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 with BMI in 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. Youths 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

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

	Prepandemic			Pandemic			
Age group, y	Start	End	Change 1 (Δ1) (95% CI)	Start	End	Change 2 (Δ2) (95% CI)	Δ2 − Δ1 (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 obesity (≥85th 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 (≥85th to <95th 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 (≥95th 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 parks; 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 (<5th, 5th-84th, 85th-94th; 95th-97th, >97th percentiles; reference, 5th-≤85th percentiles); the model for body weight is adjusted for height.

1 BMI after June 16, 2020, ie, about 3 months into the pandemic). Youths 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 (≥85th or ≥95th 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 α = .05 for 2-sided tests 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, a mean age of 11.6 years (SD, 3.8 years), and a 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. Before the pandemic, 38.9% of youths 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.

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Prevalence of SARS-CoV-2 Antibodies From a National Serosurveillance of Kenyan Blood Donors, January-March 2021

High SARS-CoV-2 antibody levels have been achieved in most of the population in high-income countries through vaccination.[1] However, global inequity exists in COVID-19 vaccine distribution, as highlighted at the June 2021 G7 Summit, which committed to providing 1 billion doses to low-income countries. This focus on doses overlooks the pace of transmission in low-income settings.

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To monitor seroprevalence in Kenya, we began surveillance of blood donors (aged 16-64 years) in April 2020.[2,3] The national prevalence of SARS-CoV-2 antibodies was estimated at 4.3% in April to June 2020[2] and 9.1% in August to September 2020.[3] In this article we estimate seroprevalence for January to March 2021.

Methods | The sampling, laboratory, and analytic methods were identical to those in the studies conducted in 2020.[2,3] Plasma samples with complete donor demographic data and sufficient volume collected from all 6 regional transfusion centers were included and assayed for anti-spike IgG using an enzyme-linked immunosorbent assay. Validated among 910 prepandemic serum samples from coastal Kenya and 174 patients with positive polymerase chain reaction test results from Nairobi, specificity was 99.0% and sensitivity was 92.7%.[2] Seropositive results were tabulated by age, sex, and region of residence. Donors were stratified into 8 regions by place of residence; these regions are unrelated to the 6 regional transfusion centers, which collate donations across different geographic catchment areas. Bayesian multilevel regression with poststratification using the rjags package in R, version 3.6.1 (R Foundation), was used to obtain seroprevalence estimates and 95% CIs adjusted for the age, sex, and regional distribution of blood donors compared with national data for individuals aged 16 to 64 years based on 2019 census data.[2,3] Adjustment was also done for test performance. The surveillance

Table. Seroprevalence of Anti–SARS-CoV-2 IgG Among Blood Donors in Kenya, January to March 2021

Characteristic	All samples, No. (%)	Seropositive samples, No.	Crude seroprevalence (95% CI), %	Kenya population, No. (%)	Bayesian population-weighted seroprevalence (95% CI), %[a]	Bayesian population-weighted, test-adjusted seroprevalence (95% CI)[a,b]
Total	3018	1333	44.2 (42.4-46.0)	25 954 858	45.3 (42.7-47.8)	48.5 (45.2-52.1)
Age, y						
16-24	1120 (37.1)	464	41.4 (38.5-44.4)	8 537 867 (32.9)	44.2 (40.8-47.2)	47.3 (43.4-51.3)
25-34	1073 (35,6)	494	46.0 (43.0-49.1)	7 424 967 (28.6)	46.8 (43.7-50.1)	50.1 (46.2-54.5)
35-44	586 (19.4)	259	44.2 (40.1-48.3)	4 909 191 (18.9)	45.3 (41.7-48.7)	48.6 (44.1-53.0)
45-54	198 (6.6)	96	48.5 (41.3-55.7)	3 094 771 (11.9)	45.9 (41.6-51.0)	49.2 (44.1-55.3)
55-64	41 (1.4)	20	48.8 (32.9-64.9)	1 988 062 (7.6)	43.9 (37.2-49.6)	47.0 (39.7-53.6)
Sex						
Female	661 (21.9)	294	44.5 (40.6-48.4)	13 177 991 (50.8)	45.1 (41.1-49.2)	48.4 (43.7-53.4)
Male	2357 (78.1)	1039	44.1 (42.1-46.1)	12 776 867 (49.2)	45.4 (43.0-47.8)	48.6 (45.4-52.2)
Region[c]						
Central	90 (3.0)	44	48.9 (38.2-59.7)	3 342 413 (12.9)	46.7 (38.1-55.6)	50.1 (40.5-60.1)
Mombasa	441 (14.6)	192	43.5 (38.9-48.3)	773 149 (3.0)	43.6 (39.1-48.4)	46.7 (41.4-52.2)
Other coast	431 (14.3)	171	39.7 (35.0-44.5)	1 593 333 (6.1)	39.8 (35.1-44.7)	42.6 (37.2-48.1)
Eastern/N Eastern	595 (19.7)	273	45.9 (41.8-50.0)	4 916 584 (18.9)	45.5 (41.5-49.6)	48.8 (44.0-53.8)
Nairobi	177 (5.9)	108	61.0 (53.4-68.2)	2 936 259 (11.3)	57.6 (50.2-64.8)	61.8 (53.2-70.6)
Nyanza	575 (19.0)	215	37.4 (33.4-41.5)	3 189 563 (12.3)	38.0 (33.8-42.3)	40.6 (35.7-45.7)
Rift Valley	637 (21.1)	307	48.2 (44.3-52.2)	6 695 382 (25.8)	47.8 (43.7-52.0)	51.3 (46.6-56.4)
Western	72 (2.4)	23	31.9 (21.4-44.0)	2 508 175 (9.7)	35.3 (25.7-44.8)	37.6 (26.9-48.2)

[a] Reweighted prevalence estimates were based on demographic data from the 2019 Kenyan census.

[b] Estimates were further adjusted to compensate for imperfect sensitivity and specificity.

[c] Donors were stratified into 8 regions by place of residence; these are unrelated to the 6 regional transfusion centers that collate donations across different geographic catchment areas.