


# Impact of COVID-19 on childhood obesity: Data from a paediatric weight management trial

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## Summary

There is growing concern that the coronavirus disease 2019 (COVID-19) pandemic is exacerbating childhood obesity. We sought to examine the effects of the pandemic on weight and weight-related behaviours among children with overweight and obesity participating in an ongoing cluster randomized controlled trial of a paediatric practice-based weight intervention with 2 study arms: nutritionist-delivered coaching telephone calls over 8 weeks with an accompanying workbook on lifestyle changes versus the same workbook in eight mailings without nutritionist coaching calls. In a pooled, secondary analysis of 373 children in central Massachusetts (aged 8–12 years, 29% Latinx, 55% White, 8% Black), the monthly rate of BMI increase more than doubled for those children whose 6-month study visit occurred post-pandemic onset ( $n = 91$ ) compared to children whose 6-month study visit occurred pre-pandemic onset ( $n = 282$ ) ( $0.13 \text{ kg/m}^2$  versus  $0.05 \text{ kg/m}^2$ ; ratio = 2.47,  $p = 0.02$ ). The post-pandemic onset group also had a significant decrease in activity levels ( $\beta -8.18$  MVPA minutes/day,  $p = 0.01$ ). Caloric intake and screen time did not differ between the pre- and post-pandemic onset groups. These findings show that after the start of the pandemic, children with overweight and obesity experienced an increase in weight and decrease in activity levels. This data can inform public health strategies to address pandemic-related effects on childhood obesity.

## KEYWORDS

childhood obesity, childhood overweight, coronavirus disease 19, COVID-19, weight gain

## 1 | INTRODUCTION

The coronavirus 2019 (COVID-19) pandemic has had a significant impact on the physical, social, and emotional health of children. With changes to in-person school structure, food security, and other social determinants of health, there have been concerns that the COVID-19 pandemic has significantly exacerbated already high childhood obesity rates and weight-related behaviours in children.<sup>1–4</sup> Yet, there is a scarcity of data from prospectively conducted randomized controlled trials

wherein weight is rigorously measured for the primary outcome of the trial. Thus far, studies showing an association between the COVID-19 pandemic and childhood weight gain have largely been limited by cross-sectional or retrospective study design.<sup>5–8</sup> Most longitudinal studies conducted have examined the associations between COVID-19 and childhood weight-related behaviours such as dietary intake, activity levels, screen time and sleep, rather than child weight or BMI.<sup>4,9–13</sup> One exception is a recent longitudinal study of over 430 000 children and adolescents with body mass index (BMI) measurements conducted at healthcare visits prior to and three months after the COVID-19 pandemic. This study found that the monthly rate of BMI increase nearly doubled during the pandemic compared to

**Abbreviations:** BMI, Body Mass Index; COVID-19, Coronavirus disease 2019; RCT, randomized controlled trial.

prior to the pandemic (0.100 vs. 0.052 kg/m<sup>2</sup>, ratio = 1.93), more so in youth with overweight or obesity.<sup>14</sup> Since BMI was collected as part of healthcare visits in this study, the authors recognize that the associations found may be over or underestimates. Many children and families avoided seeking medical attention at the onset of the pandemic and the study population therefore may have been unrepresentative of the general population.

Given that we have an ongoing cluster randomized controlled trial (RCT) of school-aged children with overweight and obesity participating in a paediatric practice-based weight intervention (R01 HL130505), we sought to examine whether children in this trial experienced differences in weight gain and weight-related behaviours, before and after the onset of the COVID-19 pandemic. The primary outcome for the cluster RCT is BMI change measured at 12 months; assessments also were completed at 6 months. We hypothesized that children whose 6-month study visit occurred after the onset of the pandemic would experience greater weight gain, lower activity levels and higher caloric intake compared with children whose 6-month study visit occurred before the pandemic.

## 2 | METHODS

We performed a secondary analysis on the study population in this cluster RCT and pooled data from both the intervention and comparison conditions. In this trial, 20 paediatric practices in central Massachusetts were randomized to one of two conditions, with families receiving either eight weekly nutritionist-delivered coaching telephone calls with accompanying workbook to help them make American Academy of Pediatrics-recommended lifestyle changes, or the same workbook in eight weekly mailings without telephone coaching. The clinical trial design, interventions, and assessments have been previously reported.<sup>15</sup> Written consent was obtained from parents and written assent was obtained from children. All procedures were approved by the University of Massachusetts Chan Medical School Institutional review board. We analysed the data of 373 children aged 8–12 years with a BMI ≥85th percentile who participated in both baseline and 6-month follow up study visits for this clinical trial. Our  $n = 373$  included 74% of the total 501 recruited subjects for this trial, as this was the number of study participants who had completed their 6-month assessment at the time of the present study. All baseline visits occurred pre-COVID-19 onset (defined as before 19 March 2020). We examined differences in change from baseline to 6-month follow-up in body mass index (BMI) (measured by research staff in the paediatric clinic), activity level (measured via accelerometry), caloric intake (measured via three 24-h dietary recalls completed by children), and screen time (measured via surveys completed by children) between those children whose 6-month follow-up occurred pre- versus post-COVID-19 onset.

Linear mixed effects regression models with a random effect for paediatric practice to account for possible within-practice clustering<sup>16</sup> tested for differences between the pre- versus post-COVID-19 onset groups in within-child change from baseline to 6-month follow-up;

outcomes of interest included BMI, daily minutes of MVPA, daily calories, and daily screen time. The first post-COVID-19 onset follow-up visit started on 17 June 2020, three months after the onset of the pandemic. Analyses adjusted for confounding variables (parent education level, race/ethnicity, and season in which the 6-month visit conducted) as well as for the number of months between baseline and 6-month assessment. All comparisons were pre-planned and thus p-values were not adjusted for multiple comparisons.<sup>17</sup>

## 3 | RESULTS

The pre- and post-COVID-19 onset groups were comparable at baseline (Table 1), except for parent education level, race/ethnicity, and season in which the 6-month visit was conducted; we adjusted for these confounding variables in the multivariate analyses. In the univariate analysis, children who had their 6-month visit post-COVID-19 onset ( $n = 91$ ) had an average monthly rate of BMI increase 2.47 times higher than children who had their 6-month visit pre-COVID-19 onset ( $n = 282$ ): 0.13 kg/m<sup>2</sup> versus 0.05 kg/m<sup>2</sup>; ratio = 2.47,  $p = 0.02$ . In the multivariate analyses, children in the post-COVID-19-onset group had a greater increase in BMI from baseline to 6 months, compared to children in the pre-COVID-19-onset group (Table 2;  $\beta$  (SE) = +0.69 kg/m<sup>2</sup> (0.32),  $p = 0.03$ ). The post-COVID-19 group also experienced a decrease in average number of minutes of moderate to vigorous physical activity (MVPA) per day from baseline to 6 months while the pre-COVID-19 group had an increase, which resulted in a significant covariate-adjusted between-group difference ( $\beta$  (SE) –8.18 MVPA minutes/day (5.96),  $p = 0.01$ ). Average calories/day and the number of hours playing video/computer games or using a computer recreationally did not significantly differ between pre- and post-COVID-19 onset participants.

## 4 | DISCUSSION

This study showed that children with overweight and obesity experienced significant weight gain after the onset of the COVID-19 pandemic, compared with prior. This statistically significant difference may be due in part to the decrease in moderate to vigorous physical activity observed in the post-pandemic group of children, compared with the pre-pandemic group of children, in which an increase in MVPA was observed during the study period.

Our findings are consistent with recent findings of attenuated weight gain during a weight management trial<sup>18</sup> as well as previous retrospective, cross-sectional, and longitudinal studies demonstrating that the pandemic has exacerbated childhood obesity.<sup>5–7,14</sup> However, we add an examination of BMI and weight-related behaviour data specifically in children with overweight and obesity from a rigorously conducted weight-related randomized clinical trial. Our effect size, wherein average monthly BMI increase more than doubled in the post-pandemic-onset versus the pre-pandemic-onset group, was slightly larger than the previous longitudinal study wherein monthly

**TABLE 1** Characteristics of the study sample

	6 Month visit was pre-or post- COVID		Total n = 373 n (%)
	Pre COVID n = 282 n (%)	Post COVID n = 91 n (%)	
<b>CHILD</b>			
Baseline Age (years)—Mean (SD)	10.4 (1.4)	10.5 (1.4)	10.5 (1.4)
BMI (kg/m <sup>2</sup> )—Mean (SD)	25.9 (4.6)	24.8 (3.8)	25.6 (4.4)
Average MVPA (min/day) —Mean (SD)	37.3 (22.2)	78.7 (35.9)	48.7 (32.4)
Average Kcal/Day—Mean (SD)	1767.2 (496.9)	1733.6 (466.3)	1759.3 (489.5)
<b>Gender</b>			
Female	136 (48.2%)	40 (44%)	176 (47.2%)
<b>Race/ethnicity*</b>			
Latino(a)	94 (33.33%)	13 (14.29%)	107 (28.69%)
Non-hispanic white	145 (51.42%)	60 (65.93%)	205 (54.96%)
Non-hispanic black	22 (7.8%)	9 (9.89%)	31 (8.31%)
Non-hispanic Asian	4 (1.42%)	6 (6.59%)	10 (2.68%)
Non-hispanic 'other'	6 (2.13%)	0 (0%)	6 (1.61%)
Non-hispanic multi-racial	11 (3.9%)	3 (3.3%)	14 (3.75%)
<b>Season baseline visit conducted in*</b>			
Winter	73 (25.9%)	42 (46.2%)	115 (30.8%)
Spring	72 (25.5%)	0 (0%)	72 (19.3%)
Summer	94 (33.3%)	6 (6.6%)	100 (26.8%)
Fall	43 (15.3%)	43 (47.3%)	86 (23.1%)
<b>PARENT</b>			
Age (years)—Mean (SD)	41.7 (6.9)	42.7 (6.7)	41.9 (6.9)
BMI (kg/m <sup>2</sup> )—Mean (SD)	32.7 (8.4)	31.8 (7.4)	32.5 (8.2)
<b>Gender</b>			
Female	251 (89%)	81 (89%)	332 (89%)
<b>Race/ethnicity*</b>			
Latino(a)	63 (22.34%)	12 (13.19%)	75 (20.11%)
Non-hispanic white	176 (62.41%)	68 (74.73%)	244 (65.42%)
Non-hispanic black	23 (8.16%)	4 (4.4%)	27 (7.24%)
Non-hispanic Asian	5 (1.77%)	7 (7.69%)	12 (3.22%)
Non-hispanic 'other'	4 (1.42%)	0 (0%)	4 (1.07%)
Non-hispanic multi-racial	11 (3.9%)	0 (0%)	11 (2.95%)
<b>Education level*</b>			
<Bachelor's degree	156 (55.3%)	29 (31.9%)	185 (46.9%)
Bachelor's degree and above	126 (44.7%)	62 (68.1%)	188 (50.4%)
<b>Marital status</b>			
Married	195 (69.2%)	68 (74.7%)	263 (70.5%)
Not married, living with partner	17 (6%)	4 (4.4%)	21 (5.6%)
Single, never married	27 (9.6%)	6 (6.6%)	33 (8.9%)
Divorced/separated or widowed	43 (15.3%)	13 (14.3%)	56 (15.0%)
<b>Relation to child</b>			
Biological mother	237 (84%)	80 (87.9%)	317 (85%)
Biological father	30 (10.6%)	9 (9.9%)	39 (10.5%)
Step and/or adoptive parent	6 (2.1%)	0 (0%)	6 (1.6%)
Grandparent	9 (3.2%)	2 (2.2%)	11 (3.0%)

(Continues)

TABLE 1 (Continued)

	6 Month visit was pre-or post- COVID		Total n = 373 n (%)
	Pre COVID n = 282 n (%)	Post COVID n = 91 n (%)	
<i>Describe child's weight</i>			
Very underweight/Underweight	2 (0.7%)	1 (1.1%)	3 (0.8%)
Normal weight	57 (20.2%)	16 (17.6%)	73 (19.6%)
Overweight	198 (70.2%)	68 (74.7%)	266 (71.3%)
Very overweight	25 (8.9%)	6 (6.6%)	31 (8.3%)
<i>Describe your weight</i>			
Underweight	2 (0.7%)	1 (1.1%)	3 (0.8%)
Normal weight	57 (20.2%)	20 (22%)	77 (20.6%)
Overweight	179 (63.5%)	58 (63.7%)	237 (63.5%)
Very overweight	44 (15.6%)	12 (13.2%)	56 (15%)

\* $\chi^2$  or fisher's exact p-value <0.05.

TABLE 2 Change in child health outcomes from baseline to 6 months pre- versus post-COVID<sup>†</sup>

Child Outcomes	Pre-COVID cohort Mean (SD)		Post-COVID cohort Mean (SD)		Adjusted coefficient <sup>a,b</sup> (SE)	p-value (for the difference in the change)
	Baseline	6mo	Baseline	6mo		
BMI (kg/m <sup>2</sup> )	25.9 (4.6)	26.2 (4.6)	24.8 (3.8)	25.7 (4.6)	0.69 (0.32)	0.03
Average MVPA (min/day)	35.2 (18.6)	34.8 (17.5)	39.3 (18.1)	31.0 (18.5)	-8.81 (3.50)	0.01
Calories per day	1767.2 (496.9)	1689.6 (477.7)	1733.6 (466.3)	1582.1 (435.2)	-82.13 (73.89)	0.27
Screen time (hours/day on average school day)	1.6 (1.4)	1.6 (1.4)	1.5 (1.5)	1.8 (1.5)	-0.02 (0.23)	0.95

<sup>a</sup>Models adjusted for number of months between baseline and 6-month visit, parent education, parent race/ethnicity and season in which the 6-month visit was conducted.

<sup>b</sup>Adjusted coefficient represents between group difference in change from baseline to 6-month follow-up in each group.

<sup>†</sup>Pre-COVID is referent.

BMI change nearly doubled from post- compared to pre-pandemic.<sup>14</sup> This may be explained somewhat by the difference in study design and study populations, underscoring the importance of examining this relationship through varied study designs and populations to enhance generalizability.

Our study also supports previous findings that children have experienced decreases in physical activity since the start of the pandemic,<sup>4,9-13,19</sup> which could be due to factors such as stay-at-home orders and cessation of sports activities in school-aged children during the pandemic. Interestingly, we observed no difference between the pre- and post-pandemic groups in change in average calories/day. This contrasts with prior studies where dietary intake, particularly of unhealthy foods, was found to be increased during the pandemic.<sup>11,12,19</sup> While it is reasonable to theorize that the pandemic-related BMI increase observed in our study population could be attributable to increased caloric consumption, our data do not support this hypothesis. It is possible that the weight gain that we observed may be attributable to the decrease found in MVPA. Perhaps our study population had lower caloric intake related to the universal nutritional

support received in both study conditions of the clinical trial. We were not powered to detect effect modification in MVPA that may be related to factors such as seasonality.

There are several study strengths. First, children's BMI was prospectively measured using standardized protocols by research staff at baseline and 6 months, rather than by varied health clinic staff, or through parental/caregiver report, enhancing the accuracy of weight measurements and hence weight change. Additionally, we analysed data which traversed the COVID-19 pandemic onset, and our study population was diverse with regard to race/ethnicity. These study findings are also subject to limitations. First, this was a secondary analysis of data from a randomized controlled trial and therefore we can report only on associations rather than causation. Second, there may have been factors that were not assessed that may have contributed to the differences observed in BMI and health behaviours. It is important to note that we observed between group differences in sociodemographic characteristics and thus our analyses included adjustment for these factors. Third, this study was conducted in only one geographic area of central Massachusetts limiting generalizability

of our findings to other geographic areas. Moreover, participants self-selected to participate in a randomized study of a weight-reduction intervention, which may have introduced selection bias towards children and families motivated to achieve weight loss, potentially introducing a floor effect (wherein families more motivated to achieve weight loss may have experienced smaller increases in BMI than the general population), and makes it challenging to comparing our study results to a non-intervened group of children. However, it is notable that when pooling children from the two study conditions (intervention and comparison condition), children experienced an overall BMI increase over the 6-month study period, indicating that this population could be representative of a larger population.

In conclusion, our study provides evidence that children with overweight and obesity experienced greater weight gain and decreased activity levels, after the onset of the COVID-19 pandemic. Our study contributes to mounting evidence that the COVID-19 pandemic may be exacerbating paediatric obesity. This highlights the importance of implementing both evidence-based interventions for children with overweight and obesity as well as paediatric obesity prevention efforts for all children during public health emergencies like the COVID-19 pandemic.<sup>14</sup> Such treatment and prevention efforts could include screening during paediatric clinical visits for BMI changes and social determinants of health like food security and availability of safe, socially distanced areas for physical activity, which would allow for targeted lifestyle modification interventions and referrals to community resources as appropriate. Future advocacy work should ensure that referral resources are available to paediatric practitioners for evidence-based paediatric weight management programs during public health emergencies.<sup>14</sup> Moreover, future longitudinal studies should seek to determine the long-term trajectory of weight and behaviour changes during the COVID-19 pandemic to examine whether these changes in BMI persist to exacerbate the paediatric obesity epidemic, or if there is a return to pre-COVID BMI. These efforts would deepen our understanding of the impact of COVID-19 and other public health emergencies on childhood obesity.

#### AUTHOR CONTRIBUTIONS

Michelle Trivedi contributed to study design, literature search, writing the first draft and substantively revising the manuscript. Alan C. Geller and Lori Pbert contributed to study design and substantively revising the manuscript. Christine Frisard and Sybil Crawford contributed to data analysis, interpretation, generation of tables, and revised the manuscript. Jennifer Bram contributed to data collection and substantively revised the manuscript.

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All authors were involved in writing the paper and approved the final manuscript, agreeing to be accountable for all aspects of the work.

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#### CONFLICT OF INTEREST

The authors have nothing to disclose.

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