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# The COVID-19 Pandemic as a Threat Multiplier for Childhood Health Disparities: Evidence from St. Louis, MO

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**Abstract** The COVID-19 pandemic has highlighted socioeconomic and racial health disparities in the USA. In this study, we examined the COVID-19 pandemic as a threat multiplier for childhood health disparities by evaluating health behavior changes among urban St. Louis, MO, children (ages 6–14) during the COVID-19 pandemic. From 27 October to 10 December 2020, 122 parents/guardians reported on their children's health behaviors (Eating, Sleeping, Physical activity, Time outside, Time with friends in-person, Time with friends remotely, Time using media for educational proposes, Time using media for non-educational proposes, and Social connectedness) prior to and during the COVID-19 pandemic. We ran *K*-means cluster analyses to identify distinct health behavior cluster profiles. Relative risks were determined to evaluate behavioral differences between the two clusters. Two distinct cluster profiles were identified: a High Impact profile ($n=49$) and a Moderate Impact profile ($n=73$). Children in the High Impact cluster had a greater risk of being diagnosed with COVID-19, developed worsened eating habits (RR = 2.10; 95% CI = 1.50–2.93), spent less time sleeping, and spent less time outdoors (RR = 1.55; 95% CI = 1.03–2.43) than the Moderate Impact cluster. The High Impact cluster was more likely to include Black children and children from single-adult households than the Moderate Impact cluster (both $p<0.05$). Our findings suggest that the COVID-19 pandemic may be a threat multiplier for childhood health disparities. Further research is needed to better understand the long-term effects of the COVID-19 pandemic on children's health.

**Keywords** Pediatric · Corona virus · Behavioral health · Cluster analysis · Disparities · Youth · Adolescent · Public health · Health equity

**Abbreviations**

| | |
|---|---|
| ECHO | Environmental Influences on Child Health Outcomes Cohort |
| S.T.E.A.M. | Science, technology, engineering, art, and math |
| CAP | Community-academic partnership |
| SLPS | St. Louis Public Schools District |

## Introduction

In response to the COVID-19 pandemic, caused by an acute respiratory syndrome coronavirus 2, countries worldwide have been forced to implement strict

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quarantine, school closures, and social distancing laws and regulations [1, 2]. While the goals of these measures have been to reduce mortality and morbidity from COVID-19, there are concerns about associated adverse health outcomes from these strict protective measures [3–5]. The COVID-19 pandemic has highlighted and exacerbated health disparities [6–8]. In the USA, mortality rates from COVID-19 are twice as high in Black, Hispanic, Latino, and Indigenous communities than their White counterparts [8]. Similar economic disparities are present, where low-income communities have higher mortality rates than high-income communities [8]. Many non-White and low-income individuals are forced to take additional health risks (such as waiting in long lines for food pantries or working as an essential worker) to ensure that basic needs are met [8].

Among children, the COVID-19 pandemic is believed to have widened educational disparities as poorly funded school districts were unable to adapt and transition to remote learning in a timely matter [9–11]. For example, several public school districts could not afford computers, tablets, and/or internet for all of their students. Thus, students without access to proper devices for remote learning faced additional learning inequities due to the digital divide [9, 10]. As equitable access to quality education is an upstream determinant of health, there is great concern over both the short-term and long-term impacts of this digital divide on the health and behavioral risk factors of both non-White and low-income children [12, 13].

In the current study, we examine the impact of the COVID-19 pandemic on health behavior outcomes among St. Louis Public Schools District (SLPS) students. SLPS is the largest non-specialized school district in the St. Louis, Missouri metropolitan area and faces well-documented health and educational disparities compared to its surrounding school districts [14–16]. In 2019, 85% of all 20,879 SLPS students were Black and/or Hispanic, and 100% of students were eligible for free or reduced lunch [16]. On March 18th 2020, due to the COVID-19 pandemic, SLPS was forced to shut down in-person schools. Three days later, the City of St. Louis issued a "Stay at Home" order, requiring residents to "stay at home when possible," except for essential activities, such as grocery shopping, and work for essential business and government activities. Although the City of St. Louis' "Stay at Home" order ended on May 17, 2020, SLPS schools remained closed to in-person instruction through the end of 2020. SLPS was unable to provide remote learning support to all the district's students in the immediate aftermath of these shutdowns, thus resulting in disparate access to school-related educational and social support. We examined the pandemic's impact using the Threat Multiplication Framework, a concept adapted from climate change research [17, 18]. A threat multiplier is an extreme event of change, such as climate change, that exacerbates stress factors in clusters of a population at pre-existing high risk of stress factors [17]. In this study, the COVID-19 pandemic is proposed as the extreme event of change; health and behavioral risk factors as the stress factors; and SLPS students as the at-risk population.

Previous literature on the COVID-19 pandemic has examined singular health and behavior changes among children [19, 20]. However, little is known on the co-occurrence or clustering of multiple health and behavioral risk factors among those impacted by the COVID-19 pandemic. Using cross-sectional, parent-reported data from Fall 2020, we describe the health behavior impacts of the COVID-19 pandemic among SLPS children aged 6 to 14 years. We hypothesized that there would be racial differences in reported behavioral impacts.

## Methods

This study was approved as exempt from written consent by the Institutional Review Boards at Washington University in St. Louis and Columbia University.

### Study Context

Prior to the COVID-19 pandemic, a pre-existing community-academic partnership (CAP) between Gateway to the Great Outdoors and the Brown School at Washington University in St. Louis provided a nature-based education intervention to SLPS schools [21–24]. In March 2020, in response to the school closures and limited access to remote learning, the CAP quickly pivoted their intervention to provide interactive S.T.E.A.M. (science, technology, engineering, art, and math) learning kits for parents to take home when picking up their free 7-day meal

kit provided by SLPS. Between April and December 2020, the CAP distributed over 4000 interactive S.T.E.A.M. to students free of charge to SLPS and the parents.

## Data Collection

From 27 October to 10 December 2020, the CAP distributed a health impact questionnaire to the parents and/or guardians picking up the S.T.E.A.M. learning kits. Table 1 presents descriptive statistics for the study sample. There were 122 guardians who completed the questionnaire. The average age of the guardians was 35.5 years old (standard deviation (SD) = 7.2). Approximately 91% of the respondents were parents, 7% legal guardians, and 3% grandparents. Only 4.9% ($n = 6$) of respondents were Hispanic and/or Latino. The respondents were 68.9% Black, 25.4% White, 3.3% Asian, and 2.5% identified as other.

The 29-item parent questionnaire included questions on how the COVID-19 pandemic impacted the child, including whether the child had been diagnosed with COVID-19. The questionnaire also included questions about nine child health behaviors (Eating, Sleeping; Physical activity; Time outside; Time with friends in-person; Time with friends remotely; Time watching TV, playing video/computer games, or using social media for educational proposes; including schoolwork, Time watching TV, playing video/computer games, or using social media for non-educational proposes; and Social connectedness). These nine questions were adapted from the National Institute of Health's Environmental Influences on Child Health Outcomes Cohort (ECHO) COVID-19 Questionnaire [25]. For each behavior, parents/guardians were given three response options: (1) the behavior increased, (2) the behavior decreased, or (3) the behavior remained the same compared to before March 1, 2020 (the emergence of the COVID-19 pandemic in the USA).

**Table 1** Guardian characteristics of the study sample ($n = 122$)

| Age (mean years (SD)) | 35.5 (7.2) | |
|---|---|---|
| People in household (mean (SD)) | 4.3 (1.5) | |
| | *n* | % |
| Hispanic/Latino | 6 | 4.90% |
| Race | | |
| Black | 84 | 68.90% |
| White | 31 | 25.40% |
| Asian | 4 | 3.30% |
| Other | 3 | 2.50% |
| Guardian status | | |
| Parent | 111 | 91.00% |
| Legal guardian | 8 | 6.60% |
| Grandparent | 3 | 2.50% |
| Relationship status | | |
| Married/living with partnership | 47 | 38.50% |
| Separated | 10 | 8.20% |
| Divorced | 11 | 9.00% |
| Widowed | 5 | 4.10% |
| In a relationship, but not living together | 6 | 4.90% |
| Single | 43 | 35.20% |
| Education | | |
| Some high school or less | 15 | 12.30% |
| Grade 12 or GED | 31 | 25.40% |
| 2-year associates degree | 10 | 8.20% |
| > 4 years of college | 41 | 33.60% |
| College graduate or more | 25 | 20.50% |
| Annual household income | | |
| Less than $25,000 | 71 | 58.20% |
| $25,000 to $750,000 | 38 | 31.10% |
| More than $750,000 | 8 | 6.60% |
| Child diagnosed with COVID-19 | 5 | 4.10% |
| Employment status | | |
| Employed and working from home | 30 | 24.60% |
| Essential/frontline worker | 50 | 41.00% |
| Laid-off or furloughed due to the pandemic | 17 | 13.90% |
| Previous unemployed/not working | 25 | 20.50% |

## Health Behavior Impacts

We used parent questionnaire data to evaluate whether the child had been diagnosed with COVID-19. We coded a child being diagnosed with COVID-19 as a negative health outcome and a child not diagnosed with COVID-19 as "no change." We also evaluated changes in each of the nine health behaviors based on a priori theoretical framework. For the eating outcome, since traumatic events during childhood have been associated with increased food insecurity, risk of obesity, and risk of developing eating disorders [26–28], we defined increased and decreased eating as negative health outcome of the COVID-19 pandemic and the "remained the same" response was coded

as no change. A large body of evidence suggests an inverse relationship between childhood health and increased time spending time watching TV, playing video/computer games, or using social media for non-educational proposes [27, 29, 30]. Therefore, we defined increased time spending time watching TV, playing video/computer games, or using social media for non-educational proposes as a negative health outcome of the pandemic, decreased time as a positive health outcome, and remained the same as no change. Finally, based on the current literature, we defined decreases in all of the other health behaviors—sleeping; physical activity; time outside; time with friends in-person; time with friends remotely; watching TV, playing video/computer games, or using social media for educational proposes, including schoolwork; and social connectedness—as negative health outcomes [31–36]. Increases were coded as positive health outcomes and remain the same was coded as no change. Positive health outcomes were coded as − 1, no change as 0, and negative health outcomes as 1.

### Analysis

The data analysis plan was twofold. First, we applied *k*-means cluster analyses on the pandemic's impact on children's health to identify distinct health behavior cluster profiles. The *k*-mean cluster analysis was based on nine health behaviors and if the child was diagnosed with COVID-19. We labeled the clusters based on the Castleberry and Nolen thematic analysis approach, rather than an a priori framework [37]. Second, once the distinct health behavior cluster profiles were identified, chi-squared and *t*-tests were used to test differences in the different cluster profiles based on parent's demographics and school responses to COVID-19. To understand the strength of the association between a health behavioral factor and the High Impact cluster, we also calculated the relative risk (RR) of the High Impact cluster compared to the Moderate Impact cluster for each of the nine health behaviors.

### Sensitivity Analysis

Children diagnosed with COVID-19 may have had different health behavior impacts than children not diagnosed with COVID-19. Accordingly, we performed a sensitivity analysis in which children diagnosed with COVID-19 were removed from the dataset.

## Results

### Health Behavior Profiles

As presented in Table 2, the *k*-means cluster analysis identified two distinct cluster profiles: a High Impact profile ($n = 49$) and a Moderate Impact profile

**Table 2** Comparison of clusters' health behavior characteristics

| | High Impact (*n* (%)) | Moderate Impact (*n* (%)) | *p*-value* | Relative risk and 95% CI |
|---|---|---|---|---|
| Total | 49 (100%) | 73 (100%) | | |
| Children diagnosed with COVID-19 | 5 (10.2%) | 0 (0.0%) | **0.02** | – |
| Children with negative eating outcomes | 38 (77.6%) | 27 (37.0%) | **< 0.001** | **2.10 (1.50, 2.93)** |
| Children with negative sleeping outcomes | 44 (90.0%) | 0 (0.0%) | **< 0.001** | – |
| Children with negative physical activity outcomes | 29 (59.2%) | 41 (56.2%) | 0.6 | 0.86 (0.62, 1.20) |
| Children with reduced time outside | 42 (85.7%) | 44 (60.3%) | **0.01** | **1.55 (1.03, 2.43)** |
| Children with reduced time with friends, in person | 44 (90.0%) | 63 (86.3%) | 0.24 | 1.67 (0.99, 2.76) |
| Children with reduced time with friends, virtually | 16 (32.7%) | 31 (42.5%) | **0.01** | **0.49 (0.28, 0.86)** |
| Children with reduced educational TV and video games time | 2 (4.1%) | 6 (8.2%) | 0.15 | 0.64 (0.37, 1.09) |
| Children with increased TV and video games time | 26 (53.1%) | 33 (45.2%) | 0.54 | 1.10 (0.85, 1.43) |
| Children with reduced social connectedness | 16 (32.7%) | 16 (21.9%) | 0.45 | 1.43 (0.86, 2.36) |

*$p$-values are derived from *t*-tests

($n=73$). The two clusters were significantly different in COVID-19 diagnosis, eating habits, sleeping habits, spending time outdoors, and spending time with friends virtually ($p<0.05$). Children in the High Impact cluster had a greater risk of being diagnosed with COVID-19, developed worsened eating habits (RR = 2.10; 95% CI = 1.50–2.93), spent less time sleeping, and spent less time outdoors (RR = 1.55; 95% CI = 1.03–2.43) than the Moderate Impact cluster (all $p \leq 0.02$). Children in the High Impact cluster were less likely to virtually spend time with friends than children in the Moderate Impact profile (RR = 0.49; 95% CI = 0.28–0.86). Sensitivity analyses revealed the robustness of our findings as we observed similar effects when children diagnosed with COVID-19 were excluded from the analyses (Appendix).

### Demographic Characteristics of Health Behavior Profiles

We then compared the demographic characteristics of the two impact profiles. Table 3 presents the differences in guardian demographics between the two clusters. The two clusters significantly differed in racial compositions ($p=0.023$). The High Impact profile had a larger proportion of Black respondents than the Moderate Impact cluster. The Moderate Impact cluster had a larger proportion of White and Asian respondents than the High Impact cluster. Guardian relationship status also varied significantly among the two clusters ($p=0.049$). The High Impact profile had a higher proportion of guardians that were separated, widowed, single, or in a relationship but not living together than the Moderate Impact cluster. There were no significant differences between the two clusters in mean guardian age, mean people in household, percent Hispanic or Latino, guardian status, guardian education level, annual household income, and employment status ($p>0.05$).

## Discussion

We examined the health behavior impacts of the COVID-19 pandemic among low-income children in the St. Louis metropolitan area. We observed two distinct cluster profiles: a High Impact cluster with children more likely to have been diagnosed with COVID-19, more likely to have worsened eating habits, more likely to have spent less time sleeping, and more likely to have spent less time spent outdoors and a Moderate Impact cluster with children more likely reduced their virtual time with friends.

We found the High Impact cluster's threat multiplied, as children in this cluster were more likely to develop worsen eaten habits as well as spending less time sleeping and time outdoors during the COVID-19 pandemic than children in the Moderate Impact cluster. The majority of St. Louis city is located in a food desert or food swamp [38, 39]. Children who reside in food deserts are at higher risk of being obese or malnourished than children who do not [40–43]. With more children developing poor eating habits during the pandemic, the threat of obesity and malnutrition for children in the High Impact cluster is enhanced.

The High Impact cluster also had a higher proportion of children with reduced time outside compared to the Moderate Impact cluster. However, it is important to note that over 60% of children in each cluster (66% of total children) saw reductions in time outside. Prior to the COVID-19 pandemic, there were well-documented racial and socioeconomic disparities to time spent outside, with Black and urban low-income children spending less time outdoors than White or urban high-income children, respectively [44–48]. During the COVID-19 pandemic, outdoor time has been observed as a buffer against the negative mental and physical health effects of social distancing regulations [49, 50]. Reduction in time outside is another alarming example of the COVID-19 pandemic as a threat multiplier.

In the USA, a large body of evidence has demonstrated that both Black people and predominantly Black communities have been disproportionally affected by the COVID-19 pandemic [7, 37, 51, 52]. One study found that Black COVID-19 patients were on average younger than White COVID-19 patients and had a larger number of comorbidities associated with increased risk COVID-19 mortality [52]. Another study discovered a positive association between ZIP codes with higher proportions of Black and Hispanic residents and increased confirmed COVID-19 cases per capita in St. Louis, Atlanta, Baltimore, Chicago, New York City, and San Diego [53]. Our study's results support this growing body of

**Table 3** Comparison of clusters based on guardian demographic characteristics

| | High Impact ($n=49$) | Moderate Impact ($n=73$) | *P*-value |
|---|---|---|---|
| Age (mean years (SD)) | 35.0 (6.95) | 35.8 (7.41) | 0.74 |
| People in household (mean (SD)) | 4.5 (1.70) | 4.0 (1.44) | 0.534 |
| Hispanic/Latino (*n* (%)) | 2 (4.1) | 4 (5.5) | 0.999 |
| Race (*n* (%)) | | | 0.023 |
| Black | 40 (81.6) | 44 (60.3) | |
| White | 7 (14.3) | 24 (32.9) | |
| Asian | 0 (0) | 4 (5.5) | |
| Other | 2 (4.1) | 1 (1.4) | |
| Guardian status (*n* (%)) | | | 0.634 |
| Parent | 44 (90.0) | 67 (91.8) | |
| Legal guardian | 3 (6.1) | 5 (6.8) | |
| Grandparent | 2 (4.1) | 1 (1.4) | |
| Relationship status (*n* (%)) | | | 0.049 |
| Married/living with partnership | 14 (28.5) | 33 (45.2) | |
| Separated | 5 (10.2) | 5 (6.8) | |
| Divorced | 2 (4.1) | 9 (12.5) | |
| Widowed | 3 (6.1) | 2 (2.7) | |
| In a relationship, but not living together | 5 (10.2) | 1 (1.4) | |
| Single | 20 (40.8) | 23 (31.5) | |
| Education (*n* (%)) | | | 0.463 |
| Some high school or less | 5 (10.2) | 10 (13.7) | |
| Grade 12 or GED | 15 (30.6) | 16 (21.9) | |
| 2-year associates degree | 6 (12.2) | 4 (5.5) | |
| >4 years of college | 14 (28.6) | 27 (37.0) | |
| College graduate or more | 9 (18.4) | 16 (21.9) | |
| Annual household income (*n* (%)) | | | 0.565 |
| Less than $25,000 | 32 (65.3) | 39 (53.4) | |
| $25,000 to $75,000 | 13 (26.5) | 25 (34.2) | |
| More than $75,000 | 2 (4.1%) | 6 (8.2) | |
| Employment status (*n* (%)) | | | 0.829 |
| Employed and working from home | 10 (20.4) | 20 (27.4) | |
| Essential/frontline worker | 23 (46.9) | 27 (37.0) | |
| Laid-off or furloughed due to the pandemic | 7 (14.3) | 10 (13.7) | |
| Previous unemployed/not working | 9 (18.4) | 16 (21.9) | |

*Categorical variable *p*-values are derived from chi-square tests and for continuous variable *p*-values are derived from *t*-tests

evidence of Black-White disparities in COVID-19-related outcomes.

Prior to the COVID-19 pandemic, there were well-documented racial disparities in childhood sleep duration and sleep quality [54, 55]. One literature review found that Black children are significantly less likely to have sufficient sleep time compared to White children [54]. Additionally, there is some evidence that children from single parent households are more likely to have sleeping complications than children from two parent households [55]. Therefore, the High Impact cluster's threat is enhanced, as this cluster that was at risk of poor sleeping outcomes prior to the pandemic has seen even further declines in sleeping patterns. Our findings suggest that the COVID-19 pandemic has widened these disparities, and therefore, Black children's threats are multiplied.

In our study, the High Impact cluster had a significantly higher proportion of children from single-adult households than the Moderate Impact cluster ($p=0.049$). The COVID-19 pandemic significantly weighted the burden of childcare for parents and families [56]. Furthermore, single guardians were forced to face this burden alone [56, 57]. The additional burden and stressors experienced by single-guardian households during the pandemic may also explain why children in the High Impact cluster were less likely to reduce their virtual time with friends than children the Moderate Impact cluster. Unlike children from two adult households, children from stressed single-guardian households may have been less likely to forgo the social support provided through peer interaction.

Our study is not without limitations. First, this study is cross-sectional and does not account for longitudinal changes throughout the COVID-19 pandemic. Second, the generalizability of this study is limited as only parents of students from the SLPS were included in the sample. A third weakness of our study is that we did not collect information on child age or gender in the parent questionnaire. Emerging literature suggests that there may be age and gender differences in pandemic-related health behavior changes [58, 59]. However, results to date have been mixed. For example, some studies have found gender effects [60–63] while others have not [64, 65], and in a systematic review of mental health outcomes during 2020, older adolescents exhibited more depressive symptoms than younger adolescents and children, while findings on anxiety differences by age group were mixed [20]. Finally, given that our findings were based on a small sample of predominately low-income parents, our study may not have been sufficiently powered to detect all significant associations, particularly associations with income status. While this study captured data during the first year of the pandemic, large, longitudinal studies will greatly improve our understanding of pandemic-related behavioral impacts.

Our findings provide valuable information that can inform interventions to help mitigate the effects of the COVID-19 pandemic and help reduce the burdens of future threat multipliers. Our study identified the characteristics of children who experienced "threat multiplication" due to the COVID-19 pandemic. Additionally, our findings identified which specific threats cluster together upon children. Therefore, study results may inform interventions that aim to mitigate the harms caused by the COVID-19 pandemic. Moreover, our findings may inform efforts to help reduce the burden of future threat multipliers as current climate change studies suggest that minority and low-income communities in the USA are at risk of threat multiplication from other extreme weather-related events [17, 18, 66].

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## Appendix Sensitivity analysis

| | High Impact (*n* (%)) | Moderate Impact (*n* (%)) | *p*-value* |
|---|---|---|---|
| Total | 52 (100%) | 65 (100%) | |
| Children diagnosed with COVID-19 | – | – | – |
| Children with negative eating outcomes | 40 (76.9%) | 21 (32.3%) | **< 0.001** |
| Children with negative sleeping outcomes | 38 (73.1%) | 2 (3.1%) | **< 0.001** |
| Children with negative physical activity outcomes | 26 (50.0%) | 39 (60%) | 0.23 |
| Children with reduced time outside | 41 (78.8%) | 40 (61.5%) | **0.005** |
| Children with reduced time with friends, in person | 42 (80.8%) | 60 (92.3%) | 0.1 |

| | High Impact (*n* (%)) | Moderate Impact (*n* (%)) | *p*-value* |
|---|---|---|---|
| Children with reduced time with friends, virtually | 15 (28.8%) | 32 (49.2%) | **< 0.001** |
| Children with reduced educational TV and video games time | 1 (1.9%) | 6 (9.2%) | 0.09 |
| Children with increased TV and video games time | 27 (51.9%) | 29 (44.6%) | 0.08 |
| Children with reduced social connectedness | 12 (23.1%) | 20 (30.7%) | 0.08 |

**P*-value is derived from *t*-tests.

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