Received: 22 May 2023 | Revised: 16 August 2023 | Accepted: 26 August 2023

DOI: 10.1002/osp4.710

SHORT COMMUNICATION

Obesity Science and Practice Open Access WILEY

Long-term effects of the COVID-19 pandemic on children's physical activity and sedentary behavior

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Funding information
National Institutes of Health, Grant/Award Numbers: U01HL146327, R01HL119255

Abstract

Background: During the early months of the COVID-19 pandemic, decreases in physical activity (PA) and increases in sedentary behavior (SB) were reported among children in the United States (U.S.). This follow-up analysis examines 13-month effects of the COVID-19 pandemic on children's PA and SB one year into the pandemic.

Methods: Parents of 5–13-year-old children in the U.S. ($N = 71$) reported on their child's PA and SB during the early COVID-19 period (April-May 2020) and again 12–14 months later (June-July 2021).

Results: Paired *t*-tests showed significant within-subject reductions in SB minutes per day ($M_{diff} = -86.20$, $t = 3.26$, $p < 0.01$) but no changes in PA minutes per day. Separate mixed-model repeated-measures analysis of covariance procedures found that within-subject changes in PA and SB did not differ by child sex or age.

Conclusion: As COVID-19 restrictions lessened, there were more opportunities for children to reduce SB, but there were still barriers to engage in PA.

KEYWORDS
coronavirus, health behaviors, parent reported, questionnaire

1 | INTRODUCTION

Physical activity (PA) participation offers many physical, mental, and developmental benefits for children,[1] whereas sedentary behavior (SB) has been associated with deleterious health outcomes among children.[2] The Centers for Disease Control and Prevention recommend that children participate in 60 min of moderate-to-vigorous PA per day.[3] After coronavirus 2019 (COVID-19) was declared a pandemic by the World Health Organization in March 2020, subsequent public health policies limited access to schools, parks, and recreational sports for children.[4,5] Reductions in PA and increases in SB were observed among children during the COVID-19 pandemic.[6–9] However, it is unclear whether these initial declines in PA and increases in SB persisted further into the pandemic or whether pre-pandemic levels of behavior eventually recovered.

The current literature investigating 13-month changes in United States (U.S.) children's PA and SB during the COVID-19 pandemic is sparse. A systematic review exploring youth's PA levels during COVID-19 uncovered several cross-sectional studies but only three longitudinal studies investigating children's PA during this time.[6,10] Similarly, another systematic review investigating SB among youth during the COVID-19 pandemic found five total studies that investigated changes

in SB.[9] None of these studies investigated long-term (>6 months) changes in SB among children in the U.S. during COVID-19.[11] Investigating PA and SB among children in response to COVID-19 has implications for a better understanding of U.S. children's health behaviors and determinants during the ongoing pandemic.

To address these gaps, the current study examined the 13-month effects of the COVID-19 pandemic on U.S. children's PA and SB occurring over a year later (June-July 2021). Specifically, there were two objectives: (1) to examine changes in parent-reported PA and SB in children from the early COVID-19 period compared to the 12-14-month follow up, and (2) to test whether changes in PA and SB from the early COVID-19 period to the 12–14-month follow-up were moderated by child age or sex, which are commonly observed determinants of PA and SB among children.[11] First, we hypothesized that PA would increase from the early COVID-19 period, as restrictions lessened during the months preceding follow-up data collection.[12] Secondly, we hypothesized that SB would decrease as restrictions for in-person activities were lessened. Thirdly, we hypothesized that changes in PA and SB would differ by sex, as boys report more PA and less SB than girls.[13,14] Finally, we hypothesized that parent-reported PA and SB would differ by age as younger children engage in more PA and less SB than younger children.[13,14]

2 | METHODS

We recruited a convenience sample of parents of children aged 5–13 years living in the U.S. More information on inclusion criteria can be found in our previous study.[7] Eligible participants were invited to consent using an anonymous online information sheet. This study was determined to present no more than minimal risk and was approved by the Institutional Review Board of the University of Southern California.

Parents completed a 20-min online baseline survey between April 25 and 16 May 2020, which we have defined as the 'early COVID period'. Parents were also asked to complete an online follow-up survey 12–14 months (June-July 2021) after the initial baseline survey was completed. Parents were asked to report PA and SB for the same child at both time points.

Parents completed measures of their child's previous day PA and SB based on those used in previous research on youth.[15] They were asked to report on the time that their child was awake during the previous day and to indicate how much time their child spent in PA and SB. Parents could select from multiple PA and SB options such as "Going for a walk" or "Watching TV," respectively. Methods for collecting children's demographic information and previous day PA and SB can be found in our previous publication.[7]

Physical activity minutes in each activity were converted to metabolic equivalents MET-minutes to assign PA intensity using the compendium of physical activities.[16] Normality assumptions were tested for PA MET-minutes and SB minutes. Data for SB was normally distributed, but the PA was positively skewed and required log transformation to meet linearity assumptions. Two age categories (older and younger) were derived from the data based on the median value (8-year) and age distribution of the study participants. Children aged 5–7 at baseline were considered younger and children aged 8–13 at baseline were considered older. Paired *t*-tests compared the within-subject changes from the early COVID-19 period to the 12–14-month follow-up in children's previous day PA (MET-minutes) per day and SB minutes per day. Mixed model repeated-measures analysis of covariance (ANCOVA) procedures examined the between-subject effects of child age category and sex on within-subject differences in PA and SB from the early COVID period, compared to the 12-14-month follow up after controlling for race, ethnicity, and annual household income.

3 | RESULTS

Of the initial 225 parents who completed the baseline survey, 74 parents responded to the 12–14-month follow-up survey, and three parents reported on a different child than at baseline and were excluded. The final sample included 71 parents of children (M_{age} = 8.39, *SD* = 2.4, 55% female, 13.5% Hispanic, 91.5% White) who reported data at both time points.

Compared to the early COVID period (April-May 2020), there were no significant within-subject changes in mean parent-reported PA MET-minutes (M_{diff} = 5.84 PA MET-minutes/day, t = 1.42, p = 0.16; Table 1). Compared to the early COVID period, there were significant within-subject reductions in SB minutes per day (M_{diff} = −86.20 SB minutes, t = 3.26, p < 0.01, Table 1) after 12–14 months. Interaction effects of child age or sex were not observed in the mixed model repeated measures ANCOVA for PA and SB (p's < 0.05, Table 2) controlling for covariates.

TABLE 1 Within-subject changes in parent-reported physical activity (PA) and sedentary behavior (SB) between baseline and follow-up (N = 71).

	Mean difference	SD	95% confidence interval (lower, upper)	*t*	*df*	*p*-value
Early COVID PA versus Follow-up PA	5.84	206.40	−0.97, 33.84	1.42	70	0.16
Early COVID SB versus Follow-up SB	*−86.20	223.1	33.39, 139.0	3.26	70	0.001

Abbreviations: SD, standard deviation; SE, standard error.

*p < 0.05.

TABLE 2 Repeated measures ANCOVA for physical activity (PA) MET-minutes and sedentary behavior (SB) minutes ($N = 71$).

	df	*F*	*p*	η^2
Physical activity	1	3.87	0.05	394.74
Age	1	1.81	0.18	439.74
Sex	1	0.001	0.97	0.31
Physical activity*Age	1	2.39	0.13	243.54
Physical activity*Sex	1	0.01	0.94	0.61
Sedentary behavior	1	8.79	<0.01	21,359.03
Age	1	13.57	<0.001	578,053.04
Sex	1	0.37	0.54	15,873.70
Sedentary behavior*Age	1	0.001	0.98	10.12
Sedentary behavior*Sex	1	0.96	0.33	23,426.57

Note: η^2 = effect size (partial eta squared). WS = within-subject effect. Hispanic/Latino (vs. non-Hispanic/Latino), and annual household income ($12,500–$26,999, $27,000–$59,999, $60,000–$99,999, more than $100,000). All models adjust for the main effects and interactions of age category (5–7 vs. 8–13 years old) and sex (male vs/female) controlling for race (white vs. not white), ethnicity (Hispanic/Latino vs. non-Hispanic/Latino), and annual household income (<$95,000, and >$95,000).

4 | DISCUSSION

Among this sample, we did not observe significant improvements in parent-reported PA among children between the early COVID-19 period and the 12–14-month follow-up. Such findings were contrary to our hypothesis that PA would have recovered one year after the onset of the COVID-19 pandemic. Without access to school and recreational sports, declines in PA were reported among children across the U.S. during the early COVID-19 period.[5–8] We hypothesized that as COVID-19 restrictions were lifted, PA would return to pre-pandemic levels. Suggesting that even as COVID-19 restrictions were lifted, there may still not have been sufficient leisure-time PA opportunities to entice children to be active during the summer (June-July) of 2021. It is also possible that children had formed inactive habits, were no longer interested in the types of physical activities performed before the pandemic, and/or lost cardiorespiratory capacity to such an extent that returning to pre-pandemic levels were hampered. Targeted efforts may be needed to support children's return to PA after pandemic-related lockdowns and isolation.

We found significant decreases in parent-reported SB from the early COVID-19 period to 12–14 months later. Perhaps, circumstances surrounding the COVID-19 pandemic (such as home-based lockdowns and school closures) that promoted sedentary behaviors changed one year later. During the early COVID-19 period, screen-time usage among children nearly doubled compared with pre-pandemic rates.[15] It is possible that as COVID-19 related children were able to leave their homes and return to school, more opportunities[17] became available for children to reduce their SB. Also, most outdoor spaces, businesses, and schools had re-opened in the U.S. by June-July of 2021.[18] Perhaps the availability of such spaces offered alternatives to activities that promote SB among children, such as screen time.

Child age and sex were not significant modifiers of the changes in children's PA and SB from the early COVID period to 12–14 months later. It was hypothesized that younger children's activity levels would recover quicker because younger children generally participate in higher rates of PA compared with older children.[19] We also expected boys' activity levels to bounce back sooner because adolescent boys tend to report greater quantities of PA than age-matched girls.[19] It is possible that moderation effects were not observed due to the participant study dropout that may have limited statistical power to detect moderation effects.

Nonetheless, findings from the present study contribute to the sparse longitudinal literature on children's PA and SB during the COVID-19 pandemic. To date, no other published research has captured U.S. children's PA and SB longitudinally during the early COVID period and again 12+ months into the pandemic. Implications of these findings are relevant when considering the potential for future pandemics, natural disasters, or other circumstances that may influence daily routines among children.

There are some limitations to this study. First, parents self-reported their child's PA and SB, which can be subject to recall errors bias. Second, this study did not control for the in-person, online, or hybrid status of schools during the time of measurement. Future studies should capture the method of daily school attendance (in-person or remote) to better evaluate the role that school attendance (and summer school attendance) has on daily PA and SB. Third, this study did not control for weather, day length, or built environment, which has been shown to influence children's PA and SB.[20] Future studies should consider controlling for these variables when investigating children's PA and SB. Finally, the small sample size in this study may limit our ability to detect small effects and results should be interpreted with some caution. Attrition bias is possible; however, no significant differences were detected among participants who responded to the baseline surveys and the follow-up.

5 | CONCLUSION

By June-July 2021, children's PA levels had not recovered after the initial declines observed in the early COVID period. Sedentary behavior levels decreased over this period, which is promising from a public health standpoint. As COVID-19 restrictions are lessened, further efforts should be made to help children regain PA patterns lost during the pandemic.

ACKNOWLEDGMENTS

National Institutes of Health R01HL119255 and National Institutes of Health U01HL146327.

CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interest.

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How to cite this article: Moore KN, Do B, Wang SD, et al. Long-term effects of the COVID-19 pandemic on children's physical activity and sedentary behavior. *Obes Sci Pract*. 2024; e710. https://doi.org/10.1002/osp4.710