

# Investigating the Effects of the COVID-19 Pandemic on Pediatric Body Mass Index, and Health Status in an Inner-City, Low-Income Setting

Martha D. Hawkins, DNP, APRN, CPNP

**Introduction:** The COVID-19 pandemic required unprecedented containment measures, including prolonged stay-at-home orders, to combat spread and prevent loss of life. One of the consequences of these mandates was the closure of schools. Children in resource-limited communities already experiencing disparities were placed at a significant disadvantage by the closure of schools. Many depended on the school systems as their primary source of nutrient-rich food. Additionally, for many, schools provide the only safe place for outdoor play and physical activity. The unintended consequences of the COVID-19 stay-at-home orders for these high-risk children are now being investigated.

**Method:** This article reports a retrospective chart review of children aged 9–11 years in a low-income, inner-city practice in a moderately sized Southeastern city. Baseline data were obtained from 2019 and compared to 2020 and/or 2021.

**Results:** Findings indicate statistically significant increases in body mass index in this high-risk population of children. Additionally, chronic conditions associated with obesity were identified in many of the unhealthy weight children in the study.

**Discussion:** This study identifies unintended consequences from the pandemic containment measures that are consistent with other emerging research related to the pandemic's effects on body mass index in children. *J Pediatr Health Care.* (2022) *XX*, 1–7

## KEY WORDS

Childhood obesity, BMI, COVID, pandemic, disparities

## INTRODUCTION

In the last 50 years, an alarming trend has been documented among children across the United States and worldwide. The rate of childhood overweight and obesity has become an epidemic. [Tsoi et al. \(2022\)](#) completed a 20-year analysis of National Health and Nutrition Examination Survey data that included > 35,000 children that showed a steady increase in childhood obesity. According to [Tsoi et al. \(2022\)](#), one in five adolescents was obese, and ethnic minority children and those from low-income communities were at the most risk of being obese.

Most of the focus of 2020 through early 2022 was on the acute containment and prevention of COVID. Many interventions are necessary to quell the spread of the virus and reduce the impact of illness on vulnerable populations carrying unintended consequences, especially for vulnerable populations such as low-income and inner-city children and children of ethnic minorities ([Mohanty et al., 2021](#)). Many children depend on the school system for safe play and quality nutrition. With the school systems closed as a containment measure for much of 2020 and 2021, many of these children did not have access to a safe place or play area or high-quality

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Associate Professor of Nursing, Pediatric Nurse Practitioner, National & Global, Indiana Wesleyan University, Marion, Indiana

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Correspondence: Martha D. Hawkins, DNP, APRN, CPNP, National & Global, Indiana Wesleyan University, 2048 Mt. Hebron Rd., Lancaster, KY 40444; e-mail: [martha.hawkins@indwes.edu](mailto:martha.hawkins@indwes.edu)  
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food (Burkart et al., 2022; Sarni et al., 2022; Stewart et al., 2022). Children replaced physical activity with increased screen time; fresh fruits and vegetables were replaced with calorie-dense processed foods (Sarni et al., 2022).

Low-income and ethnic minority children experience childhood obesity at greater rates than other children (Mohanty et al., 2021), a condition that is likely to remain into adulthood (Simmonds et al., 2015). Low-income and minority children, already more likely to be affected by the social determinants of health before the pandemic, are more likely to be impacted by the pandemic's unintended consequences; one of those unintended consequences is a sharp rise in childhood obesity.

Childhood obesity is associated with adult-onset chronic conditions, including type 2 diabetes mellitus (T2DM), hypertension, coronary artery disease, cardiomyopathy, heart failure, and certain cancers (Horesh et al., 2021). Horesh et al. (2021) posit that the earlier these diseases present in the life of an individual, the greater the risk of complications. They also point out that the attributable risk of developing T2DM for an overweight/obese adolescent male by adulthood is 57% and for a female is 61%.

According to Horesh et al. (2021), hypertension is the most common obesity-associated comorbidity found in adolescents. Metabolic syndrome and T2DM are serious comorbidities in childhood obesity and greatly impact adult health status. However, they are not the only obesity-associated comorbidities noted in children. Other obesity-associated comorbidities include airway issues such as asthma, which is often poorly controlled (Fitzpatrick et al., 2022), tonsillar hypertrophy, sleep-disordered breathing, and other sleep issues (Daar et al., 2016), musculoskeletal disorders (Molina-Garcia et al., 2021), numerous skin conditions (Baselga Torres & Torres-Pradilla, 2014), and gastrointestinal/genitourinary problems, particularly, lower urinary tract disorders and bladder-bowel dysfunction (Arlen et al., 2017). All body systems are impacted in some way by obesity-associated comorbidities.

This article reports a retrospective chart review of the rate of overweight and obesity, obesity-related comorbidities, and the use of health care resources among low-income, urban children aged 9–11 years in a moderately sized South-eastern city. Estimates of overweight and obesity within the clinic are determined and compared with state and national averages. Comparisons are made between prepandemic and postpandemic body mass index (BMI). Estimates of obesity-associated comorbidities and comparisons are made between the use of medical resources for healthy-weight and unhealthy children.

Specifically, the retrospective chart review seeks to answer the following questions:

1. What is the rate of overweight and obesity in the clinic system compared with state and national averages?
2. What percentage of overweight/obese children have documentation of comorbid conditions, and what types of conditions are seen?

3. Did the rates of overweight and obesity rise disproportionately during the pandemic confinements?
4. Did the pandemic result in children not receiving appropriate care for known health conditions?

## METHODS

### Research Design/Setting

A retrospective chart review was conducted on records of children aged 9–11 years receiving well-child care from May 1, 2020 through September 30, 2020 in an urban, inner-city, low-income pediatric practice in a moderately sized, South-eastern city to evaluate the effect of the pandemic's stay-at-home orders had on BMI. A secondary analysis was conducted to determine if overweight and obese children had any documented obesity-related comorbid conditions and if unhealthy-weight children used more health care resources than healthy-weight children.

Overweight was defined as a BMI between 85th and 95th percentile for height, weight, and gender (Centers for Disease Control and Prevention [CDC], 2021), whereas obesity was defined as a BMI  $\geq$  95th percentile for height, weight, and gender (CDC, 2021).

Although obesity-associated comorbidities occur more often in obese persons than in the general population, there may not be a definitive cause/effect relationship. Sarni et al. (2022) provided examples of obesity-associated comorbid conditions, such as adult obesity, mental health problems, diabetes, cardiovascular disease, and cancer.

Healthy weight in children included those categorized as either underweight or normal weight according to BMI, whereas unhealthy weight in children included those categorized as overweight or obese according to BMI.

### Sample

Charts eligible for the review included children aged 9–11 years who received any physical/well-child examination from January 1, 2019, through the end of the records collection period in September 2021. The health records from 2019 were used to establish baseline data for comparison standards. Health records from 2020 to 2021 determined the comparison data.

The state in which the review was conducted required documentation of a school physical for students entering the sixth grade. Children aged 9–11 years between 2019 and 2021 were targeted for the chart review because they were in the sixth grade during one of those years. It was assumed that these patient records would provide the largest sample. There were 101 eligible records reviewed. Of the reviewed records, 66 had complete data and were used to establish the BMI trajectory throughout the pandemic. The remaining records had only a single BMI recorded during the target period. These records helped to inform the prevalence of childhood obesity within the pediatric practice.

### Instruments/Measures and Ethical Approval

Data were collected into an excel spreadsheet and included BMI, height, weight, blood pressure, obesity-related

comorbid conditions, and the number of medical visits in the target years. Indiana Wesleyan University granted ethical approval with additional written permission from the pediatric practice management in which the chart review was conducted. Data were stored in a password-protected excel file on a password-protected laptop computer.

## RESULTS

### Statistical Analysis

A paired-sample *t* test was conducted to evaluate the significance of the changes in BMI from the prepandemic baseline to postpandemic status. Postpandemic BMI values were significantly higher than prepandemic BMI values (degrees of freedom [df] [65];  $t = 7.45$ ;  $p = .001$ ). These results suggest that postpandemic BMI values ( $n = 66$ ) rose disproportionately (mean  $\pm$  *SD*,  $22.76 \pm 6.53$ ) compared with prepandemic BMI values ( $20.4 \pm 6.08$ ). Cohen's effect size (*d*) was 2.58 with a point estimate of 0.92 with a 95% confidence interval of 0.63–1.20, showing a large effect size. These findings indicate a disproportional rise in BMI values throughout the pandemic, a finding consistent with other current literature.

An independent samples *t* test was conducted on the number of illness visits attended per year by healthy-weight children compared with unhealthy weight for the 2019 data only as the remaining 2 years were impacted by the pandemic. Eighty-nine children whose illness visit data were available for 2019; of these children, 42 ( $0.76 \pm 1.17$ ) were considered to have healthy BMI values, and 46 ( $1.28 \pm 1.84$ ) were considered to have unhealthy BMI values. Data were approaching significance (df [87];  $t = 1.56$ ;  $p = .06$ ).

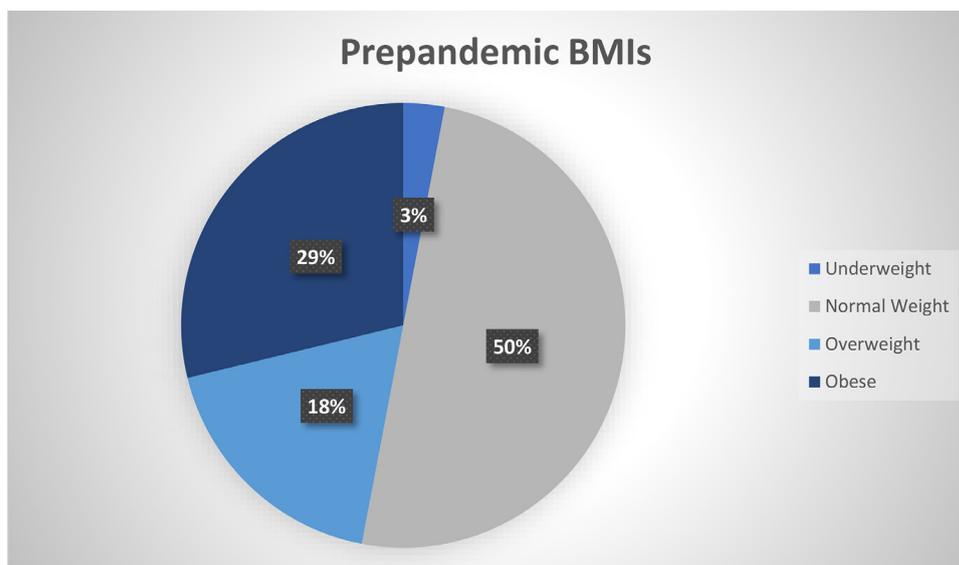
Although these findings were not statistically significant, they warrant further consideration.

### Data Analysis

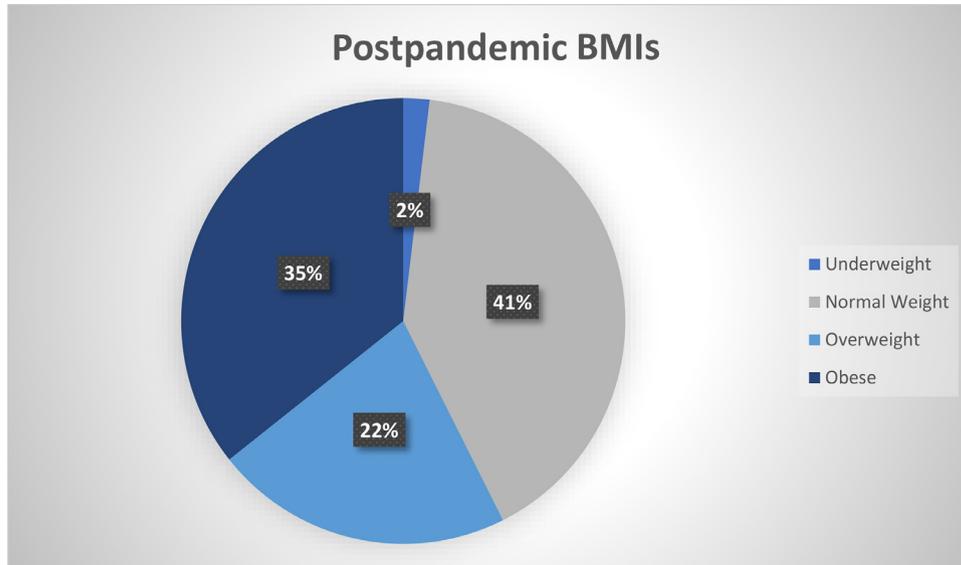
Initial data analysis began by evaluating the overall sample for the rates of overweight and obesity. Of the 101 charts sampled, 21.7% of the BMI values ( $n = 22$ ) were overweight, and 35.6% of the BMIs ( $n = 36$ ) were obese. According to the [Robert Wood Johnson Foundation \(2020\)](#), the state in which the clinic resided had a 23.8% obesity rate among similar-aged children during the same timeframe, whereas the national obesity rate was 20.7% ([CDC, 2022](#)). The sample exhibited a significantly higher obesity rate than state and national averages. Among the 66 records with complete data, the baseline overweight rate for 2019 was 18.2% ( $n = 12$ ), and the baseline obesity rate was 28.8% ( $n = 19$ ) (see [Figure 1](#)). Postpandemic overweight rate was 19.7% ( $n = 13$ ) and postpandemic obesity rate was 43.9% ( $n = 29$ ). Statistical analysis of the change in the BMI values postpandemic documents this increase in overweight and obesity in this at-risk population as statistically significant (see [Figure 2](#)). Further exploration of the post-pandemic obesity rates in the sample indicate that the rate of extreme obesity had also increased from pre-pandemic rates. BMIs of 40 or more remained stable while those between 30-40 increased moderately and those between 25-30 increased significantly (see [Figure 3](#)).

Among overweight children, 12 had documented obesity-associated comorbid conditions, while 21 of the obese children had obesity-associated comorbid conditions. The most common comorbid conditions in both groups involved airway-associated conditions and included diagnoses such as

**FIGURE 1. Prepandemic body mass index values.**



This figure appears in color online at [www.jpmedhc.org](http://www.jpmedhc.org).

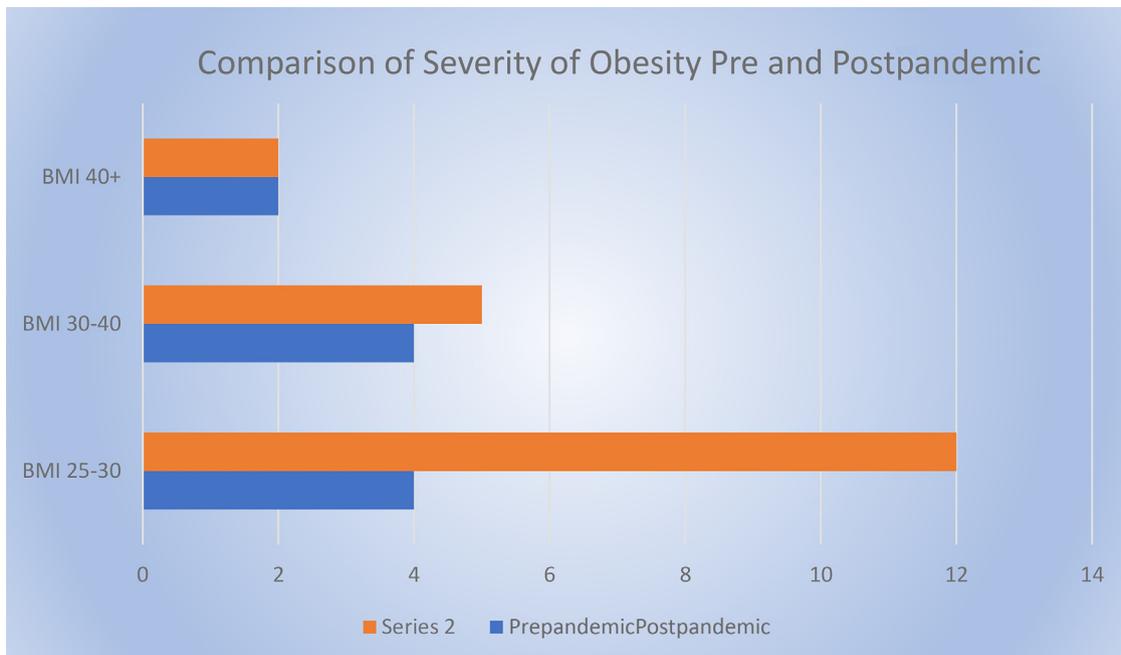
**FIGURE 2. Postpandemic body mass index values.**

This figure appears in color online at [www.jpedhc.org](http://www.jpedhc.org).

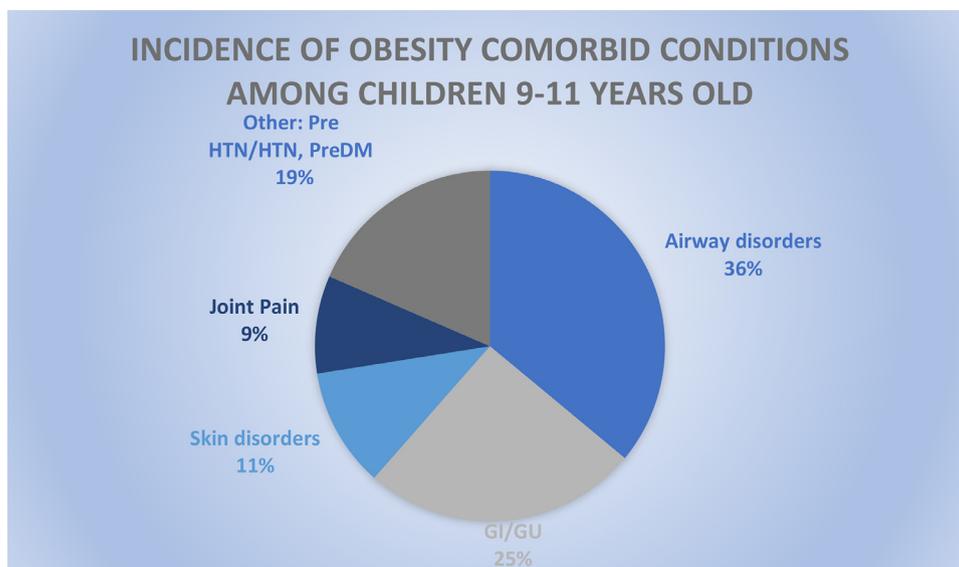
asthma, sleep-disordered breathing, and tonsillar hypertrophy. Airway issues prevailed in 16.7% of overweight children with comorbid conditions and in 42.9% of obese children with comorbid conditions. None of the records reviewed identified children with metabolic syndrome, hypertension or T2DM. One must consider the age range of children in the retrospective chart review when considering these findings with an awareness of the increased risk for these obesity-associated

comorbidities and the children approach adolescence. Other comorbid conditions found among the records included GI/GU disorders, skin problems and joint pain.

The review did not compare pre-pandemic and post-pandemic obesity-associated comorbidities; it only identified a known comorbidity. Asthma, tonsillar hypertrophy, and sleep-disordered breathing are all significantly associated with childhood obesity (Alolayan et al., 2021, Frye et al.,

**FIGURE 3. Comparison of severity of obesity prepandemic and postpandemic.**

This figure appears in color online at [www.jpedhc.org](http://www.jpedhc.org).

**FIGURE 4. Incidence of obesity-associated comorbidities in children aged 9–11 years.**

This figure appears in color online at [www.jpmedh.org](http://www.jpmedh.org).

2019) and were consistent across both overweight and obese children in this study, making up the most frequently occurring obesity-associated comorbidities. Most of the illness visit among unhealthy weight children in this review involved one of these diagnoses. Figure 4 describes the distribution of obesity-associated comorbidities identified by the review. Other obesity-associated comorbidities identified in the chart review included GI/GU disorders, skin conditions, and joint pain. Serious pre-metabolic/pre-cardiovascular comorbidities did occur in a small proportion of the children, although none qualified as metabolic syndrome. One child did have pre-diabetes, another had pre-hypertension and a third had hypertension. On Figure 4, they are represented in the “other” category.

In 2019, healthy weight children averaged eight visits per quarter for illness conditions while unhealthy children averaged 14.4 visits for similar problems. In 2020, illness visits per quarter dropped to seven for healthy weight children and to 11.5 for unhealthy weight children but these numbers included telehealth visits. In 2021, these numbers dropped further to six per quarter for healthy weight children and to nine per quarter for unhealthy children, again, including telehealth visits. While some speculation could be made that the stay-at-home orders contributed to these reduced number of patient visits by decreasing exposure to communicable illness, this warrants further exploration to determine the effect that decreased healthcare provider contact may have had on chronic condition management.

## DISCUSSION

When considering the findings of this retrospective chart review, one must examine them from the perspective of normal expectations for linear growth and weight gain in children in the same time frame. Healthy growth for prepubertal boys is expected to average 2 in./year with an

expected weight gain of six to seven pounds/year. For peak-pubertal boys, linear growth is typically 4 in./year with a weight gain of 20 pounds/year (Sass & Kaplan, 2020). For prepubertal girls, healthy growth averages 2 in./year, and weight gain averages 6 pounds/year. Peak-pubertal girls average 3 in. of linear growth per year and 17.5 pounds/year (Sass & Kaplan, 2020).

The mean age for peak height velocity for girls is 11.5 years and for boys is 13.5 years (Sass & Kaplan, 2020). The average child in this study is most likely in an early to middle stage of puberty. The boys averaged 2.2 in. of linear growth per year over the 2-year period and the girls averaged 3 in. of linear growth, very consistent with the expected averages for age and gender. However, average weight gain did not reflect this same consistency. Rather, weight increased disproportionately to linear growth. Of the children whose weight crossed into obese, 25% had BMI values between 30 and 40, whereas an additional 10% had BMI values > 40, categorizing them as morbidly obese. Simmonds et al. (2015) stated a moderate to significant correlation exists between BMI in childhood and adulthood. Particularly, children > 90th percentile for BMI aged between 9 and 13 years are five times more likely to be obese at 30 years old.

In a population of children already at great risk for long-term health complications related to social determinants of health, the additional weight burden added over the pandemic creates lifelong health problems. Sarni et al. (2022) comment that the childhood obesity epidemic increases “the global burden of chronic disease” (p. S44) because of obesity-associated comorbid conditions. In the sample population of children in this review, 60% of the obese and 58% of the overweight children already have documented obesity-associated comorbid conditions, some of which are very serious.

It is beyond the scope of this review to make direct correlations between unhealthy weight and obesity-associated

comorbidities in these children. This review can only document their presence. However, the abundance of published literature on childhood obesity and obesity-associated comorbidities allows some inferences. A systematic review by [Obita and Alkhatib \(2022\)](#) placed obese boys and children from ethnic minority groups at greater risk for obesity-associated comorbidities. Both groups are strongly represented in the data from this review. [Reinehr \(2018\)](#) discusses the association of childhood obesity with multiple comorbidities, poor medical outcomes, impacts on the next generation through epigenetics, and the creation of challenging treatment issues. The author also points out the increased use of medical resources by this population and the subsequent cost to the health care system.

Although the differences in using health care resources between the healthy-weight and unhealthy-weight children in this study only approached statistical significance, it has a clinical significance when the cost of health care is factored into the discussion. Twelve additional illness visits per year at standard Medicaid rates amounts to > \$500.00 annually. The higher reimbursement rates associated with Federally Qualified Health Centers and rural health clinics produce a sum significantly higher than \$500.00. If the sample selected for this review accurately represents the pediatric practice in which the study was conducted, over 40% of the children in practice are using an extra 12 visits per year, in a usual year unaffected by a pandemic, for illness complaints. The financial implications of this are significant.

### Implications

The COVID pandemic has had a significant impact on weight gain in children. This finding has been reinforced in multiple studies ([Chang et al., 2021](#); [Vinker-Shuster et al., 2021](#); [Vogel et al., 2021](#)). A meta-analysis of the association of adverse childhood events with the development of obesity in childhood by [Schroeder et al. \(2021\)](#) showed that children with two or more adverse childhood events are more likely to develop childhood obesity. The events surrounding the pandemic have become a trauma exposure for most children ([Pfefferbaum, 2022](#); [Srivastav et al., 2021](#)). In one study, 43% of adolescent participants reported worsening depression symptoms, 34% reported worsening anxiety symptoms during the pandemic, and 38% reported worsening their sense of well-being ([Stewart et al., 2022](#)). Most of the participants in the study related their symptoms to school closures. Students reported that school was their safe place ([Stewart et al., 2022](#)). Children potentially experienced multiple trauma exposures during the pandemic. Considering that two or more adverse childhood experiences increased the likelihood of a child becoming obese, the pandemic created multiple potential trauma exposures, and children from low-income communities and ethnic minorities are at greater risk for developing obesity, providers need to be cognizant of the increased risks in these high-risk populations. The findings of this retrospective chart review are unexpected and are consistent with the current literature. Finding like this are a call to action for health care providers

caring for vulnerable pediatric populations and researchers who are just beginning to uncover the long-term unintended consequences of the COVID pandemic.

### Limitations

There are limitations to this study. First, of the 101 charts eligible for review, only 66 had complete data available. Although a single BMI was available for the remaining records, it was impossible to tell how their BMI changed throughout the pandemic. The findings might not have been as robust if those data were available. Second, the clinic in which the retrospective chart review was conducted had paper records that had to be hand searched. There are unique challenges associated with paper records, including missing and incomplete records and the time it takes to collect data. Finally, the nature of a retrospective chart review does not allow direct correlations; only inferences can be drawn from the data. This study adds value to the growing body of literature by supporting the findings of other researchers related to the effect of the pandemic on BMI in children. It also points to further research areas that need to be explored.

### Conclusions

There is still much research on the pandemic's long-term effects on physical and mental health outcomes. Children suffer the most long-term effects from the trauma of the pandemic experience because they will live with the experience for the longest amount of time. Children already experiencing health disparities prepandemic are the most vulnerable among us for experiencing negative health outcomes postpandemic. Multiple studies have already documented an association between increased obesity and the pandemic ([Chang et al., 2021](#); [Vinker-Shuster et al., 2021](#); [Vogel et al., 2021](#)). This retrospective chart review of weight status and physical health throughout the pandemic in a low-income, inner-city, high-risk pediatric population adds additional evidence to support the findings of these other researchers. Over the next two decades, pediatric clinicians will need to practice with an increased awareness of the potentially negative impact of the pandemic on the health of their most vulnerable patients.

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