing and the slide deck were launched with the IAG at a final study meeting in September 2023.

We have worked to present findings and content directly with policy partners in their spaces and to their audiences. We submitted evidence to the Prevention Inquiry for the Health and Social Care Select Committee to explore how to improve child physical activity since COVID-19 lockdowns. Professor Jago presented study findings at the Youth Sport Trust annual conference, the UK's leading charity working to improve young people's education and development through sport and play, where he was one of four speakers in the room with the aim to bring together policy-makers, academics and insight specialists to share the latest evidence on children's activity and school sport. Locally, we presented findings to the NHS Bristol, North Somerset and South Gloucestershire Clinical Commissioning Group via their Research Showcase Seminar, to the Office for Health Improvement and Disparities' South West Children's Healthy Weight and Physical Activity community of practice meeting at the Southwest Public Health Conference 2023, which convenes regional academics and practitioners, and Active-6 was featured as a case study in the 2022/23 Director of Public Health Report for Bristol City Council, which was presented to the Bristol Health and Wellbeing Board and the Bristol City Council Cabinet.

To focus dissemination in the areas and communities that participated in the study, we worked to share study findings to the relevant teams in the four local authorities in which the study took place. Colleagues in these local authorities have shared tailored summaries of the study's key messages via newsletters and bulletins across public health, children and young people and education teams. This summary was also shared through the local authorities to primary school head teachers, so that the study reached primary school decision-makers and senior leadership team members.

Primary schools

The primary school environment is an important context for children's physical activity and school staff a key

audience for our findings. In addition to dissemination to senior leadership team members in the wider Bristol area described above, we wanted to maintain communication with the Active-6 schools so we produced and disseminated a classroom poster suggesting '4 things we can do to get active', which had input from year 6 children and teaching staff. This poster was printed for study schools as children and staff felt this would be a useful presence in the classroom to remind them of the importance of activity and movement in the school day. We also shared the animation with study schools, and primary school staff told us that within schools the animation was a useful tool for engagement with physical activity post-lockdowns that can be watched in key stage 2 assembly and classrooms (with a class discussion), and shared with wider school and academy communities via their communication platforms.

We wanted the Active-6 schools to be able to engage with their data, so we shared school-level aggregated data on MVPA and sedentary time on weekdays and weekends for children and parents after each wave of data collection. We did this via tailored A2-sized posters which were printed for each study school and an electronic PDF copy was also shared with parents and families via school mailing lists or newsletters. We created two lesson plans (with input from study year 6 teachers), which we shared with these posters, exploring different themes around physical activity that were relevant to the key stage 2 science and maths curriculums. These materials were well received, with examples of staff feedback such as:

> *I have sent the data to share in our newsletter and shared the lesson plan so that it can be used in Upper KS2 as we think about active travel and healthy schools.*
>
> *Year 6 teacher*

> *It is good to see the feedback to understand more about how exercise habits have changed in recent years.*
>
> *Year 6 teacher*

> *[The resources are] absolutely brilliant and will help to back-up and inform what we do*
>
> *PE coordinator*

Beyond study and local primary schools, it was essential to communicate our findings with PE teachers at a national scale. We worked with the Youth Sport Trust (YST), whose main audience base is PE teachers, to collaborate and share findings. Active-6 papers are included in the YST 'knowledge bank', evidence is included in their 2023 *PE and School Sport* report, and we shared study findings in a post for the YST blog. We have written an article for *PE Matters*, the official journal for the Association for Physical Education, the membership organisation for PE teachers in the UK (Autumn 2023 issue), and Professor Jago shared findings in an analysis piece in the *Times Education Supplement*, to reach a wider teaching and school staff body.

Club providers

After consulting with club provider members of our IAG, we identified the need for a summary of findings and implications tailored to providers who deliver active clubs at schools and in the community. With input from staff who run clubs in primary schools, we created a one-page PDF provider summary and shared it through local networks of club commissioners and providers.

This summary was also an appropriate format for schools, particularly PE teachers and senior leadership team members, so was also disseminated via the local authority networks and channels.

Families/general public

The families that took part in Active-6 are a particular group with which we undertook steps to engage and share study findings. We shared the animation and hub directly with all Active-6 families via e-mail.

When key study papers were published we worked on a media release to share their findings with the general public and industry. These successful in gaining media traction and Active-6 findings have been covered by over 20 news outlets including nationally in *The Times*, *The Guardian*, the BBC, and internationally in France, the USA and India. We have worked to enhance the publication of key study papers by publishing blog posts in relevant partner blogs and online media in order to provide a plain language and accessible summary of the key messages. We published a thought leadership piece in *The Conversation* on the wave 1 accelerometer data, the blog for the Youth Sport Trust mentioned above sharing the findings on the 'new normal', and a post on our findings on club participation post-lockdown on We Can Move's blog. Finally, we provide a plain language summary of each academic paper we publish on the Active-6 hub, with a link to the full paper.

Academics

To disseminate our findings to academic audiences we have 11 study papers in various stages of publication, outlined in *Table 1*, and have been accepted to presented findings at several relevant conferences. This included the Scottish Physical Activity Research Connections conference 2023, which brings together a network of physical activity researchers as well as policy-makers and practitioners.

Equality, diversity and inclusion

To maximise precision of the primary outcome, the schools invited to participate in Active-6 were 50 state primary schools which completed phase 3 of the pre-COVID B Proact1v study. These were a mixture of urban, suburban and rural schools, drawn from all five Indices of Multiple Deprivation (IMD) quintiles and of different sizes covering four local authorities in the Bristol area. The 28 schools that took part in Active-6 were broadly representative of these schools.[19] All children enrolled in year 6 in participating schools were eligible to take part. We did not employ stratified sampling to boost any specific demographic groups. Participating children were roughly equally split by gender, and were drawn from all IMD deciles, although there were more participants from higher socioeconomic backgrounds at all time points, especially in the post-lockdown data collection. The sample had low ethnic diversity, with only 8% from non-white backgrounds, slightly lower than the study area as a whole (12% estimated from 2021 Census). Participating adults were all parents/carers of 10- to 11-year-old children and were predominantly aged 35–49 years. The large majority (75%) were female; to increase participation rates we did not target parent/carers by gender.[14]

In the qualitative study, there was more scope to shape and monitor recruitment, where certain study schools and groups were targeted to increase their inclusion. However, inclusion and representation of diverse ethnic backgrounds, lower socioeconomic status groups and male parents is limited, in part due to the challenges of conducting research during a pandemic and ongoing school and family disruptions and in part due to the relatively small quantitative sample from which to draw from.[11,14]

In the study team, we were able to support the University of Bristol's Widening Participation Research Summer Internship scheme, which provides promising undergraduate students from underrepresented backgrounds with hands-on research experience to encourage postgraduate study and/or a career in research. Our intern supported all aspects of Active-6 work and made a valuable contribution to the study.

Impact and learning

Further dissemination

As described above, our dissemination plan has been underway alongside the publication of study papers. We build on work to date and continue discussions and dissemination that ensure the outcomes of our research are taken forward by stakeholders.

Many of the key ideas that have emerged from this project are being taken forward in a UK Research and Innovation-funded project called PASSPORT, which seeks to develop a context-specific intervention for primary school physical activity.[35] We intend to continue our IAG into the PASSPORT study to continue the useful and engaged dialogue we have had in Active-6.

Impact

Findings from the study that have been published to date have had some impact in the general public, study schools, policy-makers and practitioners. Longer term, we are hoping to see the impact of the dissemination of the study findings. The study findings and implications can be brought into key policy agendas and decisions in the areas of child physical activity and schools. We have set up search and track functions on Overton, a policy database, to track any policy impact.

Lessons learned for future research

The Active-6 study has provided lessons to draw on for both research design and the focus of future studies in the field. Working with schools particularly through the challenge of COVID-19 has been informative, and we have learned that successful schools-based research depends on close collaboration between a school and the research team and recognising the specific and unique context and needs of each school and school community.[35] The findings of Active-6 are building a picture of an uneven impact of the pandemic on child physical activity, with certain groups of children more adversely affected and at risk of long-term health consequences of low physical activity. In Active-6, we identified a need for future research to undertake careful recruitment of under-represented groups, particularly schools with higher deprivation indicators and the families from these schools in turn, through long-term engagement and relationship building in schools.

The PASSPORT study seeks to explore and evaluate a context-specific model for child physical activity interventions in English primary schools, building on these reflections.

Implications for decision-makers

1. Policy and programmes to support children's physical activity must be sensitive to the 'new normal' for child activity, which relies on organised activities such as clubs, with particular demand for convenient and affordable school-based clubs.

2. Primary schools need additional resources to provide a wide range of active clubs for all abilities.
3. Targeted support is needed for girls and children/schools from more disadvantaged communities, whose physical activity was more adversely affected by the lockdown.
4. There is a need to build on current initiatives to maximise the use of school facilities outside of school hours to increase children's physical activity at scale cost-effectively.
5. Community and sports organisations need financial support to deliver convenient and affordable community-based clubs that all families can access.

Research recommendations

1. There is a need to develop new ways to work in partnership with schools to design bespoke physical activity programmes that can be delivered at the school site.
2. There is a need to develop new ways to help girls and children from lower-income households to be physically active.
3. There is a need to find the most effective means of maximising existing school resources such as extended school provision (after-school clubs) and physical resources (equipment) to promote physical activity outside of curriculum time.

Conclusions

COVID-19 lockdowns impacted child physical activity, it took almost a year of no restrictions for this to recover, and sedentary time remains high. Despite this recovery, 59% of children do not meet activity guidelines. There is a new normal to child physical activity that relies on structured activities, and some children and families may face challenges to taking part in the new normal. Strategies are needed to increase child physical activity for all.

Additional information

Contributions of authors

Russell Jago (https://orcid.org/0000-0002-3394-0176) was the principal investigator, oversaw all aspects of study design and interpretation, and edited the synopsis for intellectual content.

Danielle House (https://orcid.org/0000-0001-6171-9922) was the study manager, oversaw the management of data collection and study administration, and led the writing of the synopsis.

Ruth Salway (https://orcid.org/0000-0002-3242-3951) was the statistician for the study, developed and analysed all statistical elements of the study, and contributed to all aspects of the synopsis.

Robert Walker (https://orcid.org/0000-0001-9901-5285) was the qualitative lead for the study, developed and analysed all qualitative elements of the study and contributed to all aspects of the synopsis.

Lydia Emm-Collison (https://orcid.org/0000-0002-5493-3223) was a steering group member, developed the qualitative elements of the study, oversaw data collected in wave 0, led the writing of the parent motivation section of the synopsis and edited the synopsis for intellectual content.

Kate Sansum (https://orcid.org/0000-0003-3392-6750) was a fieldworker, conducted wave 2 data collection and edited the synopsis for intellectual content.

Katie Breheny (https://orcid.org/0000-0001-6886-4049) was the health economist for the study, developed the health economics elements of the study, led the writing of the health economics section of the synopsis and edited the synopsis for intellectual content.

Sarah Churchward (https://orcid.org/0009-0007-7765-3682) was a steering group member, contributed in a PPI capacity throughout the project and edited the synopsis for intellectual content.

Joanna G Williams (https://orcid.org/0000-0002-4737-1760) was a steering group member and edited the synopsis for intellectual content.

William Hollingworth (https://orcid.org/0000-0002-0840-6254) was a steering group member and edited the synopsis for intellectual content.

Frank de Vocht (https://orcid.org/0000-0003-3631-627X) was a steering group member and edited the synopsis for intellectual content.

Acknowledgements

A special thanks to the Active-6 schools, the school staff, child participants and parents/carers for their involvement in the study.

Thanks also to previous team members, Professor Charlie Foster, who was co-applicant, and in the study management group; Byron Tibbetts, who was project manager from April

to December 2021; Tom Reid, who was fieldworker from April 2021 to January 2022; Lara Hollander, who helped to develop the wave 2 qualitative frameworks; Christine O'Shea, who was summer intern in 2022; and Tabitha Pring, who was a casual fieldworker for wave 2 data collection.

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Ethics statement

Ethical approval was gained from the School of Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150)] on 9 March 2021. The project was listed on the Research Registry.

Information governance statement

The University of Bristol is committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Bristol is the Data Controller, and you can find out more about how we handle personal data, including how to exercise your individual rights and the contact details for our Data Protection Officer here (www.bristol.ac.uk/secretary/data-protection/).

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/WYHT5821.

Primary conflicts of interest: Russell Jago, Katie Breheny, Frank de Vocht and William Hollingworth are partly funded by the National Institute for Health Research (NIHR) Applied Research Collaboration West (NIHR ARC West) at University Hospitals Bristol NHS Foundation Trust and the University of Bristol. Russell Jago is partly funded by the National Institute for Health and Care Research Bristol Biomedical Research Centre, and was a member of the PHR Prioritisation Group from 11 October 2019 to 12 October 2021, and a member of the PHR Research Funding Board from 1 June 2014 to 12 October 2021. Frank de Vocht has been on the NIHR Public Health Research Funding Board since 8 October 2019. William Hollingworth was a member of the HTA Clinical Evaluation and Trials Committee from 1 July 2016 to 31 March 2021.

Department of Health and Social Care disclaimer

This publication presents independent research commissioned by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by the interviewees in this publication are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, MRC, NIHR Coordinating Centre, the PHR programme or the Department of Health and Social Care.

This synopsis was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Publications

Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**:51. https://doi.org/10.1186/s12966-022-01290-4

Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Act* 2022;**19**:114. https://doi.org/10.1186/s12966-022-01356-3

Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary: a natural experiment. *Int J Behav Nutr Phys Act* 2023;**20**:42. https://doi.org/10.1186/s12966-023-01441-1

Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al*. Screen-viewing behaviours of children before and after the 2020-21 COVID-19 lockdowns in the UK: a mixed methods study. *BMC Public Health* 2023;**23**:116. https://doi.org/10.1186/s12889-023-14976-6

Walker R, House D, Salway R, Emm-Collison L, Hollander L, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Public Health* 2023;**23**:1432. https://doi.org/10.1186/s12889-023-16021-y

Emm-Collison L, Walker R, Salway R, House D, Sansum K, Breheny K, *et al*. Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed methods study from a self-determination theory perspective. *Public Health Res* 2024;27 March:1–35 [published online ahead of print] https://doi.org/10.3310/KPKW8220

Salway R, de Vocht F, Emm-Collison L, Sansum L, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: a latent profile analysis. *PLOS One* 2023;**18**(11):e0289344. https://doi.org/10.1371/journal.pone.0289344

Walker R, Salway R House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

House D, Walker R, Salway R, Emm-Collison L, Breheny K, Sansum K, *et al*. The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis. *Public Health Res* 2024;7 Feb:1–37. [published online ahead of print] https://doi.org/10.3310/KLML4701

Breheny K, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Quality of life, capability wellbeing, financial strain and physical activity in the short and medium term COVID 19 post-lockdown phases in the UK: a repeated cross-sectional study. *Public Health Res* (under review). https://doi.org/10.3310/LYJG6305

Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al*. School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis. *Public Health Res* (under review). https://doi.org/10.3310/WQJK9893

Study registration

This study is registered as research registry (project 6646).

Funding

This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847.

This synopsis reports on one component of the research award Assessing the impact of COVID-19 on the physical activity of 10–11-year-old children and their parents: Active-6 a mixed-methods study. For more information about this research please view the award page (https://www.fundingawards.nihr.ac.uk/award/10.3310/NIHR131847).

About this synopsis

The contractual start date for this research was in April 2021. This article began editorial review in June 2023 and was accepted for publication in March 2024. The authors have been wholly responsible for all data collection, analysis and interpretation and for writing up their work. The Health and Social Care Delivery Research editors and publisher have tried to ensure the accuracy of the authors' article and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article. This article was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

This synopsis was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Copyright

List of supplementary material

Report Supplementary Material 1
Active-6 interview and focus group topic guides.

Supplementary material can be found on the NIHR Journals Library report page (https://doi.org/10.3310/WYHT5821).

Supplementary material has been provided by the authors to support the report and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed.

Any supplementary material provided at a later stage in the process may not have been peer reviewed.

List of abbreviations

BMI	body mass index
CHU9D	Child Health Utility 9 Dimension
COVID-19	coronavirus disease
EQ-5D-5L	EuroQol-5 Dimensions, five-level version
FESS	Family Economic Strain Scale
HRQoL	health-related quality-of-life
ICECAP-A	ICEpop CAPability measure for Adults
IMD	Indices of Multiple Deprivation
MVPA	moderate to vigorous intensity physical activity
PE	physical education
YST	Youth Sport Trust

References

1. Jago R, Foster C, Williams J, de Vocht F, Hollingworth W. *Protocol for Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts & Provide Rapid Evidence to Policy Makers (ACTIVE-6)*. 2021. URL: https://fundingawards.nihr.ac.uk/award/NIHR131847 (accessed 3 October 2023).
2. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, *et al*. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med* 2020;**54**:1451–62. https://doi.org./10.1136/bjsports-2020-102955
3. Chaput JP, Willumsen J, Bull F, Chou R, Ekelund U, Firth J, *et al*. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5-17 years: summary of the evidence. *Int J Behav Nutr Phys Act* 2020;**17**:141. https://doi.org./10.1186/s12966-020-01037-z
4. Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obes Facts* 2009;**2**:187–95. https://doi.org./10.1159/000222244
5. Telama R, Yang X, Leskinen E, Kankaanpaa A, Hirvensalo M, Tammelin T, *et al*. Tracking of physical activity from early childhood through youth into adulthood. *Med Sci Sports Exerc* 2014;**46**:955–62. https://doi.org./10.1249/MSS.0000000000000181
6. Jago R, Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA. Association of BMI category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. *Int J Obes (Lond)* 2020;**44**:104–13. https://doi.org./10.1038/s41366-019-0459-0
7. Sport England. *Active Lives Children and Young People Survey Coronavirus (COVID-19) Report: Mid-May to late-July 2020 (the summer term)*. Loughborough: Sport England; 2021.
8. Sims J, Milton K, Foster C, Scarborough P. A profile of children's physical activity data from the 2012 and 2015 health survey for England. *BMC Public Health* 2022;**22**:1785. https://doi.org./10.1186/s12889-022-14150-4
9. Owen KB, Nau T, Reece LJ, Bellew W, Rose C, Bauman A, *et al*. Fair play? Participation equity in organised sport and physical activity among children and adolescents in high income countries: a systematic review and meta-analysis. *Int J Behav Nutr Phys Act* 2022;**19**:27. https://doi.org./10.1186/s12966-022-01263-7
10. Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**:51. https://doi.org./10.1186/s12966-022-01290-4
11. Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Act* 2022;**19**:114. https://doi.org./10.1186/s12966-022-01356-3
12. Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al*. Screen-viewing behaviours of children before and after the 2020-21 COVID-19 lockdowns in the UK: a mixed methods study. *BMC Public Health* 2023;**23**:116. https://doi.org./10.1186/s12889-023-14976-6
13. Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment. *Int J Behav Nutr Phys Act* 2023;**20**:42. https://doi.org./10.1186/s12966-023-01441-1
14. Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al*. The new normal for

children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Public Health* 2023;**23**:1432. https://doi.org./10.1186/s12889-023-16021-y

15. Salway R, de Vocht F, Emm-Collison L, Sansum K, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: a latent profile analysis. *PLOS ONE* 2023;**18**:e0289344. https://doi.org/10.1371/journal.pone.0289344

16. Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

17. House D, Walker R, Salway R, Emm-Collison L, Breheny K, Sansum K, *et al*. The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis. *Public Health Res* 2024;7 Feb:1–37. Epub ahead of print. https://doi.org/10.3310/KLML4701

18. Emm-Collison L, Walker R, Salway R, House D, Sansum K, Breheny K, *et al*. Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed methods study from a self-determination theory perspective. *Public Health Res* 2024;27 March:1–35 [published online ahead of print] https://doi.org/10.3310/KPKW8220

19. Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al*. School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis. *Public Health Res* 2024; in press. https://doi.org/10.3310/WQJK9893

20. Breheny K, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Quality of life, capability wellbeing, financial strain and physical activity in the short and medium term COVID 19 post-lockdown phases in the UK: a repeated cross-sectional study. *Public Health Res* 2024; in press. https://doi.org/10.3310/LYJG6305

21. Husbands S, Mitchell PM, Floredin I, Peters TJ, Kinghorn P, Byford S, *et al*. The Children and Young People Quality of Life Study: A protocol for the qualitative development of attributes for capability well-being measures for use in health economic evaluation with children and young people. *Wellcome Open Res* 2022;**7**:117. https://doi.org./10.12688/wellcomeopenres.17801.1

22. Jago R, Tibbitts B, Porter A, Sanderson E, Bird E, Powell JE, *et al*. A revised teaching assistant-led extracurricular physical activity programme for 8- to 10-year-olds: the Action 3:30R feasibility cluster RCT. *Public Health Res* 2019;**7**:1–128. https://doi.org/10.3310/phr07190

23. Hilton JM, Devall EL. The Family Economic Strain Scale: development and evaluation of the instrument with single- and two-parent families. *J Family Econ Issues* 1997;**18**:247–71.

24. Faulkner G, Zeglen L, Leatherdale S, Manske S, Stone M. The relationship between school physical activity policy and objectively measured physical activity of elementary school students: a multilevel model analysis. *Arch Public Health* 2014;**72**:20. https://doi.org./10.1186/2049-3258-72-20

25. Harvey A, Faulkner G, Giangregorio L, Leatherdale ST. An examination of school- and student-level characteristics associated with the likelihood of students' meeting the Canadian physical activity guidelines in the COMPASS study. *Can J Public Health* 2017;**108**:e348–54. https://doi.org./10.17269/cjph.108.5925

26. Brazendale K, Beets MW, Armstrong B, Weaver RG, Hunt ET, Pate RR, *et al*.; International Children's Accelerometry Database (ICAD) Collaborators. Children's moderate-to-vigorous physical activity on weekdays versus weekend days: a multi-country analysis. *Int J Behav Nutr Phys Act* 2021;**18**:28. https://doi.org./10.1186/s12966-021-01095-x

27. Brazendale K, Beets MW, Weaver RG, Pate RR, Turner-McGrievy GM, Kaczynski AT, *et al*. Understanding differences between summer vs. school obesogenic behaviors of children: the structured days hypothesis. *Int J Behav Nutr Phys Act* 2017;**14**:100. https://doi.org./10.1186/s12966-017-0555-2

28. Olds T, Maher C, Dumuid D. Life on holidays: differences in activity composition between school and holiday periods in Australian children. *BMC Public Health* 2019;**19**:450. https://doi.org./10.1186/s12889-019-6765-6

29. Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA, Jago R. A multilevel analysis of neighbourhood, school, friend and individual-level variation in primary school children's physical activity. *Int J Environ Res Public Health* 2019;**16**:4889. https://doi.org./10.3390/ijerph16244889

30. Rossi L, Behme N, Breuer C. Physical activity of children and adolescents during the COVID-19 pandemic – A scoping review. *Int J Environ Res Public Health* 2021;**18**:11440. https://doi.org./10.3390/ijerph182111440

31. Kharel M, Sakamoto JL, Carandang RR, Ulambayar S, Shibanuma A, Yarotskaya E, *et al*. Impact of COVID-19

pandemic lockdown on movement behaviours of children and adolescents: a systematic review. *BMJ Glob Health* 2022;**7**:e007190. https://doi.org./10.1136/bmjgh-2021-007190

32. Neville RD, Lakes KD, Hopkins WG, Tarantino G, Draper CE, Beck R, Madigan S. Global changes in child and adolescent physical activity during the COVID-19 pandemic: a systematic review and meta-analysis. *JAMA Pediatr* 2022;**176**:886–94. https://doi.org./10.1001/jamapediatrics.2022.2313
33. Stockwell S, Trott M, Tully M, Shin J, Barnett Y, Butler L, *et al*. Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. *BMJ Open Sport Exerc Med* 2021;**7**:e000960. https://doi.org./10.1136/bmjsem-2020-000960
34. Fairclough SJ, Beighle A, Erwin H, Ridgers ND. School day segmented physical activity patterns of high and low active children. *BMC Public Health* 2012;**12**:406. https://doi.org./10.1186/1471-2458-12-406
35. Jago R, Salway R, House D, Beets M, Lubans DR, Woods C, de Vocht F. Rethinking children's physical activity interventions at school: a new context-specific approach. *Front Public Health* 2023;**11**:1149883. https://doi.org./10.3389/fpubh.2023.1149883
36. Lewer D, Jayatunga W, Aldridge RW, Edge C, Marmot M, Story A, Hayward A. Premature mortality attributable to socioeconomic inequality in England between 2003 and 2018: an observational study. *Lancet Public Health* 2020;**5**:e33–41. https://doi.org./10.1016/s2468-2667(19)30219-1
37. Women in Sport. *Sport, Stereotypes and Stolen Dreams: Why Girls Still Feel They Don't Belong in Sport*. London: Women in Sport; 2023. https://womeninsport.org/resource/sport-stereotypes-and-stolen-dreams (accessed 2 April 2024).

Appendix 1 Recruitment and consent processes

The Active-6 study was able to recruit from the pool of 50 schools that participated in the final wave of the B-Proact1v study in 2017/18. All 50 schools were approached and invited to participate in wave 1 and again in wave 2. Each participating school signed a school study agreement outlining a key contact at the school and the broad expectations from each party.

Families were recruited from schools via briefings, undertaken by study researchers, to all year 6 pupils at the school. These were either virtual or in-person dependent on COVID-19 cases, policies and mitigation. During these briefings researchers explained why we were doing the study, why their school was participating, the data collection processes, the incentive/thank you gift participants would be given and answered any questions from the pupils and staff.

The day of the briefing a link to sign up to the study, along with participant information, was sent to all year 6 parents/carers via the school office. Families were given a week to sign up, with a reminder e-mail sent out after some days. Consent for the study was provided online via REDCap® (REDcap Consortium, Nashville, TN, USA), and both parents/carers and the children completed this form (consent and assent, respectively). Consent to be potentially contacted about a parent interview at a future date was also included at this stage, as well as yes/no parent consent for their child to take part in possible future focus groups. If consent to these was given, and if that parent or child was selected for an interview or focus group, opting out once contacted was of course possible. Additional oral consent for parent interviews was obtained at the start of the interview, and written child assent to participate in a focus group on the day.

Appendix 2 Details of study components

Quantitative component

Research aims

This component sought to measure the impact of the COVID-19 lockdowns on children's and their parent/carer's MVPA and sedentary time in the short and medium terms. We also sought to understand particular factors that might influence this impact.

Methods for data collection and analysis

Accelerometer and questionnaire data were collected from 393 children aged 10–11 years and their parents from 23 schools in wave 1 (June–December 2021) and 436 children and parents from 27 schools in wave 2 (January–July 2022). These were compared to a pre-COVID-19 comparator group (March 2017–May 2018) of 1296 children and parents in the same schools. Mean minutes of accelerometer-measured MVPA and sedentary time were derived for week and weekend days and compared across waves via linear multilevel models. We analysed the date of data collection as a time series, to explore temporal patterns via generalised additive mixed models. We gathered child and parent questionnaire data and school data to explore factors that might influence or explain changes in MVPA.

Limitations

Active-6 is a natural experiment and uses a before-and-after design, where the only available controls are historical. Therefore any differences may be due to other factors rather than COVID-19, especially if these differ over time. Although pre-pandemic data have suggested that children's MVPA is relatively stable over time and our analysis takes into account seasonal differences, we cannot rule out longer-term secular changes. Our data suggest that there are likely to be differences in adaptations post pandemic by gender and socioeconomic position; however, the sample is not powered to explicitly test for such differences.

Key findings

After an initial drop in 2021, children's MVPA returned to pre-pandemic levels by July 2022, while sedentary time remained higher. Parents' MVPA was not affected in 2021 and increased in 2022, especially at weekends. The recovery in children's physical activity is precarious and potentially susceptible to future COVID-19 outbreaks or changes in provision, and so robust measures to protect against future disruptions are needed. Furthermore, many children are still inactive, with only 41% meeting UK physical activity guidelines, so there is still a need to increase children's physical activity.

Interrelationships with other parts of the award

As a mixed-methods study, the quantitative, health economics and qualitative components add greater depth of insight and analysis. The quantitative component provides a larger general data set to observe any changes and trends, complemented by the qualitative component that explores experiences and possible explanations for any observed changes.

Health economics component

Research aims

This component explores differences in health-related quality of life and well-being over time after the COVID-19 lockdowns had been lifted. Specifically, how health-related quality of life, capability well-being and family financial strain changed after the lockdowns, the relationship between these outcomes, and whether physical activity had any mediating effect on differences in health-related quality of life and capability well-being.

Methods for data collection and analysis

Cross-sectional data were collected in May–December 2021 (wave 1) and January–July 2022 (wave 2). Children (aged 10–11 years) and their parent/carer were recruited from 23 and 27 schools in each wave, respectively, and completed validated questionnaires measuring health-related quality of life (adults: EQ-5D-5L, children: CHU9D), capability well-being (adults: ICECAP-A) and family financial strain (adults: FESS). Children also completed questions on capability well-being. Mixed-effects regression models, adjusted for gender, age group (adults only), IMD and highest household education, were used to explore differences in health-related quality of life and capability well-being between waves. In addition, the moderating effect of financial strain, and the mediating effect of MVPA on health-related quality of life and capability well-being were explored.

Limitations

Pre-COVID-19 data on health-related quality of life were not collected, so analysis was limited to post lockdown only. Participating parents were predominantly female and participation was lower among lower socioeconomic groups, limiting our ability to explore inequalities.

Key findings

There were no differences in health-related quality of life (EQ-5D, CHU9D) and capability well-being (ICECAP-A) scores between waves, but financial strain was worse in wave 2 compared with wave 1 (FESS score difference 1.14 adjusted 95% CI 0.15: 2.12). Increased financial strain was associated with lower (worse) EQ-5D-5L, CHU9D and ICECAP-A scores. There was no evidence of a mediating effect of MVPA.

This synopsis should be referenced as follows:
Jago R, House D, Salway R, Walker R, Emm-Collison L, Sansum K, *et al*. Assessing the impact of COVID-19 on the physical activity of 10–11-year-old children and their parents: Active-6 a mixed-methods study. *Public Health Res* 2024;**12**(16):1–29. https://doi.org/10.3310/WYHT5821

Interrelationships with other parts of the award

As a mixed-methods study, the quantitative, health economics and qualitative components add greater depth of insight and analysis. The health economics component provides a different perspective to the general quantitative component by exploring the specific aspect of health-related quality of life and well-being.

Qualitative component

Research aims

This component aimed to provide in-depth analysis of how the pandemic and lockdowns shaped children's physical activity patterns in the short- and medium-term periods following lockdowns. We also aimed to identify any new challenges to engaging children in physical activity and ideas to mitigate these.

Methods for data collection and analysis

Data were collected in 2021 and 2022 with one-to-one interviews with school staff (*N* = 18) and parents (*N* = 43), and 12 child focus groups (*N* = 92) and analysed using the framework method.

Limitations

Participants were predominantly white British, active and from higher socioeconomic groups, although additional steps were taken to recruit participants from more diverse backgrounds, such as targeted recruitment and purposive sampling of children. We were therefore unable to explore socioeconomic issues in-depth.

Key findings

Periods of lockdown and severe restriction limited children's activity. In 2021, following the easing of restrictions, emotional overwhelm and physical fatigue among children stemming from a sedentary and socially isolated life in lockdown were key contributors to the decreased moderate to vigorous physical activity and increased sedentary behaviour that was observed in the quantitative component. In 2022, we found a new normal for children's physical activity, characterised by increased dependence on structured and organised physical activities, such as active clubs, and less on unstructured and spontaneous physical activities, such as physical play. While this may suit many children, girls and children from lower socioeconomic households face barriers to participating in the new normal.

Interrelationships with other parts of the award

As a mixed-methods study, the quantitative, health economics and qualitative components add greater depth of insight and analysis. The qualitative component has provided useful and complementary data to explore and understand the changes observed in the quantitative component.

Appendix 3 Quantitative variables

Variable	Notes
Demographic data (parent reported)	
Child gender	
Child age	
Highest educational qualification in household	
IMD decile (from postcode)	IMD 2015 for wave 0; IMD 2019 for waves 1 and 2
Parent gender	
Parent age group	
Parent ethnicity	
Child measurement data	
Child height	Measurement data not collected for some schools in waves 1 and 2
Child weight	

Variable	Notes
Child body mass index (BMI)	
Child BMI z-score	Based on UK 1990 reference curves
Child BMI weight category	
Parent/carer characteristics	
Parent height (self-reported)	
Parent height (self-reported)	
Parent BMI	
Parent BMI category	
Employment status	
Relationship of parent/carer to child	
Number of children	
Child accelerometer data	
Number of valid days of weekday data	Wave 0: accelerometer worn for 5 days including weekend
Average weekday daily minutes sedentary time	Wave 1 and 2: accelerometer worn for 7 days including weekend
Average weekday daily minutes light activity	
Average weekday daily minutes MVPA	
Average weekday daily minutes accelerometer wear time	
Number of valid days of weekend data	
Average weekend daily minutes sedentary time	
Average weekend daily minutes light activity	
Average weekend daily minutes MVPA	
Average weekend daily minutes accelerometer wear time	
Child meets physical activity guidelines	Daily average of at least 60 minutes MVPA
Parent accelerometer data	
Number of valid days of weekday data	Wave 0: accelerometer worn for 5 days including weekend
Average weekday daily minutes sedentary time	Wave 1 and 2: accelerometer worn for 7 days including weekend
Average weekday daily minutes light activity	
Average weekday daily minutes MVPA	
Average weekday daily minutes accelerometer wear time	
Number of valid days of weekend data	
Average weekend daily minutes sedentary time	
Average weekend daily minutes light activity	
Average weekend daily minutes MVPA	
Average weekend daily minutes accelerometer wear time	
Parent meets physical activity guidelines	

Variable	Notes
Child active travel (child reported)	
Usual mode of travel to school	
Usual mode of travel from school	
Child types of physical activity (child reported)	
Frequency child attends sports club at school	
Frequency child attends sports club in the community	
Frequency child plays outside home	
Frequency child plays inside home/garden	
Frequency child is active with family	Not collected in wave 0
Frequency child is active with siblings	
Days on which child attends an active after-school club at their school	
Parental expenditure	
Weekly expenditure on community sports clubs	Not collected in wave 0
Weekly expenditure on academic tuition	
Weekly expenditure on community programmes/music etc.	
Would attend more clubs if they were cheaper	
Screen-viewing data	
Child minutes of weekday TV viewing (parent reported)	
Child minutes of weekday total leisure screen viewing (parent reported)	Wave 0: sum of games consoles, computer and phone
Child minutes of weekday schoolwork screen viewing (parent reported)	Not collected in wave 0
Child minutes of weekend TV viewing (parent reported)	
Child minutes of weekend total leisure screen viewing (parent reported)	Wave 0: sum of games consoles, computer and phone
Parent minutes of weekday TV viewing	
Parent minutes of weekday total leisure screen viewing	Wave 0: sum of games consoles, computer and phone
Parent minutes of weekend TV viewing	
Parent minutes of weekend total leisure screen viewing	Wave 0: sum of games consoles, computer and phone
Child has access to PC at home (child reported)	
Child has access to games console at home (child reported)	
Child has access to phone/tablet at home (child reported)	
Health-related quality-of-life (HRQoL) measures	
Parent HRQoL (EQ-5D)	Not collected in wave 0
Parent health scale (EQ-5D visual analogue scale)	
Parent capability well-being (ICECAP-A)	
Family financial strain (FESS)	
Family income compared to other families	
Child HRQoL (CHU9D)	

Variable	Notes
Child capability well-being questions	
Motivation etc.	
Parent motivation to be physically active (Behavioural Regulation in Exercise Questionnaire)	
Child motivation to be physically active	
Child physical activity perceived ability scale	
Parental health aspiration index	
School physical activity policies (school based)	
Policy on PE guidelines	
Policy on time spent in physical activity	
Active travel policy	
Cycle training offered	
School crossing patrol employed	
Staff continuing professional development on promotion of physical activity	
Staff facilities to promote physical activity	
PE budget	
Physical activity in the school curriculum (school based)	
Use of physical activity in non-PE subjects	
Physical activity breaks in addition to break/lunch time	
How often PE cancelled/withheld for academic reasons	
How often PE is compromised due to lack of space	
Rules about access to open space/equipment	
School active after-school clubs (school based)	
Club name and description	Not collected in wave 0
Number of children attending	
Cost to school	
Cost to parents	
How club is funded	
Whether club is subsidised	
School built environment (school based)	
Walking and cycling provision (e.g. cycle lanes, traffic calming, pedestrian crossings, road safety signs)	
Play provision (e.g. playground markings, climbing walls, sand pits, play equipment)	
Sport provision (e.g. pitches, courts, hoops and nets)	
Other facilities (e.g. allotments, drinking fountains, outdoor learning space)	
School grounds (e.g. sloped site, suitability for sport or play)	
Aesthetics (e.g. trees, planted beds, murals, well-maintained grounds)	

10.3310/GTBR5473 Public Health Research Vol. 12 No. 16

Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment

This page provides information about a publication describing research funded by the Public Health Research programme under award number NIHR131847, which has been published in a third-party journal. For information about copyright and reproduction of the original publication, please see the publisher's website.

Publication

Salway R, Charlie F, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**:51. https://doi.org/10.1186/s12966-022-01290-4

Abstract

Background

Restrictions due to the coronavirus disease 2019 (COVID-19) pandemic reduced physical activity provision for both children and their parents. Recent studies have reported decreases in physical activity levels during lockdown restrictions, but these were largely reliant on self-report methods, with data collected via unrepresentative self-report surveys. The post-pandemic impacts on children's activity levels remain unknown. A key question is how active children become once lockdown restrictions are lifted.

Methods

Active-6 is a repeated cross-sectional natural experiment. Accelerometer data from 1296 children aged 10–11 and their parents were collected in 50 schools in the Greater Bristol area, UK in March 2017-May 2018 (pre-COVID-19 comparator group), and compared to 393 children aged 10–11 and parents in 23 of the same schools, collected in May-December 2021. Mean minutes of accelerometer-measured moderate-to-vigorous physical activity (MVPA) were derived for weekdays and weekend and compared pre- and post-lockdown via linear multilevel models.

Results

After adjusting for seasonality, accelerometer wear time and child/parent demographics, children's mean weekday and weekend MVPA were 7.7 min (95% CI: 3.5 to 11.9) and 6.9 min (95% CI: 0.9 to 12.9) lower in 2021 than in 2018, respectively, while sedentary time was higher by 25.4 min (95% CI: 15.8 to 35.0) and 14.0 min (95% CI: 1.5 to 26.5). There was no evidence that differences varied by child gender or household education. There was no significant difference in parents' MVPA or sedentary time, either on weekdays or weekends.

Conclusions

Children's MVPA was lower by 7–8 min/day in 2021 once restrictions were lifted than before the pandemic for all groups, on both weekdays and weekends. Previous research has shown that there is an undesirable age-related decline in children's physical activity. The 8-min difference reported here would be broadly comparable to the decline that would have previously been expected to occur over a three-year period. Parents' physical activity was similar to pre-pandemic levels. Our results suggest that despite easing of restrictions, children's activity levels have not returned to pre-pandemic levels. There is an urgent need to understand why these changes have occurred and how long they are maintained.

Funding

This publication was funded by the Public Health Research programme as a part of award number NIHR131847.

This article reports on one component of the research award Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6). For more information about this research please view the award page [https://fundingawards.nihr.ac.uk/award/NIHR131847]

DOI

https://doi.org/10.1186/s12966-022-01290-4

10.3310/QRWT9437 Public Health Research Vol. 12 No. 16

A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021

This page provides information about a publication describing research funded by the Public Health Research programme under award number NIHR131847, which has been published in a third-party journal. For information about copyright and reproduction of the original publication, please see the publisher's website.

Publication

Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Act* 2022;**19**:114. https://doi.org/10.1186/s12966-022-01356-3

Abstract

Background

Active-6 is exploring how the COVID-19 pandemic has impacted physical activity behaviour among Year 6 children (aged 10–11 years) and their parents in Southwest England. Initial findings from the Active-6 project have shown a 7–8 min decrease in moderate-to-vigorous physical activity and an increase in sedentary behaviour among children following the easing of restrictions in the UK in latter half of 2021. This finding suggests that the pandemic has had a persistent impact on child physical activity behaviour. This paper explored the possible mechanisms behind these changes.

Methods

Interviews with parents (n = 21), members of school staff (n = 9) and focus groups with children aged 10–11 years (n = 47) were conducted between August and December 2021 to discuss the impact of the pandemic on child physical activity behaviour. The framework method was used for analysis.

Results

Five themes spanning two key stages of the pandemic were described. Three themes related to the period of lockdowns and fluctuating restrictions (March 2020 – April 2021). These included: Theme 1) Lockdown: A short-lived adventure; Theme 2) Access to facilities during restrictions; and Theme 3) The importance of the parent. A further two themes were identified related to the period following the gradual easing of restrictions in April 2021. These included: Theme 4) An overwhelming return to normal; and Theme 5) Reopening fatigue.

Conclusions

The analysis suggested that feelings of novelty experienced during the initial stages of lockdown waned as restrictions were prolonged, creating an increasingly challenging period for parents and their children. However, during periods of restrictions, the importance of parental encouragement and access to appropriate facilities in the local and home environment helped facilitate physical activity. Following the easing of COVID-19 restrictions, emotional overwhelm and physical fatigue among children, stemming from a sedentary and socially isolated life in lockdown and other restrictions, were key contributors to the decreased moderate to vigorous physical activity and increased sedentary behaviour that was observed in a related quantitative study.

Funding

This publication was funded by the Public Health Research programme as a part of award number NIHR131847.

This article reports on one component of the research award Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6). For more information about this research please view the award page [https://fundingawards.nihr.ac.uk/award/NIHR131847]

DOI

https://doi.org/10.1186/s12966-022-01356-3

Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment

Publication

Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment. *Int J Behav Nutr Phys Act* 2023;**20**:42. https://doi.org/10.1186/s12966-023-01441-1

Abstract

Background

The COVID-19 pandemic has resulted in marked impacts on children's physical activity, with large reductions in moderate-to-vigorous physical activity (MVPA) reported during lockdowns. Previous evidence showed children's activity levels were lower and sedentary time higher immediately post-COVID lockdown, while there was little change in parental physical activity. We need to know if these patterns persist.

Methods

Active-6 is a natural experiment using repeated cross-sectional data conducted in two waves. Accelerometer data were collected on 393 children aged 10–11 and their parents from 23 schools in Wave 1 (June 2021-December 2021), and 436 children and parents from 27 schools in Wave 2 (January 2022-July 2022). These were compared to a pre-COVID-19 comparator group (March 2017-May 2018) of 1,296 children and parents in the same schools. Mean minutes of accelerometer-measured MVPA and sedentary time were derived for week- and weekend-days and compared across waves via linear multilevel models. We also analysed the date of data collection as a time series, to explore temporal patterns via generalised additive mixed models.

Results

There was no difference in children's mean MVPA in Wave 2 (weekdays: -2.3 min; 95% CI: -5.9, 1.3 and weekends: 0.6 min; 95% CI: -3.5, 4.6) when compared to the pre-COVID-19 data. Sedentary time remained higher than pre-pandemic by 13.2 min (95% CI:5.3, 21.1) on weekdays. Differences compared to pre-COVID-19 changed over time, with children's MVPA decreasing over winter, coinciding with COVID-19 outbreaks, and only returning to pre-pandemic levels towards May/June 2022. Parents' sedentary time and weekday MVPA was similar to pre-COVID-19 levels, with MVPA higher than pre-pandemic by 7.7 min (95% CI: 1.4, 14.0) on weekends.

Conclusion

After an initial drop, children's MVPA returned to pre-pandemic levels by July 2022, while sedentary time remained higher. Parents' MVPA remained higher, especially at weekends. The recovery in physical activity is precarious and potentially susceptible to future COVID-19 outbreaks or changes in provision, and so robust measures to protect against future disruptions are needed. Furthermore, many children are still inactive, with only 41% meeting UK physical activity guidelines, and so there is still a need to increase children's physical activity.

Funding

This publication was funded by the Public Health Research programme as a part of award number NIHR131847.

This article reports on one component of the research award Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6). For more information about this research please view the award page [https://fundingawards.nihr.ac.uk/award/NIHR131847]

DOI

https://doi.org/10.1186/s12966-023-01441-1

10.3310/MFAT6300 Public Health Research Vol. 12 No. 16

The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK

This page provides information about a publication describing research funded by the Public Health Research programme under award number NIHR131847, which has been published in a third-party journal. For information about copyright and reproduction of the original publication, please see the publisher's website.

Publication

Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *Int J Behav Nutr Phys Act* 2023;**23**:1432. https://doi.org/10.1186/s12889-023-16021-y

Abstract

Background

The COVID-19 pandemic significantly impacted children's physical activity. Recent evidence indicated children's accelerometer-measured physical activity levels have, on average, returned to near pre-pandemic levels in 2022, though sedentary behaviour remains higher. However, insufficient physical activity levels among children continues to be a critical public health issue in the UK, with only 41% meeting physical activity guidelines. This study aimed to provide in-depth analysis of how the pandemic has shaped children's physical activity patterns beyond the short-term periods following lockdowns and identify the new challenges to engaging children in physical activity.

Methods

One-to-one interviews with parents (n = 22), school staff (n = 9), and six focus groups with children aged 10–11 years (n = 45) were conducted between February and July 2022. Topics explored changes to children's physical activity and sedentary behaviour patterns, including screen-viewing, and factors influencing any changes. The framework method was used for analysis.

Results

Five themes were generated. Theme 1 described residual lockdown habits, including increased screen-viewing within the home, while activities outside the home continued to feel less spontaneous. Theme 2 highlighted an interrupted development of social, emotional, and physical skills among children compared to what would be expected pre-pandemic. This coincided with Theme 3 which reflected increased mental health challenges among families, creating complex barriers to children's physical activity. A new normal for child physical activity was evoked and explored in Theme 4, with greater dependence on structured and organised activities. However, Theme 5 highlighted that girls and children with lower socio-economic position may be especially at risk of decreased physical activity.

Conclusions

There is a new normal for children's physical activity that is characterised by increased dependence on structured and organised physical activities, such as active clubs, and less on unstructured and spontaneous physical activities, such as physical play. While this may suit many children, girls and children from lower socio-economic households face barriers to participating in the new normal. It is important that affordable and equitable opportunities are provided to all children to prevent physical activity and health inequalities.

Funding

This publication was funded by the Public Health Research programme as a part of award number NIHR131847.

This article reports on one component of the research award Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6). For more information about this research please view the award page [https://fundingawards.nihr.ac.uk/award/NIHR131847]

DOI

https://doi.org/10.1186/s12889-023-16021-y

NIHR | National Institute for Health and Care Research

Public Health Research

Check for updates

Research Article

Quality of life, capability well-being, financial strain and physical activity in the short- and medium-term COVID-19 post-lockdown phases in the UK: a repeated cross-sectional study

Katie Breheny[1,2*] Ruth Salway[1,3] Danielle House[3] Robert Walker[3] Lydia Emm-Collison[3] Kate Sansum[3] Joanna G Williams[1,4] Frank de Vocht[1,2] Russell Jago[1,2,3] and William Hollingworth[1,2]

[1]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[2]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK
[3]Centre for Exercise, Nutrition & Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[4]Communities and Public Health, Bristol City Council, Bristol, UK

[*]**Corresponding author** katie.breheny@bristol.ac.uk

Published September 2024
DOI: 10.3310/LYJG6305

Abstract

Background: The COVID-19 lockdowns had negative effects on children's and adults' mental and physical health. There is, however, a paucity of research that explores differences in health-related quality of life (HRQL) and well-being over time after the COVID-19 lockdowns had been lifted. Furlough during lockdowns, increases in unemployment, and the emerging cost-of-living crisis all put pressure on family finances, which could have a detrimental effect on HRQL and well-being. This study, part of the wider Active-6 study, explored how HRQL, capability well-being and family financial strain changed after the lockdowns, the relationship between these outcomes, and whether physical activity had any mediating effect on differences in HRQL and capability well-being.

Methods: Cross-sectional data were collected in May–December 2021 (Wave 1) and January–July 2022 (Wave 2). Children (aged 10–11) and their parent/carer were recruited from 23 to 27 schools in each wave, respectively, and completed validated questionnaires measuring HRQL (adults – EQ-5D-5L, children – CHU9D), capability well-being (adults – ICECAP-A) and family financial strain (adults – Family Economic Strain Scale, FESS). Children also completed questions on capability well-being. Weekday minutes of moderate-to-vigorous physical activity (MVPA) were measured using accelerometers. Mixed-effects regression models, adjusted for gender, age group (adults only), IMD and highest household education, were used to explore differences in HRQL and capability well-being between waves. In addition, the moderating effect of financial strain and the mediating effect of MVPA on HRQL and capability well-being were explored.

Results: Active-6 recruited 393 parent-child pairs in Wave 1 and 436 in Wave 2. There were no differences in HRQL (EQ-5D, CHU9D) and capability well-being (ICECAP-A) scores between waves, but financial strain was worse in Wave 2 compared to Wave 1 (FESS score difference 1.14 adjusted 95% CI 0.15 to 2.12). Increased financial strain was associated with lower (worse) EQ-5D-5L, CHU9D and ICECAP-A scores. There was no evidence of a mediating effect of MVPA.

Limitations and future work: Pre-COVID-19 data on HRQL were not collected, so analysis was limited to post-lockdown only. Participating parents were predominantly female and participation was lower among lower socio-economic groups, limiting our ability to explore inequalities. Intervention planning to increase physical activity and health and well-being during the COVID-19 recovery should consider the financial strain families are experiencing and the negative implications of financial strain on HRQL.

This article should be referenced as follows:
Breheny K, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al.* Quality of life, capability well-being, financial strain and physical activity in the short- and medium-term COVID-19 post-lockdown phases in the UK: a repeated cross-sectional study. *Public Health Research* 2024;**12**(16):39–58. https://doi.org/10.3310/LYJG6305

Conclusions: There were no differences in HRQL and capability well-being in children and adults after lockdowns lifted in 2021 and a year later in 2022. The results indicate increasing financial strain, which could reflect the UK's 'cost of living crisis'.
Funding: This article presents independent research funded by the National Institute for Health and Care Research (NIHR) *Public Health Research* programme as award number NIHR131847.
A plain language summary of this research article is available on the NIHR Journals Library Website https://doi.org/10.3310/LYJG6305.

Background and introduction

Health-related quality of life (HRQL) is described as emotional and physical functioning that contributes to overall quality of life[1] and is an important factor in healthcare and policy decision-making.[2] Capability well-being measures broaden the scope and are complementary to HRQL when evaluating the cost-effectiveness of health and well-being interventions delivered outside of NHS settings (e.g. public health). Measures such as the EQ-5D,[3,4] ICEpop CAPability measure for Adults (ICECAP-A) and Child Health Urtility 9 Dimension (CHU9D)[5] were developed for use in evaluating the cost-effectiveness of health and well-being interventions for adults and children. Measures of socio-economic position including income and poverty level are important contributors to both HRQL and capability well-being.[6] The relationships between these variables are, however, complex, as access to healthcare can be socially patterned, while income can moderate availability of resources that enhance quality of life (e.g. the option to engage in recreational activities) or support an adequate standard of living (e.g. sufficient food).[6,7]

The COVID-19 lockdowns had a negative impact on the UK population's mental health and well-being,[8–10] although ongoing implications are still unclear and may be unequally distributed with different facets (e.g. sadness, optimism) impacted in different ways. The ending of lockdowns was associated with an improvement in mental health for the majority of children; however, the negative effects persisted in low-income families[9] and as such warrant further examination. The COVID-19 pandemic caused financial insecurity and hardship for many UK families[11] and the UK 'cost of living crisis' is further compounding these issues.[12] These coinciding challenges may have had a detrimental impact on the population's quality of life and well-being. For example, evidence has shown that in summer 2020 financial stress was associated with worse family well-being.[13,14] As such it is important to understand the links between these variables as the pandemic progressed. Despite its importance to policy-makers and in contrast to mental health, HRQL during the COVID-19 pandemic and period of recovery is relatively unexplored. A systematic review identified only six studies comparing pre and during COVID-19 lockdown HRQL[15] in children, none of which were UK based. The majority (four of the six) of studies indicated a decline in HRQL. Similar findings are available for adults and also showed a decline, but again the data are limited.[16]

Reported reductions in physical activity during COVID-19 lockdowns among both adults and children[17–20] could be related to declines in HRQL and well-being. Evidence does suggest a positive relationship between physical activity and HRQL in adults[21,22] and children,[23] although the strength of this relationship in children is uncertain. Methodological factors such as use of a proxy rating of HRQL and measurement of physical activity contribute to this uncertainty.[23] Studies that explored this relationship during the pandemic were also limited by these issues. A study of Spanish and Brazilian children during the pandemic found that those meeting 24-hour movement guidelines had higher parent-proxy measured HRQL.[24] This is, however, in contrast to data from the UK Born in Bradford study, which reported that there was no observed relationship between self-reported physical activity and well-being among 7–13-year-old children.[25] Thus far, evidence exploring the relationship between HRQL and physical activity during the pandemic is limited to children and seems to be uncertain. There is a need to use child-reported measures of HRQL and expand the evidence base to associations in adults.

The COVID-19 pandemic has had demonstrable negative impacts on health and well-being and physical activity but the association between them is uncertain. Furthermore, current evidence is reliant on self-reported physical activity, which has particular limitations when assessing physical activity among children and young people.[25] As such, more information is needed on the effects of the pandemic on HRQL and its relationship with physical activity. The Active-6 project reported that UK children's physical activity following COVID-19 lockdowns was lower than pre-pandemic levels in the short term, and sedentary activity was higher.[18] Screen viewing time was higher than before the lockdowns.[26] Qualitative interviews with Active-6 participants suggested that the lockdowns exacerbated fatigue and children felt emotionally overwhelmed.[27] HRQL, capability well-being and family financial strain were also collected in the study, so provide an opportunity to explore the relationship between physical activity and HRQL outcomes post COVID-19

lockdowns. This forms a unique and policy-relevant resource for intervention development and policy-making, particularly as there is currently no UK-based evidence which has examined financial hardship and its implications for the population's health and well-being.

Aims and objectives

The aim of this paper is to assess the differences in parent and child HRQL and capability well-being during the short- and medium-term post-lockdown phases of the COVID-19 pandemic. The relationships between these outcomes, family financial strain and accelerometer-measured physical activity are also explored.

Methods

The data in this paper are part of the Active-6 study, which examined the impact of the COVID-19 pandemic on the physical activity and sedentary behaviour of 10–11-year-old children and their parents/carers.[18,26–31] We report child and parent/carer questionnaire and accelerometer data collected at two time points post COVID-19 lockdowns, to assess physical activity and related measures[18] in the short- and medium-term post-lockdown phases of the pandemic.

Schools in the southwest of England were recruited from a sample of 50 that had previously participated in the B-Proact1v longitudinal study between 2017 and 2018.[32] All children aged 10–11 and one parent or carer per family were eligible to take part, including all children in families where there were two or more eligible children. Detailed information on recruitment is reported elsewhere.[17] Data were collected in two waves, with 23 schools participating in Wave 1 (May–December 2021) and 27 schools in Wave 2 (January–July 2022), including 22 participating in both waves, with 393 and 436 child–parent pairs recruited, respectively. Sample size calculations were conducted for the primary outcome of the Active-6 study only (difference in children's weekday MVPA).[28]

Data collection and measures

Parents/carers and children completed separate online questionnaires which included questions on financial strain, capability well-being and HRQL. Parents reported their gender, age group and ethnicity and their child's gender and date of birth, as well as the highest educational qualification in the household [recoded as 'Up to A level (exam at age 18) or equivalent' and 'University degree (or equivalent) and higher']. Index of Multiple Deprivation (IMD[33]) rank was calculated from home postcode. IMD rank is a continuous measure generated by ranking all neighbourhoods in England according to their level of relative deprivation on 39 indices.

Physical activity

Physical activity data were collected using accelerometers. Adults and children wore a waist-worn ActiGraph wGT3X-BT accelerometer (Actigraph LLC, Florida, USA) during waking hours for seven consecutive days, and accelerometer data were processed using an open-source R script.[34,35] Data between midnight and 6 a.m. were excluded, and a valid day was defined as at least 500 minutes of data, excluding intervals of ≥ 60 minutes of zero counts, allowing up to 2 minutes of interruptions.[36] Mean weekday minutes of moderate-to-vigorous physical activity (MVPA) were derived for participants who provided at least two valid weekdays of data using Evenson *et al.*[37] thresholds for children and Troiano *et al.*[38] thresholds for adults.

Adult health-related quality of life: EQ-5D-5L and EQ-5D VAS

The EQ-5D-5L[4,39] is a generic five-dimension preference-based measure assessing adults' HRQL 'today'. Questions address domains of usual activities, mobility, anxiety/depression, self-care and pain/discomfort with five response options, which were scored by applying population preference weights to create a utility score, using the van Hout *et al.*[40] algorithm (as only categorised parent ages were available). Scores are anchored at 0 (as bad as death) and 1 (best HRQL), with scores < 0 reflecting health states valued as worse than death. The five items are supplemented by a visual analogue scale (EQ-5D VAS), where individuals rate their health on a scale from 0 to 100.

Adult capability well-being: ICECAP-A

The ICECAP-A is a five-item measure of capability well-being for the adult general population 'at the moment'.[41,42] The five attributes assessed are attachment, stability, achievement, enjoyment and autonomy, and each question has four response options. The measure is scored by applying preference weights to produce a capability well-being index score,[43] ranging between 0 and 1, with higher scores reflecting better capability well-being.

Child health-related quality of life: CHU9D

The CHU9D is a paediatric generic measure of health-related quality of life 'today',[44,45] developed with UK children. It has nine items with five response options for each, covering areas deemed important to their lives (e.g.

tiredness, school life, friendships). Preference weights are applied to generate a utility score[5] between 0.33 and 1, with higher scores reflecting better HRQL.

Child capability well-being

Child capability well-being was measured using eight items that were based on the seven items in the UK CONTRAST study (*Appendix 1*). These were preliminary versions of items comprising a new measure of children's capability well-being.[46] The changes made were small alterations to the wording and the addition of an extra question. Specifically, in Active-6 children reflected on their well-being compared to before the January 2021 lockdown, whereas the CONTRAST questions referred to the period before the March 2020 lockdown. The additional question focused on the ability to discover and learn. Each of the eight questions had five Likert response options, which were summed to produce a total score between 8 and 32, with individual items summarised by the mean.

Family Economic Strain Scale

The Family Economic Strain Scale (FESS) is a 13-item validated measure of financial difficulties experienced by families,[47] which performs well in single-parent and two-parent families, and has good construct validity.[47] Parents reported the frequency of experiencing strain (e.g. putting off activities) on a five-point Likert scale, and a final item asked them to estimate their income in relation to other families. Items were summed to generate a total economic strain score, between 13 and 65, with higher scores reflecting greater strain.

Interpretation of HRQL and well-being outcomes

We interpreted outcomes in reference to recent published norms. The most recently published EQ-5D-3L norms for the 35–44 age group (which is the most represented group in Active-6) are 0.94 (SD 0.17) (EQ-5D utility) and 81.1 (SD 19.0) (EQ-5D VAS)[48] (*Table 1*). These values were obtained from a pooled dataset from five European countries (France, Germany, Italy, Spain and the UK). A recent UK-based study of 1071 members of the general population had a mean ICECAP-A score of 0.81 (SD 0.19).[16] Mean baseline CHU9D scores of 0.83 (SD 0.14)[49] and 0.84 (SD 0.11)[50] were obtained in two UK-based public health trials, so could be used as comparisons.

Analysis

Unless indicated, all analyses followed the study health economics analysis plan which was pre-agreed with the independent study steering committee before data analysis.[51] Missing data were examined and due to low missingness no imputation was conducted. Parent HRQL (EQ-5D-5L, EQ-5D VAS) and capability well-being (ICECAP-A), child HRQL (CHU9D) and capability well-being (capability questions) and financial strain (FESS) were summarised for Wave 1 and Wave 2 using descriptive statistics and histograms, with data presented by gender and wave-specific FESS score quartile. Missing questionnaire data were tabulated by wave. Consistent with standard practice within the field, linear regression was used for the HRQL and capability well-being outcome analyses.[52] Unadjusted and adjusted models were run, with the adjusted models forming our primary analyses. All statistical analyses were conducted in StataMP version 17 (StataCorp LP, College Station, TX, USA)[53] and mixed-effect models were used to account for the study design, with repeated children and parents nested within schools, to answer the following questions:

1. Does HRQL and capability well-being differ between waves?

TABLE 1 Summary of interpretation of HRQL and well-being outcomes

Measure	Domain	Population	Range	UK norm, or comparable score	Direction of interpretation
EQ-5D-5L	Parent HRQL	Parent	−0.594 to 1	0.94	Higher score indicated higher HRQL
EQ-5D VAS	Parent self-reported health	Parent	0–100	81.1	Higher score indicates higher self-rated health
ICECAP-A	Parent capability well-being	Parent	0–1	0.81	Higher score indicates more capability well-being
CHU9D	Child HRQL	Child	0.33–1	0.83–0.84	Higher score indicates higher HRQL
Child capability well-being	Child capability well-being	Child	8–32	N/A	Lower score indicates more capability well-being
FESS	Family financial strain	Family (parent completed)	13–65	N/A	Lower score indicates lower financial strain

Linear mixed-effect models were used to model parent differences in HRQL (EQ-5D, EQ-5D VAS), capability well-being (ICECAP-A) and financial strain (FESS) between waves, with wave included as a categorical variable, and models adjusted for parent age, gender, IMD rank (treated as a continuous variable) and highest household education. Similarly, child differences in HRQL (CHU9D) between waves were modelled with linear mixed-effect models adjusted for child gender, IMD rank and highest household education.

2. Were differences in HRQL/capability well-being between waves mediated by MVPA?

The adjusted models in the previous section were extended to include parent mean weekday MVPA (child mean weekday MVPA for child models) as a covariate and compared to the unmediated models.

3. Is there a relationship between financial strain and HRQL/capability well-being?

Health-related quality of life and capability well-being measures were plotted against financial strain (FESS score), and linear mixed-effect models were used to model the association, with HRQL measures as outcomes, and FESS as an independent variable. Models were adjusted for the same covariates as in question 1. This was an exploratory post hoc analysis.

4. Does financial strain moderate differences in HRQL/capability well-being between waves?

The model from question 3 was extended to include a wave-FESS interaction term to estimate the potential moderating effect. The FESS variable was centred to aid interpretation as differences reflect the effect deviating from the average FESS score. This was an exploratory post hoc analysis.

Patient and participant involvement and equality, diversity and inclusion

Patient and public involvement (PPI) has been a core component of the Active-6 project. A range of stakeholders were engaged in designing the study, developing materials and planning dissemination. Our stakeholders included Year 6 children, teachers, parents and school staff. Parent representatives provided useful feedback on interim findings that enhanced our interpretation and highlighted additional analyses that would be informative for families and schools. Children from participating schools have also provided feedback on dissemination materials through PPI groups.

Despite efforts to recruit schools from deprived and affluent areas, the samples included in these analyses were not ethnically diverse, and lower socio-economic groups were under-represented. In addition, the adult sample is majority female. These factors can be partially attributed to difficulties conducting research in a pandemic and disruptions to work and family life. Equality, diversity and inclusion (EDI) was an important consideration in other components of the Active-6 project where it was feasible to intentionally sample underrepresented groups. These wider projects have contributed to the interpretation of our findings and considerations of policy implications.

Results

The majority of the parent/carers were female, White British and aged 40–44 years (*Table 2*). Around two-fifths lived in areas in the lowest deprivation quintile (Wave 1 45.3% and Wave 2 39.5%), and over half were educated to degree level or higher, indicating an affluent, educated sample. Questionnaire missing data were low and ranged from 6% (Wave 1 FESS) to 8% (Wave 2 EQ-5D-5L and EQ-5D VAS) (*Appendix 1*, *Table 8*). In both waves mean adult and child HRQL values were high, as would be expected in a non-clinical sample. Mean adult HRQL was lower than previously published norms, but capability well-being was higher than comparable pre-pandemic data. Mean child HRQL was higher than pre-pandemic comparable data. Adult and child HRQL measures were negatively skewed. A ceiling effect was observed for the EQ-5D-5L, with 41% scoring the maximum score at Wave 1 and 36% at Wave 2 (*Table 3*).

Does HRQL and capability well-being differ between waves?

There were no notable differences in mean EQ-5D-5L, EQ-5D VAS, ICECAP-A or financial strain scores between Wave 1 and 2 (*Table 3*). Mean scores for children's capability well-being items were skewed towards lower values, indicating that participants rated their capability well-being as better when reflecting on their current state compared to the previous lockdown (*Table 3*). There were no notable differences between boys and girls or between waves. The total score (sum of the Likert responses) was also comparable between waves.

Mixed-effect models showed no evidence of differences in adults' or children's HRQL and capability well-being between waves (*Table 4*), but family financial strain increased between waves by 1.14 points (adjusted 95% CI 0.15 to 2.12).

TABLE 2 Adult and child participant characteristics

		Wave 1 (*N* = 393) *N* (%)		Wave 2 (*N* = 436) *N* (%)	
Adults					
Gender	Male	91 (23)		97 (22)	
	Female	297 (76)		332 (76)	
	Missing	5 (1)		7 (2)	
Age group	<30	3 (1)		5 (1)	
	30–34	35 (9)		26 (6)	
	35–39	80 (20)		90 (21)	
	40–44	136 (35)		147 (34)	
	45–49	94 (24)		112 (26)	
	50+	40 (10)		49 (11)	
	Missing	5 (1.3)		7 (2)	
Ethnicity	White British	310 (79)		323 (74)	
	Other	53 (14)		70 (16)	
	Prefer not to say	5 (1)		8 (2)	
	Missing	25 (6)		35 (8)	
Highest household education	Up to A level	131 (33)		162 (37)	
	University degree or higher	257 (65)		267 (61)	
	Missing	5 (1)		7 (2)	
IMD quintile	1 most deprived	31 (8)		31 (7)	
	2	37 (9)		60 (14)	
	3	48 (12)		62 (14)	
	4	95 (24)		107 (25)	
	5 least deprived	178 (45)		172 (40)	
	Missing	4 (1)		4 (1)	
Children					
Gender	Male	198 (50)		212 (49)	
	Female	193 (49)		224 (51)	
	Other	2 (1)		0 (0)	
		Mean	SD	Mean	SD
Age, years		10.9	(0.4)	11.1	(0.3)

IMD, Index of Multiple Deprivation; SD, standard deviation.

Does MVPA have a mediating effect on HRQL and capability well-being?

There was no evidence that MVPA had any mediating effect on differences in HRQL and well-being, with similar wave estimates in both models for all outcomes tested (*Table 5*).

Is there a relationship between financial strain and HRQL and capability well-being?

Adult HRQL and capability well-being measures were inversely associated with financial strain, with HRQL decreasing as financial strain increased (*Figures 1–4*; *Appendix 1*, *Table 9*). For children (CHU9D), the relationship was less clear, with a slight non-linear association (*Appendix 1*, *Table 9*; *Figure 4*). The linear relationship between financial strain and measures of HRQL/capability well-being was modelled explicitly via mixed models (*Table 6*). Coefficients reflect the change in outcome measure as a result of an increase of 10 points in FESS score (scale 13–65). All coefficients are negative, indicating that as financial strain increases, HRQL/capability well-being decreases in both adults and children. The association was smaller for children (CHU9D) than adults.

Does financial strain moderate any differences in HRQL and capability well-being between waves?

To test whether financial strain had a moderating effect on the association between wave and HRQL/capability well-being we included a wave-FESS interaction term, for an increase of 10 points on the FESS scale (*Table 7*). All interaction estimates were small and did not indicate that financial strain moderated the effect of wave.

All models allow for clustering at school and individual level and are adjusted for IMD and highest household education. Parent models additionally adjust for parent gender and age group, and child models additionally adjust for child gender.

TABLE 3 Descriptive statistics of HRQL, capability well-being and financial strain at Waves 1 and 2

		Wave 1		Wave 2	
Domain	**Measure**	**Mean (SD)**	***N* (%) scoring highest value**	**Mean (SD)**	***N* (%) scoring highest value**
Adult HRQL	EQ-5D-5L	0.860 (0.166)	147 (41)	0.848 (0.171)	146 (36)
Adult self-rated health	EQ-5D VAS	76.7 (16.1)	13 (4)	76.1 (17.4)	18 (5)
Adult capability well-being	ICECAP-A	0.882 (0.114)	53 (15)	0.883 (0.124)	65 (16)
Child HRQL	CHU9D	0.884 (0.086)	31 (8)	0.885 (0.086)	43 (11)
Child capability well-being	Sum of 8 items	18.28 (5.63)		18.11 (5.77)	
Family financial strain	FESS	26.3 (10.1)	10 (3)	27.5 (10.3)	6 (2)

Note
EQ-5D-5L, EQ-5D-VAS, ICECAP-A, CHU9D, higher scores are higher HRQL/well-being; FESS, higher scores are higher financial strain; child capability well-being – lower scores are more capability well-being.

TABLE 4 Mixed-effect models examining differences in HRQL, capability well-being and financial strain between Waves 1 and 2

		Unadjusted model			Adjusted model[a]		
		Difference between waves	**95% confidence interval**	***p*-value**	**Difference between waves**	**95% confidence interval**	***p*-value**
Adult HRQL	EQ-5D[a]	−0.008	−0.026 to 0.011	0.432	−0.005	−0.023 to 0.014	0.629
Adult self-rated health	EQ-5D VAS[a]	−0.56	−2.63 to 1.52	0.598	−0.18	−2.24 to 1.88	0.864
Adult capability well-being	ICECAP-A[a]	0.000	−0.014 to 0.014	0.981	0.001	−0.013 to 0.015	0.914
Family financial strain	FESS[a]	1.19	0.19: 2.19	0.019	1.14	0.15 to 2.12	0.024
Child HRQL	CHU9D[b]	0.005	−0.005 to 0.015	0.323	0.006	−0.004 to 0.016	0.234

a Parent models adjusted for parent gender, age group, IMD and highest household education.
b Child models adjusted for child gender, IMD rank and highest household education.

Note
All models allow for clustering at school and child level.

TABLE 5 Mixed models examining the mediating effect of MVPA on differences in HRQL and capability well-being between Waves 1 and 2

		Unmediated model			Mediated model[a]		
	Covariate	Estimate	95% confidence interval	*p*-value	Estimate	95% confidence interval	*p*-value
Adult HRQL (EQ-5D)	Wave difference	−0.005	−0.023 to 0.014	0.629	−0.003	−0.024 to 0.018	0.806
	MVPA				0.001	−0.000 to 0.001	0.347
Adult self-rated health (EQ-5D VAS)	Wave difference	−0.18	−2.24 to 1.88	0.864	−0.67	−2.79 to 1.44	0.532
	MVPA				0.04	0.00 to 0.08	0.064
Adult capability well-being (ICECAP-A)	Wave difference	0.001	−0.013 to 0.015	0.914	−0.001	−0.016 to 0.013	0.859
	MVPA				0.001	0.000 to 0.001	0.024
Child HRQL (CHU9D)	Wave difference	0.006	−0.004 to 0.016	0.234	0.008	−0.003 to 0.019	0.166
	MVPA				0.001	0.000 to 0.000	0.679

a Mediated models additionally adjust for parent or child weekday MVPA.
Note
All models allow for clustering at school and child level and are adjusted for IMD and highest household education. Parent models additionally adjust for parent gender and age group, and child models additionally adjust for child gender.

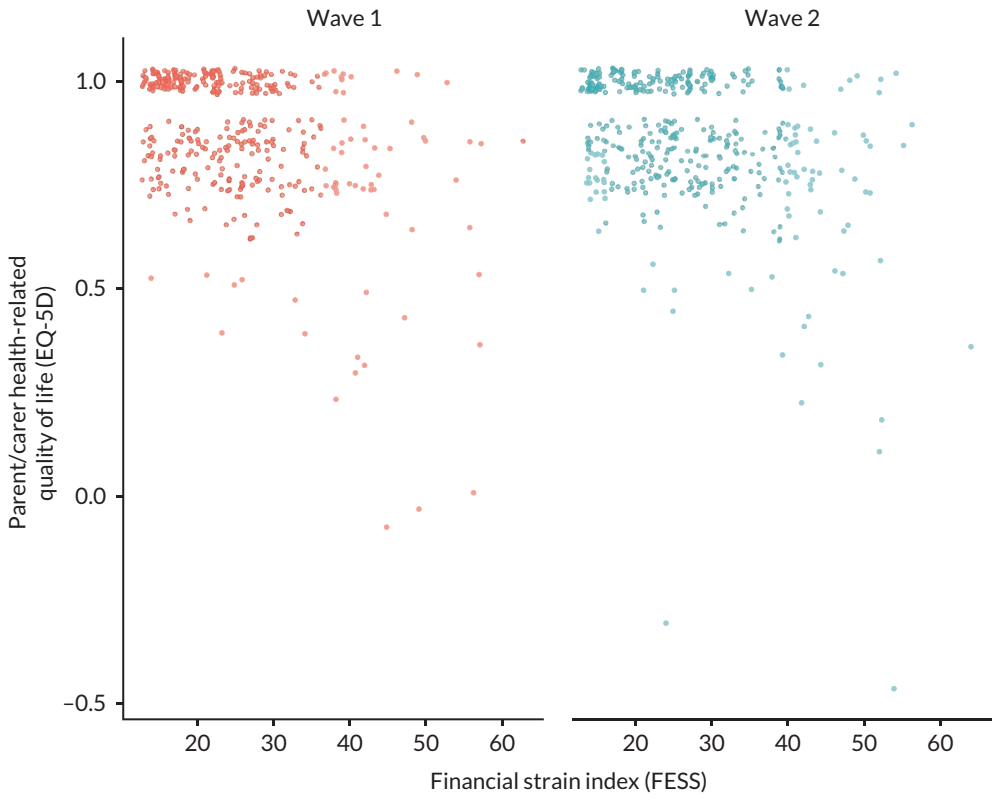

FIGURE 1 Scatter plot of parent/carer HRQL against financial strain. Note that points are jittered to avoid overplotting due to the underlying discrete nature of variables.

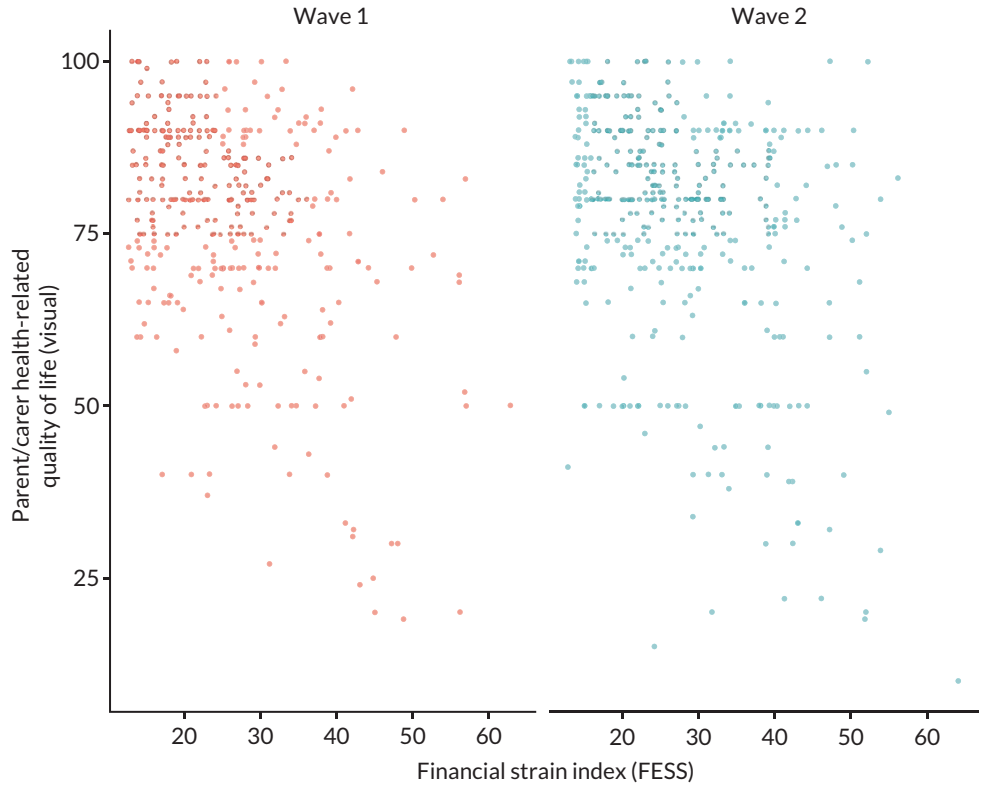

FIGURE 2 Scatter plot of parent/carer EQ-5D VAS against financial strain. Note that points are jittered to avoid overplotting due to the underlying discrete nature of variables.

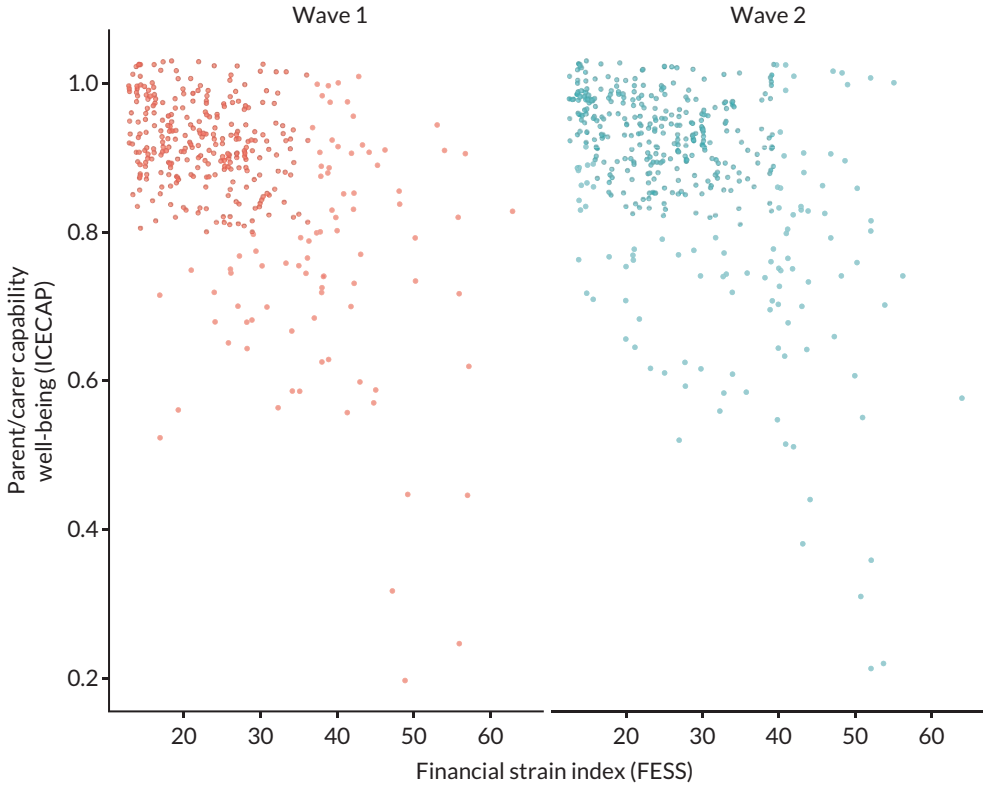

FIGURE 3 Scatter plot of parent/carer capability well-being (ICECAP-A) against financial strain. Note that points are jittered to avoid overplotting due to the underlying discrete nature of variables.

This article should be referenced as follows:
Breheny K, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al.* Quality of life, capability well-being, financial strain and physical activity in the short- and medium-term COVID-19 post-lockdown phases in the UK: a repeated cross-sectional study. *Public Health Research* 2024;**12**(16):39–58. https://doi.org/10.3310/LYJG6305

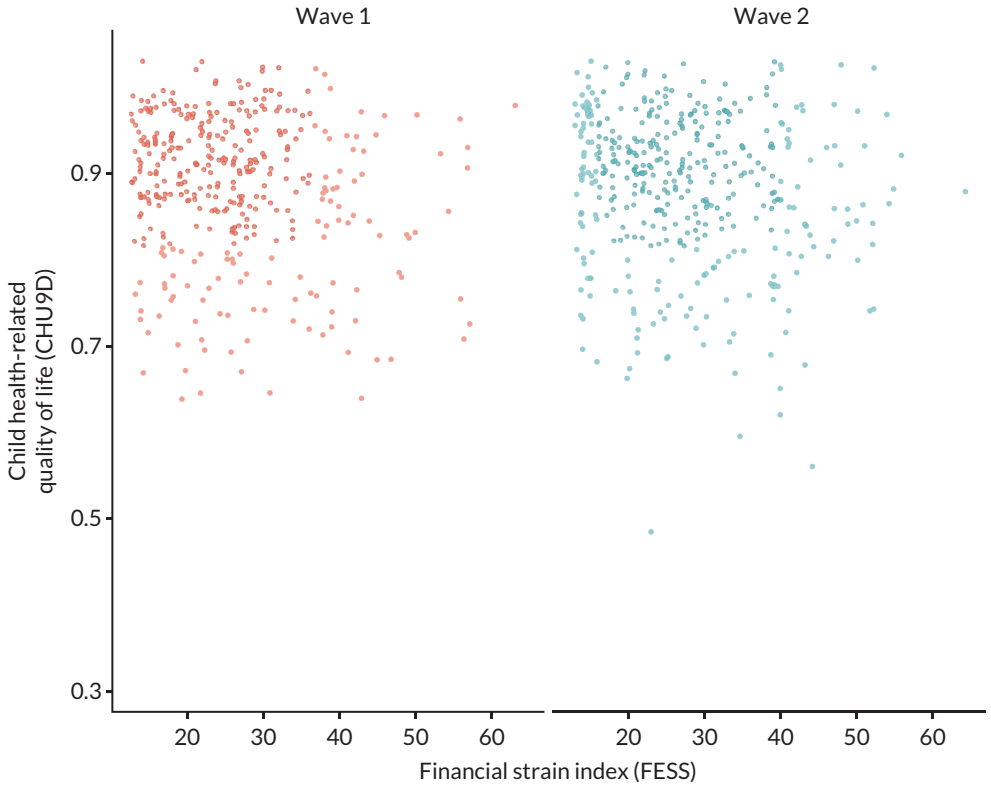

FIGURE 4 Scatter plot of child HRQL (CHU9D) against parent-reported financial strain. Note that points are jittered to avoid overplotting due to the underlying discrete nature of variables.

TABLE 6 Association between financial strain and HRQL/capability well-being measures

		Unadjusted model			Adjusted model		
Outcome		**Difference in outcome[a]**	**95% confidence interval**	***p*-value**	**Difference in outcome[a]**	**95% confidence interval**	***p*-value**
Adult HRQL	EQ-5D-5L	−0.05	−0.07 to −0.04	< 0.001	−0.05	−0.06 to −0.04	< 0.001
Adult self-rated health	EQ-5D-VAS	−5.95	−7.05 to −4.84	< 0.001	−5.72	−6.89 to −4.55	< 0.001
Adult capability well-being	ICECAP-A	−0.05	−0.06 to −0.04	< 0.001	−0.05	−0.06 to −0.05	< 0.001
Child HRQL	CHU9D	−0.01	−0.02 to 0.00	0.001	−0.01	−0.01 to 0.00	0.010

a Difference in outcome associated with a 10-unit change in FESS score.

Note
All models allow for clustering at school and child level and are adjusted for IMD and highest household education. Parent models additionally adjust for parent gender and age group, and child models additionally adjust for child gender.

TABLE 7 Associations between financial strain and HRQL/capacity well-being within each wave (moderation model)

		Wave 1		Wave 2		
		Estimate[a]	**95% confidence interval**	**Estimate[a]**	**95% confidence interval**	***p*-value[b]**
Adult HRQL	EQ-5D-5L	−0.051	−0.067 to −0.035	−0.049	−0.0664 to −0.035	0.852
Adult self-rated health	EQ-5D VAS	−5.931	−7.21 to −4.341	−5.474	−6.943 to −4.006	0.650
Adult capability well-being	ICECAP-A	−0.052	−0.063 to −0.041	−0.056	−0.066 to −0.046	0.503
Child HRQL	CHU9D	−0.008	−0.016 to 0.001	−0.011	−0.019 to −0.003	0.529

a Difference in outcome for a 10-unit increase in FESS.
b *p*-value for a test of differences between waves.

Discussion

The Active-6 project collected detailed data on HRQL, capability well-being, and financial strain in the period after the COVID-19 lockdowns were lifted in addition to accelerometer-measured MVPA. The data presented in this study make an important contribution to the field as to the best of our knowledge there is no comparable study that has used the CHU9D to measure children's HRQL in the short to medium term after lockdown.

There were no differences in HRQL and capability well-being in either adults or children when comparing the short and medium post-lockdown phases of the pandemic. The Australian DETECT study[54] collected adolescent (aged 12–18) CHU9D data from May 2020, finding higher levels of distress compared to data collected six years before. It is important to note, however, that the DETECT team did not score the CHU9D using recommended scoring algorithms, which limits comparability to our study and the wider field. Active-6 children's HRQL and parent capability well-being were better than observed in studies of similar populations observed before the COVID-19 pandemic (CHU9D 0.83–0.84,[49,50] ICECAP-A 0.81[16]). Related qualitative studies suggested some Active-6 child participants experienced increased mental health challenges, such as emotional overwhelm, and physical fatigue in the short-term post-lockdown phase.[27] Sadness and tiredness are facets of HRQL measured by the CHU9D, yet the scores we observed did not support the qualitative data. Interview and focus-group participants may not be representative of the Active-6 sample, however, or the CHU9D may not be sensitive to COVID-19 lockdown-related changes. In contrast to child HRQL, adult HRQL was below the 2014 estimates of population norms (estimate 0.94[48]) in both waves. While we are unable to explore causation using the Active-6 dataset due to lack of pre-COVID-19 data, many aspects of the experience of the COVID-19 pandemic and related lockdowns could have contributed to poorer adult HRQL. For example, social isolation could have exacerbated mental health difficulties and COVID-19 infection could have disrupted families' usual activities.

It might be expected that lockdowns would impact capability well-being more than HRQL due to the measures' focus on broader outcomes; however, we saw no difference in adult or child capability well-being between the two waves. It may be that any changes in HRQL or capability well-being during lockdowns were alleviated by the lifting of restrictions or that changes persisted post-lockdown, thus any differences were not evident at Wave 1 data collection. Alternatively, the measures used could be insensitive to impacts of lockdowns, or lockdowns may have had no effect on HRQL or capability well-being at all. For children's capability well-being, the Active-6 findings are markedly different to those found in the CONTRAST study.[55] In CONTRAST, the majority of domains indicated no change or worsening since pre-COVID-19 where only 'feeling safe and at ease', 'being able to seek support' and questions regarding relationships reported no change or a positive impact. In Active-6 data, most responses indicated that children's capability well-being had improved since the lockdown. These differences may be due to the CONTRAST study's older sample (aged 11–15), the data collection during different phases of the pandemic or other demographic characteristics. Despite piloting, children aged 10–11 may have struggled to understand and answer the questions in Active-6. The CONTRAST study's recruitment using social media could also contribute to these differences.

Families experiencing the most financial strain had worse HRQL and capability well-being, with scores well below population norms. Children from families experiencing most financial strain also appeared to have lower HRQL. This observed relationship between greater financial strain and lower HRQL/capability well-being is an important finding for future research and policy. Adult HRQL and capability well-being scores for families reporting the highest level of financial strain were below population norms and the comparable population scores. Similar relationships have been observed in the USA and Canada, where financial insecurity or material hardship (e.g. inability to afford food or rent) were associated with poorer family well-being at repeated time points during the pandemic,[14] and increased financial stress was associated with increased socioemotional and behavioural difficulties in children.[56] Our finding that financial strain appeared to increase slightly between Wave 1 and Wave 2 could reflect early effects of the 'cost of living crisis'[12] on health and well-being. Equally, the economic impacts of COVID-19 may have accumulated over time, with families initially able to absorb changes in income due to reduced opportunities to spend disposable income on holidays or leisure activities, for example. Qualitative findings from the Active-6 study indicate that children's extra-curricular physical activity behaviour has changed, with participation in more affordable school-based active clubs increasing.[31] This may reflect how families have had to adapt to the new economic context.

Family financial strain showed indications of worsening between data collection waves, but differences are difficult to interpret. There is limited use of the FESS in the UK, so the interpretation of absolute values and the impact of those changes in the context of this study is challenging. Mean

scores obtained in the FESS validation study[47] (conducted in 1997 in the USA) were 43.30 for single mothers and ranged from 29 to 30 for single and married fathers and married mothers. Mean scores in Active-6 were 26.3 (Wave 1) and 27.5 (Wave 2), suggesting marginally less financial strain, although our data were collected 25 years later and in a different context. Nevertheless, our study provides a unique insight into the financial challenges facing the UK population during the pandemic and as the 'cost of living crisis' begins to deepen, and therefore will provide a useful resource for future studies. Perceived financial strain could be an important measure to collect in future research. IMD (derived from home postcode) is typically used as an indicator of deprivation; however, financial shocks such as loss of income are unlikely to affect a family's residential address immediately, if at all. Identifying individuals or families unable to afford resources crucial for living healthy and fulfilling lives may be advantageous for quickly highlighting more targeted opportunities for public health interventions.

Physical activity had no mediating effect on differences in adult and child HRQL/capability well-being between waves. Existing evidence exploring associations between children's physical activity and HRQL/well-being during the pandemic is mixed,[24,25] although no mediation analysis examining phases of the pandemic has been conducted. Our finding that those experiencing most financial strain had poorest HRQL could have implications for the provision of interventions aiming to improve population well-being through physical activity. To avoid exacerbating inequalities, affordability of new interventions and the financial situation of the target population should be important physical activity policy-making considerations.

Strengths, limitations and future research

The Active-6 project collected data on the financial pressures experienced by England-based families, with linked data on HRQL and capability well-being in adults and children. Device-determined physical activity enabled exploration of the association of HRQL and capability well-being with activity levels. To the best of our knowledge, no other studies provide such insights into the ongoing impacts of the COVID-19 pandemic. There were also minimal missing data. The study is limited by the lack of pre-COVID-19 health economics data. We attempted to mitigate this by comparing values to population norms or pre-pandemic estimates. Ceiling effects observed reflect the non-clinical context of this study and are a recognised challenge in population-based studies.[57] Despite efforts to recruit participants from low socio-economic groups, participation was limited. There were also more female than male parents and most participants were White British. This limited our ability to explore possible inequalities across socio-economic groups, ethnicities and genders. Adult HRQL was lower post-lockdowns compared to pre-COVID-19 norms. Future research should monitor this to ascertain whether this is a continuing trend. Whether the association between HRQL and financial strain persisted as the 'cost of living crisis' continued should also be explored further. Qualitative research that examined this association would have provided valuable context to our findings and guided the design of future research addressing the longer-term effects.

Conclusions

Active-6 is the first study to explore the relationships between perceived financial hardship, HRQL capability well-being, and physical activity during the COVID-19 pandemic. We used validated outcome measures recommended for use in UK policy-making. While HRQL and capability well-being showed no differences as the pandemic progressed, families experiencing financial hardship had notably worse HRQL and capability well-being in both waves. This was most pronounced in children of parents reporting most financial difficulties. Using robust methods to collect accelerometer data, we did not observe a mediating effect of physical activity on HRQL.

Additional information

Contributions of authors

Katie Breheny (https://orcid.org/0000-0001-6886-4049) (Research Fellow, Health Economics) conducted the analysis of all models and led the writing of the manuscript.

Ruth Salway (https://orcid.org/0000-0002-3242-3951) (Research Fellow, Statistics) advised on statistical analysis and interpretation and edited the paper for intellectual content.

Danielle House (https://orcid.org/0000-0001-6171-9922) (Senior Research Associate, Study Manager) oversaw data collection in Wave 2, managed the project and edited the paper for intellectual content.

Robert Walker (https://orcid.org/0000-0001-9901-5285) (Senior Research Associate, Qualitative Lead) supported the development of the paper and edited the paper for intellectual content.

Lydia Emm-Collison (https://orcid.org/0000-0002-5493-3223) (Steering Group Member) supported the development of the paper and edited the paper for intellectual content.

Kate Sansum (https://orcid.org/0000-0003-3392-6750) (Fieldworker) conducted Wave 2 data collection, supported the development of the paper and edited the paper for intellectual content.

Joanna G Williams (https://orcid.org/0000-0002-4737-1760) (Steering Group Member) supported the development of the paper and edited the paper for intellectual content.

Frank de Vocht (https://orcid.org/0000-0003-3631-627) (Steering Group Member) supported the development of the paper and edited the paper for intellectual content.

Russell Jago (https://orcid.org/0000-0002-3394-0176) (Principal Investigator, Active-6) led the project, oversaw all aspects of study design and interpretation, supported the development of the paper and edited the paper for intellectual content.

William Hollingworth (https://orcid.org/0000-0002-0840-6254) (Steering Group Member, Health Economics) oversaw all aspects of the economic design and analysis and edited the paper for intellectual content.

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/LYJG6305.

Primary conflicts of interest: Russell Jago, Katie Breheny, Frank de Vocht and William Hollingworth are partly funded by the National Institute for Health and Care Research Applied Research Collaboration West (NIHR ARC West). Russell Jago is partly funded by the National Institute for Health and Care Research Bristol Biomedical Research Centre, and was a member of the PHR Prioritisation Group 11 October 2019–12 October 2021, and a member of the PHR – Research Funding Board 1 June 2014–12 October 2021. Frank de Vocht has been on the NIHR Public Health Research Funding Board since 8 October 2019. William Hollingworth was a member of the HTA Clinical Evaluation and Trials Committee 1 July 2016–31 March 2021. Katie Breheny is a member of the ICECAP questionnaires Management Group.

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Ethics statement

Ethical approval was gained from the School of Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150) on 9 March 2021. The project was listed on the Research Registry [Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts and Provide Rapid Evidence to Policy Makers. 2021. URL: www.researchregistry.com/browse-the-registry#home/registrationdetails/604b4760d539c90020642be6/ (accessed 27 January 2023)].[58]

Information governance statement

The University of Bristol is committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Bristol is the Data Controller, and you can find out more about how we handle personal data, including how to exercise your individual rights and the contact details for our Data Protection Officer here (www.bristol.ac.uk/secretary/data-protection/).

Study registration

The study is registered on the Research Registry (project 6646).

Funding

This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847.

Department of Health and Social Care disclaimer

This publication presents independent research commissioned by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, MRC, NIHR Coordinating Centre, the PHR programme or the Department of Health and Social Care.

This article reports on one component of the research award 'Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: Identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6)'. Other articles published as part of this thread are:

Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**:51. https://doi.org/10.1186/s12966-022-01290-4

Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Act* 2022;**19**:114. https://doi.org/10.1186/s12966-022-01356-3

Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary: a natural experiment. *Int J Behav Nutr Phys Act* 2023;**20**:42. https://doi.org/10.1186/s12966-023-01441-1

Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al*. Screen-viewing behaviours of children before and after the 2020–21 COVID-19 lockdowns in the UK: a mixed methods study. *BMC Public Health* 2023;**23**:116. https://doi.org/10.1186/s12889-023-14976-6

Walker R, House D, Salway R, Emm-Collison L, Hollander L, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Public Health* 2023;**23**:1432. https://doi.org/10.1186/s12889-023-16021-y

Emm-Collison L, Walker R, Salway R, House D, Sansum K, Breheny K, *et al*. Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed methods study from a self-determination theory perspective. *Public Health Res* 2024;27 March:1–35 [published online ahead of print] https://doi.org/10.3310/KPKW8220

Salway R, de Vocht F, Emm-Collison L, Sansum L, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: a latent profile analysis. *PLOS ONE* 2023;**18**(11):e0289344. https://doi.org/10.1371/journal.pone.0289344

Walker R, Salway R House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

House D, Walker R, Salway R, Emm-Collison L, Breheny K, Sansum K, *et al*. The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis. *Public Health Res* 2024;7 Feb:1–37 [published online ahead of print] https://doi.org/10.3310/KLML4701

Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al*. Between-school differences (school variation) in children's MVPA before and after COVID-19 lockdowns: a multilevel model analysis. *Public Health Res* (in press).

Jago R, House D, Salway R, Walker R, Emm-Collison L, Sansum K, Breheny K, Churchward S, Williams J, Hollingworth W, and de Vocht F. Assessing the impact of COVID-19 on the physical activity of 10- to 11-year-old children and their parents: Active-6 a mixed-methods study. *Public Health Res* (in press).

For more information about this research please view the award page https://fundingawards.nihr.ac.uk/award/NIHR131847

About this article

The contractual start date for this research was in April 2021. This article began editorial review in March 2023 and was accepted for publication in February 2024. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The Public Health Research editors and publisher have tried to ensure the accuracy of the authors' article and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article.

This article was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Copyright

List of abbreviations

CHU9D	Child Health Utility 9 Dimension
EDI	equality, diversity and inclusion
FESS	Family Economic Strain Scale
HRQL	health-related quality of life
IMD	Index of Multiple Deprivation
MVPA	moderate to vigorous physical activity
PPI	patient and public involvement
SD	standard deviation

References

1. Torrance GW. Utility approach to measuring health-related quality of life. *J Chron Dis* 1987;**40**:593–603. https://doi.org/10.1016/0021-9681(87)90019-1

2. NICE. *NICE Health Technology Evaluations: The Manual*. London: NICE; 2022.
3. Brooks R. EuroQol: the current state of play. *Health Pol* 1996;**37**:53–72. https://doi.org/10.1016/0168-8510(96)00822-6
4. Herdman M, Gudex C, Lloyd A, Janssen MF, Kind P, Parkin D, *et al*. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res: Int J Qual Life Aspect Treat Care Rehab* 2011;**20**:1727–36. https://doi.org/10.1007/s11136-011-9903-x
5. Stevens K. Valuation of the Child Health Utility 9D Index. *PharmacoEcon* 2012;**30**:729–47. https://doi.org/10.2165/11599120-000000000-00000
6. Baldwin S, Godfrey C, Propper C. *Quality of Life: Perspectives and Policies*. 1st edn. London: Routledge; 1994.
7. Fenge L-A, Hean S, Worswick L, Wilkinson C, Fearnley S, Ersser S. The impact of the economic recession on well-being and quality of life of older people. *Health Soc Care Commun* 2012;**20**:617–24. https://doi.org/10.1111/j.1365-2524.2012.01077.x
8. Creswell C, Shum A, Pearcey S, Skripkauskaite S, Patalay P, Waite P. Young people's mental health during the COVID-19 pandemic. *Lancet Child Adolesc Health* 2021;**5**:535–7. https://doi.org/10.1016/S2352-4642(21)00177-2
9. Burgess L, Skripkauskaite S, Waite P, Creswell C. *Children's Mental Health Symptoms Two Years After the Start of the Pandemic: March 2020 to March 2022 (Report 12) – Co-SPACE Study*. 2022. URL: https://cospaceoxford.org/wp-content/uploads/2022/07/Co-SPACE-Report-12-FINAL-Mar20-to-Mar22.pdf (accessed 16 January 2023).
10. Moore G, Anthony R, Angel L, Hawkins J, Morgan K, Copeland L, *et al*. Mental health and life satisfaction among 10–11-year-olds in Wales, before and one year after onset of the COVID-19 pandemic. *BMC Publ Health* 2022;**22**:379. https://doi.org/10.1186/s12889-022-12752-6
11. Powell A, Francis-Devine B, Clark H. *Coronavirus: Impact on the Labour Market*. London: Commons Library; 2022.
12. Institute for Government. *Cost of Living Crisis*. 2022. URL: www.instituteforgovernment.org.uk/explainer/cost-living-crisis (accessed 11 January 2023).
13. Stevenson C, Wakefield JRH, Bowe M, Kellezi B, Jones B, McNamara N. Weathering the economic storm together: family identification predicts future well-being during COVID-19 via enhanced financial resilience. *J Fam Psychol* 2022;**36**:337–45.
14. Gonzalez MR, Brown SA, Pelham Iii WE, Bodison SC, McCabe C, Baker FC, *et al*. Family well-being during the COVID-19 pandemic: the risks of financial insecurity and coping. *J Res Adolesc* 2022;**33**:43–58. https://doi.org/10.1111/jora.12776
15. Nobari H, Fashi M, Eskandari A, Villafaina S, Murillo-Garcia A, Pérez-Gómez J. Effect of COVID-19 on health-related quality of life in adolescents and children: a systematic review. *Int J Environ Res Public Health* 2021;**18**:4563. https://doi.org/10.3390/ijerph18094563
16. Mitchell PM, Morton RL, Hiligsmann M, Husbands S, Coast J. Estimating loss in capability wellbeing in the first year of the COVID-19 pandemic: a cross-sectional study of the general adult population in the UK, Australia and the Netherlands. *Eur J Health Econ* 2022;**24**:609–19. https://doi.org/10.1007/s10198-022-01498-y
17. Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment. *Int J Behav Nutr Phys Activ* 2023;**20**:42. https://doi.org/10.1186/s12966-023-01441-1
18. Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Activ* 2022;**19**:51. https://doi.org/10.1186/s12966-022-01290-4
19. Wunsch K, Kienberger K, Niessner C. Changes in physical activity patterns due to the COVID-19 pandemic: a systematic review and meta-analysis. *Int J Environ Res Public Health* 2022;**19**:2250. https://doi.org/10.3390/ijerph19042250
20. Park AH, Zhong S, Yang H, Jeong J, Lee C. Impact of COVID-19 on physical activity: a rapid review. *J Glob Health* 2022;**12**:05003. https://doi.org/10.7189/jogh.12.05003
21. Bize R, Johnson JA, Plotnikoff RC. Physical activity level and health-related quality of life in the general adult population: a systematic review. *Prev Med* 2007;**45**:401–15. https://doi.org/10.1016/j.ypmed.2007.07.017
22. Feeny D, Garner R, Bernier J, Thompson A, McFarland BH, Huguet N, *et al*. Physical activity matters: associations among body mass index, physical activity, and health-related quality of life trajectories over 10 years. *J Phys Act Health* 2014;**11**:1265–75. https://doi.org/10.1123/jpah.2012-0268

23. Marker AM, Steele RG, Noser AE. Physical activity and health-related quality of life in children and adolescents: a systematic review and meta-analysis. *Health Psychol* 2018;**37**:893–903. https://doi.org/10.1037/hea0000653

24. López-Gil JF, Tremblay MS, Tapia-Serrano MA, Tárraga-López PJ, Brazo-Sayavera J. Meeting 24 h movement guidelines and health-related quality of life in youths during the COVID-19 lockdown. *Appl Sci* 2022;**12**:8056. https://doi.org/10.3390/app12168056

25. Pybus K, Kelly B, Hou B, Ajebon M, McIvor C, Bingham D, *et al*. Changes in children's wellbeing in Bradford during COVID-19: the Born in Bradford COVID-19 longitudinal research study [version 2]. *Wellc Open Res* 2022;**7**:64. https://doi.org/10.12688/wellcomeopenres.17642.2

26. Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al*. Screen-viewing behaviours of children before and after the 2020–21 COVID-19 lockdowns in the UK: a mixed methods study. *BMC Public Health* 2023;**23**:116. https://doi.org/10.1186/s12889-023-14976-6

27. Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Activ* 2022;**19**:114. https://doi.org/10.1186/s12966-022-01356-3

28. Jago R. Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: identifying scalable actions to mitigate adverse impact & provide rapid evidence to olicy Makers (ACTIVE-6). 2021. URL: https://fundingawards.nihr.ac.uk/award/NIHR131847 (accessed 27 January 2023).

29. Salway R, de Vocht F, Emm-Collison L, Sansum K, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: a latent profile analysis. *PLOS ONE* 2023;**18**:e0289344. https://doi.org/10.1371/journal.pone.0289344

30. Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Publ Health* 2023;**23**:1432. https://doi.org/10.1186/s12889-023-16021-y

31. Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Activ* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

32. Jago R, Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA. Association of BMI category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. *Int J Obes (Lond)* 2020;**44**:104–13. https://doi.org/10.1038/s41366-019-0459-0

33. National Statistics. *English Indices of Deprivation*. 2019. Office for National Statistics.

34. R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna: R Core Team; 2020.

35. Salway R. *Accelerometer Processing Code*. 2022. URL: https://osf.io/y8mwu/ (accessed 25 August 2022).

36. Cooper AR, Goodman A, Page AS, Sherar LB, Esliger DW, van Sluijs EMF, *et al*. Objectively measured physical activity and sedentary time in youth: the International children's accelerometry database (ICAD). *Int J Behav Nutr Phys Activ* 2015;**12**:113. https://doi.org/10.1186/s12966-015-0274-5

37. Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. *J Sports Sci* 2008;**26**:1557–65. https://doi.org/10.1080/02640410802334196

38. Troiano RP, Berrigan D, Dodd KW, Mâsse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc* 2008;**40**:181–8. https://doi.org/10.1249/mss.0b013e31815a51b3

39. Feng YS, Kohlmann T, Janssen MF, Buchholz I. Psychometric properties of the EQ-5D-5L: a systematic review of the literature. *Qual Life Res* 2021;**30**:647–73. https://doi.org/10.1007/s11136-020-02688-y

40. van Hout B, Janssen MF, Feng Y-S, Kohlmann T, Busschbach J, Golicki D, *et al*. Interim scoring for the EQ-5D-5L: mapping the EQ-5D-5L to EQ-5D-3L value sets. *Value Health: J Int Soc Pharmacoecon Outc Res* 2012;**15**:708–15. https://doi.org/10.1016/j.jval.2012.02.008

41. Al-Janabi H, Flynn T N, Coast J. Development of a self-report measure of capability wellbeing for adults: the ICECAP-A. *Qual Life Res* 2012;**21**:167–76. https://doi.org/10.1007/s11136-011-9927-2

42. Afentou N, Kinghorn P. A systematic review of the feasibility and psychometric properties of the ICEpop CAPability measure for adults and its use so far in economic evaluation. *Value Health* 2020;**23**:515–26. https://doi.org/10.1016/j.jval.2019.12.010

43. Flynn TN, Huynh E, Peters TJ, Al-Janabi H, Clemens S, Moody A, Coast J. Scoring the Icecap-a capability instrument: estimation of a UK general population tariff. *Health Econ* 2015;**24**:258–69. https://doi.org/10.1002/hec.3014

44. Stevens K. Developing a descriptive system for a new preference-based measure of health-related quality of life for children. *Qual Life Res: Int J Qual Life Aspect Treat Care Rehab* 2009;**18**:1105–13. https://doi.org/10.1007/s11136-009-9524-9

45. Rowen D, Keetharuth AD, Poku E, Wong R, Pennington B, Wailoo A. A review of the psychometric performance of selected child and adolescent preference-based measures used to produce utilities for child and adolescent health. *Value Health: J Int Soc Pharmacoecon Outc Res* 2021;**24**:443–60. https://doi.org/10.1016/j.jval.2020.09.012

46. Husbands S, Mitchell P, Floredin I, Peters T, Kinghorn P, Byford S, *et al*. The children and young people quality of life study: a protocol for the qualitative development of attributes for capability wellbeing measures for use in health economic evaluation with children and young people. *Wellc Open Res* 2022;**7**:117. https://doi.org/10.12688/wellcomeopenres.17801.1

47. Hilton JM, Devall EL. The Family Economic Strain Scale: development and evaluation of the instrument with single- and two-parent families. *J Family Econ Issues* 1997;**18**:247–71. https://doi.org/10.1023/A:1024974829218

48. Janssen MF, Pickard AS, Shaw JW. General population normative data for the EQ-5D-3L in the five largest European economies. *Eur J Health Econ: HEPAC: Health Econ Prev Care* 2021;**22**:1467–75. https://doi.org/10.1007/s10198-021-01326-9

49. Adab P, Pallan MJ, Lancashire ER, Hemming K, Frew E, Barrett T, *et al*. Effectiveness of a childhood obesity prevention programme delivered through schools, targeting 6 and 7 year olds: cluster randomised controlled trial (WAVES study). *BMJ* 2018;**360**:k211. https://doi.org/10.1136/bmj.k211

50. Connolly P, Miller S, Kee F, Sloan S, Gildea A, McIntosh E, *et al*. A cluster randomised controlled trial and evaluation and cost-effectiveness analysis of the Roots of Empathy schools-based programme for improving social and emotional well-being outcomes among 8- to 9-year-olds in Northern Ireland. *Publ Health Res* 2018;**6**:1–108. https://doi.org/10.3310/phr06040

51. Breheny K, Hollingworth W, Tibbitts B. *The ACTIVE-6 Project: Detailed Health Economics Analysis Plan*. Bristol: University of Bristol; 2021.

52. Devlin N, Parkin D, Janssen B. Analysis of EQ-5D Values. In: Devlin N, Parkin D, Janssen B, editors. *Methods for Analysing and Reporting EQ-5D Data*. Cham: Springer International; 2020. pp. 61–86. https://doi.org/10.1007/978-3-030-47622-9_4

53. StataCorp. *Stata Statistical Software: Release 17*. College Station, TX: StataCorp; 2021.

54. Thomas HM, Runions KC, Lester L, Lombardi K, Epstein M, Mandzufas J, *et al*. Western Australian adolescent emotional wellbeing during the COVID-19 pandemic in 2020. *Child Adolesc Psychiat Ment Health* 2022;**16**:4. https://doi.org/10.1186/s13034-021-00433-y

55. Pallan M, Adab P, Clarke J, Duff R, Frew E, Lancashire E, *et al*. *Impacts of the First COVID-19 Lockdown on Learning, Health Behaviours and Mental Wellbeing in Young People Aged 11–15 Years*. Birmingham: University of Birmingham Institute of Applied Health Research; 2021.

56. McGill MG, Purkey E, Davison CM, Watson A, Bayoumi I. Financial stress during COVID-19: implications for parenting behaviour and child well-being. *BMJ Paediatr Open* 2022;**6**:e001569. https://doi.org/10.1136/bmjpo-2022-001569

57. Brazier J, Peasgood T, Mukuria C, Marten O, Kreimeier S, Luo N, *et al*. The EQ-HWB: overview of the development of a measure of health and wellbeing and key results. *Value Health: J Int Soc Pharmacoecon Outc Res* 2022;**25**:482–91. https://doi.org/10.1016/j.jval.2022.01.009

58. Research Registry. *Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts and Provide Rapid Evidence to Policy Makers*. 2021. Research Registry ID researchregistry6646. URL: www.researchregistry.com/browse-the-registry#home/registrationdetails/604b4760d539c90020642be6/ (accessed 27 January 2023).

Appendix 1 Child capability well-being questions

The questions below are about how things have changed since the UK went into lockdown in January 2021.

We are interested in whether you think that you have been able to have more or less of these things since the January 2021 lockdown restrictions began. For each question below, please select which statement best describes how you feel at the moment.

1. Feeling safe and at ease

I feel much more safe and at ease than I did before the start of the lockdown restrictions

I feel more safe and at ease than I did before the start of the lockdown restrictions

I feel as safe and at ease as I did before the start of the lockdown restrictions

I feel less safe and at ease than I did before the start of the lockdown restrictions

I feel much less safe and at ease than I did before the start of the lockdown restrictions

2. Talking and support from people who care about me

I am now able to talk to and seek support from the people who are there for me, much more than I could before the start of the lockdown restrictions

I am now able to talk to and seek support from the people who are there for me, more than I could before the start of the lockdown restrictions

I am now able to talk to and seek support from the people who are there for me, as much as I could before the start of the lockdown restrictions

I am now able to talk to and seek support from the people who are there for me, less than I could before the start of the lockdown restrictions

I am now able to talk to and seek support from the people who are there for me, much less than I could before the start of the lockdown restrictions

3. Having fun

I am now able to do a lot more of the things that I enjoy than I could before the start of the lockdown restrictions

I am now able to do more of the things that I enjoy than I could before the start of the lockdown restrictions

I am now able to do as many of the things that I enjoy as I could before the start of the lockdown restrictions

I am now able to do fewer of the things that I enjoy than I could before the start of the lockdown restrictions

I am now able to do a lot fewer of the things that I enjoy than I could before the start of the lockdown restrictions

4. Being able to achieve things that are important to me (these might be things like schoolwork, hobbies and interests, sports)

I am now able to achieve much more of what is important to me than I could before the start of the lockdown restrictions

I am now able to achieve more of what is important to me than I could before the start of the lockdown restrictions

I am now able to achieve as much of what is important to me as I could before the start of the lockdown restrictions

I am now able to achieve less of what is important to me than I could before the start of the lockdown restrictions

I am now able to achieve much less of what is important to me than I could before the start of the lockdown restrictions

5. Relationships

5a. Relationships with people I live with

My ability to feel close to the people I live with is much better than before the start of the lockdown restrictions

My ability to feel close to the people I live with is better than before the start of the lockdown restrictions

My ability to feel close to the people I live with is the same as before the start of the lockdown restrictions

My ability to feel close to the people I live with is worse than before the start of the lockdown restrictions

My ability to feel close to the people I live with is much worse than before the start of the lockdown restrictions

5b. Relationships with family who I don't live with

My ability to feel close to family who I don't live with is much better than before the start of the lockdown restrictions

My ability to feel close to family who I don't live with is better than before the start of the lockdown restrictions

My ability to feel close to family who I don't live with is the same as before the start of the lockdown restrictions

My ability to feel close to family who I don't live with, is worse than before the start of the lockdown restrictions

My ability to feel close to family who I don't live with is much worse than before the start of the lockdown restrictions

5c. Relationships with friends

My ability to feel close to friends is much better than before the start of the lockdown restrictions

My ability to feel close to friends is better than before the start of the lockdown restrictions

My ability to feel close to friends is the same as before the start of the lockdown restrictions

My ability to feel close to friends is worse than before the start of the lockdown restrictions

My ability to feel close to friends is much worse than before the start of the lockdown restrictions

6. Being able to discover and learn

I am able to discover and learn much more than I was before the start of lockdown restrictions

I am able to discover and learn more than I was before the start of lockdown restrictions

I am able to discover and learn as much as I was before the start of lockdown restrictions

I am able to discover and learn less than I was before the start of lockdown restrictions

I am able to discover and learn much less than I was before the start of lockdown restrictions

TABLE 8 Missing data

Domain	Measure	Wave 1, *N* = 393, *N* missing (%)	Wave 2, *N* = 436, *N* missing (%)
Adult HRQL	EQ-5D-5L	31 (8)	34 (8)
Adult self-rated health	EQ-5D VAS	31 (8)	33 (8)
Adult capability well-being	ICECAP-A	29 (7)	31 (7)
Children's HRQL	CHU9D	30 (8)	31 (7)
Parent-reported financial strain	FESS	33 (8)	34 (8)

TABLE 9 Descriptive statistics of HRQL and capability well-being by FESS quartile and wave

			Wave 1		Wave 2	
	Measure	FESS quartile	Mean (SD)	*N*	Mean (SD)	*N*
Adult HRQL	EQ-5D-5L utility	1 (lowest strain)	0.920 (0.106)	97	0.905 (0.106)	114
		2	0.877 (0.128)	89	0.847 (0.177)	92
		3	0.870 (0.123)	90	0.865 (0.117)	95
		4 (highest strain)	0.759 (0.242)	83	0.762 (0.233)	97
Adult self-rated health	EQ-5D-5L VAS	1 (lowest strain)	82.23 (11.43)	97	82.52 (12.98)	114
		2	79.35 (13.61)	89	78.83 (14.51)	92
		3	77.06 (13.47)	90	75.61 (15.48)	97
		4 (highest strain)	67.47 (20.81)	83	66.82 (21.33)	97
Adult capability well-being	ICECAP-A	1 (lowest strain)	0.927 (0.067)	97	0.934 (0.071)	115
		2	0.911 (0.073)	89	0.903 (0.084)	92
		3	0.880 (0.088)	90	0.885 (0.102)	98
		4 (highest strain)	0.799 (0.166)	84	0.800 (0.176)	97
Children's HRQL	CHU9D	1 (lowest strain)	0.896 (0.075)	95	0.905 (0.078)	115
		2	0.885 (0.082)	89	0.881 (0.091)	92
		3	0.891 (0.079)	90	0.880 (0.079)	96
		4 (highest strain)	0.865 (0.087)	84	0.868 (0.095)	97

HRQL, health-related quality of life; SD, standard deviation.

This article should be referenced as follows:
Breheny K, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al.* Quality of life, capability well-being, financial strain and physical activity in the short- and medium-term COVID-19 post-lockdown phases in the UK: a repeated cross-sectional study. *Public Health Research* 2024;**12**(16):39–58. https://doi.org/10.3310/LYJG6305

The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis

Danielle House,[1*] Robert Walker,[1] Ruth Salway,[1] Lydia Emm-Collison,[1] Katie Breheny,[2] Kate Sansum,[1] Sarah Churchward,[3] Joanna G Williams,[2,4] Frank de Vocht[2,5] and Russell Jago[1,2,5,6]

[1]Centre for Exercise, Nutrition and Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[2]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]Independent Public Member of the Project Team, Bristol, UK
[4]Communities and Public Health, Bristol City Council, Bristol, UK
[5]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK
[6]NIHR Bristol Biomedical Research Centre, University Hospitals Bristol and Weston NHS Foundation Trust and University of Bristol, Bristol, UK

*Corresponding author

Published February 2024
DOI: 10.3310/KLML4701

This report should be referenced as follows:

House D, Walker R, Salway R, Emm-Collison L, Breheny K, Sansum K, *et al*. The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis. *Public Health Res* 2024;**12**(16):59–104. https://doi.org/10.3310/KLML4701

Abstract

The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis

Danielle House,[1*] Robert Walker,[1] Ruth Salway,[1] Lydia Emm-Collison,[1] Katie Breheny,[2] Kate Sansum,[1] Sarah Churchward,[3] Joanna G Williams,[2,4] Frank de Vocht[2,5] and Russell Jago[1,2,5,6]

[1]Centre for Exercise, Nutrition and Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[2]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]Independent Public Member of the Project Team, Bristol, UK
[4]Communities and Public Health, Bristol City Council, Bristol, UK
[5]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK
[6]NIHR Bristol Biomedical Research Centre, University Hospitals Bristol and Weston NHS Foundation Trust and University of Bristol, Bristol, UK

[*]Corresponding author Danielle.House@bristol.ac.uk

Background: The COVID-19 lockdowns and social distancing measures, including school closures, had a major impact on children's physical activity in England, with data showing an initial reduction in activity in the short-term post-lockdown phase of the pandemic followed by a recovery on average in the medium-term post-lockdown period. The school environment is an important context for child physical activity. The purpose of this study is to understand the changes that took place to school physical activity environments once schools reopened after lockdowns. This information will improve understanding of why changes to children's physical activity have occurred over the course of the pandemic and the implications for future promotion of physical activity in schools.

Methods: Interviews with parents (n = 43), school staff (n = 18) and focus groups with 10- to 11-year-old children (participant n = 92) were conducted at two time points: between September–December 2021 and February–July 2022. Interview and focus group guides covered the impact of the pandemic on child physical activity and changes to this over time. The framework method was used for analysis.

Results: Three themes and three subthemes were generated: (1) the return to school; (2) over-pressured staff and environment and (3) the uneven impact of the pandemic. Theme 3 consists of three subthemes: (a) retained pandemic policies, (b) impact on physical activity culture and (c) different children need different things.

Limitations and future work: Conducting this research in schools during ongoing COVID-19 disruptions was a challenge and may have limited school and participant participation, particularly school staff. The parent interview sample is predominantly female, active and of higher socioeconomic status, so the experiences of male, less active and lower socioeconomic parents are limited. This study suggests that the impact of COVID-19 on child physical activity is uneven, affecting some children more than others. Future work is therefore needed to explore the details of this potential diverging experience.

Conclusion: The COVID-19 pandemic, school closures and post-lockdown school policies have impacted upon primary school physical activity environments. The post-lockdown school environment

is highly pressured, impacting the extent to which schools can support and encourage child physical activity. Future research is needed to further explore the impact of post-lockdown changes on physical activity environments in schools, particularly over the longer term, as schools continue to adapt post lockdowns. Strategies required to support school physical activity environments must be context specific and sensitive to these changes, pressures and needs.

Funding: This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847.

List of supplementary material

Report Supplementary Material 1 Topic guides

Report Supplementary Material 2 Further qualitative research information

Supplementary material can be found on the NIHR Journals Library report page (https://doi.org/10.3310/KLML4701).

Supplementary material has been provided by the authors to support the report and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed. Any supplementary material provided at a later stage in the process may not have been peer reviewed.

Plain language summary

Why did we do this study?

Schools are important spaces for children's physical activity. Children can be active in physical education lessons, break times, after-school clubs and travelling to school. School closures and other COVID-19 restrictions affected children's physical activity. We wanted to know how physical activity in primary schools might have changed since the pandemic.

What did we do?

We spoke to school staff, pupils and parents two times after schools reopened. We asked about children's physical activity, and if or how this had changed over the course of the pandemic. We asked school staff about school policies around physical activity.

What did we find?

When children went back to school, schools needed a 'recovery' approach. Children's academic, social and physical skills had been affected. For this time schools prioritised physical activity, but this was short-lived. Since then, schools have been highly pressured. They have had to 'catch up' on missed learning, staff are overloaded and some pupils are still affected by the lockdowns. Physical activity policies in schools have changed, but in many different ways. Some have kept social distancing policies; others feel their school culture has changed. Additionally, pupil ability and needs are more polarised. These factors have shaped, but are also shaped by, the high pressure in schools.

What does this mean for children's physical activity?

- Supporting changing child needs in highly pressured schools is hard for state primary schools.
- Changes to school physical activity policies need to be understood and evaluated.
- Strategies to ease pressure in schools are needed to support physical activity.

Background and introduction

Physical activity is important for health and well-being across the life course,[1,2] and physical activity behaviours can track from childhood to adulthood.[3,4] In children, physical activity has been associated with reduced cardiometabolic risk and depression, and improved emotional well-being and academic performance.[5–10] The World Health Organization (WHO) and UK chief medical officers (CMOs) advise that children should partake in at least an average of 60 minutes moderate to vigorous intensity physical activity (MVPA) each day, which can be accumulated across the day.[1,2,11]

The COVID-19 pandemic and associated lockdowns in 2020 and 2021 had a major impact on children's physical activity in England and beyond, when schools were closed to most pupils, leisure and other facilities were closed and stay at home orders were in place.[12–23] Data from the acute phase of the pandemic found child and adult physical activity levels were reduced.[15,24–27] In an associated study, we reported that accelerometer measured child MVPA was 7–8 minutes lower per weekday on average in 2021 than a pre-COVID-19 comparator. Weekday sedentary time was higher by 25 minutes per day on average.[28] Factors that influence these findings have been identified, such as individual, interpersonal and environmental factors during lockdowns,[20–22,29] and various social and emotional challenges in the recovery phase.[21,27,29] More recent data measuring the medium-term impact of the lockdowns on child physical activity found average child MVPA had recovered to pre-pandemic levels in the first 6 months of 2022, but sedentary time remained higher, and most children were still not meeting WHO and CMO activity guidelines.[30]

The school environment is an important context for child physical activity.[31,32] The structured nature of the school day regulates obesogenic behaviours through compulsory physical activity, restricted eating habits, reduced screen time and regulated sleep schedules.[33–35] One study, however, found divergence in weekend MVPA dependent on child activity profiles, where more active children had higher MVPA on weekends compared to weekdays, and less active children had lower MVPA on weekends compared to weekdays.[36] In England, lockdowns to limit the spread of COVID-19 closed schools to most children. When schools re-opened COVID-19 mitigation policies were in place for several months and impacted upon a school's physical activity environment, that is policies around child physical activity and physical education (PE), how much space children had access to, how active play could be supported, and active travel (see *Figure 1* for details on school closures and policies alongside national restrictions and this study's data collection waves). However, there is a lack of information on the changes to school physical activity environments that took place, how these were experienced by staff and pupils and if/how these were removed or retained. Providing this information is essential for understanding why changes to children's physical activity occurred and the implications of any changes for the future promotion of physical activity in schools going forward.

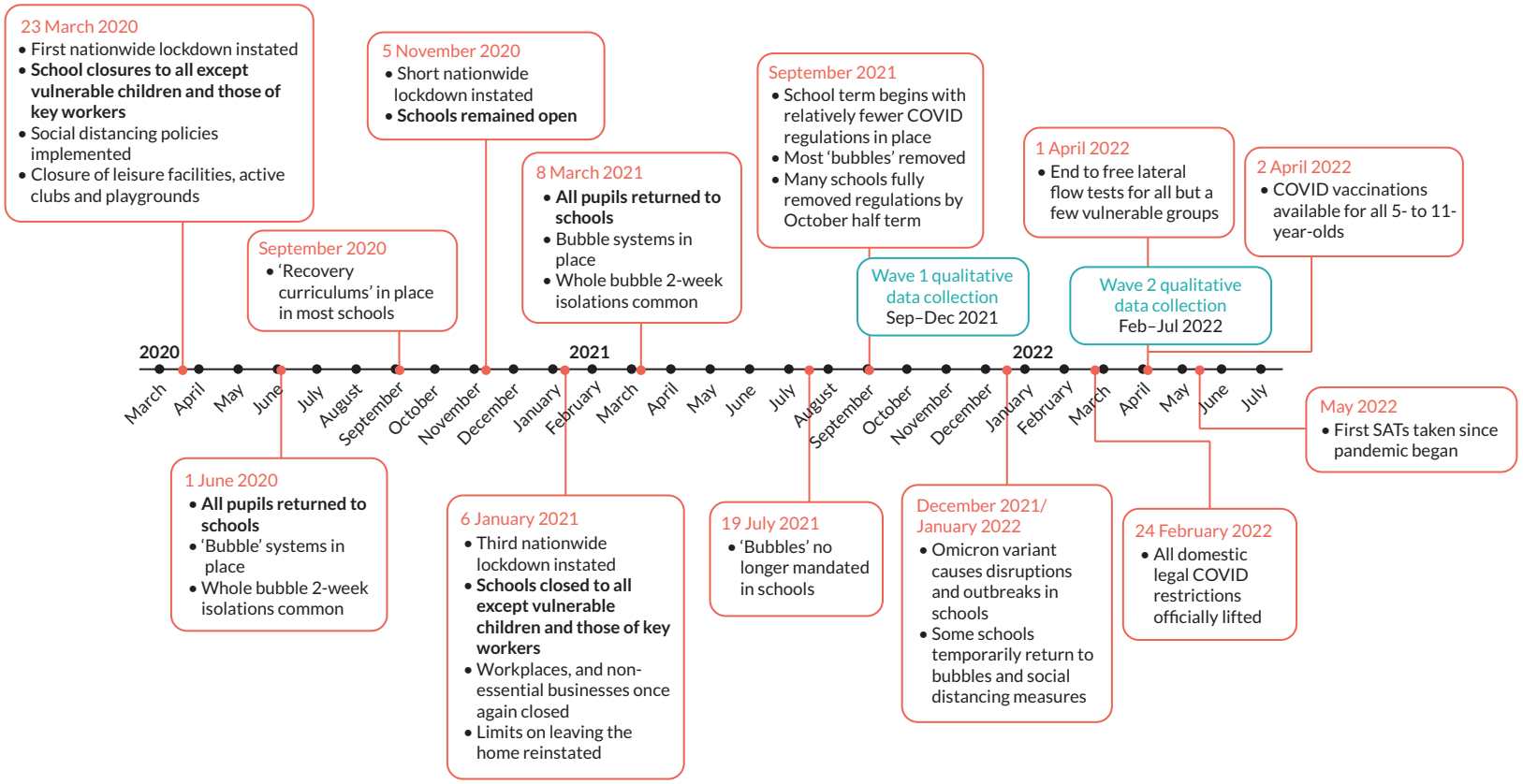

FIGURE 1 Timeline of school closures and COVID-19 policies in England. SAT, standard assessment tests.

Aims and objectives

The aims of this study are to:

1. understand the impact of COVID-19 on the physical activity environment in English primary schools and the longer-term legacy of this on child physical activity;
2. highlight implications of COVID-19-related changes on children's physical activity for schools and governing bodies to increase and support children's physical activity in the school environment.

Methods

Participants and procedure

The Active-6 project is a repeated cross-sectional natural experiment examining the impact of the COVID-19 pandemic on the physical activity of 10- to 11-year-old children and their parents/carers in England.[28–30,37–39] To measure differences over time, accelerometer, questionnaire and qualitative data were collected in two waves (Wave 1: July–December 2021; Wave 2: January–July 2022), which were then compared with baseline data collected in 2017–8 during the B-Proact1v project (Wave 0).[28,40] The schools that took part in Active-6 were state primary schools in the wider Bristol area, England, recruited from those that took part in B-Proact1v. Fifty schools participated in B-Proact1v and 28 continued into Active-6, with a range of inner-city, suburban, rural and small town schools; size in terms of classes per year group and pupil numbers; local authority, academy and faith schools; and high/medium/low deprivation based on percentage of pupils receiving free school meals and school postcode Index of Multiple Deprivation (IMD) score.

This study is drawn from qualitative data collected in Waves 1 and 2 of Active-6 (see *Figure 1*). Participant groups were (1) children aged 10–11 years (Year 6) who had worn accelerometers for Active-6, (2) parents or carers of the child participants who had worn accelerometers for Active-6 and (3) primary school staff from the participating schools. Eligibility criteria for parents and children were that they had worn an accelerometer as part of the Active-6 project and had consented to being recontacted, while school staff needed to be a member of a school supporting the Active-6 project. Parents and children were approached via the contact information provided during the Active-6 sign-up process, whereas school staff were approached directly via e-mail. Parents and children who participated in the qualitative aspects of Active-6 were not related and there was no 'complete' data set that included a child, their parent and their schoolteacher. Due to recruitment challenges, parents and school staff were convenience sampled, whereas children were purposively sampled using their accelerometer data and individual and school demographic information. Semistructured interviews were conducted with parents and school staff and focus groups were conducted with children. In total, 12 focus groups were facilitated (Wave 1 = 6, Wave 2 = 6) with 92 children from 12 schools. The number of children in these focus groups was on average 8 and ranged from 5 to 10, with no repeat children between waves. Forty parents from 15 schools participated in 43 one-to-one semistructured interviews (Wave 1 = 21, Wave 2 = 22; 3 parents were interviewed in both waves). Lastly, 18 one-to-one semistructured interviews with 13 members of school staff from 12 schools were conducted (Wave 1 = 9, Wave 2 = 9; 5 school staff were interviewed in both waves). Information power was used to derive sample size, whereby the study's aim, the extent of participants' specific knowledge and experiences in relation to our research question, theoretical background of the study, dialogue quality and the adopted cross-case analysis were reflected on and discussed within the research team throughout data collection.[41] *Tables 1–3* display participant demographic information, and participants for each group came from a range of study schools, which is explored further in the equality, diversity and inclusion (EDI) section below.

In Wave 1, parents were interviewed remotely between September and December 2021 and school staff between November and December 2021 (also remotely) by RW, TR and BT. Child focus groups were conducted in December 2021 in person in schools, facilitated by RW, TR, BT or DH. In Wave 2, parent interviews were conducted remotely via Zoom or telephone by RW between February and July 2022, and school staff interviews between May and July 2022 by RW (eight remotely via telephone or Zoom and one in-person). Child focus groups were facilitated by RW, DH and KS between May and June 2022 (see *Figure 1* for data collection waves alongside school COVID-19 measures). Parent interviews ranged from 27 to 75 minutes in duration, school contact interviews from 33 to 59 minutes and child focus groups from 33 to 61 minutes.

TABLE 1 Characteristics of Active-6 school staff interviews

School staff	Wave 1 *N* 9	Wave 2 *N* 9
Gender		
Male	3	5
Female	6	4
Role		
Year 6 teacher	7	5
Full-time PE co-ordinator	1	2
Deputy/headteacher	1	2

TABLE 2 Characteristics of Active-6 parent interviews

Parents	Wave 1 *N* 21	Wave 2 *N* 22
Gender		
Male	0	7
Female	21	15
Parent activity levels		
High MVPA	11	12
Medium MVPA	9	5
Low MVPA	1	5
Insufficient data	0	1
Child activity levels[a]		
High MVPA	7	8
Medium MVPA	6	10
Low MVPA	8	4
Insufficient data	0	1
Age (years)		
30–34	1	1
35–39	2	10
40–44	11	11
45–49	7	1
Ethnicity		
White British	17	16
Other	4	4
No data	0	2

TABLE 2 Characteristics of Active-6 parent interviews (*continued*)

Parents	Wave 1 *N* 21	Wave 2 *N* 22
IMD decile		
≤ 5	4	5
> 5	17	17
Parent education		
Higher degree	9	4
Degree	7	16
A level	5	2

a Twenty-three children's activity levels are reported for Wave 2 as one participant was a parent of twins.

Note
IMD decile ≤ 5 = greater level of deprivation, > 5 = lesser level of deprivation.

TABLE 3 Characteristics of Active-6 child focus groups

Children	Wave 1 *N* 47	Wave 2 *N* 45
Gender		
Male	26	22
Female	21	23
Child activity levels		
High MVPA	16	11
Medium MVPA	16	17
Low MVPA	15	17
Parent ethnicity		
White British	38	32
Other	8	7
No data	1	6

All adult participants provided written informed consent, parents consented to their child participation in the focus groups and children provided additional written assent.[42] As an appreciation of their time, parents and school staff were given a £10 gift voucher, and the children received a small incentive when they took part in Active-6 (a frisbee or kit bag). Ethical approval was gained from the School for Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150). This project is funded by the National Institute for Health and Care Research (Public Health Research Programme NIHR131847) and the project was listed on the research registry (www.researchregistry.com/browse-the-registry#home/registrationdetails/604b4760d539c90020642be6/).

Study materials

Topic guides were developed by the research team to facilitate discussions in the semistructured interviews and focus groups. An independent parent patient and public involvement (PPI) member of the study management group provided feedback on all topic guides. A flexible, iterative process of reflection was used to adjust topic guides throughout the data collection process. We felt that each interview and focus group ran well and added valuable information related to our research question. In Wave 1, these focused on changes to parent and child physical activity behaviour over the COVID-19 pandemic, any factors that may have influenced any changes, and school environment changes in this time period that might have influenced activity levels among Year 6 pupils. Building on the data collected in Wave 1, Wave 2 topic guides explored parent and child changes in physical activity and screen-viewing behaviour from January 2022 onwards, factors that had influenced possible changes and the school perspective regarding changes to and influences upon activity levels among Year 6 pupils. All topic guides are presented in *Report Supplementary Material 1* and details on the researchers and analysis in *Report Supplementary Material 2*.

Data analysis

Data were analysed using the framework method and organised using the NVivo 1.0 program (QSR International, Warrington, UK).[43] This process consisted of seven stages: (1) *verbatim* transcription of interview/focus group audio recordings (using an encrypted Dictaphone) by a university approved transcription service; (2) data familiarisation through reading and re-reading transcripts; (3) coding, undertaken by three members of the team (Wave 1 RW, BT, TR, DH or KS; Wave 2 RW, DH and KS) who each coded two transcripts from each participant group each wave using inductive and deductive codes. This process allowed the team to discuss and deliberate codes and our subjectivity in interpretation, leading to consensus;[29] (4) collectively developing a working analytical framework using inductive and deductive codes; (5) applying the analytical framework to all transcripts; (6) charting raw data into the framework matrix using NVivo, which was then manually summarised by RW and LH; and (7) interpreting the data. At the interpretation stage, we combined school, child and parent perspectives, enabling triangulation of diverse experiences. All adult participants were given the opportunity to read and amend their transcripts prior to analysis, but none opted to do this.

This study was based in critical realism, a philosophical meta-theory that argues a world exists independently of human beings (ontological realism), but our perceptions and understanding of this world are derived through perceptions mediated by language, culture and human practices (epistemological relativism).[45] This allowed us to synthesise multiple perspectives in the context of the other, wider mixed-methods findings within the Active-6 project. This also means that we recognise the subjectivity of our qualitative analysis and that our interpretations are culturally situated.

Patient and public involvement

Patient and public involvement has been central to the Active-6 project. Year 6 children, teachers and school staff in a range of roles have been engaged in our research design, study materials and dissemination plans, in two-way feedback between participants and the research team. This has included parent members of study governance groups, running child PPI group sessions at schools to review data collection methods and dissemination materials, and sharing early school-level results with schools and participating families. This engagement has provided valuable feedback to Active-6, enabling us to improve and adapt the study as it rolled out.

Equality, diversity and inclusion

Equality, diversity and inclusion were considered in participant recruitment for this study. A range of schools in terms of location (urban, suburban, town, rural), size (number of Year 6 classes) and deprivation (school postcode IMD) were included in each participant group. As recruitment was taking place each wave, participant demographics were monitored and certain schools and groups were targeted to increase their inclusion in the study. However, inclusion and representation of diverse ethnic backgrounds, lower socioeconomic status (SES) groups and male parents are limited, in part due to the challenges of conducting research during a pandemic and ongoing school and family disruptions. School staff who facilitated the accelerometer data collection were invited to participate in an interview, with attention paid to securing a range of job roles and a gender balance, which was better achieved in Wave 2 (see *Table 1*). Parents were categorised as low, medium or high MVPA level based on their accelerometer measured weekday MVPA in comparison to their school group. Their IMD score (based on home postcode), age, ethnicity and highest level of educational qualification were all noted. The majority of participants were female, white British, higher qualified, higher IMD and active. Intentional sampling helped to achieve a greater balance in Wave 2 regarding parent gender, but not in terms of participation of lower SES parents (see *Table 2*). Child activity levels were generated in the same manner, and even ratios of children with low/medium/high MVPA from schools situated in an even range of urban/rural and high/low deprivation areas were invited to attend a focus group (see *Table 3*). The demographics of the sample may mean that those schools and families facing greatest challenges are not represented in this study, and therefore work that includes these experiences is needed to ensure policy implications are relevant and suitable for all.

Results

Three main themes were generated: (1) the return to school, (2) over-pressured staff and environment and (3) the uneven impact of the pandemic. Theme 3 consists of three subthemes: (a) retained pandemic policies, (b) impact on physical activity culture and (c) different children need different things. A thematic map with hypothesised theme relationships can be seen in *Figure 2*, and overviews of these themes and their scope are provided in *Table 4*.

Theme 1: the return to school

When schools re-opened to all students after the first national lockdown in June 2020, it was apparent to school staff that children's physical, social and academic development had been impacted. We have reported elsewhere that parents who had children at home with them during lockdowns particularly noticed that not only had children lost their curriculum PE sessions, but they lost any active travel to and from school, active play during breaktimes, active after-school clubs and spontaneous after-school park visits.[29] Although strategies to promote physical activity at home during school closures were developed, teachers expressed difficulty in creating exciting virtual PE sessions using the child's home environment and children expressed that PE at home under lockdowns was boring.[29] It became particularly challenging for teachers to influence and engage children who were not motivated to take part and did not have a parent to encourage them, as well as children who had issues accessing the necessary technology or enough space to be able to participate.[29]

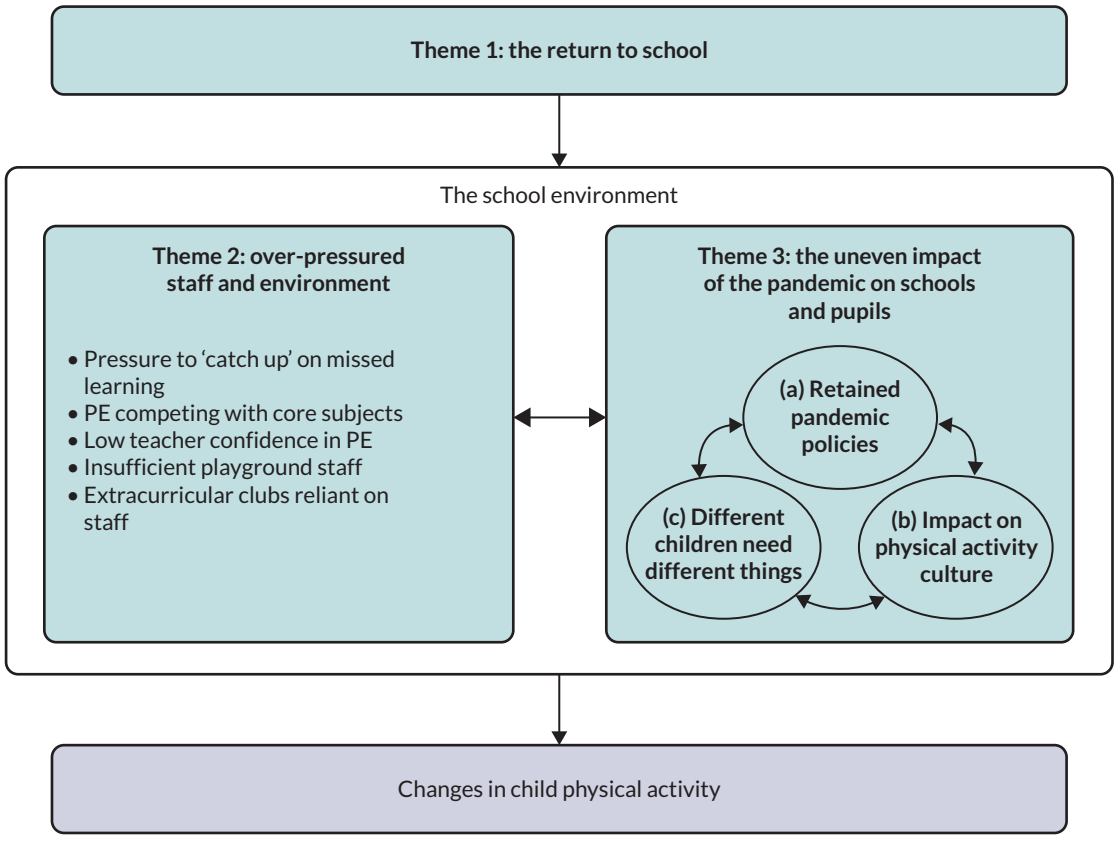

FIGURE 2 Thematic map with hypothesised relationships between themes.

TABLE 4 Theme names and overviews

Theme	Overview
Theme 1: the return to school	This theme explores schools' prioritisation of children's well-being activities, including physical activity, during the first return to school after the initial lockdown. Physical activity was perceived to be intrinsic to school attendance and diverging experiences could be seen among children. 'Recovery curriculums' reflected schools' priorities, which were implemented to even out the detrimental impact of lockdown.
Theme 2: over-pressured staff and environment	This theme explores the over-pressured staff body and school environment once the 'recovery' period was over. School staff described an exceptional pressure to 'catch up' on lost learning, that PE competed with core subjects, how staffing issues led to insufficient playground support staff, and that extracurricular clubs were reliant on scarce teaching staff time. The uneven impact of the pandemic on schools and pupils (Theme 3) has at times contributed to this pressure.
Theme 3: the uneven impact on schools and pupils	This theme reflects the uneven impact of lockdowns and COVID-19 measures on schools and their pupils. The post-lockdown physical activity environment is characterised by variation, and is explored through the following three subthemes:
Subtheme a: retained pandemic policies	The uneven impact of the pandemic was highlighted in the extent to which schools retained their social distancing policies. The retention of some policies seems to be for convenience in the over-pressured post-lockdown school environment (Theme 2).
Subtheme b: impact on physical activity culture	This theme highlights the diverse impacts of the pandemic on physical activity culture among schools. Some schools were unable to prioritise physical activity due to post-lockdown pressures (Theme 2), while others strengthened their physical activity culture having understood its benefits to pupils through the pandemic. Several schools described significant disruptions to peer role modelling for physical activity.
Subtheme c: different children need different things	The COVID-19 pandemic, school closures and ongoing disruptions have had an uneven impact on children's physical activity. School staff observed that children who were already inclined to be physically active have returned to their activities. Conversely, staff described greater challenges in getting less active children active post lockdowns, creating greater polarisation between active and inactive children. Meeting these diverse and complex needs is a challenge for schools in the over-pressured school environment (Theme 2).

Across the parent and school staff interviews, it was felt that the return to the school environment increased children's physical activity and the opportunity to develop physical skills, even while social distancing measures were in place.

> *When they went back to school they were doing more physical activity, because they were at school and so they still had their playtimes and they had just being up and about, and naturally doing more throughout their day than being at home and home-schooling. Walking to school, walking back from school … You know, all those little parts.*
>
> *Parent 17, Female, School ID 75, Wave 1*

The positive impact of attending school on physical activity was discussed through 'keyworker' children – children whose parents worked in key services that continued through lockdowns so attended school in-person. Several teachers described how during lockdowns, due to a prioritisation of well-being at school, COVID-19 mitigation measures, good weather and the smaller number of children in school, they were in fact able to do more active and outdoor activities than under pre-pandemic school conditions, and keyworker parents noted this in our interviews. PE for keyworker children in school was largely enjoyed, but some noted technical difficulties that at times made the sessions challenging, such as participating in a 'blended' lesson in a classroom while classmates at home joined virtually, or being limited to the classroom space.

> *It was warm, it was spring, it was summer, we went out and let [keyworker children] play for longer. […] If anything, they probably had more physical activity when they were in school. […] So COVID-19 made us kind of freer to go out. The children at home, we knew, would not be doing very much physical activity*
>
> *School Contact 6, Year 6 Teacher, School ID 71, Wave 1*

> *I was in school. Playtime was amazing then. [… We] used to play tennis, because we used to be able to get, like, balls and tennis rackets out*
>
> *Focus Group 3, School ID 95, Wave 1*

> *We had to do [PE] in class, which was annoying because we did not get to move around as much and run around*
>
> *Focus Group 5, School ID 72, Wave 1*

In September 2020 when the school term began, most schools undertook some form of 'recovery curriculum' to support the development of the pupils' social, physical and emotional skills and reacclimatise them to the school environment (see *Figure 1*). Underlying this approach was recognition of the uneven impact school closures had on pupils, and how some children had fallen far behind expected development levels. The recovery curriculum, then, meant pushing academic priorities aside in the short term to bring children up to a base-level skill set to cope with the school environment, while understanding that these measures were a necessary pathway to be able to once again focus on academic outcomes. Being physically active in school at this time played a key role in this adjustment, with schools using physical activities, sports and games to practise teamworking, increase stamina and assist conflict resolution. The COVID-19 risk levels at this time being relatively high also encouraged staff to spend more time in outdoor activities.

> *We found that when the children came back, they didn't even know how to sit on the chair properly, they'd been sat on the sofa doing their work for the last six months. They just had their brother or sister to deal with for the last six months, they didn't have these 30-odd children. […] For the first term, we completely redesigned our curriculum. For the first weeks there was no maths and English. […] We focused on our five golden threads. A lot around team-building, physical activity, conflict resolution. […] It was all around the social skills and their building up stamina to be able to sit down and do an English lesson. […] Then, when we were going into the fourth, fifth, sixth week of the first term, we started dripping in snappy maths and English lessons. Again, very physical [active] maths and English lessons. […] Then, we started weaving in the more classic maths and English lesson of sitting down and doing a worksheet*
>
> *School Contact 7, Deputy Head Teacher, School ID 57, Wave 1*

Theme 2: over-pressured staff and environment

Lost learning and skill development among children over the pandemic created exceptional pressure for students to academically 'catch up', which staff explained exacerbated pre-existing issues within the highly demanding state primary school environment, such as limited resources and overburdened workloads. Although school staff described an ability to prioritise social, emotional and physical well-being and recovery during the first reopening of schools in September 2020 (Theme 1), by September 2021 pressures from governing bodies impacted the extent to which they could diverge from the expected curriculum, including a waning of the use of physical activity to assist social, academic and physical development. This pressure for pupils to academically catch up was exacerbated by an increased need to support children who were not yet reaccustomed to learning in the school environment.

> *The government has made it clear that they would like pupils to be back on track … I think that's just filtered through our Trust and it's filtered through the Heads and it's filtered through to classes*
>
> *School Contact 1, Head Teacher, School ID 44, Wave 2*

> *I feel like I'm needing to do more for them than I would have done historically with the same aged cohorts. Just a little bit more spoon-feeding and I don't even mean academically. I just mean helping them listen, helping them achieve what I've asked them to do, or helping them understand what the structure of the activity is*
>
> *School Contact 9, Year 6 Teacher, School ID 61, Wave 2*

These post-lockdown school pressures impacted upon the time for and quality of structured and unstructured physical activity. For the Year 6 cohort in this study, who took the first Standard Assessment Test (SAT) exams since the pandemic began (in May 2022), teachers described how PE lessons and other additional physical activities competed for time against 'higher priority' core subjects which are assessed. This is counter to the experience of many schools during the recovery curriculum, where outdoor and active time helped children's behaviour and ability to concentrate in the classroom.

> *At the moment, I don't think many [classes] are doing [The Daily Mile] because the curriculum is so tight that we can't literally fit it in*
>
> *School Contact 5, Year 6 Teacher, School ID 25, Wave 1*

> *Before SATs we didn't do as much PE as we did. I think it was because we were all getting ready for SATs. […] the teachers are always like, 'We'll do PE if we have time.' It's like PE is for the spare time. It's not really that important to them*
>
> *Focus Group 5, School ID 75, Wave 2*

Many Year 6 teachers described a lack of confidence in delivering quality PE at the Year 6 level. At this age, pupils can be experienced in a sport or activity if they attend a club outside of school. Teachers are aware these pupils are about to go to secondary school where PE will be taught by a subject specialist, and several teachers described how they felt the PE provision in the postgraduate certificate of education (PGCE) teaching qualification was inadequate and left them feeling ill-equipped to teach. Staff described how this had been an issue before the pandemic but was exacerbated by post-lockdown academic pressures. Teachers described feeling inclined to cancel PE or preferring for it to be delivered by external providers, to use PE time to complete administrative tasks. Using timetabled PE to catch up on other work further reduces PE training and continuing professional development (CPD) opportunities for staff, and improving delivery of PE lessons requires teachers to find time in their already over-burdened workload or, more often, to do so outside of work hours.

> *When you are a primary school teacher, obviously you deliver all of the provision. We can't all be brilliant at everything. So, the most obvious thing to say is there are some teachers who don't feel that they are good at delivering PE, particularly as you go higher up the school, where actually there are children who might do the sport externally and might actually end up knowing more than you do. It can sometimes feel like you are trying your best, but maybe what you are delivering is not as good as it could be*
>
> *School Contact 9, Year 6 Teacher, School ID 61, Wave 2*

> *Occasionally we'll have a PE staff meeting but they're few and far between. I don't think many people do [the CPD courses that are available] because of time. When you go back to it, it's down to time*
>
> *School Contact 4, Year 6 Teacher, School ID 71, Wave 2*

Playground support staff were often insufficient as staff retention was challenging at this time. This impacted upon the quality of the playground support staff, where the high turnover required ongoing training in facilitating games and activities. With fewer staff in the playground and lower staff-to-children ratios, fewer physical activities were supported during break and lunch times.

> *Sometimes I do training with the lunchtime staff and I train them in what things they could do at lunchtime with the children, so different sports, different games they can play. Whether it's because of COVID or not, we have such a high turnover of staff and quite often there's not a lot of staff that turn up*

> *for work. […] If we've only got a couple of staff outside, they can't then offer the activities. [… We then have an issue with] whether we can keep upskilling them because every year we keep getting different ones and it keeps changing all the time*
>
> *School Contact 3, PE Coordinator, School ID 72, Wave 2*

School environment pressures also impacted the number and variety of extracurricular clubs, which were often dependent on staff skills and availability. However, the teaching workload required teachers to use their spare time in the evenings or weekends to find the capacity to run these clubs, which meant needing to catch up on core academic workloads. For these reasons, it required staff who were highly motivated to organise these clubs, without which the number and variety of clubs might have been reduced.

> *It's having enough adults on the staff team, that aren't at complete breaking point, that are willing to help us [the PE lead and assistant]. […] Ideally, because we've got so many children who are engaged in clubs, we would take every child to an event with us but it's having those adults who are willing to do it*
>
> *School Contact 6, PE Coordinator, School ID 74, Wave 2*

Theme 3: the uneven impact of the pandemic

This theme describes how the lockdowns and COVID-19 measures had an uneven impact on schools and their pupils. The post-lockdown physical activity environment is characterised by variation and is explored through three subthemes: retained pandemic policies; impact on physical activity culture and different children need different things.

Subtheme a: retained pandemic policies

Many measures were put in place in schools to reduce the spread of COVID-19, such as 'bubbles' (smaller groups of children and at times staff that limited contact at school, often at the year group level), limited access to sports equipment due to sanitisation requirements, staggered break and lunch times, and staggered times for the start and end of the school day. These had an impact on pupils' physical activity. How these restrictions were retained once they were no longer prescribed varied greatly across schools. When students returned to school, many were not adjusted to the social expectations and demands of the school environment (Theme 1). This translated to the playground, with several teachers describing increased conflict and incidents in the playground post lockdowns.[29] For many schools, retaining 'bubbles' and staggered break and lunch times beyond necessary COVID-19 measures was positive, seen as a way to mitigate this, as children had more space to move around in, less competition to access the sports and other playground resources, and smaller and familiar groups encouraged some children to participate in break time sports and activities.

> *What we realised was that having fewer children in the playground meant 1) there were fewer accidents happening and 2) all of the children could use the equipment, all of the children had much more space to run around and enjoy and it has worked really successfully. […] So all the school is never in the one playground at the one time anymore. And the children love it, we love it as staff from a safety perspective, and it has worked really, really well*
>
> *School Contact 8, Year 6 Teacher, School ID 31, Wave 2*

> *The interesting thing is when they were in their bubbles at school, obviously you only played with those 30 children, but a lot of the girls started playing football with [the boys] at lunchtime and [male child] really loved that. He said, 'We're really lucky at our school, the girls are allowed to play with us,' and now they've sort of continued that*
>
> *Parent 15, Female, School ID 61, Wave 1*

Despite some schools finding many COVID policies to be beneficial to child well-being, others sought to remove COVID-19 playground restrictions as soon as possible. Although incidences of conflict may have been reduced by bubbles and zoning, opportunities for conflict resolution and older peer modelling were also reduced (Subtheme b). Some school staff described choosing to remove COVID-19 restrictions to enable such social encounters to return, with one Head Teacher critiquing a culture of structured play as a barrier to developing essential social skills. These staff saw greater opportunity for children to access space and equipment for physical activity *without* social distancing restrictions.

> *There has been a bit of a drive to structure play all the time for children in schools. Actually, sometimes, just letting them play without structure is what's important socially for them. Then, they come across problems, and they have to solve them themselves*
>
> *School Contact 7, Head Teacher, School ID 71, Wave 2*

> *the whole 'bubble' system within schools, that kind of limited play opportunities and everyone was segregated into separate areas and we couldn't have everyone out to play at once [… and] they couldn't use all of the equipment […] I think the whole school play thing is far healthier in terms of physical health and far healthier in terms of children being able to play with each other*
>
> *School Contact 1, Head Teacher, School ID 44, Wave 2*

For some schools the post-lockdown social and behavioural challenges in their pupils were not resolved within the recovery curriculum period (Theme 1). A return to unstructured play and pre-pandemic playground culture was not feasible for some pupils, even if desired by the staff, and nor was it feasible for the staff in the over-pressured post-lockdown school environment (Theme 2). Staff found some children needed a continuation of structured play, which several teachers referred to as 'scaffolding' in the playground and classroom, while they developed their social, physical and academic skills (Theme 1 and Subtheme c). Other children and staff described retaining COVID-19 policies for staff convenience and not necessarily what might be best for pupils and their physical activity.

> *It was causing more arguments, taking a class outside and just letting them play. We were getting lots of issues. Then a lot of teachers were like, 'Well I don't want to do that then, I just want to keep them in the classroom because [going out] creates arguments.' That's not the solution, the solution was that they needed structured games and they needed to be taught that conflict resolution*
>
> *School Contact 2, Year 6 Teacher, School ID 81, Wave 2*

> *We're usually set in different zones for different games but I think it'd be nice if people get to choose where they want to go. […] I think [the school is] keeping it just because they find it easier*
>
> *Focus Group 1, School ID 74, Wave 2*

Beyond the playground, schools retained other social distancing and recovery curriculum policies as staff found them to be beneficial to academic learning, physical activity, behaviour and well-being. However, where schools decided to continue the use of outdoor or movement breaks it was explicitly linked to improving pupil concentration and academic learning. Having pupils come to school dressed for PE, a policy to reduce sanitation needs, maximises PE time but also potentially relieves small pressures from an over-pressured environment.

> *Again, in line with most schools, because of the whole sanitising and touching thing, we opted to get rid of the change [of clothes] for PE. We asked children, on PE days, to come in already in their tracksuits and trainers. […] We've maintained it because that has affected physical activity positively because when you've got your timetabled slot for PE you can just go and do it. […] so that maximises PE time*
>
> *School Contact 1, Head Teacher, School ID 44, Wave 2*

Subtheme b: impact on physical activity culture

Some school staff and parents described their school as having a culture that prioritised sport and physical activity. A positive and supportive culture for physical activity in primary schools was seen to have broad positive impacts on the pupils, by providing opportunities to have most, if not all, pupils engaged in physical activity, building confidence, social skills, co-operative behaviour and academic capacity. Most parents and staff who described this culture in their school perceived it to be a priority set by the senior leadership team (SLT), specifically a Head Teacher or Principal, or in some cases driven by members of teaching staff. Several school policies and expectations set by the SLT around increasing physical activity were described, such as a requirement for every teacher to run an extracurricular club, schools working to have every child attend an after-school club or policies protecting PE lessons or ensuring external PE provision was used as teacher CPD.

Building on Theme 2, many schools described the challenge of prioritising physical activity in the post-lockdown school environment. Structural issues such as competing academic priorities, a lack of staff resource and a post-lockdown reduced external provider offer meant some schools were unable to support physical activity at lunchtimes, bring their extracurricular club offer back to pre-COVID-19 levels, or teachers cancelled PE for core priorities. These structural issues directly impacted on the physical activity culture within a school.

> *Post-pandemic we've been fully focused on just the daytime core offer of what we're here for, so the afterschool clubs have taken a backseat*
>
> *School Contact 1, Head Teacher, School ID 44, Wave 2*

> *One thing that, maybe, [the pandemic] has impacted slightly is other staff's willingness to run clubs […] outside of school at the moment. Obviously they're still adjusting back to their own roles really*
>
> *School Contact 6, PE Coordinator, School ID 74, Wave 2*

Conversely, having seen the social, physical and academic benefits of prioritising physical activity and well-being once schools returned (Theme 1), some schools felt that the COVID-19 pandemic strengthened the physical activity culture among the SLT and/or teaching staff. Despite the over-pressured environment described in Theme 2, several schools we spoke to described how they ensure PE remains a priority lesson that is never cancelled, or had a stronger structured breaktime and extracurricular club offer than before the pandemic. The ability to ring-fence these activities in the post-lockdown school environment was connected by interviewees to the SLT setting a physical activity culture. Despite in some ways adding pressure to staff workload, this expectation gave staff permission to prioritise physical activity.

> *I would say that since COVID the senior leadership team have been more aware of getting as much activity into the school day as possible. And there has been a push on certain members of the lunchtime team, at lunchtime, focusing on certain activities outside*
>
> *School Contact 2, PE Coordinator, School ID 72, Wave 1*

School staff also described changed patterns of role modelling and peer aspiration around physical activity within schools, since school closures. Peer role modelling was seen by several staff as an important factor in maintaining an active school culture, whereby pupils saw children like themselves taking part in and enjoying activities, enabling them to consider taking part themselves. As we have reported in a related study, with 2 years of interruptions to this, several schools described how the physical activity culture among the pupils had been eroded, particularly among girls.[39] Where children no longer aspired to participate in active clubs and physical activity they retreated from these, leading to a lower skill level which in turn adversely affected their enjoyment and motivation to take part.

> *We absorb messages, and habituate something by seeing it. In lockdown the messages from seeing their peers, seeing sport, those vanished. […] A new narrative emerged where it's cooler to hang at the park*

> *or play PlayStation because they did it in lockdown. I don't think it will be a long-lived thing, but I do worry for this current cohort [Year 5 and 6], and the cohort that is currently Year 7, how they will fare going through*
>
> *School Contact 7, Head Teacher, School ID 71, Wave 2*

Subtheme c: different children need different things

The pandemic had a varied impact on children's physical activity, dependent on whether they attended school or not, that is keyworker children, their parental/carer support, their home and local environment, and their post-lockdown school environment, amongst others (Theme 1, see also).[29] A related Active-6 study has suggested that the impacts of the pandemic on child physical activity differ by socioeconomic position and gender with greater impact on children living in lower income households and among girls.[39] Many school staff we spoke to observed that children who were already inclined to participate in physical activity, returned to or maintained their activity through the ongoing COVID-19-related disruptions to school. Conversely, some staff described challenges in getting less active children participating in clubs, creating greater polarisation between active and inactive children. Lost learning, physical skill development and active school culture over 2 years of COVID-19 disruptions have made it harder for children who would previously have struggled to attend clubs to do so post lockdowns.

> *[Pre-pandemic] with the pupil premium funding [a grant given to schools in England to decrease the attainment gap for the most disadvantaged children] you would make sure that every pupil premium child attended a club after school, because it gave […] them confidence, you know, it made a huge difference. That has been harder to reach, because there has been such interruption of the clubs. […] We brought them back […at] the very earliest we could, when lots of schools didn't. […] [But pupil premium students] just didn't come back to clubs in the numbers that they previously were. So, those children weren't feeling part of the cricket team, the football team, the dance group, the performing arts group, the IT, the athletics and cross-country*
>
> *School Contact 7, Head Teacher, School ID 71, Wave 2*

Across our interviews we heard a vast range of child preferences for types of activity, the ethos of these, the skill level and the environment for them. This creates a challenge for schools to try to offer opportunities that provide for this, due to such divergent post-lockdown child abilities and needs (Theme 1) and the over-pressured school environment (Theme 2). But school staff, children and parents described how choice and variety would encourage more children to participate. Yet the disruption to the development of children's physical and social skills,[39] particularly in teamworking and conflict resolution (Theme 1 and Subtheme a), as well as the increasingly pressured environment for staff (Theme 2) now set the broader context of how physical activity is unfolding in the post-lockdown school environment. These are also reasons why participation in physical activity and active extracurricular clubs could be of greater importance for well-being than before the pandemic.

> *For some children, the academic pressures are such that school is really tough for them. [PE is], maybe, one time in the week that they really feel success and confidence. […] For other children, they have really poor stamina and fitness, it's really important for them to be able to ensure that develops. For other children, who need to develop social skills around fairness, particularly for the transition to secondary school, […] they have to learn the lessons that are all about the social, mental health, things*
>
> *School Contact 5, Year 6 Teacher, School ID 63, Wave 2*

In the increasingly pressured post-lockdown state primary school environment, meeting these varied needs was expressed as challenging, and schools may struggle to find the resources and skills to meet these complex and varied needs. Some school staff are concerned that not engaging children in physical activity in younger years may result in some children falling through the cracks and their physical activity being impacted for life.

Our deputy is very keen, at the moment, to work out who can swim and who can't before we move into Year 7 because we have that national curriculum objective that we have to have them know how to swim 25m. […] If parents can't pay for it then it doesn't happen. We're going to end up with a few children who are never going to be able to swim.

School Contact 4, Year 6 Teacher, School ID 71, Wave 2

Discussion

This analysis has provided a unique multi-perspective qualitative understanding of child physical activity environments in English state primary schools over the first year post-COVID-19 lockdowns. The three themes and three subthemes provide insight into how the school physical activity environment changed over the first year post lockdown and school closures, particularly in regard to school and teacher prioritisation of physical activity, if/how social distancing measures were retained, pupil engagement and ability, and how these were experienced by pupils and staff. These insights are an essential part of the picture of understanding why changes to children's physical activity occurred post lockdown and has implications for promoting and supporting physical activity in schools from this point onwards.

Structured environments such as schools have been suggested to increase children's physical activity.[33–35] School closures and COVID-19 restrictions meant most children in England were home schooled for many months, impacting upon their school regulated activity, diet, screen use and sleep patterns. This study suggested that children's physical activity was improved when children returned to schools, which is supported by other research,[23] and has flagged the central role of school and the school day on children's physical activity. However, previous studies have highlighted pre-existing barriers to school and teacher attempts to increase and support child physical activity within the school environment. These have included individual teacher factors such as confidence, motivation and the value they place on physical activity; school level factors such as space and facilities, senior support to prioritise physical activity and heavy workloads; and pupil factors such as ability and interest.[46–50] This study suggests the over-pressured post-lockdown school environment has exacerbated these pre-existing challenges to promoting physical activity, and that the extent to which schools are able to facilitate physical activity is uneven. This finding is also consistent with the body of evidence that has shown that there is a need to increase PE teaching expertise among primary school staff.[51,52]

This study has found schools have retained COVID-19 and social distancing policies to varying degrees. These policies and changes need to be evaluated and considered in conjunction with current knowledge of each policy area and its impact on child physical activity. For example, in this study we found several schools retained a policy of pupils coming dressed for PE on PE days which reduced contact and assisted COVID-19 mitigation, but also eased some pressure in the day. This policy could enable general child activity across the day. Studies have explored the impact of school uniform in limiting physical activity and how a 'sports uniform' could improve activity, which may be gendered.[53–55] However, other studies have found particular groups, for example girls or girls from particular faith communities, feel self-conscious or uncomfortable in PE kit.[56,57] These complex factors need to be considered. School culture is an important factor in school physical activity.[58] Peer modelling has been identified as a key predictor of children's physical activity,[59] and reductions in peer role modelling and participation in physical activity were observed in this study. SLT support to set a physical activity culture in a school has been highlighted elsewhere as an important factor,[60] which supports this study's findings, but school cultures have also been disrupted unevenly by the pandemic and are influenced by the highly pressured school environment.

To encourage children to be active, schools need a range of clubs and staff capacity to support varying child needs,[51,52] however, other Active-6 analysis has found an increased demand for school-based active clubs since the lockdowns, which schools are struggling provide.[61] Other recent evidence, including Active-6, has also found that the impact of the pandemic on child physical activity, and the recovery, is uneven across demographic groups such as gender, age, ethnicity and SES.[25,62] These findings are mirrored in this study, which suggest that children who were active before the pandemic lockdowns returned to active clubs, and those who were less active are now even harder to engage, resulting in a greater polarisation of child ability and activity levels. The Active-6 study has found that although child physical activity has returned to near pre-pandemic levels,[30] children are more dependent on organised activities, such as active clubs, for this physical activity.[39] Combined with the findings of this present study, it seems that school-based active clubs and activity (such as PE lessons) may be of

greater importance in child physical activity than before the pandemic, particularly in addressing the growing polarisation and inequalities of child physical activity.[62]

Study implications

The key findings and implications of this study are summarised in *Table 5*. The study's key finding is that the post-lockdown primary school environment and staff body are characterised as over-pressured, with staff expected to deliver on core academic work while trying to meet complex post-lockdown pupil needs. This is impacting upon the child physical activity environment, although this impact is characterised by variety and divergence of experience. Schools would benefit from upstream policy changes to alleviate the pressure placed on them through school governance systems. This might enable schools to retain and continue the physical activity and well-being-centred approach seen during recovery curriculums. This implication has been included in an Active-6 study policy briefing which has been developed in partnership with key policy and practitioner stakeholders.

Several additional implications have arisen in this study. Many Year 6 class teachers feel unconfident in delivering quality PE lessons. COVID-19 social distancing policies have been retained to varying degrees within schools, at times in the interests of pupils and at others in the interests of the over-pressured school. These policies should be evaluated for their impact on child physical activity. Schools' physical activity cultures have changed in varying ways since lockdowns. Context-specific research is necessary to understand how these cultures are created and shaped, and future intervention work should make school culture, ethos and context central in their implementation and evaluation. Lastly, the COVID-19

TABLE 5 Key findings and implications

	Key finding	Implications
1.	The post-lockdown state primary school environment is characterised as over-pressured, with expectations for staff to deliver on academic core work while trying to meet complex post-lockdown pupil needs. This can be at the detriment to child physical activity and well-being.	Government and the Department for Education should reduce pressure on the school system. This could enable schools to balance physical activity with academic core work through: • increasing staff supported active club offers • enabling teaching and playground staff to take up opportunities for PE CPD • enabling staff to support complex pupil needs and address barriers preventing participation.
2.	Many teachers feel unconfident in delivering quality PE lessons, particularly to older children/ year groups.	Training in PE in the general primary school teacher qualification is currently inadequate. Awarding bodies could dedicate more time in the training to deliver quality PE. PE CPD provision must be available but, importantly, teachers need to feel they are able to take up opportunities (see *Study implications*).
3.	COVID-19 social distancing policies have been retained to varying degrees in schools. These have been in the interests of pupils at times, but also in the interests of the over-pressured school.	Schools should seek evaluation of these policies for their impact on child physical activity.
4.	Schools' physical activity cultures have changed and been impacted by the pandemic in varying ways.	Further context-specific academic research is warranted to understand how school physical activity cultures are created and shaped. Future research and intervention must understand school culture and ethos and develop school-specific strategies.
5.	The COVID-19 lockdowns had an uneven impact on children's physical activity, and some groups risk getting left behind.	Strategies to have all pupils participating in physical activity are necessary even more so than before the pandemic. Schools should be supported in meeting these more divergent levels of child ability and need.

lockdowns had an uneven impact on children's physical activity, and some groups risk getting left behind. Strategies to reach all pupils are necessary even more so than before the pandemic, and schools should be supported in meeting these now more divergent levels of child ability and need.

Strengths, limitations and future research

This study has several strengths. It combines school, parent and child perspectives, enabling triangulation of opinions and experiences. Furthermore, data were collected at two time points in a period of rapid change, both in COVID-19 policy and mitigation strategies, particularly within schools, but also in embodied experiences of the pandemic and restrictions. This has provided rich data on a complex issue, supporting an analysis that has been able to consider how experiences have changed over time.

Active-6 was limited to the school sample from the comparator baseline B-Proact1v study. At the time of data collection (both quantitative and qualitative) schools were under great pressure, negotiating ongoing COVID-19 complications and outbreaks while supporting our work. This likely limited the numbers of schools able to participate in Active-6. Although a range of schools participated in this qualitative study (see *Methods*), these factors again may have contributed to our participant sample from within these schools. It was challenging to recruit staff for interviews, particularly SLT staff, and the parent interview sample is predominantly female, active and of higher SES. Therefore, the experiences of male, less active and lower SES parents are limited, and this must be considered in interpretation of the parent findings.

This study suggests that the impact of COVID-19 on child physical activity is uneven, affecting some children more than others. Future work is therefore needed to explore the details of this potential diverging experience, to understand which sorts of schools followed which paths through the pandemic and how children have been differently affected, particularly over the longer term. Importantly, in light of the varying experiences this study has highlighted, future work to support schools to improve child physical activity and their physical activity environments must be context specific: sensitive to staff abilities and capacities, the SLT, school space and environment, facilities, wider neighbourhoods and environments, demographics, cultures and indicators of deprivation such as numbers of pupils receiving free school meals.

Conclusion

The COVID-19 pandemic, school closures and post-lockdown school policies have impacted upon primary school physical activity environments. The post-lockdown school environment is highly pressured, impacting the extent to which schools can support and encourage child physical activity. Future research is needed to further explore the impact of post-lockdown changes on physical activity environments in schools, particularly over the longer term, as schools continue to adapt post lockdowns. Strategies required to support school physical activity environments must be context specific and sensitive to these changes, pressures and needs.

Additional information

Acknowledgements

A special thank you to the Active-6 schools, the school staff, child participants and parents/carers for their involvement in the study.

Thank you also to previous team members: Prof. Charlie Foster, who was co-applicant and in the Study Management Group; Byron Tibbetts, who was Project Manager from April to December 2021; Tom Reid, who was Fieldworker April 2021–January 2022; Lara Hollander, who helped to develop the Wave 2 qualitative frameworks; Christine O'Shea, who was summer Intern in 2022; and Tabitha Pring, who was a casual fieldworker for Wave 2 data collection.

Contributions of authors

Danielle House (https://orcid.org/0000-0001-6171-9922) (Study Manager) conducted analysis and led on the writing of the paper.

Robert Walker (https://orcid.org/0000-0001-9901-5285) (Qualitative Research Associate) supported all analysis and writing of the paper.

Ruth Salway (https://orcid.org/0000-0002-3242-3951) (Senior Research Associate, Statistics) edited the paper for intellectual content.

Lydia Emm-Collison (https://orcid.org/0000-0002-5493-3223) (Lecturer in Physical Activity and Behaviour Change) edited the paper for intellectual content.

Katie Breheny (https://orcid.org/0000-0001-6886-4049) (Senior Research Associate, Health Economics) edited the paper for intellectual content.

Kate Sansum (https://orcid.org/0000-0003-3392-6750) (Fieldworker) edited the paper for intellectual content.

Sarah Churchward (https://orcid.org/0009-0007-7765-3682) (PPI member of Study Management Group) edited the paper for intellectual content.

Joanna G Williams (https://orcid.org/0000-0002-4737-1760) (Consultant in Public Health) edited the paper for intellectual content.

Frank de Vocht (https://orcid.org/0000-0003-3631-627X) (Professor in Epidemiology and Public Health) edited the paper for intellectual content.

Russell Jago (https://orcid.org/0000-0002-3394-0176) (Principal Investigator, Professor of Physical Activity and Public Health) oversaw all aspects of study design and interpretation, and edited the paper for intellectual content.

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/KLML4701.

Primary conflicts of interest: Russell Jago, Katie Breheny and Frank de Vocht are partly funded by the National Institute for Health Research (NIHR) Applied Research Collaboration West (NIHR ARC West) at University Hospitals Bristol NHS Foundation Trust and the University of Bristol. Russell Jago is partly funded by the National Institute for Health and Care Research Bristol Biomedical Research Centre, and was a member of the PHR Prioritisation Group (11 October 2019–12 October 2021) and a member of the NIHR PHR – Research Funding Board (1 June 2014–12 October 2021). Frank de Vocht has been on the NIHR Public Health Research Funding Board since 8 October 2019.

Ethics statement

Ethical approval was gained from the School of Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150), on 9 March 2021. The project was listed on the Research Registry.

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Information governance statement

The University of Bristol is committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Bristol is the Data Controller, and you can find out more about how we handle personal data, including how to exercise your individual rights and the contact details for our Data Protection Officer here (www.bristol.ac.uk/secretary/data-protection/).

Funding

This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847. The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, the PHR programme or the Department of Health and Social Care. If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, the PHR programme or the Department of Health and Social Care. Study data were collected and managed using REDCap hosted at the University of Bristol. The sponsor of this study is University of Bristol, Research and Enterprise Development, One Cathedral Square, Bristol, BS1 5DD, UK www.bristol.ac.uk/red/.

Article history

The contractual start date was in April 2021. This article began editorial review in February 2023 and was accepted for publication in July 2023. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PHR editors and production

house have tried to ensure the accuracy of the authors' article and would like to thank the reviewers for their constructive comments on this article document. However, they do not accept liability for damages or losses arising from material published in this article.

This article reports on one component of the research award The impact of the COVID-19 pandemic on the physical activity environment in English primary schools: a multi-perspective qualitative analysis. For more information about this research please view the award page [https://www.fundingawards.nihr.ac.uk/award/NIHR131847]

List of abbreviations

CMOs	chief medical officers	PPI	patient and public involvement
CPD	continuing professional development	SAT	standard assessment test
		SES	socioeconomic status
IMD	Index of Multiple Deprivation	SLT	senior leadership team
MVPA	moderate to vigorous intensity physical activity	WHO	World Health Organization
PE	physical education		

References

1. Bull FC, Al-Ansari SS, Biddle S, Borodulin K, Buman MP, Cardon G, *et al*. World Health Organization 2020 guidelines on physical activity and sedentary behaviour. *Br J Sports Med* 2020;**54**(24):1451–62. https://doi.org/10.1136/bjsports-2020-102955
2. Chaput JP, Willumsen J, Bull F, Chou R, Ekelund U, Firth J, *et al*. 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: summary of the evidence. *Int J Behav Nutr Phys Act* 2020;**17**(1):141. https://doi.org/10.1186/s12966-020-01037-z
3. Telama R. Tracking of physical activity from childhood to adulthood: a review. *Obes Facts* 2009;**2**(3):187–95. https://doi.org/10.1159/000222244
4. Telama R, Yang X, Leskinen E, Kankaanpaa A, Hirvensalo M, Tammelin T, *et al*. Tracking of physical activity from early childhood through youth into adulthood. *Med Sci Sports Exerc* 2014;**46**(5):955–62. https://doi.org/10.1249/MSS.0000000000000181
5. Ekelund U, Luan J, Sherar LB, Esliger DW, Griew P, Cooper A, International Children's Accelerometry Database (ICAD) Collaborators. Moderate to vigorous physical activity and sedentary time and cardiometabolic risk factors in children and adolescents. *JAMA* 2012;**307**(7):704–12. https://doi.org/10.1001/jama.2012.156
6. Strong WB, Malina RM, Blimkie CJ, Daniels SR, Dishman RK, Gutin B, *et al*. Evidence based physical activity for school-age youth. *J Pediatr* 2005;**146**(6):732–7. https://doi.org/10.1016/j.jpeds.2005.01.055
7. de Greeff JW, Bosker RJ, Oosterlaan J, Visscher C, Hartman E. Effects of physical activity on executive functions, attention and academic performance in preadolescent children: a meta-analysis. *J Sci Med Sport* 2018;**21**(5):501–7. https://doi.org/10.1016/j.jsams.2017.09.595
8. Schuch FB, Stubbs B. The role of exercise in preventing and treating depression. *Curr Sports Med Rep* 2019;**18**(8):299–304.
9. Owen CG, Nightingale CM, Rudnicka AR, Sattar N, Cook DG, Ekelund U, Whincup PH. Physical activity, obesity and cardiometabolic risk factors in 9- to 10-year-old UK children of white European, South Asian and black African-Caribbean origin: the Child Heart And health Study in England (CHASE). *Diabetologia* 2010;**53**(8):1620–30. https://doi.org/10.1007/s00125-010-1781-1
10. Skrede T, Steene-Johannessen J, Anderssen SA, Resaland GK, Ekelund U. The prospective association between objectively measured sedentary time, moderate-to-vigorous physical activity and cardiometabolic risk factors in youth: a systematic review and meta-analysis. *Obes Rev* 2019;**20**(1):55–74. https://doi.org/10.1111/obr.12758
11. United Kingdom Chief Medical Officers. *UK Chief Medical Officers' Physical Activity Guidelines*. London: Department of Health and Social Care; 2019.
12. Kharel M, Sakamoto JL, Carandang RR, Ulambayar S, Shibanuma A, Yarotskaya E, *et al*. Impact of COVID-19 pandemic lockdown on movement behaviours of children and adolescents: a systematic review. *BMJ Glob Health* 2022;**7**(1):e007190. https://doi.org/10.1136/bmjgh-2021-007190
13. Chang TH, Chen YC, Chen WY, Chen CY, Hsu WY, Chou Y, Chang Y-H. Weight gain associated with COVID-19 lockdown in children and adolescents: a systematic review and meta-analysis. *Nutrients* 2021;**13**(10):3668. https://doi.org/10.3390/nu13103668

14. Bates LC, Zieff G, Stanford K, Moore JB, Kerr ZY, Hanson ED, *et al*. COVID-19 impact on behaviors across the 24-hour day in children and adolescents: physical activity, sedentary behavior, and sleep. *Children (Basel)* 2020;**7**(9):138. https://doi.org/10.3390/children7090138

15. Stockwell S, Trott M, Tully M, Shin J, Barnett Y, Butler L, *et al*. Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. *BMJ Open Sport Exerc Med* 2021;**7**(1):e000960. https://doi.org/10.1136/bmjsem-2020-000960

16. Burkart S, Parker H, Weaver RG, Beets MW, Jones A, Adams EL, *et al*. Impact of the COVID-19 pandemic on elementary schoolers' physical activity, sleep, screen time and diet: a quasi-experimental interrupted time series study. *Pediatr Obes* 2022;**17**(1):e12846. https://doi.org/10.1111/ijpo.12846

17. Ganzar LA, Salvo D, Burford K, Zhang Y, Kohl HW, Hoelscher DM. Longitudinal changes in objectively-measured physical activity and sedentary time among school-age children in Central Texas, US during the COVID-19 pandemic. *Int J Behav Nutr Phys Act* 2022;**19**(1):56. https://doi.org/10.1186/s12966-022-01299-9

18. Dallolio L, Marini S, Masini A, Toselli S, Stagni R, Bisi MC, *et al*. The impact of COVID-19 on physical activity behaviour in Italian primary school children: a comparison before and during pandemic considering gender differences. *BMC Public Health* 2022;**22**(1):52. https://doi.org/10.1186/s12889-021-12483-0

19. ten Velde G, Lubrecht J, Arayess L, van Loo C, Hesselink M, Reijnders D, Vreugdenhil A. Physical activity behaviour and screen time in Dutch children during the COVID-19 pandemic: pre-, during- and post-school closures. *Pediatr Obes* 2021;**16**(9):e12779. https://doi.org/10.1111/ijpo.12779

20. Riazi NA, Wunderlich K, Gierc M, Brussoni M, Moore SA, Tremblay MS, Faulkner G. 'You can't go to the park, you can't go here, you can't go there': exploring parental experiences of COVID-19 and its impact on their children's movement behaviours. *Children (Basel)* 2021;**8**(3):219. https://doi.org/10.3390/children8030219

21. Szpunar M, Vanderloo LM, Bruijns BA, Truelove S, Burke SM, Gilliland J, *et al*. Children and parents' perspectives of the impact of the COVID-19 pandemic on Ontario children's physical activity, play, and sport behaviours. *BMC Public Health* 2021;**21**(1):2271. https://doi.org/10.1186/s12889-021-12344-w

22. Richards AB, Minou M, Sheldrick MP, Swindell N, Griffiths LJ, Hudson J, Stratton G. A socioecological perspective of how physical activity and sedentary behaviour at home changed during the first lockdown of COVID-19 restrictions: the HomeSPACE project. *Int J Environ Res Public Health* 2022;**19**(9):5070. https://doi.org/10.3390/ijerph19095070

23. Hurter L, McNarry M, Stratton G, Mackintosh K. Back to school after lockdown: the effect of COVID-19 restrictions on children's device-based physical activity metrics. *J Sport Health Sci* 2022;**11**:530–6. https://doi.org/10.1016/j.jshs.2022.01.009

24. Rossi L, Behme N, Breuer C. Physical activity of children and adolescents during the COVID-19 pandemic: a scoping review. *Int J Environ Res Public Health* 2021;**18**(21):11440. https://doi.org/10.3390/ijerph182111440

25. Sport England. *Active Lives Children and Young People Survey Coronavirus (COVID-19) Report: Mid-May to late-July 2020 (The Summer Term)*. London: Sport England; 2021.

26. Neville RD, Lakes KD, Hopkins WG, Tarantino G, Draper CE, Beck R, Madigan S. Global changes in child and adolescent physical activity during the COVID-19 pandemic: a systematic review and meta-analysis. *JAMA Pediatr* 2022;**176**(9):886–94. https://doi.org/10.1001/jamapediatrics.2022.2313

27. Richards AB, Sheldrick MP, Swindell N, Barker HG, Hudson J, Stratton G. Qualitative changes in children's physical activity and sedentary behaviours throughout the COVID-19 pandemic: the HomeSPACE project. *PLOS ONE* 2023;**18**(1):e0280653. https://doi.org/10.1371/journal.pone.0280653

28. Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**(1):51. https://doi.org/10.1186/s12966-022-01290-4

29. Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Act* 2022;**19**(1):114. https://doi.org/10.1186/s12966-022-01356-3

30. Jago R, Salway R, House D *et al*. Short and medium term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment. *Int J Behav Nutr Phys Act* 2023;**20**(42). https://doi.org/10.1186/s12966-023-01441-1

31. Faulkner G, Zeglen L, Leatherdale S, Manske S, Stone M. The relationship between school physical activity policy and objectively measured physical activity of elementary school students: a multilevel model analysis. *Arch Public Health* 2014;**72**(1):20. https://doi.org/10.1186/2049-3258-72-20

32. Harvey A, Faulkner G, Giangregorio L, Leatherdale ST. An examination of school- and student-level characteristics associated with the likelihood of students' meeting the Canadian physical activity guidelines in the COMPASS study. *Can J Public Health* 2017;**108**(4):e348–54. https://doi.org/10.17269/cjph.108.5925

33. Brazendale K, Beets MW, Armstrong B, Weaver RG, Hunt ET, Pate RR, *et al*., International Children's Accelerometry Database (ICAD) Collaborators. Children's moderate-to-vigorous physical activity on weekdays versus weekend days: a multi-country analysis. *Int J Behav Nutr Phys Act* 2021;**18**(1):28. https://doi.org/10.1186/s12966-021-01095-x

34. Brazendale K, Beets MW, Weaver RG, Pate RR, Turner-McGrievy GM, Kaczynski AT, *et al*. Understanding differences between summer vs. school obesogenic behaviors of children: the structured days hypothesis. *Int J Behav Nutr Phys Act* 2017;**14**(1):100. https://doi.org/10.1186/s12966-017-0555-2

35. Olds T, Maher C, Dumuid D. Life on holidays: differences in activity composition between school and holiday periods in Australian children. *BMC Public Health* 2019;**19**(S2). https://doi.org/10.1186/s12889-019-6765-6

36. Jago R, Salway R, Lawlor DA, Emm-Collison L, Heron J, Thompson JL, Sebire SJ. Profiles of children's physical activity and sedentary behaviour between age 6 and 9: a latent profile and transition analysis. *Int J Behav Nutr Phys Act* 2018;**15**(1):103. https://doi.org/10.1186/s12966-018-0735-8

37. Jago R, Foster C, Williams J, de Vocht F, Hollingworth W. *Protocol for Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts & Provide Rapid Evidence to Policy Makers (ACTIVE-6)*. 2021. URL: https://fundingawards.nihr.ac.uk/award/NIHR131847 (accessed 10 January 2024).

38. Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al*. Screen-viewing behaviours of children before and after the 2020–21 COVID-19 lockdowns in the UK: a mixed methods study. *BMC Public Health* 2023;**23**(116). https://doi.org/10.1186/s12889-023-14976-6

39. Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Public Health* 2023;**23**(1432). https://doi.org/10.1186/s12889-023-16021-y

40. Jago R, Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA. Association of BMI category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. *Int J Obes (Lond)* 2020;**44**(1):104–13. https://doi.org/10.1038/s41366-019-0459-0

41. Malterud K, Siersma VD, Guassora AD. Sample size in qualitative interview studies: guided by information power. *Qual Health Res* 2016;**26**(13):1753–60. https://doi.org/10.1177/1049732315617444

42. Jago R, Bailey R. Ethics and paediatric exercise science: issues and making a submission to a local ethics and research committee. *J Sports Sci* 2001;**19**(7):527–35. https://doi.org/10.1080/026404101750238980

43. Gale NK, Heath G, Cameron E, Rashid S, Redwood S. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Med Res Methodol* 2013;**13**(1):117. https://doi.org/10.1186/1471-2288-13-117

45. Archer M, Bhaskar R, Collier A, Lawson T, Norrie A. *Critical Realism: Essential Readings*. London: Routledge; 2013.

46. Alcántara-Porcuna V, Sánchez-López M, Martínez-Andrés M, Martínez-Vizcaíno V, Ruíz-Hermosa A, Rodríguez-Martín B. Teachers' perceptions of barriers and facilitators of the school environment for physical activity in schoolchildren: a qualitative study. *Qual Res Sport Exerc Health* 2022;**14**(7):1113–37. https://doi.org/10.1080/2159676x.2022.2037696

47. Copeland KA, Kendeigh CA, Saelens BE, Kalkwarf HJ, Sherman SN. Physical activity in child-care centers: do teachers hold the key to the playground? *Health Educ Res* 2012;**27**(1):81–100. https://doi.org/10.1093/her/cyr038

48. Webster CA, Zarrett N, Cook BS, Egan C, Nesbitt D, Weaver RG. Movement integration in elementary classrooms: teacher perceptions and implications for program planning. *Eval Program Plann* 2017;**61**:134–43. https://doi.org/10.1016/j.evalprogplan.2016.12.011

49. Michael RD, Webster CA, Egan CA, Nilges L, Brian A, Johnson R, Carson RL. Facilitators and barriers to movement integration in elementary classrooms: a systematic review. *Res Q Exerc Sport* 2019;**90**(2):151–62. https://doi.org/10.1080/02701367.2019.1571675

50. Morgan PJ, Hansen V. Classroom teachers' perceptions of the impact of barriers to teaching physical education on the quality of physical education programs. *Res Q Exerc Sport* 2008;**79**(4):506–16. https://doi.org/10.1080/02701367.2008.10599517

51. Emm-Collison L, Cross R, Garcia Gonzalez M, Watson D, Foster C, Jago R. Children's voices in physical activity research: a qualitative review and synthesis of UK children's perspectives. *Int J Environ Res Public Health* 2022;**19**(7):3993. https://doi.org/10.3390/ijerph19073993

52. Sylvester BD, Jackson B, Beauchamp MR. The effects of variety and novelty on physical activity and healthy nutritional behaviors. In Elliot AJ, editor. *Advances in Motivation Science*, vol. 5. Oxford: Elsivier. 2018. pp. 169–202.

53. Norrish H, Farringdon F, Bulsara M, Hands B. The effect of school uniform on incidental physical activity among 10-year-old children. *Asia Pac J Health Sport Phys Educ* 2012;**3**(1):51–63. https://doi.org/10.1080/18377122.2012.666198

54. McCarthy N, Hope K, Sutherland R, Campbell E, Hodder R, Wolfenden L, Nathan N. Australian primary school principals', teachers', and parents' attitudes and barriers to changing

school uniform policies from traditional uniforms to sports uniforms. *J Phys Act Health* 2020;**17**(10):1019–24. https://doi.org/10.1123/jpah.2020-0116

55. Nathan N, McCarthy N, Hope K, Sutherland R, Lecathelinais C, Hall A, *et al*. The impact of school uniforms on primary school student's physical activity at school: outcomes of a cluster randomized controlled trial. *Int J Behav Nutr Phys Act* 2021;**18**(1):17. https://doi.org/10.1186/s12966-021-01084-0

56. O'Reilly M, Wiltshire G, Kiyimba N, Harrington D. 'Is everybody comfortable?' thinking through co-design approaches to better support girls' physical activity in schools. *Qual Res Sport Exerc Health* 2022;**15**:248–63. https://doi.org/10.1080/2159676x.2022.2083663

57. Elliott D, Hoyle K. An examination of barriers to physical education for Christian and Muslim girls attending comprehensive secondary schools in the UK. *Eur Phys Educ Rev* 2014;**20**(3):349–66. https://doi.org/10.1177/1356336x14534358

58. Jago R, Salway R, House D, Beets M, Lubans DR, Woods C, de Vocht F. Rethinking children's physical activity interventions at school: a new context-specific approach. *Front Public Health* 2023;**11**. https://doi.org/10.3389/fpubh.2023.1149883

59. Jago R, Macdonald-Wallis K, Thompson JL, Page AS, Brockman R, Fox KR. Better with a buddy: influence of best friends on children's physical activity. *Med Sci Sports Exerc* 2011;**43**(2):259–65. https://doi.org/10.1249/MSS.0b013e3181edefaa

60. Hills AP, Dengel DR, Lubans DR. Supporting public health priorities: recommendations for physical education and physical activity promotion in schools. *Prog Cardiovasc Dis* 2015;**57**(4):368–74. https://doi.org/10.1016/j.pcad.2014.09.010

61. Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lock-downs: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

62. Salway R, de Vocht F, Emm-Collison L, Sansum K, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: A latent profile analysis. *PLOS ONE* 2023;**18**(11):e0289344. https://doi.org/10.1371/journal.pone.0289344

Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed-methods study from a self-determination theory perspective

Lydia Emm-Collison,[1*] Robert Walker,[1] Ruth Salway,[1,2] Danielle House,[1] Kate Sansum,[1] Katie Breheny,[2] Sarah Churchward,[3] Joanna G Williams,[2,4] Frank de Vocht[2,5] and Russell Jago[1,2,5]

[1]Centre for Exercise, Nutrition & Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[2]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]Independent Public Member of the Project Team
[4]Communities and Public Health, Bristol City Council, Bristol, UK
[5]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK

[*]Corresponding author

Published March 2024
DOI: 10.3310/KPKW8220

This article should be referenced as follows:

Emm-Collison L, Walker R, Salway R, House D, Sansum K, Breheny K, *et al.* Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed-methods study from a self-determination theory perspective. *Public Health Res* 2024;**12**(16):105–146. https://doi.org/10.3310/KPKW8220

Abstract

Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed-methods study from a self-determination theory perspective

Lydia Emm-Collison,[1*] Robert Walker,[1] Ruth Salway,[1,2] Danielle House,[1] Kate Sansum,[1] Katie Breheny,[2] Sarah Churchward,[3] Joanna G Williams,[2,4] Frank de Vocht[2,5] and Russell Jago[1,2,5]

[1]Centre for Exercise, Nutrition & Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[2]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]Independent Public Member of the Project Team
[4]Communities and Public Health, Bristol City Council, Bristol, UK
[5]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK

[*]Corresponding author Lydia.Emm-Collison@bristol.ac.uk

Background and objectives: The COVID-19 lockdowns impacted physical activity for all, but especially parents, because they had to balance home, work and leisure activities. Motivation for exercise is consistently shown to be associated with physical activity levels. Self-determination theory provides a framework through which the motivation for exercise and its social-contextual antecedents can be explored. The purpose of this study is to explore the role of motivation in determining physical activity in parents and carers of English primary school children before, during and after the COVID-19 lockdowns.

Design, setting and participants: This study uses a mixed-methods design combining quantitative data and individual interviews. Participants were all parents/carers of children in year 6 (aged 10–11 years) at English primary schools in the United Kingdom.

Methods: Quantitative data were collected on three occasions: between March 2017 and May 2018 (Wave 0, *N* = 1296), between May and December 2021 (Wave 1, *N* = 393) and between January and July 2022 (wave 2, *N* = 436). Motivation for exercise was assessed using the Behavioural Regulations in Exercise Questionnaire-2 and moderate-to-vigorous physical activity was estimated via waist-worn accelerometers. Data were analysed via regression models. Interviews with a subsample of parents (*N* = 43) were conducted on two occasions: between September and December 2021 and between February and July 2022. Interviews covered the impact of the pandemic on children and parents' physical activity and changes over time. This study focuses on discussions around the parents' own physical activity behaviour and their motivation. The framework method was used for analysis.

Results: In separate linear regression models, intrinsic and identified regulation were associated with higher moderate-to-vigorous physical activity in waves 0 and 2. Amotivation was associated with lower moderate-to-vigorous physical activity in waves 0 and 2. In fully adjusted multivariable regression models, identified regulation was associated with a 4.9-minute increase in moderate-to-vigorous physical activity and introjected regulation was associated with a 2.3-minute decrease in moderate-to-vigorous physical activity at wave 0. Associations with moderate-to-vigorous physical activity were different in wave 2, with introjected regulation changing direction and a negative association with amotivation, although confidence intervals were wide due to smaller sample sizes. In the interviews,

parents spoke of the effects that the COVID-19 lockdowns had on their motivation to be physically active in four theoretically driven themes: (1) motivation for physical activity, (2) perceived autonomy for physical activity, (3) perceived competence for physical activity and (4) perceived relatedness for physical activity.

Limitations: The smaller sample sizes for waves 1 and 2 may have limited the ability to identify associations between behavioural regulations and moderate-to-vigorous physical activity post pandemic. Across all waves, parents were predominantly active, females, white and from higher socioeconomic areas and therefore may not reflect broader experiences.

Conclusions and future work: Autonomous motivation, especially enjoyment and the importance for mental and physical well-being, was a key driver in keeping parents active during lockdowns and remains important for physical activity post lockdown, with introjected regulation potentially playing an increased role. Parents' interviews highlighted that while for some the lockdowns *promoted* autonomous motivation for exercise, others had enduring *negative* influences on their autonomy, competence and relatedness, which could be detrimental to their well-being. Strategies that focus on offering a range of novel activities for parents and that bring parent groups together may be effective.

Funding: This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847.

Plain language summary

What was the question?

The COVID-19 pandemic affected parents' ability to be active. Motivation is important for taking part in physical activity. We wanted to know how motivation for exercise had changed since before the pandemic and how it might still impact parents' physical activity.

What did we do?

We asked groups of parents of children in year 6 (aged 10–11 years) to complete a questionnaire and wear a device that measures physical activity. One group did this before the pandemic and two groups did this after the lockdowns. We also spoke to parents two times after schools reopened. We asked about their physical activity, what they felt helped or stopped them being active and how this changed during the pandemic.

What did we find?

Motivation plays a part in how much physical activity parents do. Enjoying activities, being active because it is part of your identity and being active due to health make parents more active. Some parents felt they were more active in the first lockdown, as they had more time, freedom and a choice of new and exciting activities, while others felt the lockdowns led to them being less active. This was due to a loss of connection with other people and feeling less confident in their physical activity.

What does this mean?

This means that

- it is important that parents are well-supported in their physical activity post pandemic
- efforts to help parents be active should focus on creating opportunities for parents to try new activities
- opportunities for parents to be active together might lead to more physical activity, improved connections with others and better well-being.

Background

Physical activity is positively associated with physical health and well-being.[1,2] In the UK it is recommended that adults aged 19–64 years engage in at least 150 minutes of moderate-to-vigorous physical activity (MVPA) or 75 minutes of vigorous physical activity per week.[3] However, there is consistent evidence to show that many adults do not meet these recommendations.[4–6] Around 42% of the UK adult population are parents of dependent-age children.[7] Evidence indicates that parents of dependent-age children are less active than non-parents[8,9] and promoting more physical activity in parents could also have health benefits for the child.[10] Identifying appropriate routes to promote greater physical activity engagement in parents is, therefore, a key public health objective.

Low levels of physical activity may be due to low motivation or inconsistent self-regulatory processes.[11,12] Self-determination theory (SDT) is a theory of human motivation that conceptualises motivation as a multidimensional construct and offers a framework to explore the impact of motivation quality on behaviour,[13] including physical activity.[14] Within SDT, it is proposed that motivation exists on a continuum where different types of motivation differ in the extent to which they are *autonomous* and *controlled*.[15,16] More autonomous forms of motivation are intrinsic motivation, characterised by enjoyment and satisfaction from being physically active; integrated regulation, when being physically active aligns with an individual's identity; and identified regulation, characterised by personally valuing being active.[13] More controlled forms of motivation are introjected regulation, where behaviour is driven by internal pressures such as avoiding feelings of guilt, and external regulation, where behaviour is driven by external pressures such as rewards.[15] A lack of motivation is referred to as amotivation.[13] Evidence shows that more autonomous motivation is associated with higher self-reported and accelerometer-assessed physical activity[17,18] and is central to facilitating long-term behaviour change leading to long-term physical activity engagement.[19–22]

Autonomous motivation is facilitated when the three basic psychological needs are satisfied: (1) autonomy (feelings of volition, ownership and the self-endorsement of actions),[23] (2) competence (a sense of mastery over behaviour)[13] and (3) relatedness (feeling connected, involved and cared for).[13] Supportive environments contribute to the satisfaction of psychological needs and subsequently facilitate more autonomous motivation, whereas environments that thwart psychological needs contribute to the frustration of these needs and inhibit autonomous motivation.[24–27]

The COVID-19 pandemic led to nationwide lockdowns in England, which limited physical activity opportunities for all. Data collected during the lockdowns indicate that activity levels reduced among adults.[28–31] However, our findings suggest that parent's MVPA returned to pre-pandemic levels shortly after lockdowns were lifted and has potentially increased a year following the easing of restrictions.[32] Evidence from a SDT perspective indicates that associations between behavioural regulations and physical activity may have been tempered by the COVID-19 lockdowns.[33] However, this was based on retrospective reporting and so there is a need for data from more robustly designed studies to explore the changing associations between motivation and MVPA. Many of the movement restrictions during the COVID-19 lockdowns have the potential to thwart the basic psychological needs (e.g. less choice about daily activities, a loss of structure and less social connection). However, there has been little exploration of individuals' experiences of lockdown restrictions from a SDT perspective. Furthermore, evidence suggests that parents were disproportionally adversely affected by the lockdowns in terms of their physical activity levels, physical activity motivation and well-being.[34] It is important to understand the psychological mechanisms underpinning the impact that lockdown restrictions had on parents' motivation for physical activity and their physical activity engagement to inform the development of strategies to support parents' physical activity.

Aims and objectives

This study aims to explore the changing role of motivation in determining physical activity in parents/carers of English primary school children before, during and after the COVID-19 lockdowns. Using a combination of quantitative and qualitative methods we will:

1. examine cross-sectional associations between behavioural regulations and parents' accelerometer-estimated physical activity before and after COVID-19 lockdowns in UK
2. explore parents' perceptions of their physical activity motivation during and after the COVID-19 lockdowns
3. explore the psychological mechanisms through which the COVID-19 lockdowns may have affected physical activity motivation and engagement.

Methods

This study provides quantitative data from two related studies. The B-Proact1v study[35,36] involved 1296 parents/carers of 10- to 11-year-old children recruited from 50 schools in England between March 2017 and May 2018 (wave 0). Active-6 is a follow-up study to explore the impact of the COVID-19 pandemic on the physical activity of 10- to 11-year-old children and their parents. In Active-6 study, 50 B-Proact1v schools were invited to participate between May and December 2021 (wave 1) and again between January and July 2022 (wave 2) with 23 and 27, respectively, schools participating; 393 parent/carers took part in wave 1 and 436 took part in wave 2. Qualitative interviews with a subsample of parents took place on two occasions: between August and September 2021 (wave 1) and between February and July 2022 (wave 2). In this study, we report cross-sectional comparisons of parents' motivation for physical activity before and after the COVID-19 lockdowns, using parent data from all three waves. We also report parents' qualitative perspectives on their motivation for physical activity during and after the COVID-19 lockdowns, using data from both waves 1 and 2.

Quantitative measures

Parents/carers completed a questionnaire which included their gender, height, weight and motivation for exercise. In wave 0, date of birth was used to calculate parent age and in waves 1 and 2 parents were asked to report their age category. Across all waves, height and weight were used to calculate body mass index (BMI). The Behavioural Regulation in Exercise Questionnaire-2 (BREQ-2) was used to assess motivation for exercise.[37] This 19-item measure assesses five forms of behavioural regulations: intrinsic regulation (e.g. *I enjoy my exercise sessions*), identified regulation (e.g. *It's important to me to exercise regularly*), introjected regulation (e.g. *I feel ashamed when I miss an exercise session*), external regulation (e.g. *I feel under pressure from family/friends to exercise*) and amotivation (e.g. *I don't see the point in exercising*). Responses were given on a 5-point Likert scale ranging from 0 (not true for me) to 4 (very true for me) and an average of items within the same subscale was taken to represent each behavioural regulation. The subscales showed very good internal consistency across all waves (see *Tables S1–S3*, *Report Supplementary Material 1*).

Parents were asked to wear a waist-mounted accelerometer (ActiGraph wGT3X-BT, ActiGraph, LLC, Pensacola, FL, USA) for 5 days, including 2 weekend days, in wave 0 and 7 days, including 2 weekend days, in waves 1 and 2. Accelerometer data from all waves were processed using a script written in R software available from the Open Science Framework.[38,39] Data between midnight and 6 a.m. were excluded and analysis was restricted to participants who provided at least 3 valid days of data, including at least 1 weekend day. A valid day was defined as at least 500 minutes of data after excluding intervals of at least 60 minutes of zero counts (indicating non-wear time) but allowing up to 2 minutes of interruptions.[40,41] Average MVPA minutes per day were derived for each participant using population-specific cut-off points for adults (≥ 2020 counts per minute).[42] As specified in the Active-6 protocol,[43] we used continuous MVPA as the outcome because this has more statistical power than a dichotomised variable and focuses on linear associations between motivation and physical activity, consistent with the motivation literature.

Quantitative analysis

Analyses were conducted in STATA MP version 17.[44] Only parents with valid accelerometer data and complete BREQ-2 data were included in the analyses (see *Table S4*, *Report Supplementary Material 1*). Cross-sectional linear regression models were used to examine associations between behavioural regulations and MVPA separately for each wave. First, regression analyses were conducted to explore the individual associations between each of the behavioural regulation types and average daily MVPA (separate motivation models). Next, multiple regression analyses were conducted with all five behavioural regulation types included in the model (combined motivation models). All models were

adjusted for age, gender and BMI.[41,45] Considering the broader study design, robust standard errors were used to account for clustering within schools, and residuals for all regression models were explored visually to check model assumptions.

Qualitative interviews

The qualitative phases of the Active-6 project are explained in detail elsewhere.[46,47] The data used in this study are taken from two phases of semistructured interviews with parents that took place between September and December 2021 (wave 1: 21 parents) and between February and July 2022 (wave 2: 22 parents). The interviews were conducted by RW (waves 1 and 2), TR (wave 1) and BT (wave 1). A variety of topics were covered, including the role of motivation (e.g. *To what extent do you feel that your motivation for physical activity changed at this time?*) and social influences (e.g. *To what extent did social distancing and not being able to see other people influence your/your child's physical activity*?). The present study uses qualitative data from these discussions that was concerned with parent's own physical activity engagement and motivation during different stages of the COVID-19 pandemic. Convenience sampling was used to recruit parents. Across the two waves of interviews, 36 parents were females, 33 were white British (5 white other), 36 were educated to degree level or higher and 34 were from less-deprived areas [higher Index of Multiple Deprivation (IMD) decile]. The sample were largely active with 14 classified as having medium activity and 23 classified as having high activity compared to other parents within the same school.

Qualitative analysis

The framework method was used to support qualitative data analysis with the aim of identifying commonalities among the qualitative data, exploring relationships between different parts of data and drawing explanatory conclusions based on themes.[48] There were seven stages to analysis: (1) verbatim transcription by a university-approved transcription service, (2) data familiarisation, (3) coding, (4) developing a working analytical framework, (5) applying the analytical framework, (6) charting data into the framework matrix and (7) interpreting the data. In the third stage, two transcripts were independently coded by three researchers (wave 1: RW, BT, TR, DH or KS; wave 2: RW, DH and KS). Interview content and interpretations were discussed and codebooks were developed inductively. These codebooks were then applied to the remaining transcripts. Coding was performed independently to facilitate researcher reflexivity and to support a more nuanced and deeper interpretation of the data. Following this, all codes were reviewed to determine whether they could be interpreted as aligning with the behavioural regulation types proposed within SDT or whether they could hold aspects of autonomy, competence and relatedness. These codes were then charted into a deductive, SDT-informed, framework matrix. Verbatim quotes are used to illustrate each of the subthemes. Quotes are presented alongside parent number, gender and data collection wave.

Patient and public involvement

The Active-6 project has been designed with patient and public involvement (PPI) at its centre. Year 6 children, parents, teachers and school staff in a variety of roles have been involved in all stages of the project including the research design, development of study materials and plans for dissemination. This has included parent representatives being active members of study governance groups, running child PPI group sessions at schools to review data collection methods and dissemination materials, and sharing early school-level results with schools and participating families.

Equality, diversity and inclusion

Equality, diversity and inclusion (EDI) were considered during participant recruitment for this study. Recruitment for each wave involved the monitoring of parent and school-level demographics, with some targeted recruitment in order to increase study inclusion (e.g. to increase the proportion of fathers in the qualitative interviews). For recruitment to the interviews in waves 1 and 2, parents were categorised as low, medium, or high MVPA level based on their accelerometer measured weekday MVPA in comparison to their school group, and their IMD score (based on home postcode), age, ethnicity and highest level of educational qualification were all noted. Intentional sampling helped to achieve a greater balance in wave 2 regarding parent gender.

Results

Quantitative results

Descriptive statistics for all study variables are presented in *Table 1*, correlations between variables are presented in *Tables S1–S3* (*Report Supplementary Material 1*) and a summary of missing data is presented in *Table S4* (*Report Supplementary Material 1*). Across waves, missing data were predominantly due to insufficient accelerometer data. In wave 0, the final sample consisted of 710 parents (73% were females) with an average BMI of 25.9 [standard deviation (SD) = 4.8]. In wave 1, the final sample consisted of 218 parents (77% were females) with an average BMI of 25.8 (SD = 5.0). In wave 2, the final sample consisted of 237 parents (77% were females), and average BMI was 25.7 (SD = 5.0). Across all waves, most parents were either aged 40–44 years (34–39%) or >45 years (35–38%). Average daily MVPA was highest in parents who participated in wave 2, with 56.4 minutes (SD = 27.5) compared to 51.8 minutes (SD = 25.6) in wave 0. The mean and SDs for motivation variables were largely consistent across each wave, with high levels of intrinsic and identified regulation and low levels of external regulation and amotivation. Correlations between behavioural regulation types were consistent across waves, with a strong positive association between identified and intrinsic regulation, moderate associations between amotivation and external regulation and between identified and introjected regulation, and moderate negative correlation between amotivation and identified/intrinsic regulation.

In separate motivation models, adjusted for age, gender and BMI, intrinsic and identified regulations were associated with higher MVPA in waves 0 and 2 (*Table 2*). Amotivation was associated with lower MVPA in waves 0 and 2 (see *Table 2*), with a larger association in wave 2. Combined motivation models

TABLE 1 Characteristics of participants and descriptive statistics of subscales in the cross-sectional regression analysis

	Wave 0 (%)	Wave 1 (%)	Wave 2 (%)
Age (years)			
< 39	23	30	28
40–44	39	35	34
> 45	38	35	38
Gender			
Female	73	77	77
Male	27	23	23
	M (SD)	M (SD)	M (SD)
BMI	25.86 (4.80)	25.79 (5.03)	25.74 (5.04)
MVPA (average minutes per day)	51.79 (25.55)	54.68 (25.00)	56.43 (27.47)
Motivation			
Intrinsic	2.50 (1.12)	2.67 (1.02)	2.65 (0.99)
Identified	2.63 (0.96)	2.79 (0.88)	2.75 (0.87)
Introjected	1.31 (1.06)	1.39 (1.06)	1.33 (1.07)
External	0.33 (0.55)	0.45 (0.71)	0.39 (0.62)
Amotivation	0.26 (0.55)	0.30 (0.64)	0.29 (0.59)

Note
Responses for motivation measures were provided on a scale of 0–4.

TABLE 2 Cross-sectional linear regression with MVPA

	Wave 0			Wave 1			Wave 2		
	β	*p*-value	CI (lower, upper)	β	*p*-value	CI (lower, upper)	β	*p*-value	CI (lower, upper)
Intrinsic	3.38	0.00	1.64 to 5.11	1.62	0.34	−1.83 to 5.07	4.84	0.05	0.11 to 9.58
Identified	4.72	0.00	2.53 to 6.92	2.11	0.33	−2.25 to 6.47	6.04	0.03	0.78 to 11.31
Introjected	−0.14	0.87	−1.85 to 1.58	−0.79	0.67	−4.58 to 3.00	3.46	0.13	−1.11 to 8.04
External	−2.29	0.21	−5.88 to 1.30	0.01	0.98	−3.70 to 3.71	−1.89	0.62	−9.56 to 5.79
Amotivation	−4.32	0.04	−8.39 to −0.25	−3.71	0.25	−10.28 to 2.84	−7.35	0.05	−14.80 to 0.10

Note
Models are adjusted for parents' gender, age, BMI and school clustering.

TABLE 3 Cross-sectional multiple regression between motivation variables and MVPA in fully adjusted models

	Wave 0			Wave 1			Wave 2		
	β	*p*-value	CI (lower, upper)	β	*p*-value	CI (lower, upper)	β	*p*-value	CI (lower, upper)
Intrinsic	0.77	0.55	−1.80 to 3.35	0.05	0.99	−5.33 to 5.42	1.96	0.50	−3.94 to 7.87
Identified	4.92	0.01	1.28 to 8.56	2.39	0.58	−6.43 to 11.21	2.37	0.43	3.67 to 8.42
Introjected	−2.31	0.04	−4.47 to −0.15	−2.04	0.38	−6.79 to 2.71	2.89	0.27	−2.32 to 8.10
External	0.25	0.91	4.16 to 4.66	2.59	0.33	−2.82 to 8.01	−1.44	0.77	−11.26 to 8.37
Amotivation	−1.39	0.58	−6.41 to 3.63	−4.08	0.41	−14.11 to 5.95	−4.67	0.29	−13.54 to 4.20

Note
Models are adjusted for parents' gender, age, BMI and school clustering.

(*Table 3*) found a positive association between identified regulation and MVPA in wave 0, with a one-unit increase in identified regulation associated with a 4.9-minute [95% CI (1.3 to 8.6)] increase in MVPA (adjusting for other forms of motivation), and a negative association between introjected regulation and MVPA, with a one-unit increase in introjected regulation associated with a 2.3-minute decrease in MVPA [95% CI (0.2 to 4.5)]. Small sample sizes mean that there was no evidence for an association between any types of behavioural regulation at wave 1 or 2, when adjusting for other types of behavioural regulation, although estimates for amotivation were larger in wave 2 compared to wave 0 and estimates for introjected regulation changed sign. Overall, the combined motivation model accounted for 8% of the total variance in MVPA at wave 0, 10% of the variance in MVPA at wave 1 and 11% of the variance in MVPA at wave 2, suggesting a slight increase in the overall role of motivation in parent physical activity post COVID-19 lockdowns. Residual plots did not reveal any issues with model assumptions.

Qualitative results

Parents spoke of their motivation for physical activity fluctuating through the course of the COVID-19 pandemic and identified several motivational factors that align with the regulation types specified within SDT. They also highlighted many features of the pandemic and associated lockdowns that impacted their motivation to be active, which can be mapped onto the basic psychological needs of autonomy, competence and relatedness. The qualitative results are presented in four theoretically driven themes with data-driven subthemes within each: (1) motivation for physical activity, (2) perceived autonomy for physical activity, (3) perceived competence for physical activity and (4) perceived relatedness for physical activity (see *Table 4* and *Figure 1* for subthemes).

TABLE 4 Themes and subthemes generated through qualitative work

Theoretically driven theme	Data-driven subtheme
1 Motivation for physical activity	1.1 Maintaining physical health
	1.2 Promoting mental well-being
	1.3 Enjoying physical activity
	1.4 Physical activity as part of identity
2 Perceived autonomy for physical activity	2.1 Access to activities
	2.2. Being creative with activity
	2.3 The luxury of time
	2.4 Repetitiveness of activities and increased pressures
3 Perceived competence for physical activity	3.1 Loss of structure
	3.2 Seeking challenge
4 Perceived relatedness for physical activity	4.1 Being active with others
	4.2 Being part of an active community
	4.3 Keeping connected at a distance

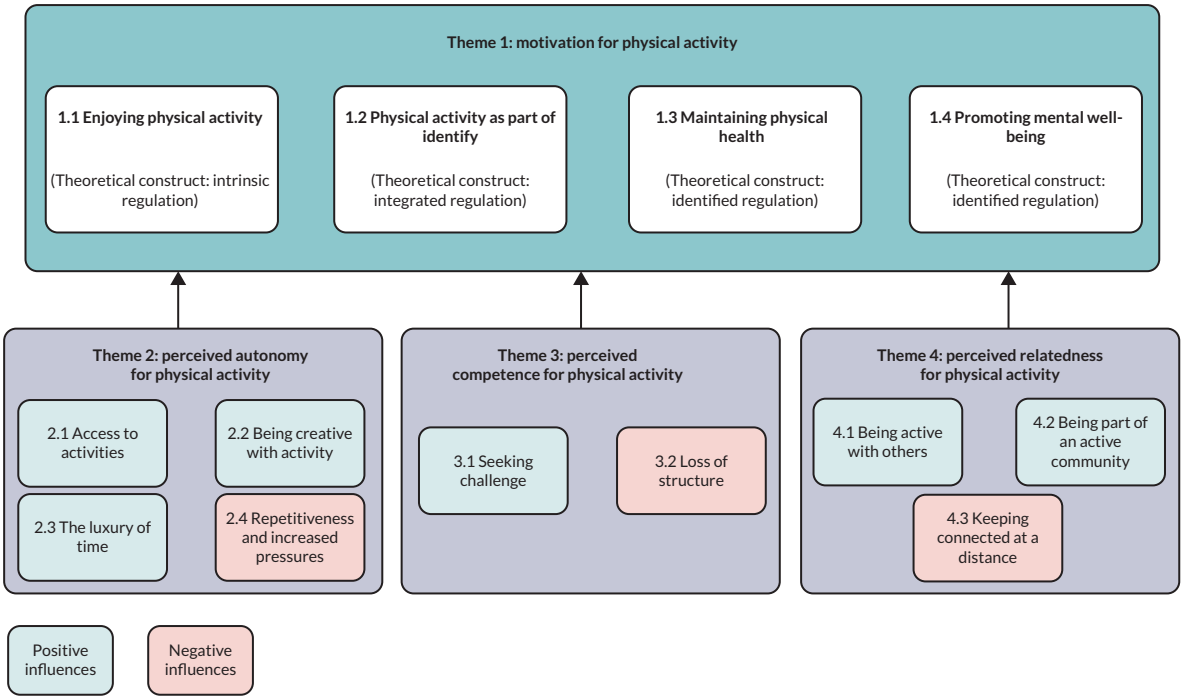

FIGURE 1 Thematic map with theoretical relationships between themes.

Theme 1: motivation for physical activity

Reflecting on the COVID-19 lockdowns in England, there were very different perspectives on the impact that the lockdowns had on parents' motivation to be physically active. Most parents spoke of fluctuating motivations during the pandemic related to the restrictions at the time, the weather and as the novelty of lockdowns waned (Theme 2). Some parents felt that the lockdowns pushed them to be more active.

> *Activity levels and motivation fluctuated a lot, particularly with motivation at an all-time low in the second lockdown.*
>
> *Parent 2, female, wave 2*

> *I made a conscious decision that I wanted to be more active in lockdown, my body probably told me that it needed to be more active. I think the more that you do the more you want to do.*
>
> *Parent 6, male, wave 2*

Participants spoke of a variety of reasons for engaging in physical activity during the COVID-19 lockdowns.

Maintaining physical health

In line with the identified regulation facet of SDT, many parents discussed their physical health, specifically focusing on maintaining or improving physical activity and avoiding adverse health outcomes:

> *If you're the type of person that understands the benefit to health of physical activity, you're going to want to do that regardless of obstacles. If you don't see the benefit then you're not going to do it anyway.*
>
> *Parent 2, female, wave 2*

A focus on physical health was often related to wanting to avoid adverse physical health that parents had seen in family members or wanting to control their own body weight, particularly during the pandemic:

> *For me, personally, my mum died when she was 49 with heart problems and a bad stroke, so I want to keep myself healthy.*
>
> *Parent 2, female, wave 1*

> *I did a big walk around the area. I was getting out, getting fresh air, getting some exercise. I think it was just because I felt like I had done a lot of sitting around, and a lot of not doing stuff. And I felt I'd put on a little bit of weight. I just didn't feel as fit as I did before [the pandemic].*
>
> *Parent 20, female, wave 1*

One parent reflected on how the pandemic raised public awareness of the importance of physical activity for maintaining well-being, suggesting that the pandemic has had a beneficial impact on motivation and subsequent physical activity levels:

> *… fitness for life and health thing is much bigger than things like wanting to play sport or lose weight. I think the pandemic really raised the awareness of how physical activity is crucial on those parts of your wellbeing, including mental and social health, as well.*
>
> *Parent 1, male, wave 2*

Promoting mental well-being

Also in line with identified regulation many parents used physical activity as a way of maintaining and promoting mental health and well-being. Primarily, the COVID-19 lockdowns and spending more time inside and at home led many parents to prioritise their exercise time as a way of preserving their mental health:

> *Once that first lockdown hit, I got into a routine where I prioritised that exercise because there were days where you wouldn't go outside. I would logout of everything and go on to that session because that was really important to me that I kept up that level of physical activity, and that was my absolute lifeline in lockdown for my sanity.*
>
> *Parent 15, female, wave 1*

For some parents, being outside in nature, through walks or spending time at their allotments, was particularly beneficial for their well-being, while for others the positive impact of physical activity on their mental health was attributed to the routine that their exercise time gave them:

> *I think I'm still feeling the effects of the second lockdown physically and in my attitude towards exercise. I think I benefit mentally and physically from being outside particularly in nature quite a lot.*
>
> *Parent 14, male, wave 2*

> *Myself and my partner have always been into fitness … A lot of it is for routine and mental health. If I don't feel like I've done anything, I do get really restless.*
>
> *Parent 11, female, wave 2*

Enjoying physical activity

Parents generally spoke of engaging in physical activity that they enjoyed during the COVID-19 lockdowns, either through continuing their previous pursuits, starting or restarting an activity (sometimes as a family). In line with intrinsic regulation within SDT, enjoyment of activities was the main driver for parents to continue to be active throughout the lockdowns, and those who began a new activity, enjoyment led them to continue the activity once restrictions were lifted. Parents who engaged in physical activity on their own saw this to be a valuable time to be themselves:

> *We got started doing more big long walks during the pandemic and we realised we quite enjoyed it, so we're continuing with that. You just feel the benefits of it, it's quite energising.*
>
> *Parent 2, female, wave 2*

> *The pandemic made me start something new, not being able to do anything else and with the gym closed. I would never have done it because I don't see myself as a runner. I do it at my own pace but I still enjoy it. I love being outside now and doing more walking and running rather than going back in the gym.*
>
> *Parent 12, female, wave 2*

However, some parents spoke of not inherently enjoying physical activity, meaning that they engaged in activity less frequently. While some parents spoke of not necessarily enjoying the activities, but their awareness of the benefits of certain activities meant that they still engaged in them:

> *I like swimming, and know it's good for me. I like walking the dog each day. I'm not sure if I enjoy Pilates but I know that it's good for me so I do that.*
>
> *Parent 13, female, wave 2*

Physical activity as part of identity

For some parents, being physically active is so engrained in who they are that there was never a consideration that the pandemic and associated lockdowns, closure of facilities and social distancing measures would lead to them being less active. The nature of physical activity becoming part of one's identity aligns with integrated regulation within SDT. This was related to their enjoyment of activity as well as learning from previous experience of major life changes where activity remained important to them throughout:

> *I've always done sport, I've always been physically active, and I have continued right through my teens into my twenties. So all of those different transition points where there may have been times where I decided that wasn't for me, as people hit their teens, as they have children, as they get married, etc., it always was something that still remained important to me. So for me, [during the pandemic] it was never a consideration to stop.*
>
> *Parent 15, female, wave 1*

> *I just love being outside in the weather and elements. We've got two dogs, so that is all part of it. I love going to beautiful places. I love that feeling when you're physically tired rather than mentally drained. It feels so, I suppose, integral to who I am.*
>
> *Parent 19, female, wave 2*

Theme 2: perceived autonomy for physical activity

Parents spoke of several positive aspects of the lockdowns that increased their physical activity-related autonomy. Some parents felt they had more choice about the activities they undertook, but this depended on the facilities they had access to, the geography of their local area, their access to exercise equipment and the increased amount of free time that they experienced as a result of the COVID-19 lockdowns. Parents felt that some parts of the lockdowns inhibited their perceptions of autonomy and had a negative impact on their physical activity motivation. In particular, throughout the winter lockdown the need to balance less-flexible working with periods of homeschooling as well as the novelty of the newer activities wearing off had a negative impact on parent's physical activity.

Access to activities

Having access to different activities kept many parents and families active during the pandemic, as it allowed them to ensure variety and choice over their daily activities (a key characteristic of autonomy). For some parents, this led to taking up new activities based on their location, while for others it was discovering new places to walk in their local area:

> *We live near the coast, so it's so opened our eyes to water-sports. Paddleboarding, surfing. Again, right on our doorstep.*
>
> *Parent 14, female, wave 1*

> *It was really good, actually because we found loads of walks around where we live, where we've lived all our lives, but we'd forgotten or didn't know were there. So, we just did all sorts of different walks with the dog, different places we hadn't been or not been for a long time.*
>
> *Parent 9, female, wave 1*

However, access to activities was seen to be a perpetuator of health inequalities during the pandemic. Parents recognised that specialist equipment within the home, or being able to afford certain activities, was a luxury that many families did not, and still do not, have access to:

> *I think the pandemic has just created even more of a gulf between those that have and those that haven't. I certainly think there are huge swathes of society that are in a far worse place than they were beforehand.*
>
> *Parent 1, male, wave 2*

However, the limitations that COVID-19 restrictions imposed also negatively impacted some parents' motivation to be physically active, such as the rule of only leaving the house for exercise once a day. This was particularly the case for parents who valued going for a daily walk as a family but then felt unable to engage in their usual exercise routines:

> *It was harder to maintain my activity levels in the very first lockdown, when you were officially only meant to go out once. If we'd been out for a family walk I didn't officially feel like I could go for an additional run or bike ride.*
>
> *Parent 10, female, wave 2*

Being creative with activity

The loss of previous routines and structures (theme 3), as well as a reduction in choice of activities, meant that parents were forced to be more creative with their physical activities. Parents spoke of thinking beyond their normal activities, considering what was available to them in their very local area as well as integrating indoor, and often screen-based, physical activity into their daily lives. Particularly in the first lockdown, the need to be creative and the novelty of new activities supported parents' autonomy and meant that enjoyment in being physically active increased:

> *Me and my friends were really bored with all online exercises, and we just ended up finding MTV Hip Hop workout videos from the '80s and things, just something that was a bit different. That was fun.*
>
> *Parent 17, female, wave 1*

> *[During the lockdowns] you didn't have the choice of the gym, or swimming pools and that kind of thing, so you had to find different resources. I've never used an app or done any exercise class stuff online. For myself, I just thought this is what I need to do. Now I've just got into that routine …*
>
> *Parent 7, female, wave 2*

The luxury of time

For many parents, the aspects of the lockdowns that had a positive impact on their autonomy and subsequent motivation, such as the ability to be creative with their physical activities, were directly related to an increase in free time. One parent described the first lockdown as *an extended summer holiday* with several parents highlighting that the loss of routine and structure (theme 3) during this time allowed them to be more flexible and spend quality time together being active as a family:

> *I think the first lockdown, if we're quite honest, we quite enjoyed as a family. We had time together, which we've never really had before. I mean we obviously had our moments where it wasn't utopian but it was a nice time. The weather was nice and we enjoyed being out and cycling and walking. Life felt very unpressurised.*
>
> *Parent 18, female, wave 1*

Repetitiveness of activities and increased pressures

Despite several aspects of the lockdowns having a positive impact on parent's perceived autonomy in the short term, the flexibility and novelty of the first lockdown started to wane as the pandemic progressed and restrictions stayed in place for longer than parents had anticipated. Physical activities that had previously been fun and exciting became repetitive, and perceived autonomy and motivation to maintain activity levels reduced. This was particularly discussed in relation to home workouts:

> *There were definitely motivational issues at the time for home workouts because it was like, 'Do we [whole family] have to do this again?'*
>
> *Parent 7, female, wave 1*

For parents in particular, as the pandemic progressed pressures increased from balancing working from home with the pressures of homeschooling. Thus, during the second winter lockdown, more effort was required to choose physical activity over more sedentary behaviours, and maintaining happiness and well-being meant that physical activity often reduced:

> *The second lockdown was a very dark time. I was expected to be working, while the children weren't at school with quite a lot of schoolwork pressure, without the support to do that. I spoke with the school as they only provided website stuff, no online lessons or anything. It was cold, dark, miserable and we couldn't go out and do stuff. You either decided to keep yourself healthy and get through this, or ride it through with the odd drink, loads of food, whatever it takes to be happy. I probably fluctuated between those.*
>
> *Parent 2, female, wave 2*

Theme 3: perceived competence for physical activity

Several subthemes discussed by parents align with aspects of physical activity-related competence. A loss of perceived physical activity competence during and after the lockdowns was felt due to the loss of daily structure and a subsequent loss of confidence in the activities they engaged in prior to the pandemic. Despite this, some parents mentioned trying to combat the loss of routine by seeking activity-related challenges, which they felt helped to keep them motivated in their activities, perhaps through supporting their need for competence.

Loss of structure

The loss of daily structure and routine was a key aspect of the lockdowns that parents highlighted as impacting their physical activity. This impacted on incidental activity, such as through commuting or normal work activities. This loss of structure had differing impacts on parents, with some able to replace this activity with another form of being active, while for others it made their overall day more sedentary:

> *I have started going in some days per week, back into work, and that means half an hour's walk each direction. I think for me, the not being able to go into work; that was a massive impact. I'm lucky that I can work from home, but it made it more urgent to replace the hour's walk each day, with something else.*
>
> *Parent 3, female, wave 1*

> *I made the effort, in my head mentally, to try and do more, because I realised that I was not doing the exercise, the incidental exercise, that I used to. So I did make an effort to, sort of, go out on the allowed hour's walk for the day.*
>
> *Parent 4, female, wave 1*

The loss of daily routine, and associated loss of structured physical activity for many parents, made the return to their previous activities more difficult, possibly due to the loss of physical activity habits that were a result of the lockdowns and associated restrictions:

> *A lot of the friends that I swim with are just dads from school. After a year and a half off, they've got out of the habit of it, so they've just not got back into it. I still go sometimes and try to coordinate with one of the other dads, but the rest have lost interest in swimming or gone their separate ways.*
>
> *Parent 5, male, wave 2*

In response to the loss of daily routine, parents spoke of trying to build and implement their own structures while largely based at home. This included integrating regular periods of physical activity into their daily routine, such as exercising first thing in the morning before work:

> *In Autumn 2020, we continued to work from home, so that made it necessary to carry on with the self-discipline of going for a run in the morning, or going to the gym, so it's a mixture of that.*
>
> *Parent 3, female, wave 1*

Seeking challenge

During the pandemic, many parents sought out physically active challenges to help them stay motivated and active. Feeling challenged in ones' pursuits, and having the structure in place to build on and overcome these challenges, is a key component of competence in SDT. Having an element of personal challenge to their activities and seeing personal improvement was something that several parents felt kept them motivated. These included daily walking challenges and programmes such as 'couch-to-5k'.

> *I'm not really a runner, but I did take on this year 5k for the Stroke Association in memory of my mum. I did a 5k at a school thing a few years ago and that nearly killed me. That was more peer pressure. But this time I trained. I went out in the rain, in the snow, in the hail and everything and really pushed myself mentally. Because I had a goal … I've tried to keep that up a little bit, on, off.*
>
> *Parent 2, female, wave 1*

> *We did the BRIT Challenge, so got to raise £2021 for universities. It's not competitive, but we had targets to try and do so many miles walking every week. I think that was quite motivating as well. So, it really encouraged me to go out running and walking and record those totals.*
>
> *Parent 5, female, wave 1*

Theme 4: perceived relatedness for physical activity

Issues related to social connection were frequently discussed in relation to aiding or inhibiting physical activity during the lockdowns and subsequent easing of restrictions. The importance of relatedness was highlighted by most parents talking of preferring to be active with friends and family, and, for some, the need to be active while meeting during lockdowns led to ongoing activity that continued as the pandemic eased. However, many physical activity-related connections from before COVID-19 lockdowns were not re-established once restrictions were eased. Some parents also spoke of finding social situations more overwhelming than before the lockdowns, which implicates their physical activity behaviour.

Being active with others

Parents frequently spoke of being active with other people, including friends and family, as being important for their motivation because of having increased connections and accountability. Parents reflected that being active with others is motivating; for example, it encourages walking further and building fitness. Several of these active relationships were established during the lockdowns and have remained in place:

> *The only one change that actually has remained [post lockdown], for me, is my best friend and I would all catch up. We used to go to each other's houses and go to the pub once a week, but, actually, during the lockdown we took to walk around our local business park quite a few times, having a chat and catching up*

> *that way, because we could not go into each other's houses, could not go anywhere, apart from outside. It is one habit that we have retained.*
>
> *Parent 4, female, wave 1*

> *We played tennis and five-a-side football a fair bit in between lockdowns when we could do socially, with friends and acquaintances. There're physical benefits but it's more the fun social thing. I guess that kind of innate blokey competitiveness as well. It gives you a bit of mental space to go off with some quite good friends, you've got your thing that you do.*
>
> *Parent 14, male, wave 2*

Being active with family was seen as a good parental practice, as it helps to make physical activity normal and a regular part of life. This led to several parents taking up a specific activity with their children:

> *We have just started a CrossFit parent and kid session in our CrossFit gym, encouraging more family participation in things. I think there's an opportunity around that, to help families that are struggling to be active.*
>
> *Parent 18, female, wave 2*

Although many parents valued the opportunity to be active with other people, some highlighted a lack of provision for working parents who want to meet others like them:

> *You see them all with their mat under their arm and tinkering off to the village hall. On a Monday, it's the ladies, and on a Tuesday, it's the gentlemen, and on a Wednesday, it's a mixed group. A big part of it is socialising, isn't it? It's just a shame that there isn't that for my generation.*
>
> *Parent 9, female, wave 2*

Being part of an active community

Parents reflected on the communities that they spend time in and felt that what was typical activity for their community impacted on how active they were during the pandemic. In some communities, this led to a reduction in activity, whereas for others spending time with people who valued being active encouraged them to maintain their activity levels throughout the lockdowns:

> *In my experience, it's sort of within the community, a lot of people didn't want to do exercise, and so, I think that was a total switch-off for people.*
>
> *Parent 6, female, wave 1*

> *A lot of the circles of people that I spend time with are probably quite similar mindset, so those people continued to exercise throughout lockdown, they've continued to exercise since. The majority of them anyway have continued with a pattern of something even if they've changed their activity, they've still continued to do something.*
>
> *Parent 15, female, wave 1*

Embedding themselves in an active community, such as joining an active sports club, helped many parents to continue being active even when the activity itself was not able to continue.

> *When you're used to being part of that team and your values and you've got responsibility and they're dependent on you turning up, [you get] that bit of a mindset of you just bite the bullet and go with it, even if you are a bit tired, even if you can't be bothered. You know, if you don't go, you're going to let people down.*
>
> *Parent 15, female, wave 1*

Keeping connected at a distance

Maintaining social connection throughout the pandemic was important to all parents and screens became the predominant way to do so. This also translated to their physical activity as many activities moved online, and the opportunity to connect with others in this way increased parents' perceptions of relatedness:

> *That hour of sport a day over Zoom was my time, and that was when everybody in the house knew that it doesn't matter what was going on, that's my gym time. It was a social connection. There were a lot of us that went to it. A lot of us that went on to those sessions were similar people of a similar background, similar age. It was just that support network of people that was someone different, that weren't your family that were living and breathing this with you. It was other people, and people that could push you as well.*
>
> *Parent 15, female, wave 1*

Although this helped some parents feel connected to others, for many being active online was not motivating and the online interaction that was relied on during the lockdowns was not an appropriate substitute for in-person socialising:

> *Personally, just the way I am. I am really not motivated to do exercise at home. Even having the accountability of somebody on Zoom, it is not really the same. It is not as fun.*
>
> *Parent 17, female, wave 1*

Discussion

This study presents a mixed-methods exploration of physical activity motivation and physical activity behaviour in parents of English primary school children during the COVID-19 pandemic and in the short- and medium-term recovery periods. The quantitative findings suggest that the role of motivation for exercise in determining physical activity engagement remains important following the COVID-19 pandemic and associated lockdowns, but differences in the magnitude of the estimates indicate that the impact of the lockdowns on behavioural regulations is complex. Qualitative interviews with parents highlighted several positive and negative impacts that the COVID-19 lockdowns had on their motivation for physical activity directly and on the motivational precursors of the basic psychological needs. In terms of negative impacts, there appears to be enduring negative influences on competence and relatedness satisfaction, which should be addressed in order to support parents to be physically active and to maintain their well-being. Conversely, parents who enjoyed physical activity (intrinsic regulation), were mindful of the physical and mental health benefits of being active (identified regulation) and felt that being active was part of their identity (integrated regulation) identified these as key drivers for themselves in maintaining physical activity levels throughout the lockdowns and in the recovery period.

The role of motivation for exercise in parent physical activity engagement remains important following lockdowns, with autonomous forms of motivation (intrinsic and identified regulation) and amotivation both appearing to be slightly more strongly associated with MVPA post lockdowns (wave 2). While post-lockdown sample sizes make it difficult to draw firm conclusions, introjected regulation may also be positively associated with MVPA in wave 2. This is in contrast to previous evidence that suggested behavioural regulations have become less important in determining physical activity behaviour in adults over the course of the pandemic.[33] However, the findings of the present study are based on accelerometer-estimated physical activity measured after the lockdowns and do not rely on retrospective self-report data. Moreover, our study specifically focuses on parents (the majority of whom are females) and so may not be indicative of all adults. Motivation is multidimensional in nature, with our findings highlighting that, individually, the behavioural regulations have both positive and negative associations with MVPA. Differences between waves in the multiple regression model, when behavioural regulation types are mutually adjusted for each other, suggest that there may be complex differences in how motivation types are associated with each other, particularly the role of identified and introjected regulations and amotivation. Previous analyses have emphasised how motivations can combine in different ways, leading to differential impacts on physical activity outcomes.[49,50] This is particularly the case for introjected regulation, which has been shown to combine with both more autonomous regulations and more controlled regulations, leading to very different motivation profiles and different levels of MVPA.[49] While interpretation is not straightforward, especially as behavioural regulation types are correlated with each other, it is possible that this reflects a post-lockdown increase in physical activity motivated by introjected regulation, for example, driven by internal pressures such as guilt. As previous evidence suggests that autonomous motivation is a better facilitator for more sustainable long-term behaviour change,[21] it is therefore possible that the increase in MVPA observed among parents may not last.

The qualitative data support the notion that there were complex changes to physical activity-related motivation during the COVID-19 lockdowns with some aspects of the pandemic having long-lasting effects on their motivation through the basic psychological needs of autonomy, competence and relatedness. Despite the lockdown restrictions, some parents felt that an increase in free time and opportunity to discover new ways to be physically active in their neighbourhood was facilitative of activity engagement and enjoyment during the first lockdown (starting in March 2020), but this novelty had worn off by the second lockdown (November 2020). Novelty satisfaction has been explored quantitatively and been shown to be positively associated with autonomous motivation for exercise, effort and enjoyment.[51] From SDT perspective, intrinsic regulation predicts physical activity engagement through inherent interest and enjoyment in the activity,[52–54] which novel activities have also been

shown to promote.[55] Relatedly, it has been hypothesised that novelty could be incorporated into SDT as a fourth basic psychological need highlighting the importance of this construct in promoting more autonomous forms of behavioural regulation.[56,57] The regular introduction of novel physical activity opportunities may therefore increase enjoyment and interest in being physically active and, as we emerge from the COVID-19 pandemic, it is imperative that there are opportunities for parents to try new activities.

Parents highlighted that the change in daily routines that occurred due to the lockdowns has had a long-lasting negative effect on their motivation to be physically active. Lockdowns resulted in a reduction in commuting, physical shopping trips and use of leisure facilities that previously helped parents to be active during the day, and evidence suggests that in the UK these behaviours have not returned to pre-pandemic patterns, with more online shopping and hybrid working patterns being prevalent.[58,59] Some systems for arranging organised physical activities that have remained in place following the COVID-19 restrictions, such as limited numbers and advance booking, have led to a loss of spontaneity.[47] Parents felt that attendance at organised activities became less predictable as the lockdowns eased and therefore planning their weekly schedules became more difficult. This, combined with a loss of confidence in their exercise abilities, may have inhibited some parents from re-establishing the physical activity routines and habits that were established pre COVID-19.[60,61] Many parents spoke of engaging in physical activity behaviours that were more informal and do not require booking, such as walking, cycling and running, which may indicate that the type of activities that parents engage in post COVID-19 have changed. This is in contrast to patterns seen in children, where organised active clubs have become the mainstay of activity for children following lockdowns,[47] particularly active clubs based at the child's school, but this has been socio-demographically patterned.[46,47,62,63]

The qualitative discussions highlighted the importance of social connection during the pandemic for increasing enjoyment and effort in physical activity. Connecting with others was often one of the main reasons for engaging in online physical activity and going for walks with friends. Quantitative evidence indicates that online physical activity platform use increased during the COVID-19 lockdowns and was associated with adults meeting physical activity recommendations.[64] However, it is evident that this online connection may not have been sufficient to satisfy the basic psychological need of relatedness, with many parents highlighting that they felt more isolated, with a feeling of social overwhelm as life post COVID-19 lockdowns resumed. More specific opportunities for parents of school-aged children to meet to be physically active are needed in order to support their well-being and increase social connectivity in this population.

Lessons learnt and future research

These findings suggest that there is a need for more targeted strategies to support parents of primary school children in their physical activity following COVID-19 to help maintain not only their own physical activity levels and well-being but also those of their children. Specifically, this study has three key findings and implications (*Table 5*). Strategies should aim to increase social connectivity and perceived competence through the use of novel physical activity opportunities. This may include group

TABLE 5 Key findings and implications

Key finding	Implication
Enjoyment of physical activity has decreased during lockdowns due to limited options	Promote a broad range of novel activities to increase enjoyment and autonomous forms of motivation
Many parents reported feeling socially isolated and overwhelmed	Harness physical activity as a means for parents of school-aged children to socially reconnect after the pandemic
Perceived competence for physical activity has decreased over the pandemic	Physical activities that allow parents to rebuild their perceived competence post pandemic are needed

activities that change location or activity type on a regular basis and that can be adapted to a lower intensity if needed. For example, our participants described sports/exercise clubs and walking groups as activities that they found beneficial.

However, in order to develop more targeted interventions, there is a need for more in-depth quantitative exploration of the role of individual behavioural regulations post pandemic, accounting for the multidimensional nature of motivation as to whether motivational profiles have changed as a result of the COVID-19 pandemic. While physical activity levels may have been maintained in this population – and for some parents the pandemic promoted more autonomous motivation for exercise – the COVID-19 restrictions appear to have had some enduring negative influences on parent's physical activity-related autonomy, competence and relatedness which, if sustained in the long term, could have a detrimental influence on parents' well-being.[13] Future research should therefore seek to work collaboratively with parents in order to identify what they would like in terms of physical activity opportunities. Additionally, there needs to be more exploratory work conducted into how best to promote autonomy, competence and relatedness satisfaction in parents. From the qualitative discussions presented in this study, harnessing the potential for novel activities by ensuring parents have regular opportunities to try a variety of new physical activities may offer potential. Providing opportunities for parents to meet together to be physically active may also help to increase social connection.

Limitations

This study extends previous studies that have explored the quantitative associations between motivation and physical activity during the pandemic by using accelerometer-assessed physical activity estimates and combining with qualitative data to provide an in-depth exploration of how lockdowns impacted parents' physical activity motivation. However, it is important to highlight several limitations. Firstly, the samples of parents in waves 1 (N = 218) and 2 (N = 237) are smaller than the pre-pandemic wave 0 (N = 710), which may mean that we lack power to identify associations between behavioural regulations and MVPA post pandemic. Because we used a continuous measure of MVPA as the outcome, we are unable to explore associations between behavioural regulation types and whether the parent meets current physical activity guidelines, as this would have reduced power still further. While the mean values of key variables were consistent across waves, it is also possible that the post-pandemic samples do not capture the breadth of parents that were involved pre pandemic. Additionally, the convenience sampling used for the qualitative parts of the study has led to a very active parent sample that is predominantly female, white and from higher socioeconomic areas. The findings therefore may not reflect the broader parent population, but reflect the opportunities and challenges among those who are striving to be active, rather than barriers among those who are inactive. The interviews asked parents to reflect back on their physical activity during the lockdowns, yet the quantitative data were collected post lockdowns, which means that the quantitative and qualitative data do not follow the same timeline. Lastly, it is important to highlight that the BREQ-2 measure refers specifically to exercise behaviour, whereas MVPA and the discussions with parents reflect physical activity more broadly. The qualitative discussions are therefore referring to physical activity behaviours more broadly than the quantitative data.

Conclusions

Motivation appears to play a stronger role in physical activity behaviour post pandemic, and parents highlighted many motivational factors that they perceive to be important for supporting their physical activity. The COVID-19 lockdowns have had a long-term negative impact on some aspects of autonomy,

competence and relatedness in relation to physical activity, and there is a need for future strategies to support parents not only to ensure physical activity levels are maintained but also facilitate well-being in this population. There is a need to work collaboratively with parents to identify key strategies; however, those that focus on offering a range of novel activities and those that bring parents together may hold potential.

Additional information

Acknowledgements

We thank all the schools and families that took part in the Active-6 project. We acknowledge the contributions of Byron Tibbitts (BT) Study Manager (May–December 2021) and Tom Reid (TR) Fieldworker (May 2021–January 2022) for their work on study design, delivery and data collection. We also thank Lara Hollander (June 2022–January 2023) for her work on the wave 2 qualitative frameworks.

Contributions of authors

Lydia Emm-Collison (https://orcid.org/0000-0002-5493-3223) (Lecturer in Physical Activity and Behaviour Change) oversaw data collected in wave 0, conducted the analysis of all models and led the writing of the manuscript.

Robert Walker (https://orcid.org/0000-0001-9901-5285) (Qualitative Research Associate) supported the development of the manuscript and edited it for intellectual content.

Ruth Salway (https://orcid.org/0000-0002-3242-3951) (Senior Research Associate, Statistics) advised on statistical analysis and interpretation and edited the manuscript for intellectual content.

Danielle House (https://orcid.org/0000-0001-6171-9922) (Senior Research Associate, Study Manager) oversaw data collection in wave 2, managed the project and edited the manuscript for intellectual content.

Kate Sansum (https://orcid.org/0000-0003-3392-6750) (Fieldworker) conducted wave 2 data collection, supported the development of the manuscript and edited it for intellectual content.

Katie Breheny (https://orcid.org/0000-0001-6886-4049) (Senior Research Associate, Health Economics) supported the development of the manuscript and edited it for intellectual content.

Sarah Churchward (https://orcid.org/0009-0007-7765-3682) (PPI member of the Study Management Group) supported the development of the manuscript and edited it for intellectual content.

Joanna G Williams (https://orcid.org/0000-0002-4737-1760) (Consultant in Public Health) supported the development of the manuscript and edited it for intellectual content.

Frank de Vocht (https://orcid.org/0000-0003-3631-627X) (Professor in Epidemiology and Public Health) supported the development of the manuscript and edited it for intellectual content.

Russell Jago (https://orcid.org/0000-0002-3394-0176) (Principal Investigator, Professor of Physical Activity and Public Health) led the project, oversaw all aspects of study design and interpretation, supported the development of the manuscript and edited it for intellectual content.

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/KPKW8220.

Primary conflicts of interest: Russell Jago, Katie Breheny and Frank de Vocht are partly funded by the National Institute for Health Research (NIHR) Applied Research Collaboration West (NIHR ARC West) at University Hospitals Bristol NHS Foundation Trust and the University of Bristol. Russell Jago is partly funded by the National Institute for Health and Care Research Bristol Biomedical Research Centre, and was a member of the PHR Prioritisation Group 11/10/2019–12/10/2021, and a member of the PHR – Research Funding Board 01/06/2014–12/10/2021. Frank de Vocht has been on the NIHR Public Health Research Funding Board since 08/10/2019.

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Ethics statement

Ethical approval was gained from the School of Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150) on 9 March 2021. The project was listed on the Research Registry www.researchregistry.com/browse-the-registry#home/registrationdetails/604b4760d539c90020642be6/.

Information governance statement

The University of Bristol is committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Bristol is the Data Controller, and you can find out more about how we handle personal data, including how to exercise your individual rights and the contact details for our Data Protection Officer here (www.bristol.ac.uk/secretary/data-protection/).

Department of Health and Social Care disclaimer

This publication presents independent research commissioned by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by the interviewees in this publication are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, MRC, NIHR Coordinating Centre, the Public Health Researchprogramme or the Department of Health and Social Care.

Funding

This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847. The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, the PHR programme or the Department of Health and Social Care.

If there are verbatim quotations included in this publication the views and opinions expressed by the interviewees are those of the interviewees and do not necessarily reflect those of the authors, those of the NHS, the NIHR, the PHR programme or the Department of Health and Social Care.

Study registration

This study is registered as research registry (project 6646).

About this article

The contractual start date for this research was in April 2021. This article began editorial review in April 2023 and was accepted for publication in August 2023. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The PHR editors and publisher have tried to ensure the accuracy of the authors' article and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article.

This article reports on one component of the research award Exploring parents' physical activity motivation during the COVID-19 pandemic: a mixed-methods study from a self-determination theory perspective. For more information about this research please view the award page https://www.fundingawards.nihr.ac.uk/award/NIHR131847

List of supplementary material

Report Supplementary Material 1 Supplementary tables

Supplementary material can be found on the NIHR Journals Library report page (https://doi.org/10.3310/KPKW8220).

Supplementary material has been provided by the authors to support the report and any files provided at submission will have been seen by peer reviewers, but not extensively reviewed. Any supplementary material provided at a later stage in the process may not have been peer reviewed.

List of abbreviations

BMI	body mass index	IMD	Index of Multiple Deprivation
BREQ-2	Behavioural Regulations in Exercise Questionnaire version 2	MVPA	moderate-to-vigorous physical activity
COVID-19	coronavirus disease 2019	PPI	patient and public involvement
EDI	equality, diversity and inclusion	SDT	self-determination theory

References

1. Kyu HH, Bachman VF, Alexander LT, Mumford JE, Afshin A, Estep K, *et al*. Physical activity and risk of breast cancer, colon cancer, diabetes, ischemic heart disease, and ischemic stroke events: systematic review and dose–response meta-analysis for the Global Burden of Disease Study 2013. *BMJ* 2016;**354**:i3857. https://doi.org/10.1136/bmj.i3857
2. Rebar AL, Stanton R, Geard D, Short C, Duncan MJ, Vandelanotte C. A meta-meta-analysis of the effect of physical activity on depression and anxiety in non-clinical adult populations. *Health Psychol Rev* 2015;**9**:366–78. https://doi.org/10.1080/17437199.2015.1022901
3. UK Chief Medical Officers. UK Chief Medical Officers' Physical Activity Guidelines. 2019. URL: https://assets.publishing.service.gov.uk/media/5d839543ed915d52428dc134/uk-chief-medical-officers-physical-activity-guidelines.pdf (accessed January 2024).
4. Colley RC, Garriguet D, Janssen I, Craig CL, Clarke J, Tremblay MS. *Physical Activity of Canadian Adults: Accelerometer Results from the 2007 to 2009 Canadian Health Measures Survey. Health Reports*. 2011. URL: www150.statcan.gc.ca/n1/en/pub/82-003-x/82-003-x2011001-eng.pdf?st=Hu12atme (accessed February 2024).
5. Hallal PC, Andersen LB, Bull FC, Guthold R, Haskell W, Ekelund U; Lancet Physical Activity Series Working Group. Global physical activity levels: surveillance progress, pitfalls, and prospects. *Lancet* 2012;**380**:247–57. https://doi.org/10.1016/s0140-6736(12)60646-1
6. Kapteyn A, Banks J, Hamer M, Smith JP, Steptoe A, van Soest A, *et al*. What they say and what they do: comparing physical activity across the USA, England and the Netherlands. *J Epidemiol Community Health* 2018;**72**:471–6. https://doi.org/10.1136/jech-2017-209703
7. Office for National Statistics. *Families and Households in the UK: 2021*. London: Office for National Statistics; 2022.
8. Bellows-Riecken KH, Rhodes RE. A birth of inactivity? A review of physical activity and parenthood. *Prev Med* 2008;**46**:99–110. https://doi.org/10.1016/j.ypmed.2007.08.003
9. Berge JM, Larson N, Bauer KW, Neumark-Sztainer D. Are parents of young children practicing healthy nutrition and physical activity behaviors? *Pediatrics* 2011;**127**:881–7. https://doi.org/10.1542/peds.2010-3218
10. Hamilton K, White KM. Social influences and the physical activity intentions of parents of young-children families: an extended theory of planned behavior approach. *J Fam Issues* 2012;**33**:1351–72. https://doi.org/10.1177/0192513X12437151
11. Choi J, Lee M, Jong-Koo L, Kang D, Choi J-Y. Correlates associated with participation in physical activity among adults: a systematic review of reviews and update. *BMC Publ Health* 2017;**17**:356. https://doi.org/10.1186/s12889-017-4255-2
12. Lachman ME, Lipsitz L, Lubben J, Castaneda-Sceppa C, Jette AM. When adults don't exercise: behavioral strategies to increase physical activity in sedentary middle-aged and older adults. *Innov Aging* 2018;**2**:igy007. https://doi.org/10.1093/geroni/igy007
13. Ryan RM, Deci E. *Self-determination Theory: Basic Psychological Needs in Motivation, Development, and Wellness*. New York, NY: Guilford Press; 2017.
14. Lindahl J, Stenling A, Lindwall M, Colliander C. Trends and knowledge base in sport and exercise psychology research: a bibliometric review study. *Int Rev Sport Exerc Psychol* 2015;**8**:71–94. https://doi.org/10.1080/1750984x.2015.1019540

15. Deci EL, Ryan RM. The 'what' and 'why' of goal pursuits: human needs and the self-determination of behavior. *Psychol Inq* 2000;**11**:227–68. https://doi.org/10.1207/S15327965pli1104_01

16. Howard J, Gagne M, Bureau JS. Testing a continuum structure of self-determined motivation: a meta-analysis. *Psychol Bull* 2017; **143**:1346–77. https://doi.org/10.1037/bul0000125

17. Solomon-Moore E, Sebire SJ, Thompson JL, Zahra J, Lawlor DA, Jago R. Are parents' motivations to exercise and intention to engage in regular family-based activity associated with both adult and child physical activity? *BMJ Open Sport Exerc Med* 2016;**2**:e000137. https://doi.org/10.1136/bmjsem-2016-000137

18. Standage M, Sebire SJ, Loney T. Does exercise motivation predict engagement in objectively assessed bouts of moderate-intensity exercise? A self-determination theory perspective. *J Sport Exerc Psychol* 2008;**30**:337–52. https://doi.org/10.1123/jsep.30.4.337

19. Barbeau A, Sweet SN, Fortier M. A path-analytic model of self-determination theory in a physical activity context. *J Appl Biobehav Res* 2010;**14**:103–18. https://doi.org/10.1111/j.1751-9861.2009.00043.x

20. Emm-Collison L, Jago R, Salway R, Thompson JL, Sebire SJ. Longitudinal associations between parents' motivation to exercise and their moderate-to-vigorous physical activity. *Psychol Sport Exerc* 2019;**43**:343–9. https://doi.org/10.1016/j.psychsport.2019.04.007

21. Gunnell KE, Crocker PRE, Mack DE, Wilson PM, Zumbo BD. Goal contents, motivation, psychological need satisfaction, well-being and physical activity: a test of self-determination theory over 6 months. *Psychol Sport Exerc* 2014; **15**:19–29. https://doi.org/10.1016/j.psychsport.2013.08.005

22. Samdal GB, Eide GE, Barth T, Williams G, Meland E. Effective behaviour change techniques for physical activity and healthy eating in overweight and obese adults; systematic review and meta-regression analyses. *Int J Behav Nutr Phys Activ* 2017;**14**:42. https://doi.org/10.1186/s12966-017-0494-y

23. Ryan RM, Deci EL. Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being. *Am Psychol* 2000;**55**:68–78.

24. Adie JW, Duda JL, Ntoumanis N. Perceived coach-autonomy support, basic need satisfaction and the well- and ill-being of elite youth soccer players: a longitudinal investigation. *Psychol Sport Exerc* 2012;**13**:51–9. https://doi.org/10.1016/j.psychsport.2011.07.008

25. De Meyer J, Soenens B, Vansteenkiste M, Aelterman N, Van Petegem S, Haerens L. Do students with different motives for physical education respond differently to autonomy-supportive and controlling teaching? *Psychol Sport Exerc* 2016;**22**:72–82. https://doi.org/10.1016/j.psychsport.2015.06.001

26. Haerens L, Aelterman N, Vansteenkiste M, Soenens B, Van Petegem S. Do perceived autonomy-supportive and controlling teaching relate to physical education students' motivational experiences through unique pathways? Distinguishing between the bright and dark side of motivation. *Psychol Sport Exerc* 2015;**16**:26–36. https://doi.org/10.1016/j.psychsport.2014.08.013

27. Curran T, Hill AP, Niemiec CP. A conditional process model of children's behavioral engagement and behavioral disaffection in sport based on self-determination theory. *J Sport Exerc Psychol* 2013;**35**:30–43.

28. Neville RD, Lakes KD, Hopkins WG, Tarantino G, Draper CE, Beck R, Madigan S. Global changes in child and adolescent physical activity during the COVID-19 pandemic: a systematic review and meta-analysis. *JAMA Pediatr* 2022;**176**:886–94. https://doi.org/10.1001/jamapediatrics.2022.2313

29. Rossi L, Behme N, Breuer C. Physical activity of children and adolescents during the COVID-19 pandemic: a scoping review. *Int J Environ Res Public Health* 2021;**18**:11440. https://doi.org/10.3390/ijerph182111440

30. Sport England. *Active Lives Children and Young People Survey Coronavirus (COVID-19) Report: Mid-May to Late-July 2020 (The Summer Term)*. London: Sport England; 2021.

31. Stockwell S, Trott M, Tully M, Shin J, Barnett Y, Butler L, *et al*. Changes in physical activity and sedentary behaviours from before to during the COVID-19 pandemic lockdown: a systematic review. *BMJ Open Sport Exerc Med* 2021;**7**:e000960. https://doi.org/10.1136/bmjsem-2020-000960

32. Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment. *Int J Behav Nutr Phys Activ* 2023;**20**:42. https://doi.org/10.1186/s12966-023-01441-1

33. Bird JM, Karageorghis CI, Hamer M. Relationships among behavioural regulations, physical activity, and mental health pre- and during COVID-19 UK lockdown. *Psychol Sport Exerc* 2021;**55**:101945. https://doi.org/10.1016/j.psychsport.2021.101945

34. Nienhuis CP, Lesser IA. The impact of COVID-19 on women's physical activity behavior and mental well-being. *Int J Environ Res Public Health* 2020;**17**:9036. https://doi.org/10.3390/ijerph17239036

35. Jago R, Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA. Association of BMI category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. *Int J Obes* 2020;**44**:104–13. https://doi.org/10.1038/s41366-019-0459-0

36. Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**:51. https://doi.org/10.1186/s12966-022-01290-4

37. Markland D, Tobin V. A modification to the behavioural regulation in exercise questionnaire to include an assessment of amotivation. *J Sport Exerc Psychol* 2004;**26**:191–6. https://doi.org/10.1123/jsep.26.2.191

38. R Core Team. *R: A Language and Environment for Statistical Computing*. Vienna: R Foundation for Statistical Computing; 2020.

39. Salway R. *Accelerometer Processing Code. Open Source Framework*. 2022. URL: https://osf.io/y8mwu/ (accessed 14 June 2022).

40. Aadland E, Ylvisaker E. Reliability of the Actigraph GT3X+ accelerometer in adults under free-living conditions. *PLOS ONE* 2015;**10**:e0134606. https://doi.org/10.1371/journal.pone.0134606

41. Trost SG, Owen N, Bauman AE, Sallis JF, Brown W. Correlates of adults' participation in physical activity: review and update. *Med Sci Sports Exerc* 2002;**34**:1996–2001. https://doi.org/10.1249/01.mss.0000038974.76900.92

42. Troiano RP, Berrigan D, Dodd KW, Masse LC, Tilert T, McDowell M. Physical activity in the United States measured by accelerometer. *Med Sci Sports Exerc* 2008;**40**:181–8. https://doi.org/10.1097/00005768-200212000-00020

43. Jago R, Foster C, Williams J, de Vocht F, Hollingworth W. *Protocol for Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts & Provide Rapid Evidence to Policy Makers (ACTIVE-6)*. 2021. URL: https://fundingawards.nihr.ac.uk/award/NIHR131847 (accessed 14 June 2022).

44. *Stata Statistical Software: Release 17 [Program]*. College Station, TX: StataCorp LLC; 2021.

45. Cerin E, Leslie E, Owen N. Explaining socio-economic status differences in walking for transport: an ecological analysis of individual, social and environmental factors. *Soc Sci Med* 2009;**68**:1013–20. https://doi.org/10.1016/j.socscimed.2009.01.008

46. Walker R, House D, Emm-Collison L, Salway R, Tibbitts B, Sansum K, *et al*. A multi-perspective qualitative exploration of the reasons for changes in the physical activity among 10–11-year-old children following the easing of the COVID-19 lockdown in the UK in 2021. *Int J Behav Nutr Phys Activ* 2022;**19**:114. https://doi.org/10.1186/s12966-022-01356-3

47. Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Publ Health* 2023;**23**:1432. https://doi.org/10.1186/s12889-023-16021-y

48. Gale NK, Heath G, Cameron E, Rashid S, Redwood S. Using the framework method for the analysis of qualitative data in multi-disciplinary health research. *BMC Med Res Methodol* 2013;**13**:117. https://doi.org/10.1186/1471-2288-13-117

49. Emm-Collison LG, Sebire SJ, Salway R, Thompson JL, Jago R. Multidimensional motivation for exercise: a latent profile and transition analysis. *Psychol Sport Exerc* 2020;**47**:101619. https://doi.org/10.1016/j.psychsport.2019.101619

50. Lindwall M, Ivarsson A, Weman-Josefsson K, Jonsson L, Ntoumanis N, Patrick H, *et al*. Stirring the motivational soup: within-person latent profiles of motivation in exercise. *Int J Behav Nutr Phys Act* 2017;**14**:4. https://doi.org/10.1186/s12966-017-0464-4

51. Hsu WT, Lin A, Shang IW. The role of novelty satisfaction in distance physical education during the COVID-19 pandemic: a self-determination theory perspective [published online ahead of print May 7 2022]. *Psychol Rep*. https://doi.org/10.1177/00332941221092655

52. Ryan RM, Frederick CM, Lepes D, Rubio N, Sheldon KM. Intrinsic motivation and exercise adherence. *Int J Sport Psychol* 1997;**28**:355–54.

53. Teixeira PJ, Carraca EV, Markland D, Silva MN, Ryan RM. Exercise, physical activity, and self-determination theory: a systematic review. *Int J Behav Nutr Phys Act* 2012;**9**:78. https://doi.org/10.1186/1479-5868-9-78

54. Gardner B, Lally P. Does intrinsic motivation strengthen physical activity habit? Modeling relationships between self-determination, past behaviour, and habit strength. *J Behav Med* 2012;**36**:488–97. https://doi.org/10.1007/s10865-012-9442-0

55. Sylvester BD, Jackson B, Beauchamp MR. The effects of variety and novelty on physical activity and healthy nutritional behaviors. *Adv Motiv Sci* 2018;**5**:169–202. https://doi.org/10.1016/bs.adms.2017.11.001

56. Bagheri L, Milyavskaya M. Novelty-variety as a candidate basic psychological need: new evidence across three studies. *Motiv Emot* 2020;**44**:32–53. https://doi.org/10.1007/s11031-019-09807-4

57. Fernandez-Espinola C, Almagro BJ, Tamayo-Fajardo JA, Saez-Lopez P. Complementing the self-determination theory with the need for novelty: motivation and intention to be physically active in physical education students. *Front Psychol* 2020;**11**:1535. https://doi.org/10.3389/fpsyg.2020.01535

58. Cummins S, Berger N, Cornelsen L, Eling J, Er V, Greener R, *et al*. COVID-19: impact on the urban food retail system and dietary inequalities in the UK. *Cities Health* 2020;**5**:S119–22. https://doi.org/10.1080/23748834.2020.1785167

59. Office for National Statistics. *Is Hybrid Working Here to Stay?* 2022. URL: www.ons.gov.uk/employmentandlabourmarket/peopleinwork/employmentandemployeetypes/articles/ishybridworkingheretostay/2022-05-23 (accessed 10 February 2023).

60. Gardner B, Lally P. Does intrinsic motivation strengthen physical activity habit? Modeling relationships between self-determination, past behaviour, and habit strength. *J Behav Med* 2013;**36**:488–97. https://doi.org/10.1007/s10865-012-9442-0

61. Rhodes RE, Rebar AL. Conceptualizing and defining the intention construct for future physical activity research. *Exerc Sport Sci Rev* 2017;**45**:209–16. https://doi.org/10.1249/JES.0000000000000127

62. Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

63. Salway R, de Vocht F, Emm-Collison L, Sansum K, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: A latent profile analysis. *PLOS ONE* 2023;**18**:e0289344. https://doi.org/10.1371/journal.pone.0289344

64. Parker K, Uddin R, Ridgers ND, Brown H, Veitch J, Salmon J, *et al*. The use of digital platforms for adults' and adolescents' physical activity during the COVID-19 pandemic (our life at home): survey study. *J Med Internet Res* 2021;**23**:e23389. https://doi.org/10.2196/23389

NIHR | National Institute for Health and Care Research

Public Health Research

Check for updates

Research Article

School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis

Ruth Salway[1,2*] Danielle House[1] Robert Walker[1] Lydia Emm-Collison[1] Katie Breheny[2,3] Kate Sansum[1] Joanna G Williams[2,4] William Hollingworth[2,3] Frank de Vocht[2,3] and Russell Jago[1,2,3,5]

[1]Centre for Exercise, Nutrition & Health Sciences, School for Policy Studies, University of Bristol, Bristol, UK
[2]Population Health Sciences, Bristol Medical School, University of Bristol, Bristol, UK
[3]The National Institute for Health Research, Applied Research Collaboration West (NIHR ARC West), University Hospitals Bristol and Weston NHS Foundation Trust, Bristol, UK
[4]Communities and Public Health, Bristol City Council, Bristol, UK
[5]NIHR Bristol Biomedical Research Centre, University Hospitals Bristol and Weston NHS Foundation Trust and University of Bristol, Bristol, UK

[*]Corresponding author Ruth.Salway@bristol.ac.uk

Published October 2024
DOI: 10.3310/WQJK9893

Abstract

Background and objectives: Schools play a crucial role in facilitating physical activity among children, but the COVID-19 pandemic has affected both children's physical activity and the school environment. It is essential to understand between-school differences in children's physical activity post lockdown, to determine if and how the role of schools has changed.

Design and participants: Active-6 is a natural experiment comparing postlockdown accelerometer-estimated physical activity to a pre-COVID-19 comparator group. Accelerometer and individual data were collected on 1296 children aged 10–11 pre-COVID-19 (2017–8), with school characteristics collected from the 50 schools they attended. Post lockdown, we collected accelerometer, individual and school data from 393 children in 23 of the same schools and 436 children in 27 of the same schools in 2021 (Wave 1) and 2022 (Wave 2), respectively.

Methods: Sources of variation (between-school, between-pupil and within-pupil) in child weekday moderate to vigorous physical activity at each wave were modelled using linear mixed-effects models with school-level wave random coefficients. We extended the model to estimate the proportion of between-school variation explained by school policy, curriculum and physical environment factors and school-aggregated pupil characteristics. We also explored the extent to which postlockdown differences in moderate to vigorous physical activity were mediated by individual or school factors.

Results: Between-school variation comprised 13% of the total variation pre-COVID-19, 7% in Wave 1 and 13% in Wave 2. School factors associated with moderate to vigorous physical activity were the following: whether physical education was compromised due to space (often: 9 minutes lower moderate to vigorous physical activity; sometimes: 5.4 minutes lower); high after-school club attendance (7 minutes higher moderate to vigorous physical activity for each additional club attended on average in the school); cycle training policy (4 minutes higher moderate to vigorous physical activity); and higher prevalence of active travel (1 minute higher moderate to vigorous physical activity for each 10% point increase in prevalence). These factors explained 22% of the between-school variation pre-COVID-19, and 72% at Wave 2. The relative importance changed, with cycle training policy and active travel being the most important pre-COVID-19 and cycle training policy, active after-school clubs and compromised physical education space most important in Wave 2. No factors were found to mediate the postlockdown differences in moderate to vigorous physical activity, except compromised physical education space, which had a suppressor effect in Wave 2.

This article should be referenced as follows:
Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al.* School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis. *Public Health Res* 2024;**12**(16):147–168. https://doi.org/10.3310/WQJK9893

Limitations: Only 27 of the initial 50 schools participated post lockdown, limiting our ability to make comparisons across waves. Sample sizes were additionally affected by missing data for some variables.
Conclusions and future work: While schools continue to play an important role in facilitating children's physical activity, the factors that contribute to this have changed post-COVID-19, with cycle training, active after-school clubs and ensuring physical education is prioritised even when space is limited now explaining nearly three-quarters of the between-school variation in children's moderate to vigorous physical activity. School-level interventions that focus on these areas, and policies that support them, may offer the potential to increase children's physical activity.
Funding: This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847.
A plain language summary of this research article is available on the NIHR Journals Library Website https://doi.org/10.3310/WQJK9893.

Background

Physical activity is important for children's mental and physical health, including improved psychological well-being and a lower risk of cardiometabolic diseases.[1,2] The World Health Organization and UK Chief Medical Officers recommend that children should engage in an average of 60 minutes of moderate to vigorous physical activity (MVPA) per day,[3,4] and in the UK, government guidelines recommend that 30 minutes of this should take place during the school day.[4] Children spend a large portion of their time at school, and therefore schools play a crucial role in promoting and facilitating physical activity among children.

Children's physical activity levels vary between schools, with between-school variation, that is unmeasured school-level factors, accounting for 6–18% of the total variance in child daily accelerometer-measured MVPA.[5–8] These between-school differences remain even after adjustment for individual demographics such as age, gender, ethnicity and socioeconomic position, indicating that differences are due to features of the school environment rather than differing pupil demographics. Unmeasured school-level factors are estimated to be responsible for one and a half times more of the variation in children's MVPA than known individual correlates, such as demographics, active travel and active clubs.[7] Despite this, most studies focus on individual-level factors associated with physical activity,[9] resulting in limited evidence on the role of the school environment, such as school policies, curriculum and the physical environment. The existing literature suggests that physical activity is positively associated with policies that support active travel,[5,10] school crossing patrol[10] and cycle training for children.[11] Aspects of the curriculum can be both positive, such as time spent on physical education (PE), outdoor breaks[12] and the use of physical activity in non-PE subjects,[11] or negative, such as compromised PE due to lack of space and restriction on access to open space or facilities.[11] Evidence for associations with the physical environment (such as playground equipment and markings) and facilities is mixed,[13–15] with much of the research focused on specific contexts, such as active play during breaks, rather than across the full school day, despite current UK guidance, which advocates a 'whole-school' approach.[16,17]

Lockdowns due to the COVID-19 pandemic have affected both children's physical activity and the school environment, as schools closed, and children remained at home for large periods of the day. After lockdowns were lifted, children's physical activity was initially lower than before,[18,19] although recent work suggests that MVPA has now recovered to pre-pandemic levels after about a year.[20,21] We also found substantial variation in how the pandemic has affected the school environment, with initial prioritisation of physical activity in the curriculum when schools reopened giving way to pressure to catch up on academic learning, staffing pressures impacting on support for physical activity, and some social distancing policies retained for convenience.[22] These differences in adaptations, policies and provision in schools mean that it is essential to understand between-school variation in children's physical activity post lockdown, to determine if and how the role of schools has changed, and whether there are key recommendations that can help schools promote physical activity in future.

Aim and objectives

The aim of this report is to explore between-school variation (between-school differences) in children's physical activity before and after the COVID-19 lockdowns. We will investigate the following:

1. whether the proportion of between-school variation has changed post lockdown, which would indicate a potential change in the role that schools play
2. the extent to which school-level factors explain between-school variation in children's MVPA and whether this has changed post lockdown.

A secondary aim is to explore whether individual or school-level factors mediate the postlockdown reduction in children's MVPA.

Methods

The Active-6 study[18,20,23] compared postlockdown accelerometer-measured MVPA collected in two waves between May 2021 and July 2022 to a pre-COVID-19 comparator group, to investigate the effects of the COVID-19 lockdowns on the physical activity of children aged 10–11 years (in Year 6 of primary school). Pre-COVID-19 data came from the B-Proact1v study,[24] which collected data from 10- to 11-year-old children between March 2017 and May 2018 from 50 schools in and around Bristol, UK. Active-6 invited the same 50 schools to participate, with 23 schools taking part in Wave 1 (May–December 2021) and 27 schools in Wave 2 (January–July 2022); 22 schools participated in both waves. Wave 1 took place when schools had reopened, but some restrictions, such as size of gatherings remained, and there were still disruptions due to COVID-19 outbreaks. Wave 2 took place in 2022 when all restrictions were removed. At all measurement points, we collected child accelerometer and questionnaire data from both children and their parent/carer. Data on a total of 1296 children were collected pre-COVID-19, 393 children in Wave 1 and 436 children in Wave 2 (of whom 128 also participated in Wave 1). Full details of both studies are given elsewhere.[20,24] Both studies received ethical approval from the School of Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150) and parental consent was received for all participants.[25] The project was listed on the Research Registry (project 6646).[26]

Data

Outcome data

Children wore a waist-worn ActiGraph wGT3X-BT accelerometer (ActiGraph LLC; FL, USA) for 5 consecutive days in the pre-COVID-19 data, including weekends, and 7 consecutive days in Waves 1 and 2, increased to maximise the amount of valid data under difficult data collection conditions. Between 4 and 5 days of monitoring, including weekends, has been found to provide reliable estimates of usual physical activity in children.[27] Average accelerometer wear time and mean weekday minutes of MVPA, using Evenson population-specific cut-points for children,[28] were derived for all children who provided valid data (at least 500 minutes) on a minimum of 2 weekdays.[29]

Individual level data

Parents/carers reported child date of birth and gender and the highest education qualification in the household, which was recoded into two groups as 'Below University degree or equivalent' and 'University degree or equivalent or higher'. Parents reported the time their child typically spent engaging in screen-viewing on weekdays, with questions differing between pre- and post-COVID-19 studies.[30] In the pre-COVID-19 study, separate questions were asked about time spent screen-viewing from TVs, computers, phones/tablets and games consoles and time spent multiscreen-viewing (i.e. using multiple devices simultaneously), each coded from 'None' to '4 hours or more'. We summed the midpoints of each category over devices and subtracted the minutes of multiscreen viewing. In Active-6, parents/carers reported total leisure weekday screen-viewing in hourly categories from 'Less than 1 hour' up to '> 5 hours', and midpoints of each category were used to estimate the total leisure weekday screen-viewing. Children reported on which days (Monday to Friday) they attended an active after-school club based at their school, which was summed to give the number of days they attended a school-based active after-school club. Children also reported how they typically travelled to school. In the pre-COVID-19 data, children were asked about travel mode on each day of the week and we used the modal value to represent typical travel, as there was very little daily variation.[31] In the postlockdown data, children were asked directly for their typical travel mode. In both cases, we created a binary indicator of whether they typically used active (walk, bike or scooter) or inactive (car, bus or train) modes of travel to school. Quintiles of Index of Multiple Deprivation (IMD[32]) were derived from parent-reported postcode and categorised as most deprived area (lowest quintile) versus less deprived (above the lowest quintile).

School-level data

The number of pupils in Year 6 was reported by a school contact, the percentage of children in the school receiving free school meals[33] was retrieved from publicly available school data and school IMD quintile and population density of the local area[34] derived from school postcode. We also calculated aggregated pupil characteristics for each school: the percentage living in the most deprived IMD quintile, percentage using active travel to school, average number of after-school clubs attended and average minutes of weekday leisure screen-viewing.

A member of school staff was asked to provide information on the school policy environment and use of physical activity in the curriculum, using items

from the school physical activity policy assessment.[10,35] Trained fieldworkers completed a playground audit[11,36] during a normal school day to assess the presence of walking/cycling, sport and play provision, and design and aesthetics of the school grounds. The full policy, curriculum and playground audit measures collected are described in detail elsewhere.[11] In this report, we focus on policy and curriculum factors, which may have changed over the pandemic, and aspects of the school physical environment previously found to be associated with children's MVPA.[10,11] We included policies: cycle training, active travel and school crossing patrol and any restrictions on access to outdoor open space; curriculum: whether PE was often compromised due to space, whether physical activity was used in non-PE subjects and whether teachers provided activity breaks during lesson-time; and environment: provision of allotments, assault courses, pitches, drinking fountains and five or more pieces of playground equipment.

Statistical analysis

Individual and school characteristics and missing data were summarised by wave. Sources of variation and mediation were explored in relation to a base model, in a series of exploratory analyses as pre-specified in the Statistical Analysis Plan.[37] As this analysis was exploratory, we avoided formal hypothesis testing and focused on a combination of model fit [Akaike Information Criterion (AIC) and log likelihood] magnitude, precision of estimates and *p*-values. The base model, described in detail in the main Active-6 paper,[20] is a linear mixed-effects random intercepts model for child weekday MVPA, with repeated measurements within children within schools. Wave was included as a categorical explanatory variable, with pre-COVID-19 as the reference category, and the model was adjusted for accelerometer wear time, COVID-19 restrictions,[18] hours of daylight, seasonality via second-order harmonic sine/cosine functions,[38] and child age, gender and highest household education. This model partitions the total variation in child MVPA into different sources: between-school variation (attributable to unmeasured school-level factors), between-pupil variation (attributable to unmeasured individual characteristics) and within-pupil variation (due to repeated measures). The focus of this report is specifically in understanding between-school variation, so results in the main report present between-school variation only, however all sources of variation are reported in the Appendix tables. Models were run in MLwiN v3.06 [version 3.06 (program): Centre for Multilevel Modelling, University of Bristol, 2022] via the runmlwin[39] command in Stata v17 [Stata Statistical Software: Release 17 (program). College Station, TX: StataCorp LLC, 2021].

Between-school variation

To compare the proportion of between-school variation across the three waves, we extended the base model to include wave random coefficients at the school level, allowing the between-school variation to differ between waves (between- and within-pupil variation was assumed constant). We explored different covariance structures (unstructured and diagonal covariance matrix under different parameterisations) and used likelihood ratio tests and AIC to identify the best-fitting wave random coefficient model. We compared this to the base model via a likelihood ratio test to identify whether between-school variation differed between waves, and estimated the percentage of the total variation attributable to between school, between pupil and within pupil for each wave. We then used this model to estimate school-specific estimates of average weekday MVPA at each wave and plotted the change for each school, which included data at all three time points.

School characteristics that explain between-school variation

The between-school variation wave random coefficients model above estimates the percentage of the total variation due to unmeasured school factors. We explored how much of this between-school variation was explained by school characteristics, school-aggregated pupil characteristics, policy, curriculum and environmental school factors, by adding each variable to the wave random coefficients model separately. For school-aggregated pupil characteristic models we also included the corresponding individual variable, centred on school means, to allow school-level effects to be interpreted as contextual effects. Thus, for example, child weekday MVPA is assumed to relate to both the number of after-school clubs a child attends as well as the mean number of clubs attended by children in their year group. Factors that were separately associated with child MVPA were identified on the basis of magnitude and precision of estimates. These factors were then added to a combined model, assuming additive effects, and refined using a model selection process based on magnitude of estimates, *p*-values and model fit (AIC), to produce a final school characteristics model. We excluded any factors with substantial amounts of missing data at school level but added them to the final school characteristics model in a separate sensitivity analysis. For each model, we calculated the proportion of between-school variation explained by the variables included in the model for each wave.

Mediation by individual and school factors

We explored the extent to which differences in MVPA between pre- and post lockdown were mediated by

individual factors (active travel to school, screen-time and number of after-school clubs) and school factors (policy, curriculum and environment variables), which might feasibly have changed pre- and post-COVID-19. Formal mediation tests can be problematic in multilevel models and introduce confounding, as mediators may act at different levels,[40] and so we did not attempt to directly estimate a mediation effect. Instead, we identified potential mediators as those which were associated with MVPA, which varied between waves, and which made substantial changes to the estimates of differences in child weekday MVPA between waves. We restricted mediation analysis to those factors that were found to be associated with MVPA in the previous school characteristic models, with each potential mediator considered separately. To determine if potential individual mediators differed between waves, we fit an appropriate mixed-effects model (logistic model for active travel, Poisson model for screen-time[30] and number of after-school clubs) for differences between waves, with child and school random intercepts and adjusting for age, gender and household education. For potential school-level mediators, we compared proportions by wave descriptively, due to the lower number of schools. For both individual and school-level variables if the potential mediator differed sufficiently between waves, we fit the wave random coefficients model, adjusting for the potential mediator, and used a combination of magnitude and precision of estimates and *p*-values to assess the extent to which the potential mediator was responsible for all, part or none of the observed postlockdown differences in MVPA. Finally, if multiple mediators were identified, we included all of them simultaneously in the wave random coefficients model, to explore their combined additive effect.

Patient and public involvement

Patient and public involvement was integral throughout the Active-6 project, with children, parents, teachers and school staff involved in research design, data collection methods, development of study materials and dissemination plans. Parent representatives are active members of the study management and steering groups, children have participated in group sessions at schools to review materials, and early school-level results have been shared with schools and participating families.

Equality, diversity and inclusion

The 50 schools invited to take part in Active-6 were those that completed Phase 3 of the B-Proact1v study, which comprised a mix of urban and rural schools of different sizes across four local authorities in the Bristol area. Schools that took part in Active-6 were broadly representative of these schools. Participating children were roughly equally split by gender, and drawn from all IMD deciles, although with more participants from higher socioeconomic backgrounds, especially in the post-COVID-19 samples where the challenges of recruiting in a pandemic affected response rates especially among those who are typically less likely to engage in research. The sample had low ethnic diversity, with only 9% from non-white backgrounds, although this is typical of the ethnic diversity of the area as a whole.

Results

Individual and school characteristics are summarised by wave in *Tables 1* and *2*, respectively, with missing values presented in *Appendix 1*, *Table 5*. Although fewer schools took part in Waves 1 and 2, demographics were similar. As no schools reported more than five pieces of playground equipment post lockdown, this variable was excluded from subsequent analysis. In addition, we note that active travel policy, school crossing patrol and restrictions on access to open space had larger amounts of missing data (26–34%) and so should be treated with caution.

Between-school variation

A random coefficients model with school-level random-effect terms for each wave was used to compare the percentage of between-school variation across the three waves, which is the percentage of the total variation in child MVPA that can be attributed to school-level factors. A diagonal covariance matrix was found to be sufficient to capture the covariance structure, based on AIC and the log-likelihood ratio test (see *Appendix 1*, *Table 6*). A log-likelihood ratio test ($p < 0.001$) concluded that the school-level wave random coefficients model was a better fit to the data than the random intercepts model (see *Appendix 1*, *Table 6*), but that within-school random coefficients for waves were not needed. Total variation in child MVPA was similar between pre-COVID-19 and Wave 2, and slightly lower in Wave 1 (see *Appendix 1*, *Table 7*). The percentage of between-school variation (attributable to school-level factors) changed across waves, from 14% pre-COVID-19, dropping to 7% in Wave 1 and increasing again to 13% in Wave 2 (see *Figure 1*; *Appendix 1*, *Table 7*). *Figure 2* plots the difference in average MVPA for each school by wave, plotted for those schools with data at all three time points, although estimates of variation are based on data from all schools. Nearly all schools mirrored the overall pattern of an initial drop in average MVPA in Wave 1, followed by a recovery to pre-pandemic levels.

This article should be referenced as follows:
Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al.* School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis. *Public Health Res* 2024;**12**(16):147–168. https://doi.org/10.3310/WQJK9893

TABLE 1 Individual child characteristics, and characteristics of the households in which they live

	Pre-COVID-19 2017–8	Post lockdown 2021–2	
		Wave 1	Wave 2
Female: *N* (%)	680 (52)	193 (49)	224 (51)
Household education degree or higher: *N* (%)	636 (53)	257 (66)	267 (62)
White British ethnicity: *N* (%)	944 (87)	310 (84)	323 (81)
Most deprived areas[a]: *N* (%)	142 (11)	31 (8)	31 (7)
Active travel to school: *N* (%)	747 (58)	227 (62)	238 (58)
Screen-viewing (minutes): mean (SD)	147 (92)	144 (77)	143 (75)
Number after school clubs attended: mean (SD)	0.7 (1.1)	0.7 (1.0)	0.7 (0.9)

a Percentage in most deprived Index of Deprivation quintile.

TABLE 2 School-level characteristics

	Pre-COVID-19 2017–8	Post lockdown	
	N = 50	Wave 1 (2021) *N* = 23	Wave 2 (2022) *N* = 27
Urban: *N* (%)	45 (90)	19 (83)	24 (89)
Schools in most deprived areas[a]: *N* (%)	7 (14)	2 (9)	3 (11)
Population density: mean (SD)	32.3 (26.5)	31.8 (32.2)	34.9 (30.2)
Size of year group: mean (SD)	41.1 (20.1)	44.5 (23.8)	46.7 (26.0)
% pupils receiving free school meals: mean (SD)	10.2 (8.5)	12.9 (7.7)	12.9 (8.4)
% pupils of White British ethnicity: mean (SD)	85 (13)	84 (12)	78 (16)
% pupils living in most deprived areas[a]: mean (SD)	14 (22)	9 (20)	10 (17)
% pupils using active travel: mean (SD)	56 (21)	56 (25)	54 (23)
Mean number of after-school clubs attended: mean (SD)	0.8 (0.5)	0.7 (0.5)	0.7 (0.4)
Cycle training policy: *N* (%)	14 (33)	6 (26)	6 (24)
Written active travel policy: *N* (%)	17 (52)	6 (33)	9 (45)
School crossing patrol: *N* (%)	18 (53)	9 (50)	11 (52)
Restrictions on open space: *N* (%)	19 (51)	9 (50)	11 (55)
PA used in other subjects: *N* (%)	32 (78)	17 (74)	17 (71)
PE compromised due to space: *N* (%)			
Rarely	11 (27)	20 (87)	23 (88)
Sometimes	12 (29)	2 (9)	2 (8)
Often	18 (44)	1 (4)	1 (4)
Activity breaks during lesson-time: *N* (%)	13 (36)	11 (48)	12 (46)
Presence of allotments: *N* (%)	22 (44)	15 (65)	20 (74)
Presence of assault courses: *N* (%)	40 (80)	20 (87)	22 (81)

TABLE 2 School-level characteristics (*continued*)

	Pre-COVID-19 2017–8	Post lockdown	
	N = 50	Wave 1 (2021) *N* = 23	Wave 2 (2022) *N* = 27
Presence of pitches: *N* (%)	27 (54)	15 (65)	20 (74)
Presence of drinking fountains: *N* (%)	11 (22)	6 (26)	4 (15)
Five+ playground equipment: *N* (%)	11 (22)	0 (0)	0 (0)

a Percentage in most deprived Index of Deprivation quintile.

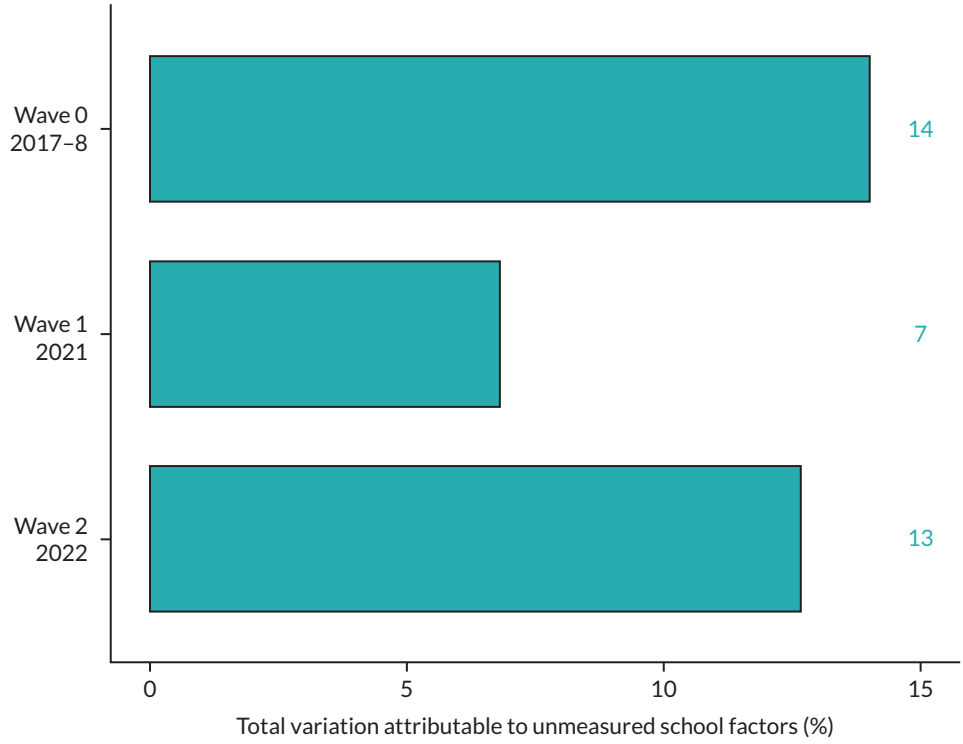

FIGURE 1 Percentage of unmeasured variation attributable to between-school variation by wave.

School characteristics that explain between-school variation

Table 3 shows the associations of school characteristics, school-aggregated pupil characteristics, policy, curriculum and environment school factors with child MVPA by adding each variable to the wave random coefficients model separately. The factors identified for the full school characteristics model were school IMD, cycle training policy, compromised PE space, allotments and pitches, plus individual and contextual effects for low IMD, active travel and number of active after-school clubs attended. The potentially relevant variables of an active travel policy and restrictions on access to open space were excluded from this stage due to high levels of missing schools (see *Appendix 1*, *Table 5*), but considered later in a sensitivity analysis.

The final school characteristics model (*Table 4*) included additive effects for the presence of a school cycle training policy, compromised PE space and individual and contextual effects for active travel and active after-school clubs. A cycle training policy in the school was associated with 4.0 minutes higher average daily MVPA (95% CI 0.4 to 7.5) for children in that school, compared to children in schools without cycle training. Children in schools where PE was sometimes compromised due to space engaged in an average of 5.4 minutes less MVPA (95% CI 0.5 to 10.2), rising to 9.3 minutes less (95% CI 4.4 to 14.1) when PE was often compromised. Individual-level effects were 6.0 minutes higher MVPA (95% CI 3.8 to 8.1) for a child using active travel, and 1.6 minutes higher MVPA (95% CI 0.5 to 2.6) for each active after-school club attended. Additional contextual effects were seen for attending

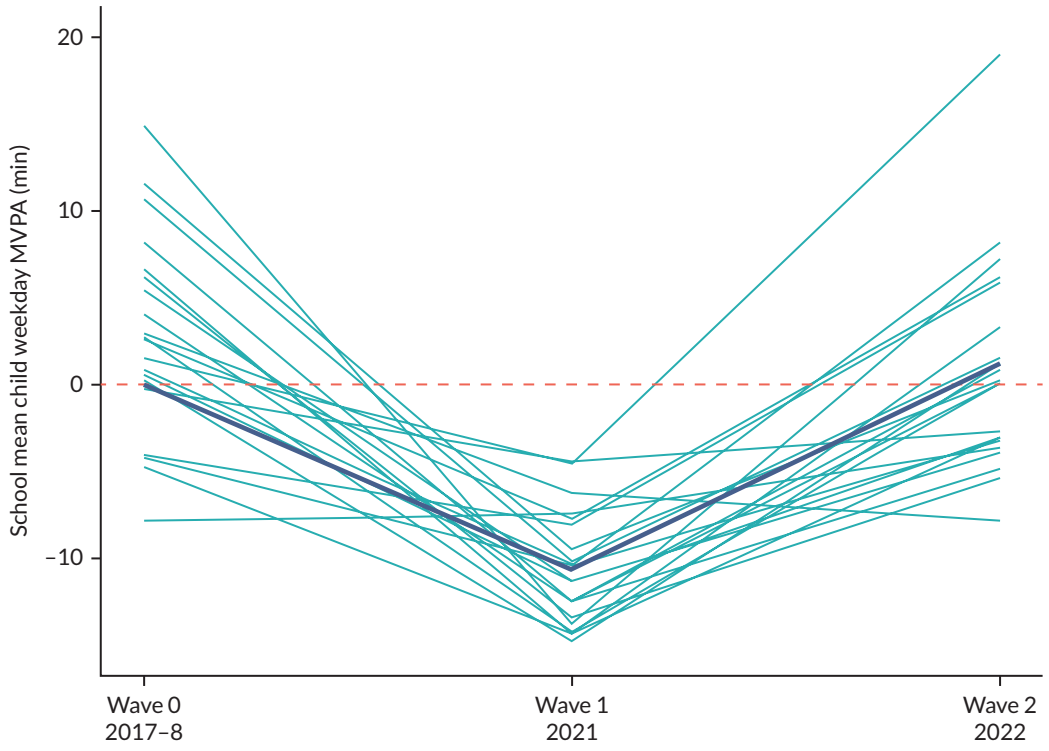

FIGURE 2 Between-school variation in MVPA by wave for wave random coefficients model. Note: Lighter lines plot the average MVPA by school (*N* = 21 schools with data at all three waves); the darker line indicates the overall average difference. Lines plotted in reference to overall pre-pandemic average (59.9 minutes; red dashed line).

a school with a higher percentage of pupils using active travel, of 1.0 minute higher MVPA (95% CI 0.3 to 1.7) for each 10% point increase in school active travel prevalence (e.g. from 10% to 20% or from 40% to 50%), and for attending a school where children attended more active after-school clubs, of 7.0 minutes higher MVPA (95% CI 3.5 to 10.5) for each additional club attended on average in the school. Together these factors explained 22% of the between-school variation in child MVPA (i.e. variation attributable to school-level factors) pre-COVID-19, with the proportion more than tripling to 82% at Wave 1 and 72% at Wave 2 (see *Figure 3*; *Appendix 1*, *Tables 8* and *9*). This represented 3%, 6% and 9%, respectively, of the total variation in child MVPA, that is variation attributable to the combination of both school and individual factors (see *Appendix 1*, *Table 9*). The relative importance of each school-level factor also changed, with cycle training policy and active travel most important pre-COVID-19, active after-school clubs, active travel and compromised PE space most important in Wave 1 and cycle training policy, active after-school clubs and compromised PE space most important in Wave 2. In a sensitivity analysis we added the variables for a written active travel policy and restrictions on access to open spaces to the model, both of which had a high number of schools missing data. Estimates for the previously included factors were similar (see *Appendix 1*, *Table 10*), although with larger confidence intervals and slightly larger estimates for compromised PE space. Restrictions on access to open spaces were additionally associated with 2.3 minutes lower MVPA (95% CI −2.3 to 7.0), compared to children in schools with no restrictions. There was no association with a school active travel policy.

Mediation by individual and school factors

The following factors were associated with child MVPA (see *Table 3*) and used in the mediation analysis: cycle training policy, compromised PE space, allotments, pitches, individual active travel to school and individual number of active after-school clubs. *Appendix 1*, *Table 11* gives modelled differences between waves for individual potential mediators, with the proportion in each wave for differences between waves for potential school mediators shown previously in *Table 2*. Potential mediators identified at this stage were cycle training policy, compromised PE space, allotments, pitches and individual number of active after-school clubs. All mediators were considered separately, and the postlockdown differences in MVPA for the mediated models are summarised in *Appendix 1*, *Table 12*. None of the variables were found to individually mediate the postlockdown differences in MVPA, with the exception of compromised PE space, which had a

TABLE 3 Associations between school characteristics, school-aggregated pupil characteristics, policy, curriculum and environment factors and child MVPA

		Estimate	95% CI	*N*
School characteristics				
Year 6 size (per 10 pupils)		0.8	0.0 to 1.5	1777
% in most deprived areas (per percentage point)		−4.0	−9.8 to 1.9	1777
% free meals (per percentage point)		< 0.1	−0.2 to 0.3	1777
Population density (per 10 people/hectare)		0.3	−3.0 to 9.5	1777
School policies				
Cycle training policy		5.1	1.2 to 9.1	1641
Written active travel policy		3.6	−0.6 to 7.7	1232
School crossing patrol policy		1.2	−2.9 to 5.2	1332
Restrictions on access to open space		−2.5	−6.7 to 1.8	1353
School curriculum				
PE compromised due to space[a]: often		−6.5	−12.1 to −0.9	1610
PE compromised due to space[a]: sometimes		−2.2	−7.8 to 3.3	1610
PA used in other subjects		3.0	−0.9 to 6.9	1574
Activity breaks during lesson-time		2.7	−1.3 to 6.7	1515
Playground environment				
Presence of allotments		4.5	0.9 to 8.1	1777
Presence of assault courses		−1.5	−6.0 to 3.1	1777
Presence of pitches		3.1	−0.5 to 6.8	1777
Presence of drinking fountains		3.0	−1.2 to 7.3	1777
Aggregated contextual effects				
Most deprived	Individual	1.313	−2.7 to 5.3	1742
	Contextual[b]	−1.162	−2.1 to −0.2	
Active travel	Individual	5.869	3.9 to 7.9	1735
	Contextual[b]	1.081	0.3 to 1.9	
Screen-viewing (per 10 minutes)	Individual	−0.081	−0.2 to 0.0	1647
	Contextual	−0.343	−1.03 to 0.4	
No. clubs attended	Individual	1.606	0.7 to 2.6	1744
	Contextual[c]	6.566	3.0 to 10.1	

a Compared to rarely compromised.
b Increase in MVPA for each 10% point increase in school prevalence, for example, from 10% to 20%.
c Increase in MVPA for each additional club attended on average in school.

suppressor effect in Wave 2. PE was compromised less often after the lockdowns, which explained some of the Wave 2 recovery in MVPA to pre-pandemic levels. As only a single mediator was identified, we did not explore potential additive effects of the different mediators.

Discussion

While average children's MVPA differed between schools and across waves, nearly all schools showed the same pattern of an initial drop in Wave 1 and recovery in Wave 2.

TABLE 4 Estimates from final school characteristics model (*N* = 1542)

		Estimate	95% CI
Cycle training policy		4.0	0.4 to 7.5
PE compromised due to space			
Sometimes		−5.4	−10.2 to −0.5
Often		−9.3	−14.1 to −4.4
Aggregated contextual effects			
Active travel	Individual	6.0	3.8 to 8.1
	Contextual[a]	1.0	0.3 to 1.7
No. clubs attended	Individual	1.6	0.5 to 2.6
	Contextual[b]	7.0	3.5 to 10.5
Wave estimates (compared to pre-COVID-19 2017–8)			
Wave 1 (2021)		−16.2	−24.8 to −7.6
Wave 2 (2022)		−2.4	−7.3 to 2.6

a Increase in MVPA for each 10% point increase in school prevalence, for example, from 10% to 20%.
b Increase in MVPA for each additional club attended on average in school.

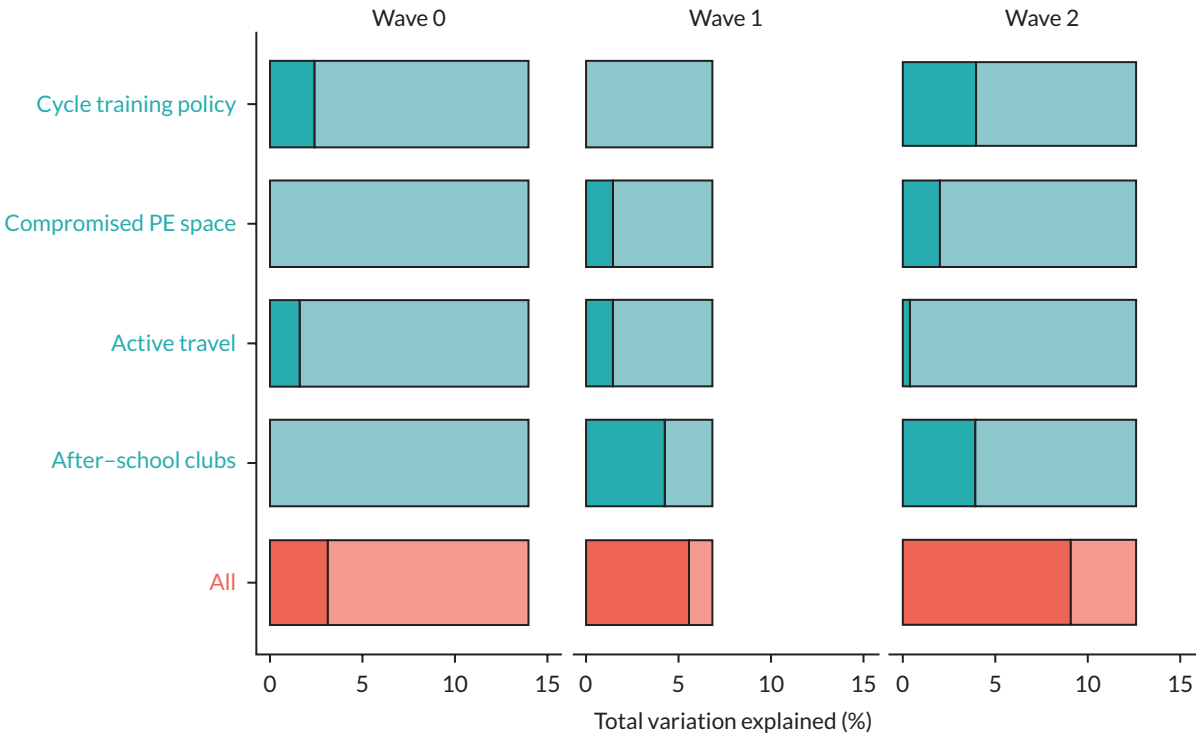

FIGURE 3 Between-school variation explained by school characteristics at each wave. Note: Box indicates total amount of between-school variation, while shaded area represents the proportion explained by the variables.

Moreover, there do not seem to be any systematic patterns to which schools experienced the largest drops in terms of school characteristics. There was no difference in the amount of within-school variation (between- and within-pupil), but between-school variation differed between waves, with the percentage of between-school variation in Wave 1 around half that pre-COVID-19 and in Wave 2 (7% compared to 14/13%). This suggests that in the initial months after restrictions were eased, it was individual factors that dictated a child's physical activity, with schools

only regaining their role as life became more settled by Wave 2. This is not surprising as during the initial period there were still disruptions due to COVID-19 outbreaks, such as school or class closures, and multiple children isolating. We also found no evidence that the initial drop was mediated by either individual- or school-level factors. Although we cannot entirely rule out the explanation that the drop is due to some other unknown factor changing over this time frame, these results support the conclusion that the COVID-19 pandemic and lockdowns led to reductions in children's physical activity in the shortterm, and that there was little schools could do to mitigate this.

The role of schools remains important after the COVID-19 lockdowns. School factors were responsible for 14% of the total variation in children's MVPA before COVID-19, consistent with pre-pandemic estimates seen elsewhere,[5–8] and returned to a similar level in 2022. Between-school differences in MVPA were explained by the following school factors: whether PE was compromised due to space (often: 9 minutes lower MVPA; sometimes: 5.4 minutes lower), high after-school club attendance (7 minutes higher MVPA for each additional club attended on average in the school), a cycle training policy (4 minutes higher MVPA), and higher prevalence of active travel (1 minute higher MVPA for each increase in 10% points). Individually, these associations of around 5–7 minutes difference in MVPA are moderate in size, representing around 20% of the 30 minutes MVPA recommended during the school day, but could cumulatively contribute to even greater increases, with associated health benefits. For example, replacing 10 minutes of sedentary time with 10 minutes of MVPA is associated with improved cardiometabolic indicators,[41] which in turn are associated with lower risk of cardiovascular disease in adulthood. However, there were postlockdown differences in both the overall and relative importance of these factors in describing difference between schools. In Wave 2, these factors explained nearly three-quarters (72%) of all between-school variation, compared to only a fifth (22%) pre-pandemic. This amounts to 9% of the total variation explained post lockdown, which aside from gender, equates to more than any of the individual factors considered (household education, individual club attendance, individual active travel), either separately or combined. There was also a change in which factors were most important in explaining variation between schools, where cycle training and active travel dominated pre-pandemic and cycle training, high active club attendance and compromised PE space most important in 2022. Thus, while the overall importance of the school has not changed, these factors are stronger contributors and have changed in relative importance, suggesting a change in the way in which schools influence children's physical activity post lockdown. These changes reflect other Active-6 findings, which suggest that although children's physical activity has recovered to pre-pandemic levels there are notable differences in who is being active and how.[20,42-44] This suggests that understanding the school-specific context is very important for future approaches to increase physical activity at school,[45] and that future research should explore the potential of a whole school approach.[17]

Pre-COVID-19, while active after-school clubs were important for individual child MVPA, they did not explain between-school differences. This has changed post lockdown, with differences in after-school clubs now accounting for nearly a third (30%) of the between-school variation. This is consistent with other Active-6 results, which found an increased reliance on structured activities, such as clubs post lockdown,[43] with a high demand for active school-based clubs that some schools were struggling to meet.[44] The findings in this report reinforce the importance of ensuring schools are able to meet that demand, as the benefits to children include both individual and contextual effects. This means that children benefit not just from attending an after-school club themselves, but from being in a school where children are encouraged or able to attend more active after-school clubs. A child who attends an additional club per week will have an MVPA 1.6 minutes higher on average across the week, but a child who attends a school where on average all the children attend an additional club will have an MVPA 7 minutes higher – even if they do not themselves attend a club. As mentioned above, there are potential health benefits associated with increases in MVPA of this magnitude. We are not aware of any other research that has looked at contextual effects on children's physical activity, where children benefit both directly from participating in an activity themselves, and indirectly by being in an environment where other children regularly take part, and so further exploration of contextual effects could be a fruitful area of future research.[45] Such factors could be due to a combination of school leadership, culture and/or expectations, as a school that provides lots of clubs that children are encouraged to attend are likely to encourage physical activity in other ways as well. It could also be through the influence of children themselves, with children who attend clubs more active at other times,[31] leading to their friends being more active as well,[7,46,47] and this in turn shapes the school culture with a higher demand for an active environment. Regardless, it is crucial to ensure that schools are supported in the provision of affordable, and accessible active clubs that are sufficient to meet demand, especially in an increasingly pressured environment.[22]

Other positive school factors identified were a cycle training policy and active travel. The importance of a school cycle training policy has nearly doubled, now explaining around a third of the total between-school variation. While previous evidence has shown an association between schools that offer cycle training and higher MVPA,[11] other research has found that cycle training did not increase cycling frequency or independent cycling,[48] and so it is not clear what is driving this association. Anecdotally, some parents reported that cycle training helped them feel more confident taking their children on bike rides, so cycle training may build confidence and skills and facilitate being more active generally. Cycling was one of the few activities possible during lockdowns, and less crowded roads may have encouraged children to put their training into practice. Cycling infrastructure, both in school (e.g. storage) and out of school (cycle routes), and safety have also been found to be related to active travel to school.[49] In this study, we found that the main benefit of active travel was at the individual level, presumably as it is highly dependent on location, traffic safety and environment as well as individual circumstances.[50,51] There was a small contextual effect of active travel, with 2 minutes higher MVPA for children attending a school with 60% active travel compared to 40%, which may be capturing differences between local neighbourhoods rather than between schools. However, there was no association with a school active travel policy, a reminder that it is the behaviour itself that is associated with MVPA, rather than just the existence of a policy, an important point to consider when recommending a school cycle training policy on the basis of these results.

A negative factor associated with postlockdown differences between schools was if PE lessons were sometimes or often compromised due to space, although this did not explain differences before the pandemic. We note that there was a large change in the number of schools reporting compromised PE sometimes or often before and after lockdowns, from 73% to 13%, respectively, so the role in between-school differences is potentially driven by the few schools where PE is still compromised, which have lower average MVPA. This factor was reported by a member of school staff, and it is possible that this result reflects changes in who answered the questionnaire pre- and post lockdown, although this would have needed to be a systematic change in nearly all the schools in our sample. Alternatively, it could be due to differences in interpretation of the question, with the experience of delivering virtual PE during lockdowns leading to a much wider definition of 'compromised', and PE lessons now being seen as less compromised by comparison. It may also be a genuine change, with schools placing more value on physical activity post lockdown[22] and thus more likely to prioritise it. Increased options for virtual PE during lockdowns may mean that even when space is an issue, there are now more classroom-based online activities available and so PE can be delivered more effectively in smaller spaces without compromise. The mediation analysis also suggests that the reduction in compromised PE in schools may be responsible for some of the recovery in children's MVPA to pre-pandemic levels. A related factor is restrictions on access to outdoor space, including the use of rota systems. Unfortunately, missing data makes it difficult to draw firm conclusions, but the study results suggest that such restrictions may be associated with a reduction in MVPA. This is concerning as some schools have reported the continuation of such systems introduced during the pandemic, often for convenience.[22] Access to open space is important for promoting physical activity and lack of sufficient space can impact both on facilitating PE lessons and in managing outdoor free play during play times.[52,53] However, these results show the need to prioritise physical activity even when space is an issue. Schools that use rota systems should ensure that these are in place for the benefit of pupils, rather than for the convenience of the school, and that they facilitate rather than limit physical activity. Those schools that still struggle to deliver PE due to space could explore wider options, such as classroom-based and/or online activities. It may be advantageous to work with schools that have overcome this problem, in order to identify examples of good practice that can be shared.

These findings suggest that post lockdown, the role of schools remains important, but the nature of this role has changed, with cycle training and active clubs being key school-level contributors to explaining difference between schools, along with ensuring that PE lessons are not compromised. It is possible that these are proxies for some other school-level factors that are responsible for differences in MVPA, although there were no strong associations between these factors and any of the extensive range of policies, curriculum and the built environment measures we investigated. They may also reflect a general positive school ethos around physical activity, rather than the presence of these features directly, although a review of the impact of the school physical activity climate on adolescents was inconclusive.[52] However, note that the reverse is also true: not allowing physical activity to be compromised and promoting cycle training, active clubs and active travel are themselves actions that can help build a positive culture around physical activity. The key message is that the focus should be on reducing differences between schools by increasing opportunities for physical activity through a number of

different strategies, depending on the school.[45] The study results suggest that a combination of the following could provide a good place to start:

- prioritising physical activity and PE lessons even when space is limited by sharing examples of good practice
- supporting pressured schools to meet the demand for active after-school clubs by offering a wide range of options and encouraging uptake to ensure these are accessible to as many as possible
- offering cycle training to pupils.

These factors are all associated with increases in MVPA of a magnitude that can be linked to improved cardiovascular health in both childhood and adulthood, which suggests that implementing these changes may have the potential to make a substantial public health impact, both in the short- and long-term.

Strengths, limitations and future research

This study has a number of strengths. It uses rich school-level data on the policies, curriculum and playground environment and combines this with accelerometer-measured MVPA and questionnaire from individual children. The use of the same schools before and after the COVID-19 lockdowns removes the between-school variability from measures of change across waves. In addition, the multilevel modelling includes all schools that provide data from at least one time point and allows us to jointly model both individual and school-level factors. In particular, the separation of individual and contextual effects gives a unique insight into which differences are attributable to differences in pupil behaviour versus differences in the schools themselves. However, only 27 of the initial 50 schools participated in the postlockdown study. Although these schools are broadly comparable to those included in terms of demographics and characteristics, they were slightly less likely to be from the most deprived areas, which limits our ability to make comparisons across waves, especially if the impact of lockdown has disproportionately affected schools in more deprived areas. Sample sizes were additionally affected by missing data for some variables, so, for example, we are unable to draw firm conclusions about the impact of rota systems and other restrictions on access to open space.

While schools play an important role, pre-COVID-19 research on school factors was limited. As these results suggest that context may have changed, with some factors playing a stronger role, it is therefore even more important to explore this further. School-level interventions, particularly those aimed at active clubs and cycle training, offer a promising avenue to increasing children's physical activity and the changes post lockdown mean that it may be worth revisiting approaches that were not found to be sufficiently effective pre-pandemic. In particular, it is important to understand and account for the school context when designing interventions.[45] In addition, future research should explore further the separation of individual and contextual effects of child behaviours, such as club attendance and active travel. Finally, more work is needed to explore further the possible impact of residual lockdown restrictions on open space, such as rota systems.

Conclusions

Nearly all schools experienced the same pattern of an initial short-term drop in MVPA followed by a recovery. While schools continue to play an important role in facilitating children's physical activity, the factors that contribute to this have changed post-COVID-19, with cycle training, active after-school clubs and ensuring PE is prioritised even when space is limited now explaining nearly three-quarters of the between-school differences in children's MVPA. School-level interventions that focus on these areas and policies that support them offer the potential to increase children's physical activity.

Additional information

Acknowledgements

We would like to thank all the schools and families that took part in the Active-6 project. We would also like to acknowledge the contributions of Byron Tibbitts (BT), Study Manager (May–December 2021) and Tom Reid (TR), Fieldworker (May 2021–January 2022) for their work on study design, delivery and data collection.

Contributions of authors

Ruth Salway (https://orcid.org/0000-0002-3242-3951) Senior Research Associate, Statistics. Conducted the statistical analysis of all models and led the writing of the report.

Danielle House (https://orcid.org/0000-0001-6171-9922) Senior Research Associate, Study Manager. Oversaw data collection in Wave 2, managed the project and edited the report for intellectual content.

Robert Walker (https://orcid.org/0000-0001-9901-5285) Research Associate, Qualitative Lead. Supported the development of the report and edited the report for intellectual content.

This article should be referenced as follows:
Salway R, House D, Walker R, Emm-Collison L, Breheny K, Sansum K, *et al.* School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis. *Public Health Res* 2024;**12**(16):147–168. https://doi.org/10.3310/WQJK9893

Lydia Emm-Collison (https://orcid.org/0000-0002-5493-3223) Steering Group Member. Oversaw data collected in Wave 0, supported the development of the report and edited the report for intellectual content.

Katie Breheny (https://orcid.org/0000-0001-6886-4049) Senior Research Associate, Health Economics. Supported the development of the report and edited the report for intellectual content.

Kate Sansum (https://orcid.org/0000-0003-3392-6750) Fieldworker. Conducted Wave 2 data collection, supported the development of the report and edited the report for intellectual content.

Joanna G Williams (https://orcid.org/0000-0002-4737-1760) Steering Group Member. Supported the development of the report and edited the report for intellectual content.

William Hollingworth (https://orcid.org/0000-0002-0840-6254) Steering Group Member, Health Economics. Supported the development of the report and edited the report for intellectual content.

Frank de Vocht (https://orcid.org/0000-0003-3631-627X) Steering Group Member. Supported the development of the report and edited the report for intellectual content.

Russell Jago (https://orcid.org/0000-0002-3394-0176) Principal Investigator, Active-6. Led the project, oversaw all aspects of study design and interpretation, supported the development of the report and edited the report for intellectual content.

Disclosure of interests

Full disclosure of interests: Completed ICMJE forms for all authors, including all related interests, are available in the toolkit on the NIHR Journals Library report publication page at https://doi.org/10.3310/WQJK9893.

Primary conflicts of interest: Russell Jago, Katie Breheny, Frank de Vocht and William Hollingworth are partly funded by the National Institute for Health and Care Research Applied Research Collaboration West (NIHR ARC West) at University Hospitals Bristol NHS Foundation Trust and the University of Bristol.

Russell Jago is partly funded by the National Institute for Health and Care Research Bristol Biomedical Research Centre, and was a member of the PHR Prioritisation Group 11 October 2019–12 October 2021, and a member of the PHR – Research Funding Board 1 June 2014–12 October 2021.

Frank de Vocht has been on the NIHR Public Health Research Funding Board since 8 October 2019.

William Hollingworth was a member of the HTA Clinical Evaluation and Trials Committee 1 July 2016–31 March 2021.

Data-sharing statement

All data requests should be submitted to the corresponding author for consideration. Access to anonymised data may be granted following review.

Ethics statement

Ethical approval was gained from the School of Policy Studies Ethics Committee at the University of Bristol, UK (Ref SPSREC/20-21/150) on 9 March 2021. The project was listed on the Research Registry.

Information governance statement

The University of Bristol is committed to handling all personal information in line with the UK Data Protection Act (2018) and the General Data Protection Regulation (EU GDPR) 2016/679. Under the Data Protection legislation, the University of Bristol is the Data Controller, and you can find out more about how we handle personal data, including how to exercise your individual rights and the contact details for our Data Protection Officer here (www.bristol.ac.uk/secretary/data-protection/).

Department of Health and Social Care disclaimer

This publication presents independent research commissioned by the National Institute for Health and Care Research (NIHR). The views and opinions expressed by authors in this publication are those of the authors and do not necessarily reflect those of the NHS, the NIHR, MRC, NIHR Coordinating Centre, the PHR programme or the Department of Health and Social Care.

Funding

This article presents independent research funded by the National Institute for Health and Care Research (NIHR) Public Health Research programme as award number NIHR131847.

This article reports on one component of the research award School-level variation in children's moderate to vigorous intensity physical activity before and after COVID-19: a multilevel model analysis. For more information about this research please view the award page [https://www.fundingawards.nihr.ac.uk/award/NIHR131847].

About this article

The contractual start date for this research was in April 2021. This article began editorial review in May 2023 and was accepted for publication in December 2023. The authors have been wholly responsible for all data collection, analysis and interpretation, and for writing up their work. The Public Health Research editors and publisher have tried to ensure the accuracy of the authors' article and would like to thank the reviewers for their constructive comments on the draft document. However, they do not accept liability for damages or losses arising from material published in this article.

This article was published based on current knowledge at the time and date of publication. NIHR is committed to being inclusive and will continually monitor best practice and guidance in relation to terminology and language to ensure that we remain relevant to our stakeholders.

Copyright

List of abbreviations

AIC	Akaike Information Criterion
IMD	Index of Multiple Deprivation
MVPA	moderate to vigorous physical activity
PE	physical education

References

1. Skrede T, Steene-Johannessen J, Anderssen SA, Resaland GK, Ekelund U. The prospective association between objectively measured sedentary time, moderate-to-vigorous physical activity and cardiometabolic risk factors in youth: a systematic review and meta-analysis. *Obes Rev* 2018;**20**:55–74. https://doi.org/10.1111/obr.12758
2. Ahn JV, Sera F, Cummins S, Flouri E. Associations between objectively measured physical activity and later mental health outcomes in children: findings from the UK Millennium Cohort Study. *J Epidemiol Community Health* 2018;**72**:94–100. https://doi.org/10.1136/jech-2017-209455
3. Chaput JP, Willumsen J, Bull F, Chou R, Ekelund U, Firth J, *et al.* 2020 WHO guidelines on physical activity and sedentary behaviour for children and adolescents aged 5–17 years: summary of the evidence. *Int J Behav Nutr Phys Act* 2020;**17**:141. https://doi.org/10.1186/s12966-020-01037-z
4. UK Chief Medical Officers. *UK Chief Medical Officers' Physical Activity Guidelines*. London, UK: Department of Health and Social Care; 2019. URL: www.gov.uk/government/publications/physical-activity-guidelines-uk-chief-medical-officers-report (accessed 2 May 2023).
5. Faulkner G, Zeglen L, Leatherdale S, Manske S, Stone M. The relationship between school physical activity policy and objectively measured physical activity of elementary school students: a multilevel model analysis. *Arch Public Health* 2014;**72**:20. https://doi.org/10.1186/2049-3258-72-20
6. Kristensen PL, Olesen LG, Ried-Larsen M, Grontved A, Wedderkopp N, Froberg K, Andersen LB. Between-school variation in physical activity, aerobic fitness, and organized sports participation: a multi-level analysis. *J Sports Sci* 2013;**31**:188–95. https://doi.org/10.1080/02640414.2012.723818
7. Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA, Jago R. A multilevel analysis of neighbourhood, school, friend and individual-level variation in primary school children's physical activity. *Int J Environ Res Public Health* 2019;**16**:4889. https://doi.org/10.3390/ijerph16244889
8. Fairclough SJ, Beighle A, Erwin H, Ridgers ND. School day segmented physical activity patterns of high and low active children. *BMC Public Health* 2012;**12**:406. https://doi.org/10.1186/1471-2458-12-406
9. Sterdt E, Liersch S, Walter U. Correlates of physical activity of children and adolescents: a systematic review of reviews. *Health Educ J* 2014;**73**:72–89. https://doi.org/10.1177/0017896912469578
10. van Sluijs EM, Jones NR, Jones AP, Sharp SJ, Harrison F, Griffin SJ. School-level correlates of physical activity intensity in 10-year-old children. *Int J Pediatr Obes* 2011;**6**:e574–81. https://doi.org/10.3109/17477166.2010.518239

11. Emm-Collison L, Salway R, Matthews J, Reid T, Jago R. Associations between the built environment, policies and curriculum in schools and primary school children's physical activity. *Wellcome Open Res* 2023;**8**:85. https://doi.org/10.12688/wellcomeopenres.18262.1

12. Morton KL, Corder K, Suhrcke M, Harrison F, Jones AP, van Sluijs EM, Atkin AJ. School polices, programmes and facilities, and objectively measured sedentary time, LPA and MVPA: associations in secondary school and over the transition from primary to secondary school. *Int J Behav Nutr Phys Act* 2016;**13**:54. https://doi.org/10.1186/s12966-016-0378-6

13. Harvey A, Faulkner G, Giangregorio L, Leatherdale ST. An examination of school- and student-level characteristics associated with the likelihood of students' meeting the Canadian physical activity guidelines in the COMPASS study. *Can J Public Health* 2017;**108**:348–54. https://doi.org/10.17269/cjph.108.5925

14. Willenberg LJ, Ashbolt R, Holland D, Gibbs L, MacDougall C, Garrard J, *et al*. Increasing school playground physical activity: a mixed methods study combining environmental measures and children's perspectives. *J Sci Med Sport* 2010;**13**:210–6. https://doi.org/10.1016/j.jsams.2009.02.011

15. Black IE, Menzel NN, Bungum TJ. The relationship among playground areas and physical activity levels in children. *J Pediatr Health Care* 2015;**29**:156–68. https://doi.org/10.1016/j.pedhc.2014.10.001

16. Public Health England. *What Works in Schools and Colleges to Increase Physical Activity?* 2020. URL: www.gov.uk/government/publications/what-works-in-schools-to-increase-physical-activity-briefing (accessed 2 May 2023).

17. Jones G, Longbon K, Williams S. Exploring the acceptability and feasibility of a whole school approach to physical activity in UK primary schools: a qualitative approach. *BMC Public Health* 2022;**22**:2236. https://doi.org/10.1186/s12889-022-14647-y

18. Salway R, Foster C, de Vocht F, Tibbitts B, Emm-Collison L, House D, *et al*. Accelerometer-measured physical activity and sedentary time among children and their parents in the UK before and after COVID-19 lockdowns: a natural experiment. *Int J Behav Nutr Phys Act* 2022;**19**:51. https://doi.org/10.1186/s12966-022-01290-4

19. Ganzar LA, Salvo D, Burford K, Zhang Y, Kohl HW, Hoelscher DM. Longitudinal changes in objectively-measured physical activity and sedentary time among school-age children in Central Texas, US during the COVID-19 pandemic. *Int J Behav Nutr Phys Act* 2022;**19**:56. https://doi.org/10.1186/s12966-022-01299-9

20. Jago R, Salway R, House D, Walker R, Emm-Collison L, Sansum K, *et al*. Short and medium-term effects of the COVID-19 lockdowns on child and parent accelerometer-measured physical activity and sedentary time: a natural experiment. *Int J Behav Nutr Phys Act* 2023;**20**:42. https://doi.org/10.1186/s12966-023-01441-1

21. Sport England. *Active Lives Children and Young People Survey, Academic Year 2021–22. UK: Sport England*; 2022. URL: www.sportengland.org/news/childrens-activity-levels-recover-pre-pandemic-levels (accessed 2 May 2023).

22. House D, Walker R, Salway R, Emm-Collison L, Breheny K, Sansum K, *et al*. The impact of the COVID-19 pandemic on the physical activity environment in UK primary schools: a multi-perspective qualitative analysis. *Public Health Research*; in press.

23. Jago R, Foster C, Williams J, de Vocht F, Hollingworth W. *Protocol for ASSESSING the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts & Provide Rapid Evidence to Policy Makers (ACTIVE-6)*; 2021. URL: https://fundingawards.nihr.ac.uk/award/NIHR131847 (accessed 14 June 2022).

24. Jago R, Salway R, Emm-Collison L, Sebire SJ, Thompson JL, Lawlor DA. Association of BMI category with change in children's physical activity between ages 6 and 11 years: a longitudinal study. *Int J Obes (Lond)* 2020;**44**:104–13. https://doi.org/10.1038/s41366-019-0459-0

25. Jago R, Bailey R. Ethics and paediatric exercise science: issues and making a submission to a local ethics and research committee. *J Sports Sci* 2001;**19**:527–35. https://doi.org/10.1080/026404101750238980

26. Research Registry. *Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts and Provide Rapid Evidence to Policy Makers*; 2021. URL: www.researchregistry.com/browse-the-registry#home/registrationdetails/604b4760d539c90020642be6/ (accessed 2 May 2023).

27. Trost S, Pate R, Freedson P, Sallis JF, Taylor W. Using objective physical activity measures with youth: how many days of monitoring are needed? *Med Sci Sports Exerc* 2000;**32**:426–31.

28. Evenson KR, Catellier DJ, Gill K, Ondrak KS, McMurray RG. Calibration of two objective measures of physical activity for children. *J Sports Sci* 2008;**26**:1557–65. https://doi.org/10.1080/02640410802334196

29. Salway R. *Accelerometer Processing Code: OSF*; 2022. URL: https://osf.io/y8mwu (accessed 18 March 2022).

30. Salway R, Walker R, Sansum K, House D, Emm-Collison L, Reid T, *et al*. Screen-viewing behaviours

of children before and after the 2020-21 COVID-19 lockdowns in the UK: a mixed methods study. *BMC Public Health* 2023;**23**:116. https://doi.org/10.1186/s12889-023-14976-6

31. Salway R, Emm-Collison L, Sebire S, Thompson J, Lawlor D, Jago R. The association of school-related active travel and active after-school clubs with children's physical activity: a cross-sectional study in 11-year-old UK children. *Int J Behav Nutr Phys Act* 2019;**16**:1–10. https://doi.org/10.1186/s12966-019-0832-3

32. Ministry of Housing Communities and Local Government. *English Indices of Deprivation 2019: Ministry of Housing, Communities and Local Government*; 2019. URL: www.gov.uk/government/statistics/english-indices-of-deprivation-2019 (accessed 3 February 2023).

33. Department for Education. *Get Information about Schools UK*; 2022. URL: https://get-information-schools.service.gov.uk/ (accessed 17 February 2022).

34. Office for National Statistics. *Lower layer Super Output Area population density (National Statistics)*; 2020. URL: www.ons.gov.uk/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/lowersuperoutputareapopulationdensity (accessed 3 February 2023).

35. Lounsbery MA, McKenzie TL, Morrow JR Jr, Holt KA, Budnar RG. School physical activity policy assessment. *J Phys Act Health* 2013;**10**:496–503. https://doi.org/10.1123/jpah.10.4.496

36. Jones NR, Jones A, van Sluijs EM, Panter J, Harrison F, Griffin SJ. School environments and physical activity: the development and testing of an audit tool. *Health Place* 2010;**16**:776–83. https://doi.org/10.1016/j.healthplace.2010.04.002

37. Salway R, Jago R, Tibbitts B. *The ACTIVE-6 Project: Detailed Statistical Analysis Plan: Assessing the Impact of COVID-19 on the Physical Activity of Year 6 Children and Their Parents: Identifying Scalable Actions to Mitigate Adverse Impacts and Provide Rapid Evidence to Policy Makers*. Bristol, UK: University of Bristol; 2021. URL: https://research-information.bris.ac.uk/en/publications/the-active-6-project-detailed-statistical-analysis-plan-assessing (accessed 14 June 2022).

38. Bhaskaran K, Gasparrini A, Hajat S, Smeeth L, Armstrong B. Time series regression studies in environmental epidemiology. *Int J Epidemiol* 2013;**42**:1187–95. https://doi.org/10.1093/ije/dyt092

39. Leckie G, Charlton C. runmlwin: a program to run the MLwiN multilevel modeling software from within Stata. *J Stat Softw* 2013;**52**:1–40. https://doi.org/10.18637/jss.v052.i11

40. Zhang Z, Zyphur MJ, Preacher KJ. Testing multilevel mediation using hierarchical linear models: problems and solutions. *Organ Res Methods* 2009;**12**:695–719. https://doi.org/10.1177/1094428108327450

41. Hansen BH, Anderssen SA, Andersen LB, Hildebrand M, Kolle E, Steene-Johannessen J, *et al.*; International Children's Accelerometry Database (ICAD) Collaborators. Cross-sectional associations of reallocating time between sedentary and active behaviours on cardiometabolic risk factors in young people: an international children's accelerometry database (ICAD) analysis. *Sports Med* 2018;**48**:2401–12. https://doi.org/10.1007/s40279-018-0909-1

42. Salway R, de Vocht F, Emm-Collison L, Sansum K, House D, Walker R, *et al*. Comparison of children's physical activity profiles before and after COVID-19 lockdowns: a latent profile analysis. *PLOS ONE*; in press.

43. Walker R, House D, Salway R, Emm-Collison L, Hollander LE, Sansum K, *et al*. The new normal for children's physical activity and screen viewing: a multi-perspective qualitative analysis of behaviours a year after the COVID-19 lockdowns in the UK. *BMC Public Health* 2023;**23**:1432. https://doi.org/10.1186/s12889-023-16021-y

44. Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

45. Jago R, Salway R, House D, Beets M, Lubans DR, Woods C, de Vocht F. Rethinking children's physical activity interventions at school: a new context-specific approach. *Front Public Health* 2023;**11**:1149883. https://doi.org/10.3389/fpubh.2023.1149883

46. Salway RE, Sebire SJ, Solomon-Moore E, Thompson JL, Jago R. Associations within school-based same-sex friendship networks of children's physical activity and sedentary behaviours: a cross-sectional social network analysis. *Int J Behav Nutr Phys Act* 2018;**15**:18. https://doi.org/10.1186/s12966-018-0653-9

47. Prochnow T, Delgado H, Patterson MS, Unstattd Meyer MR. Social network analysis in child and adolescent physical activity research: a systematic literature review. *J Phys Act Health* 2020;**17**:250–60. https://doi.org/10.1123/jpah.2019-0350

48. Goodman A, van Sluijs EM, Ogilvie D. Impact of offering cycle training in schools upon cycling behaviour: a natural experimental study. *Int J Behav Nutr Phys Act* 2016;**13**:34. https://doi.org/10.1186/s12966-016-0356-z

49. Ikeda E, Hinckson E, Witten K, Smith M. Associations of children's active school travel with perceptions of the physical environment and characteristics of the social environment: a systematic review. *Health Place* 2018;**54**:118–31. https://doi.org/10.1016/j.healthplace.2018.09.009

50. Page A, Cooper AR, Griew P, Jago R. Independent mobility, perceptions of the built environment and children's participation in play, active travel and structured exercise and sport: the PEACH Project. *Int J Behav Nutr Phys Act* 2010;**7**:17. https://doi.org/10.1186/1479-5868-7-17

51. van Sluijs EM, Fearne VA, Mattocks C, Riddoch C, Griffin SJ, Ness A. The contribution of active travel to children's physical activity levels: cross-sectional results from the ALSPAC study. *Prev Med* 2009;**48**:519–24. https://doi.org/10.1016/j.ypmed.2009.03.002

52. Morton KL, Atkin AJ, Corder K, Suhrcke M, van Sluijs EM. The school environment and adolescent physical activity and sedentary behaviour: a mixed-studies systematic review. *Obes Rev* 2016;**17**:142–58. https://doi.org/10.1111/obr.12352

53. Dyment JE, Bell AC, Lucas AJ. The relationship between school ground design and intensity of physical activity. *Child Geogr* 2009;**7**:261–76. https://doi.org/10.1080/14733280903024423

Appendix 1

TABLE 5 Missing data

	Wave 0		Wave 1		Wave 2	
	N	%	*N*	%	*N*	%
Individual						
Active travel to school	17	1	24	6	27	6
Screen-viewing (minutes)	229	18	31	8	31	7
No. after-school clubs attended	2	< 1	24	6	28	6
Most deprived areas	45	3	4	1	4	1
School						
Size of year group	0	0	0	0	0	0
% free school meals	0	0	0	0	0	0
IMD	0	0	0	0	0	0
Population density	0	0	0	0	0	0
Cycle training policy	8	16	0	0	2	7
Written active travel policy	17	34	5	22	7	26
School crossing patrol	16	32	5	22	6	22
Restrictions on access to open space	13	26	5	22	7	26
PA used in other subjects	9	18	0	0	1	4
PE compromised due to space	9	18	0	0	3	11
Activity breaks during lesson-time	14	28	0	0	1	4
Presence of allotments	0	0	0	0	0	0
Presence of assault courses	0	0	0	0	0	0
Presence of pitches	0	0	0	0	0	0
Presence of drinking fountains	0	0	0	0	0	0
Five+ playground equipment	0	0	0	0	0	0

TABLE 6 Comparison of random intercept and random coefficient models

	AIC	Log-likelihood	Degrees of freedom	*p*-value
Random intercept	15612	−7787.8	18	
Random intercept and between-school wave coefficients				
Unstructured	15570	−7762.1	23	< 0.001[a]
Diagonal	15570	−7764.9	20	< 0.001[a]
Random intercept, between-school and between-pupil coefficients				
Diagonal	15611	−7784.6	21	1.000[b]

AIC, Akaike Information Criterion: lower value indicates better model fit.
a Compared to random intercept model.
b Compared to random intercept and between-school wave coefficients model.

Note
All *p*-values doubled due to testing variances on the boundary of the parameter space.

TABLE 7 Sources of variation at each level: wave random components model

	Wave 0	Wave 1	Wave 2
% between-school variation	14.0	6.8	12.6
% between-pupil variation	54.8	59.4	55.7
% within pupil variation	31.2	33.8	31.7
Total variation	414.3	382.3	407.9

TABLE 8 Percentage of variation explained by school factors

	Wave 0 (%)	Wave 1 (%)	Wave 2 (%)
Between-school variation	14	7	13
% of school variation explained by:			
Cycle training policy	17	0	31
No. active after school clubs attended	0	62	30
PE compromised due to space	0	21	16
Active travel to school	12	22	3
All	22	82	72
% of total variation explained at schoollevel	3	6	9

TABLE 9 Sources of variation at each level: final school characteristics model

	Wave 0	Wave 1	Wave 2
% variation explained (compared to wave random components model)			
% between-school variation	22	82	72
% between-pupil variation	0.4	0.5	0.5
% within pupil variation	0	0	0
% total variation	3	6	9
% variation unexplained			
% between-school variation	11.2	1.3	3.8
% between-pupil variation	56.3	62.6	61.0
% within pupil variation	32.4	36.1	35.1
Total variation	406.1	368.8	382.1

TABLE 10 Estimates from final school characteristics sensitivity model

		Estimate	95% CI
Cycle training policy		2.8	−1.8 to 7.4
Active travel policy		−0.3	−4.4 to 3.8
Restrictions on access to open space		−2.3	−7.0 to 2.3
PE compromised due to space			
Sometimes		−8.3	−14.0 to −2.7
Often		−12.5	−18.9 to −6.1
Aggregated contextual effects			
Active travel	Individual	5.2	2.5 to 7.8
	Contextual[a]	1.5	0.6 to 2.4
No. clubs attended	Individual	2.5	1.3 to 3.8
	Contextual	5.2	−0.0 to 10.4
Wave estimates (compared to Wave 0)			
Wave 1		−23.5	−34.0 to −13.0
Wave 2		−1.8	−8.3 to 4.7

a Per 10% points.

Note
Missing data in restrictions on access to open space means this model is based on reduced data: *N* = 1017, from 29 schools in Wave 0, 15 in Wave 1 and 16 in Wave 2.

TABLE 11 Potential individual mediators: differences between waves

	Difference in MVPA between Wave 0 and Wave 1		Difference in MVPA between Wave 0 and Wave 2		*p*-value
	Estimate	95% CI	Estimate	95% CI	
Individual					
Active travel to school (OR)	1.3	0.8 to 1.9	0.8	0.6 to 1.1	0.344
No. after-school clubs (RR)	0.7	0.5 to 0.9	0.9	0.5 to 0.9	0.004

OR, odds ratio; RR, relative rate ratio.

TABLE 12 Mediation models

	Difference in MVPA between Wave 0 and Wave 1		Difference in MVPA between Wave 0 and Wave 2		*N*
	Estimate	95% CI	Estimate	95% CI	
Base	−10.7	−19.3 to −2.0	1.2	−4.3 to 6.6	1777
Individual					
No. after-school clubs	−9.7	−18.1 to −1.4	0.7	−4.6 to 6.0	1744
School					
Cycle training policy	−10.3	−19.1 to −1.5	2.3	3.0 to 7.5	1641
PE compromised due to space	−10.1	−17.8 to −2.5	−7.6	−12.1 to −3.2	1610
Allotments	−11.4	−19.9 to −2.8	−0.1	−5.6 to 5.4	1777
Pitches	−11.5	−20.2 to −2.9	0.6	−3.9 to 6.1	1777

10.3310/BSKH6585 Public Health Research Vol. 12 No. 16

The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice

This page provides information about a publication describing research funded by the Public Health Research programme under award number NIHR131847, which has been published in a third-party journal. For information about copyright and reproduction of the original publication, please see the publisher's website.

Publication

Walker R, Salway R, House D, Emm-Collison L, Breheny K, Sansum K, *et al*. The status of active after-school clubs among primary school children in England (UK) after the COVD-19 lockdowns: implications for policy and practice. *Int J Behav Nutr Phys Act* 2023;**20**:120. https://doi.org/10.1186/s12966-023-01499-x

Abstract

Background

Children's physical activity in England is more dependent on active clubs after the COVID-19 pandemic. However, it is unclear how the COVID-19 pandemic and related cost-of-living crisis have impacted on active club participation, costs and provision. This mixed-methods natural experiment explored school-based and community-based active clubs after lockdowns, using a unique combination of data sources to highlight implications for policy and practice post-COVID-19.

Methods

Cross-sectional questionnaire data on school and community active clubs were collected from 10-11-year-old children pre-COVID-19 in 2017-18 (N = 1,296; 50 schools), in 2021 (N = 393; 23 schools), and 2022 (N = 463; 27 schools). Club participation and attendance frequency were modelled using logistic and Poisson mixed effects models, adjusted for child age, gender and household education. In 2021 and 2022, parents reported expenditure on community-based clubs and schools provided data on school-based club provision, with data summarised descriptively. Qualitative data were collected in 2021 and 2022, with one-to-one interviews with school staff (N = 18) and parents (N = 43), and twelve child focus groups (N = 92), and analysed using the framework method.

Results

School-based active club participation was higher in 2022 compared to pre-pandemic (50% /43%), while community-based club participation was lower (74%/80%). Children attended 0.3 fewer clubs per week. Those from lower education households were less likely to participate in both types of active clubs, and girls less likely to attend community clubs. In 2022, the median cost of community and school club sessions were £6.67 and £3.88 respectively, with 52% of school-based clubs free to parents. Schools offered an average of 3.4 active clubs per week for 10-11-year-olds in 2022, with 34% partly/wholly subsidised. Qualitative analysis highlighted the impact of the cost-of-living crisis and COVID-19 pandemic on family resources, encouraging a shift to more affordable and convenient school-based active clubs, which negatively impacted the community-based active club environment. However, many schools struggled to meet this increased demand.

Conclusions

Findings emphasise the importance for policymakers to support schools to meet increased demand for clubs and community clubs to increase affordable and convenient physical activity opportunities. Targeted support is needed to prevent socioeconomic and gender inequalities.

Funding

This publication was funded by the Public Health Research programme as a part of award number NIHR131847.

This article reports on one component of the research award Assessing the impact of COVID-19 on the physical activity of Year 6 children and their parents: identifying scalable actions to mitigate adverse impacts & provide rapid evidence to policy makers (ACTIVE-6). For more information about this research please view the award page [https://fundingawards.nihr.ac.uk/award/NIHR131847]

DOI

https://doi.org/10.1186/s12966-023-01499-x

EME
HSDR
HTA
PGfAR
PHR

Part of the NIHR Journals Library
www.journalslibrary.nihr.ac.uk

Published by the NIHR Journals Library