

Letters

RESEARCH LETTER

Changes in Body Mass Index Among Children and Adolescents During the COVID-19 Pandemic

The COVID-19 pandemic has been associated with weight gain among adults,¹ but little is known about the weight of US children and adolescents. To evaluate pandemic-related changes in weight in school-aged youths, we compared the body mass index (BMI; calculated as weight in kilograms divided by height in meters squared) of youths aged 5 to 17 years during the pandemic in 2020 to the same period before the pandemic in 2019.

Methods | We conducted a retrospective cohort study using Kaiser Permanente Southern California (KPSC) electronic health record data. Youth between 5 and 17 years with continuous health care coverage were included if they had an in-person visit with at least 1 BMI measure before the pandemic (March 2019-January 2020) and another BMI measure during the pandemic (March 2020-January 2021 with at least 1 BMI after June 16, 2020, ie, about 3 months into the pan-

demic). Youth with complex chronic conditions were excluded.^{2,3} Race and ethnicity based on caregiver report or birth certificates were used to compare with the underlying population. Outcomes were the absolute distance of a youth's BMI from the median BMI for sex and age,⁴ weight adjusted for height, and overweight or obesity (≥ 85 th or ≥ 95 th percentile of BMI for age, respectively).^{5,6} We fit mixed-effect and Poisson regression models accounting for repeated measures within each individual, using an autoregressive correlation structure and maximum likelihood estimation of covariance parameters to assess each outcome. Similar to an interrupted time-series design, we included a binary indicator representing the periods before or during the pandemic plus a calendar month by period interaction term. We divided youths into 3 age strata (5.0- <12 , 12- <16 , 16- <18 years) based on age at the start of the pandemic.

Models were adjusted for sex, race and ethnicity, state-subsidized health insurance, neighborhood education, neighborhood income, and number of parks in the census tract. Mixed-effects models also included BMI-for-age class at baseline. All analyses were performed with $\alpha = .05$ for 2-sided tests

Table. Weight Changes in Youths Over an 11-Month Period Before and During the Pandemic^a

Age group, y	Prepandemic			Pandemic			
	Start	End	Change 1 ($\Delta 1$, 95% CI)	Start	End	Change 2 ($\Delta 2$, 95% CI)	$\Delta 2 - \Delta 1$ (95% CI)
Distance from the median BMI for age, mean (SD) ^{b,c}							
5-11	0.26 (0.03)	0.41 (0.03)	0.15 (0.11 to 0.18)	0.48 (0.03)	2.20 (0.03)	1.72 (1.67 to 1.76)	2.30 (2.23 to 2.36)
12-15	0.52 (0.03)	0.48 (0.03)	-0.03 (-0.07 to -0.00)	0.47 (0.03)	1.34 (0.03)	0.87 (0.83 to 0.91)	2.31 (2.19 to 2.43)
16-17	0.52 (0.05)	0.27 (0.05)	-0.25 (-0.30 to -0.21)	0.30 (0.05)	0.53 (0.05)	0.23 (0.18 to 0.28)	1.02 (0.85 to 1.20)
Body weight, mean (SD), kg ^{b,c}							
5-11	27.58 (0.04)	27.65 (0.04)	0.07 (0.03 to 0.11)	27.67 (0.04)	30.04 (0.04)	2.37 (2.32 to 2.42)	2.30 (2.23 to 2.36)
12-15	48.73 (0.08)	50.12 (0.08)	1.39 (1.31 to 1.46)	50.34 (0.08)	54.05 (0.08)	3.70 (3.61 to 3.80)	2.31 (2.19 to 2.43)
16-17	59.52 (0.13)	60.54 (0.13)	1.02 (0.91 to 1.13)	60.96 (0.14)	63.00 (0.13)	2.04 (1.91 to 2.18)	1.02 (0.85 to 1.20)
Overweight or obese (≥ 85 th percentile), rate (SD), % ^b							
5-11	34.76 (0.23)	35.70 (0.23)	0.94 (0.58 to 1.30)	36.16 (0.26)	45.74 (0.28)	9.58 (9.01 to 10.16)	8.65 (7.96 to 9.33)
12-15	39.04 (0.31)	38.52 (0.31)	-0.53 (-0.97 to -0.08)	38.74 (0.35)	43.41 (0.34)	4.67 (3.99 to 5.35)	5.19 (4.37 to 6.02)
16-17	37.97 (0.48)	36.57 (0.46)	-1.40 (-2.04 to -0.76)	36.52 (0.50)	38.20 (0.48)	1.67 (0.75 to 2.59)	3.07 (1.94 to 4.21)
Overweight (≥ 85 th to <95 th percentile), rate (SD), % ^b							
5-11	17.22 (0.20)	16.87 (0.20)	-0.35 (-0.80 to 0.10)	16.99 (0.26)	18.86 (0.23)	1.87 (1.16 to 2.57)	2.22 (1.37 to 3.06)
12-15	19.23 (0.27)	18.82 (0.27)	-0.41 (-0.98 to 0.16)	19.69 (0.34)	19.35 (0.29)	-0.34 (-1.20 to 0.52)	0.07 (-0.98 to 1.12)
16-17	19.32 (0.41)	18.20 (0.39)	-1.12 (-1.92 to -0.31)	17.66 (0.46)	17.54 (0.40)	-0.12 (-1.23 to 0.98)	1.00 (-0.39 to 2.38)
Obesity (≥ 95 th percentile), rate (SD), % ^b							
5-11	17.27 (0.18)	18.38 (0.18)	1.11 (0.83 to 1.39)	18.79 (0.21)	26.11 (0.25)	7.32 (6.84 to 7.80)	6.21 (5.66 to 6.76)
12-15	19.19 (0.25)	19.06 (0.25)	-0.13 (-0.47 to 0.22)	18.58 (0.27)	23.20 (0.30)	4.62 (4.06 to 5.18)	4.75 (4.09 to 5.42)
16-17	18.18 (0.37)	17.97 (0.37)	-0.21 (-0.70 to 0.28)	18.41 (0.41)	20.07 (0.41)	1.66 (0.93 to 2.39)	1.87 (0.99 to 2.75)

^a Total body mass index (BMI, calculated as weight in kilograms divided by height in meters squared) measures included in the models totaled 425 855 from March 2019 to January 2020 (2.22 BMI measures per youth) compared with 283 718 from March 2020 to January 2021 (1.48 BMI measures per youth).

^b All models are adjusted for race and ethnicity (Asian or Pacific Islander, Hispanic, non-Hispanic Black, non-Hispanic White [reference], and other race), state-subsidized health care [reference, none], parks (no parks,

≥ 2 , reference, 1 park), neighborhood education, and neighborhood income. Estimates are shown for the reference group. After initial decrease, in-person well-child visits were back to 84% of prepandemic visits by June 2020.

^c Models for distance from the median BMI for age and body weight were also adjusted for baseline weight class (<5 th, 5th-84th, 85th-94th; 95th-97th, >97 th; reference, 5th- ≤ 85 th), the model for body weight is adjusted for height.

using SAS version 9.4 (SAS Institute Inc). The KPSC institutional review board approved the study and granted a waiver for informed consent.

Results | The cohort (n = 191 509) was racially and ethnically diverse (10.4% Asian and Pacific Islander, 50.4% Hispanic, 7.0% non-Hispanic Black, and 25.3% non-Hispanic White) with 49.6% girls, mean age of 11.6 years (SD, 3.8 years), and mean prepandemic BMI of 20.7 (SD, 5.4). The study population was comparable with the overall KPSC pediatric population with regard to sex, age, race and ethnicity, and socioeconomic factors. Prepandemic, 38.9% of youth in the cohort were overweight or obese compared with 39.4% in the KPSC source population.

Youths gained more weight during the COVID-19 pandemic than before the pandemic (Table). The greatest change in the distance from the median BMI for age occurred among 5- through 11-year-olds with an increased BMI of 1.57, compared with 0.91 among 12- through 15-year-olds and 0.48 among 16- through 17-year-olds. Adjusting for height, this translates to a mean gain among 5- through 11-year-olds of 2.30 kg (95% CI, 2.24-2.36 kg) more during the pandemic than during the reference period, 2.31 kg (95% CI, 2.20-2.44 kg) more among 12- through 15-year-olds, and 1.03 kg (95% CI, 0.85-1.20 kg) more among 16- through 17-year-olds. Overweight or obesity increased among 5- through 11-year-olds from 36.2% to 45.7% during the pandemic, an absolute increase of 8.7% and relative increase of 23.8% compared with the reference period (Table). The absolute increase in overweight or obesity was 5.2% among 12- through 15-year-olds (relative increase, 13.4%) and 3.1% (relative increase, 8.3%) among 16- through 17-year-olds. Most of the increase among youths aged 5 through 11 years and 12 through 15 years was due to an increase in obesity.

Discussion | Significant weight gain occurred during the COVID-19 pandemic among youths in KPSC, especially among the youngest children. These findings, if generalizable to the US suggest an increase in pediatric obesity due to the pandemic.

Study limitations include the observational design and inclusion of only those with in-person appointments. However, the analyses benefited from longitudinal data with prepandemic BMI and in-person well-child visits resuming at 84% of prepandemic levels by June 2020. Furthermore, the sample was comparable in all relevant characteristics with the overall KPSC pediatric membership.

Research should monitor whether the observed weight gain persists and what long-term health consequences may emerge. Intervention efforts to address COVID-19 related weight gain may be needed.

Susan J. Woolford, MD, MPH
Margo Sidell, ScD
Xia Li, MSc
Veronica Else, RN, MSN
Deborah R. Young, PhD
Ken Resnicow, PhD
Corinna Koebnick, PhD

Author Affiliations: Child Health Evaluation and Research Center, University of Michigan, Northville (Woolford); Department of Research & Evaluation, Kaiser Permanente Southern California, Pasadena (Sidell, Li, Young, Koebnick); Kaiser Permanente Yorba Linda Medical Offices, Southern California Permanente Medical Group, Yorba Linda (Else); Department of Health Behavior, Health Education of the School of Public Health of the University of Michigan, Ann Arbor (Resnicow).

Corresponding Author: Corinna Koebnick, PhD, Department of Research & Evaluation, Kaiser Permanente Southern California, 100 S Los Robles, Second Floor, Pasadena, CA 91101 (corinna.koebnick@kp.org).

Accepted for Publication: August 18, 2021.

Published Online: August 27, 2021. doi:[10.1001/jama.2021.15036](https://doi.org/10.1001/jama.2021.15036)

Author Contributions: Dr Koebnick had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. Drs Woolford and Sidell shared equal first-author roles.

Concept and design: Woolford, Sidell, Resnicow, Koebnick.

Acquisition, analysis, or interpretation of data: Woolford, Sidell, Li, Else, Young, Koebnick.

Drafting of the manuscript: Woolford, Sidell, Resnicow, Koebnick.

Critical revision of the manuscript for important intellectual content: Woolford, Sidell, Li, Else, Young, Resnicow.

Statistical analysis: Woolford, Sidell, Li, Resnicow, Koebnick.

Obtained funding: Koebnick.

Administrative, technical, or material support: Else, Resnicow, Koebnick.

Supervision: Koebnick.

Conflict of Interest Disclosures: None reported.

Funding/Support: The current project was supported by Kaiser Permanente Community Benefits.

Role of the Funder/Sponsor: Kaiser Permanente had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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