Received: 8 January 2022 | Revised: 13 February 2022 | Accepted: 15 February 2022

DOI: 10.1111/cob.12522

ORIGINAL RESEARCH ARTICLE

Clinical OBESITY WILEY

Change in weight category among youth early in the COVID-19 pandemic

Ihuoma Eneli[1,2,3] | Jinyu Xu[1] | Keeley Pratt[2,4]

[1]Center for Healthy Weight & Nutrition, Nationwide Children's Hospital, Columbus, Ohio, USA

[2]The Ohio State University College of Medicine, Columbus, Ohio, USA

[3]Division of Primary Care Pediatrics, Nationwide Children's Hospital, Columbus, Ohio, USA

[4]Department of Human Sciences, College of Education and Human Ecology, The Ohio State University, Columbus, Ohio, USA

Correspondence
Ihuoma Eneli, Center for Healthy Weight & Nutrition, Nationwide Children's Hospital, 380 Butterfly Garden's Drive, Columbus, OH 43215, USA.
Email: ihuoma.eneli@nationwidechildrens.org

Summary

Remote learning and shelter-in-place orders during the COVID-19 pandemic are associated with obesity risk factors such as decreased physical activity, altered routines and sleep schedules, increased screen time, and non-nutritious food choices. The objective of this brief report is to describe change in weight category 3–6 months after the onset of the pandemic in a cohort of 4509 low-income youth. Inclusion criteria were youth aged 2–17 years with weight and height measure in a large primary care network between 1 January and 30 March 2020 (Q1), designated as pre-COVID period; and 1 June–30 September 2020, (Q3), as early-COVID period. Change in weight category was assessed between Q1 and Q3. Adjusting for visit type and time lapse, logistic regression was conducted to examine the association between weight category change and age, sex, and race/ethnicity. The proportion of youth with overweight or obesity increased from 37.8% to 44.6%; and declined by 5.6% in the healthy weight category. Over the 3–6 month period, 23.1% of youth gained ≥5 kg, 4.3% gained ≥10 kg, and 17.8% increased their BMI by ≥2 units. Among underweight youth, 45.3% switched to the healthy weight category, with a median weight gain of 2.1 kg (interquartile range [IQR] = 2.1 kg). Median weight gain was highest among those youth with severe obesity (5.8 kg, IQR = 5.2 kg). Younger age (2–9 years), female and ethnic-minority youth were more likely to change to a higher/worse weight category. Significant weight gain occurred in the first 3–6 months of the pandemic among low-income youth, reflecting the short-term effects of the pandemic.

KEYWORDS
children, covid, obesity, severe obesity

1 | INTRODUCTION

In response to the COVID pandemic, a midwestern state in the United States implemented full mitigation measures which included school closures, suspension of youth and afterschool activities, facility and restaurant closures, ban on social gatherings, scaled down in-person work hours except for emergency workers by the third week in March 2020. Remote learning and shelter-in-place orders, two of mitigation efforts in response to the COVID-19 pandemic affected youth disproportionately with decreased opportunities for physical activity, altered routines and sleep schedules, increased screen time, and consumption of non-nutritious foods.[1,2] An increased number of families were impacted by economic instability and food insecurity following the onset of the pandemic, as governments grappled with instituting policies and programmes to provide relief.[3,4] The USDA report on nutrition security found increased rates of food insecurity among minority households and those with children in 2020.[5]

The early period of the pandemic was marked with uncertainty about the virus, its transmissibility, severity, and treatment options. In addition to the strict mitigation practices, families were inundated with alarming media reports on the morbidity and mortality from the disease. These factors, in addition to simultaneous increasing negative economic impacts, especially among low-income populations, created a perfect storm that led to undesirable effects on psychological health. With the pandemic, there has been an increase in anxiety, irritability and depressive symptoms among youth and adults, all potential risk factors for obesity.[6,7]

A number of studies projected an increase in overweight and obesity in youth based on models that accounted for the convergence of these factors in response to the pandemic.[1,8] Recent studies confirm these projections.[9,10] Lange et al.[9] reported a doubling in the increase in body mass index (BMI) per month in a large cohort of youth 2–19 years old up to 9 months during the pandemic when compared to 12 months prior to the onset of the pandemic. In another study, 5–11-year olds had the largest increase in pandemic weight gain, with the rate of overweight and obesity rising from 35.7% to 46% over 11 months.[10] While most of the studies highlight differences in age groups, the impact on children in lower socioeconomic strata remains limited. Building on this evidence, the objective of this brief report was to examine the early impact of the COVID-19 pandemic (3–6 months following the onset) on change in weight category in a cohort of predominantly low-income youth.

2 | METHODS

This retrospective cohort study used electronic health record data of youth seen at a large network of 12 primary care clinics in a children's hospital in the State of Ohio. The network provides care for >100 000 youth, most of whom receive public insurance, e.g., Medicaid.

Inclusion criteria were youth aged 2–17 years, with at least one weight and height documented at any type of clinic visit between the pre-COVID period of 1 January– 30 March 2020 (designated as Quarter 1 [Q1]) *and* the early-COVID period of 1 June–30 September 2020 (Q3). When youth had multiple visits during a quarter, the last documented weight and height were used. To ensure a minimum 3-month exposure to the COVID mitigation efforts, visits between 1 April and 30 June 2020 (Q2) were not included in analysis. In addition, Q2 was an outlier due to low volume of clinic visits from pandemic-related restrictions. Youth with biologically implausible anthropometric values according to the Centers for Disease Control and Prevention (CDC) modified *z*-score algorithm (BMI *z*-score <−4 or >8) and the Daymont's algorithm were excluded.[11,12]

Youth with complex chronic conditions who may have increased frequency of visits or differential weight gain trajectory due to chronic health problems were identified and excluded from the cohort.[13] To determine if the cohort was representative of youth seen in the primary care network, comparisons of demographic characteristics, obesity rates and type of visit (well-child or acute) between youth with Q1 *and* Q3 visits and youth who had a Q1 but not Q3 visit were conducted (data not shown). The group with visits in Q1 *and* Q3, had a small increase in percentage of 2–5-year olds (39.5% vs. 36.6%, $p < .005$) and decrease in percentage of non-Hispanic Black youth (47.2% vs. 52.9%, $p < .001$) compared to the group with only a Q1 visit. The proportion of overweight and obesity was similar in the study cohort and among youth seen only in Q1 and not in Q3 in 2020, (37.8% vs. 37.1%, $p = .32$), respectively.

Based on the 2000 CDC growth chart, weight category was defined using age- and sex-specific BMI percentiles for underweight (<5th percentile), healthy weight (≥5th–<85th percentile) overweight (≥85th–<95th) obesity (≥ 95th percentile–<120% of the 95th percentile) and severe obesity (≥120% of the 95th percentile).[14] Based on these weight categories, change between Q1 and Q3, was divided into two categories. *Concerning Weight Category change* (CWC) defined as an increase or decrease in body mass index with a resultant change to a higher or underweight weight category: (i) 'healthy weight' to 'overweight' or 'obesity' or 'severe obesity'; (ii) 'overweight' to 'obesity' or 'severe obesity'; (iii) 'obesity' to 'severe obesity'; or (iv) 'healthy weight' to 'underweight'. *Non-Concerning Weight Category change* (NCWC) was defined as (i) a weight category that remained the same; change from (ii) 'severe obesity' to 'obesity' or 'overweight'; (iii) 'obesity' to 'overweight' or 'healthy weight'; (iv) 'overweight' to 'healthy weight'; and (v) 'underweight' to 'healthy weight'.

A binomial logistic regression model was conducted to determine the odds of change in weight category (CWC, NCWC) with independent variables: age group (2–5, 6–9, 10–13, 14–17 reference), sex (male, female reference), race/ethnicity (non-Hispanic Black, Hispanic, other, non-Hispanic White reference) and insurance status (Medicaid, private, other reference). Covariates were visit type (sick visit, well-child visit reference) and time between visits in Q1 and Q3. Given the significant finding of age group in the first binomial model, four additional models were conducted stratified by youth age group (Model 1 ages 2–5, Model 2 ages 6–9, Model 3 ages 10–13, Model 4 ages 14–17) to determine the odds of change in weight category with the same variables and reference categories includes as above. Analyses were performed with $\alpha = .05$ for two-sided tests with SAS 9.4 (SAS Institute). The Nationwide Children's Hospital institutional review board approved this study.

3 | RESULTS

In a cohort of 4509 youth, aged 2–17 years seen in Q1 and Q3, the proportion of youth with overweight, obesity or severe obesity increased from 37.8% to 44.6%; and the proportion of youth in the healthy weight category declined by 5.6%. Over this 3–6-month period, 23.1% of youth gained ≥5 kg, 4.3% gained ≥10 kg and 17.8% increased their BMI by ≥2 units. Between Q1 and Q3, most children were in the NCWC group (80.5%); 73.8% of youth maintained their weight category and 6.7% improved their weight category, while 19.5% moved to the CWC group (Figure 1). For youth who switched from healthy weight in Q1 to overweight or obesity in Q3, the median

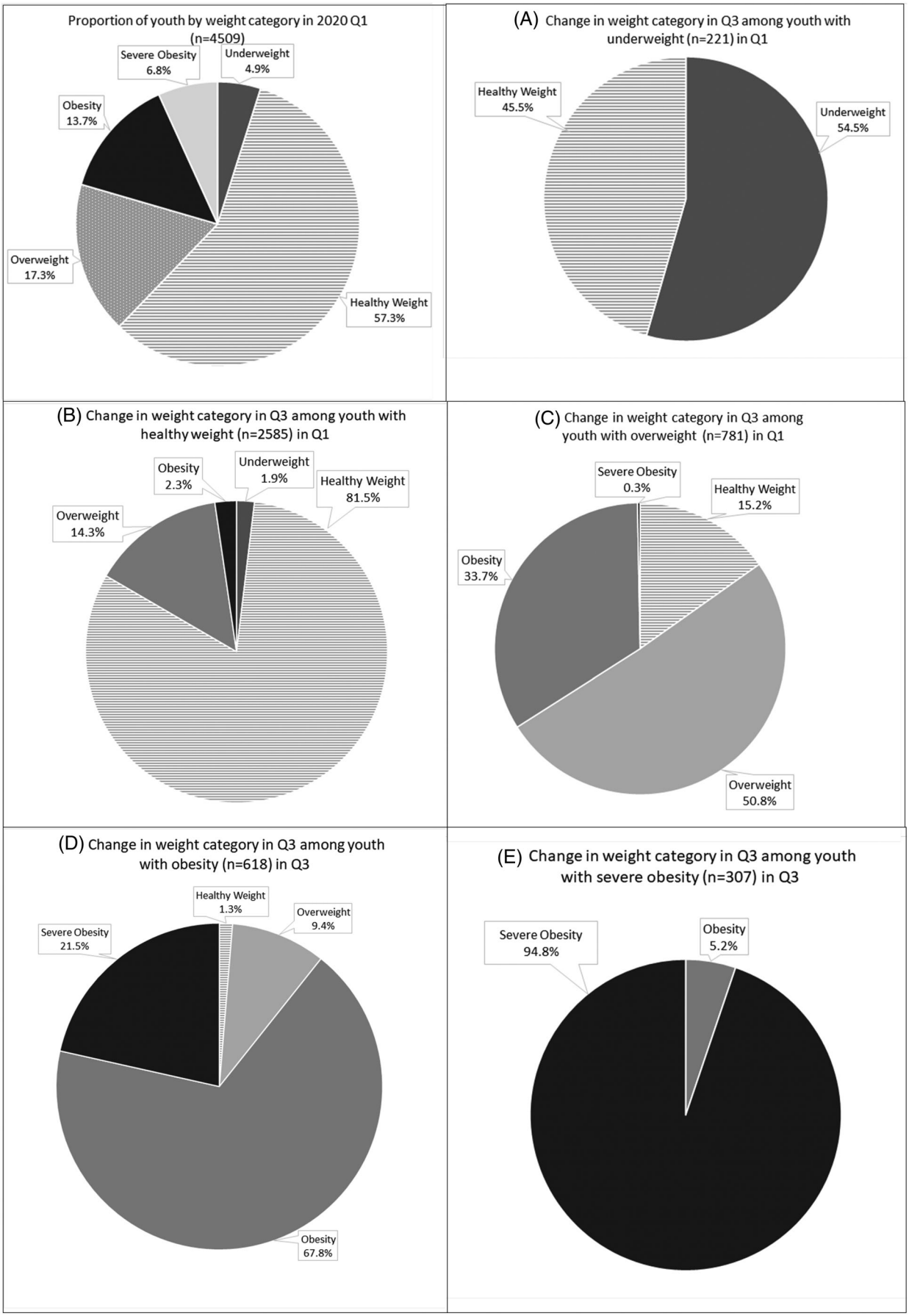

FIGURE 1 Change in weight category in Q3 (1 June– 30 September 2020) by weight category in Q1 (1 January– 30 March 2020), $N = 4509$

TABLE 1 Binomial logistic regression model on characteristics associated with concerning weight change (CWC)

Characteristics	Standard error	Wald χ^2	*p* Value	Odds ratio	95% CI for mean	
					Lower	Upper
Age group						
2–5-year-old	0.13	23.61	<.0001	1.90	1.47	2.46
6–9-year-old	0.14	19.96	<.0001	1.85	1.41	2.43
10–13-year-old	0.15	3.48	.062	1.31	0.99	1.75
Sex: male	0.08	0.00	.994	1.00	0.86	1.16
Race/ethnicity						
Hispanic	0.13	4.00	.046	1.30	1.01	1.67
Non-Hispanic Black	0.11	3.16	.075	1.22	0.98	1.51
Other	0.13	3.32	.069	1.27	0.98	1.65
Insurance						
Private	0.22	1.62	.203	1.33	0.86	2.06
Medicaid	0.19	3.17	.075	1.41	0.97	2.05
Visit type: Acute visit	0.09	1.42	.233	1.12	0.93	1.34
Days between visits	0.00	0.63	.427	1.00	1.00	1.00

Note: Model fit: χ^2 (8) = 17.07, $p = .029$. Reference categories: age group (14–17-year-old), sex (female), race/ethnicity (non-Hispanic White), insurance (other), and visit type (well child check visit).

change in weight was 3.7 kg (interquartile range [IQR] = 3.6 kg) and 1.8 BMI units (IQR = 1.6). Among underweight youth, 45.3% switched to the healthy weight category, with a median weight gain of 2.1 kg (IQR = 2.1 kg). In the proportion of youth who remained in the same weight categories from Q1 to Q3, the median weight gain was highest among those with severe obesity (5.8 kg, IQR = 5.2 kg, $n = 291$), followed by youth in obesity (4.3 kg, IQR = 3.9 kg, $n = 419$), overweight (2.7 kg, IQR = 3.2 kg, $n = 397$) and healthy weight (1.7 kg, IQR = 2.0 kg, $n = 2101$) categories.

In the first binomial logistic regression model, youth age group was significantly associated with weight category change (Table 1). Specifically, the odds among 2–5-year-old youth to move to CWC in Q3 was 1.9 compared to 14–17-year-old youth (odds ratio [OR], 1.90; confidence interval [CI], 1.47–2.46; $p < .0001$, Table 1), and 6–9-year-old youth were 1.85 times more likely to move to CWC compared to 14–17-year-old youth (OR, 1.85; CI, 1.41–2.43; $p < .0001$). In stratified analyses by age group (Table S1), among 2–5-year olds, male compared to female youth were less likely to change to CWC (OR, 0.73; CI, 0.58–0.91; $p = .006$) while Hispanic were more likely to change to CWC (OR = 2.04, 95% CI: 1.33–3.10; $p = .001$) than non-Hispanic-White peers. In the 6–9-year-old age group (Table S2), male compared to female youth were more likely to change to CWC (OR, 1.36; CI, 1.01–1.82; $p = .040$). In the 10–13-year-old age group, the odds of change to CWC was higher among non-Hispanic Black youth than non-Hispanic White youth (OR, 1.87; CI, 1.12–3.13; $p = .016$).

4 | DISCUSSION

This brief report demonstrates marked increase in weight and change to CWC among low-income cohort of youth 2–17 years during the immediate 3–6 months following onset of the COVID-19 pandemic. Nearly, 1 in 5 youth increased their BMI by ≥2 units in 3–6 months, increasing the likelihood of crossing BMI percentiles into higher weight categories. Almost half of youth who were underweight changed into the healthy weight category and 15.2% of children in the overweight category switched to healthy weight in 3–6 months, both positive outcomes during the period. Our results of increased weight gain during the pandemic are in broad agreement with prior studies that found increased weight gain across all age groups, albeit over longer pre- and post-lockdown timeframes.[9,10,15,16] In assessing the immediate post-lockdown period, our results capture the effects of a sustained 3–6 month period when intensive mitigation practices (e.g., full lockdown) were in effect, and families were insufficiently prepared to respond given the sudden disruption to their daily routine and limited boosts to existing social and safety systems.

The change to CWC among Hispanic youth compared with non-Hispanic White youth suggests the pandemic over time may result in a further widening of racial/ethnic disparities already observed for obesity.[3,17] Compared with an obesity prevalence of 14.1% among non-Hispanic youth 2–19 years old, the rates are higher among their African American and Hispanic peers at 22% and 25.8%, respectively.[17] Access to obesity care is also disproportionately lower in minority populations,[14] which will further compound health inequity in the future. In addition, as reported in other studies,[9] the largest increase in weight gain and switch to concerning weight category occurred among youth who met the criteria for obesity or severe obesity, two weight categories already at increased risk for serious health consequences and increased healthcare utilization.[14] The differences in weight gain among males and females seen among 2–5 and 6–9 years need further study with larger sample sizes. Although other studies have reported sex differences, as we found in our 2–5-

and 6–9-year-old youth, the reason is largely unclear.[16] Future studies to elucidate the reason behind this finding will be strengthened by a qualitative component.

There are study limitations. The cohort is restricted to a single primary care network which limits external generalizability. Although youth with chronic diseases were excluded using a validated algorithm,[13] it is still possible that youth in our cohort may differ from their peers as all relevant risk factors for obesity, e.g., lifestyle behaviours, sleep patterns could not be identified from the electronic health record nor accounted for in the analysis. Subsequent population-based studies can provide more generalizable estimates of weight gain trajectory and obesity rates across different timeframes during the pandemic and explore the emerging racial/ethnic disparity as the negative effect on social drivers of health were disproportionately amplified among minority and low-income populations.

With several negative pandemic-related consequences on child health (e.g., increased mental health concerns, food insecurity, deficits in immunization coverage and school performance) jostling for attention, addressing the excessive weight gain may not be a top priority for families, administrators or policymakers. Childhood obesity persists into adulthood,[18] is associated serious comorbidities,[14,19] and challenges with access to care and treatment[14] and with the pandemic continuing into 2022, there is a collective need for action. Interventions should target specific drivers of pandemic-related weight gain upstream by integrating efforts in health care, the community, and public policy, especially for low-income populations who are at higher risk for obesity.[20] With school re-openings, providing universal meals to all children in schools regardless of financial need will address issues of food insecurity and offer more balanced nutritious meal options.[21,22]

At the family level, an initial step is to educate paediatric health providers on how to address concerns about unhealthy lifestyle behaviours and excessive weight gain during the pandemic, with sensitivity and to recognize related stressors. Working on small changes (e.g., limiting available sugar-sweetened beverages or high calorie snack options in the home, including short bursts of activity through the day, and normalizing day and night-time routines) are initial ways to intervene and not overwhelm families. This paper focused on early pandemic findings. However, understanding the pattern of weight change and how long the effect of the risk factors or behaviours endure over the 2 years of the pandemic is important as treating obesity is often more challenging than prevention. Finally, as a society, there is much to be learned and addressed from the disproportionate effect of the pandemic on social determinants of health and existing structural inequities that cause obesity. These results should inform decision making in short-term responses to catastrophic events, particularly when safety and social networks to support families are limited.

ACKNOWLEDGEMENTS

The authors thank Zachary Grey for compiling the database from electronic health records, Emeka Eneli for data graphing, and Alex Kemper MD for review of earlier drafts.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

AUTHOR CONTRIBUTIONS

Ihuoma Eneli conceptualized and designed the study, drafted the initial manuscript, and reviewed and revised the analyses and manuscript. Jinyu Xu collected data, carried out the analyses, reviewed and revised the manuscript. Keeley Pratt assisted with the analyses, drafted, and revised the manuscript.

ORCID

Ihuoma Eneli https://orcid.org/0000-0002-4436-7141
Jinyu Xu https://orcid.org/0000-0002-0385-324X
Keeley Pratt https://orcid.org/0000-0002-8800-4326

REFERENCES

1. Rundle AG, Park Y, Herbstman JB, Kinsey EW, Wang YC. COVID-19-related school closings and risk of weight gain among children. *Obesity*. 2020;28(6):1008-1009.
2. Dunton GF, Do B, Wang SD. Early effects of the COVID-19 pandemic on physical activity and sedentary behavior in children living in the US. *BMC Public Health*. 2020;20(1):1351.
3. Belanger MJ, Hill MA, Angelidi AM, Dalamaga M, Sowers JR, Mantzoros CS. Covid-19 and disparities in nutrition and obesity. *N Engl J Med*. 2020;383(11):e69.
4. Bleich SN, Sullivan K, Broad Leib E, et al. *Technical Report. Strengthening the Public Health Impacts of SNAP: Key Opportunities for the Next Farm Bill*. Healthy Eating Research; 2021.
5. Coleman-Jensen A, Rabbitt MP, Gregory CA, Singh A. *Household Food Security in the United States in 2020, ERR-298*. Department of Agriculture, Economic Research Service; 2021.
6. Higashi RT, Sood A, Conrado AB, Shahan KL, Leonard T, Pruitt SL. Experiences of increased food insecurity, economic and psychological distress during the COVID-19 pandemic among supplemental nutrition assistance program-enrolled food pantry clients. *Public Health Nutr*. 2022;25:1027-1037.
7. Tham WW, Sojli E, Bryant R, McAleer M. Common mental disorders and economic uncertainty: evidence from the COVID-19 pandemic in the U.S. *PloS One*. 2021;16(12):e0260726.
8. An R. Projecting the impact of the coronavirus disease-2019 pandemic on childhood obesity in the United States: a microsimulation model. *J Sport Health Sci*. 2020;9(4):302-312.
9. Lange SJ, Kompaniyets L, Freedman DS, et al. Longitudinal trends in body mass index before and during the COVID-19 pandemic among persons aged 2-19 years—United States, 2018-2020. *MMWR Morb Mortal Wkly Rep*. 2021;70(37):1278-1283.
10. Woolford SJ, Sidell M, Li X, et al. Changes in body mass index among children and adolescents during the COVID-19 pandemic. *JAMA*. 2021;326(14):1434-1436.
11. Bailey LC, Milov DE, Kelleher K, et al. Multi-institutional sharing of electronic health record data to assess childhood obesity. *PLoS One*. 2013;8(6):e66192.
12. Daymont C, Ross ME, Russell Localio A, Fiks AG, Wasserman RC, Grundmeier RW. Automated identification of implausible values in growth data from pediatric electronic health records. *J Am Med Inform Assoc*. 2017;24(6):1080-1087.
13. Feinstein JA, Russell S, DeWitt PE, Feudtner C, Dai D, Bennett TD. R package for pediatric complex chronic condition classification. *JAMA Pediatr*. 2018;172(6):596-598.
14. Kelly AS, Barlow SE, Rao G, et al. Severe obesity in children and adolescents: identification, associated health risks, and treatment

approaches: a scientific statement from the American Heart Association. *Circulation*. 2013;128(15):1689-1712.
15. Pietrobelli A, Pecoraro L, Ferruzzi A, et al. Effects of COVID-19 lockdown on lifestyle behaviors in children with obesity living in Verona, Italy: a longitudinal study. *Obesity*. 2020;28(8):1382-1385.
16. Brooks CG, Spencer JR, Sprafka JM, et al. Pediatric BMI changes during COVID-19 pandemic: An electronic health record-based retrospective cohort study. *EClinicalMedicine*. 2021;38:101026.
17. Hales CM, Fryar CD, Carroll MD, Freedman DS, Ogden CL. Trends in obesity and severe obesity prevalence in US youth and adults by sex and age, 2007-2008 to 2015-2016. *JAMA*. 2018;319(16):1723-1725.
18. Rundle AG, Factor-Litvak P, Suglia SF, et al. Tracking of obesity in childhood into adulthood: effects on body mass index and fat mass index at age 50. *Child Obes*. 2020;16(3):226-233.
19. Kumar S, Kelly AS. Review of childhood obesity: from epidemiology, etiology, and comorbidities to clinical assessment and treatment. *Mayo Clin Proc*. 2017;92(2):251-265.
20. Rogers R, Eagle TF, Sheetz A, et al. The relationship between childhood obesity, low socioeconomic status, and race/ethnicity: lessons from Massachusetts. *Child Obes*. 2015;11(6):691-695.
21. Chung A, Tully L, Czernin S, Thompson R, Mansoor A, Gortmaker SL. Reducing risk of childhood obesity in the wake of covid-19. *BMJ*. 2021;374:n1716.
22. Kenney EL, Barrett JL, Bleich SN, Ward ZJ, Cradock AL, Gortmaker SL. Impact of the healthy, hunger-free kids act on obesity trends. *Health Aff*. 2020;39(7):1122-1129.

SUPPORTING INFORMATION

Additional supporting information may be found in the online version of the article at the publisher's website.

How to cite this article: Eneli I, Xu J, Pratt K. Change in weight category among youth early in the COVID-19 pandemic. *Clinical Obesity*. 2022;12(3):e12522. doi:10.1111/cob.12522