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A B S T R A C T

Purpose: To assess changes in adolescent visits with substance use disorders (SUDs) at children’s hospitals during COVID-19.

Methods: We conducted a retrospective cohort study of adolescents (11–18 years) with SUD diagnoses during a hospital visit in the Pediatric Health Information System. Study periods were defined as spring (03/15–05/31), summer (06/01–08/31), and fall (09/01–12/31), pre-COVID-19 (2017–2019), or during COVID-19 (2020). We summarized the change in weekly median visits and interquartile range (IQR) by characteristics and compared between the two periods (e.g., spring pre-COVID-19 [3/15–05/31/2017–2019] versus spring COVID-19 [3/15–05/31/2020]) using median regression.

Results: There were 42,979 SUD visits (10,697 COVID-19; 32,282 pre-COVID-19) and 256 annual weekly median adolescent SUD visits [IQR 235, 280] pre-COVID-19 and 268 [IQR 245, 278] during COVID-19. The median number of weekly SUD visits increased by 14.3% during summer COVID-19 (median visits, [IQR]: 272 [268, 278]) compared to pre-COVID-19 (median visits: 237, IQR [216, 249]; p < .001) but did not significantly differ in spring (p = .091) or fall (p = .65) COVID-19.

Discussion: Our findings suggest increased problematic adolescent substance use during summer COVID-19. Efforts to increase the identification and treatment of adolescent SUDs remain critical.

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COVID-19 emergency department (ED) and inpatient (IP) settings during and SUDs [7], may have been even greater during the COVID-19 healthcare, already high for those with underlying mental health use, and to date, little is known regarding adolescent hospital visits for SUDs during COVID-19. In addition, hospital reliance for healthcare, already high for those with underlying mental health and SUDs [7], may have been even greater during the COVID-19 pandemic while primary care clinics were operating at reduced capacity. To understand the impact of the COVID-19 pandemic on hospital-based care for SUDs, we aimed to describe changes in adolescent visits with a SUD diagnosis at children’s hospitals’ emergency department (ED) and inpatient (IP) settings during COVID-19.

### Methods

We conducted a retrospective cohort study of adolescents (11–18 years old) with a hospital encounter (IP, including observation; ED), in the Pediatric Health Information System (Children’s Hospital Association, Lenexa, KS) database, which contains up to 41 diagnoses on each encounter using the International Classification of Diseases Tenth Revision [8]. Hospitals that provided data throughout the study period were included (42 out of 49).

### Table 1

<table>
<thead>
<tr>
<th>Race/Ethnicity</th>
<th>Overall</th>
<th>11–13</th>
<th>14–15</th>
<th>16–18</th>
<th>Sex</th>
<th>Male</th>
<th>Female</th>
<th>Payor</th>
<th>Government</th>
<th>Private</th>
<th>Other</th>
<th>Rurality</th>
<th>Urban</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Percent change in median visits (95% CI)</td>
<td>p</td>
<td>0.19</td>
<td>0.90</td>
<td>0.11</td>
<td>0.587</td>
<td>0.866</td>
<td>0.70</td>
<td>0.355</td>
<td>1.000</td>
<td>0</td>
<td>0.67</td>
<td>0.87</td>
</tr>
<tr>
<td></td>
<td>Overall</td>
<td>16.5–24.3</td>
<td>0.070</td>
<td>15.4–24.9</td>
<td>0.01</td>
<td>7.1–13.4</td>
<td>0.002</td>
<td>16.5–24.4</td>
<td>0.001</td>
<td>5–41.2</td>
<td>0.279</td>
<td>0.01</td>
<td>0.90</td>
</tr>
<tr>
<td>Disposition</td>
<td></td>
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<tr>
<td></td>
<td>Percent change in median visits (95% CI)</td>
<td>p</td>
<td>20.2–54</td>
<td>0.008</td>
<td>23.9–34</td>
<td>0.001</td>
<td>16.9–25.6</td>
<td>0.003</td>
<td>0–5.5</td>
<td>0.725</td>
<td>0.01</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td></td>
<td>Overall</td>
<td>176–272</td>
<td>0.050</td>
<td>16.5–23.9</td>
<td>0.001</td>
<td>14.3–23.8</td>
<td>0.000</td>
<td>15.4–26.5</td>
<td>0.003</td>
<td>0–3.3</td>
<td>0.725</td>
<td>0.00</td>
<td>0.00</td>
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<td>Mental Health Disorder</td>
<td>Substance Use or Addiction Disorders</td>
<td>11.8–22.8</td>
<td>0.292</td>
<td>18.4–22.2</td>
<td>0.003</td>
<td>14.4–22.1</td>
<td>0.000</td>
<td>19.7–22.2</td>
<td>0.003</td>
<td>19.9–21.7</td>
<td>0.001</td>
<td>0.00</td>
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<td></td>
<td>Depression Disorder</td>
<td>12.3–31.5</td>
<td>0.194</td>
<td>18.8–29.7</td>
<td>0.001</td>
<td>7.9–16.5</td>
<td>0.000</td>
<td>19.3–16.5</td>
<td>0.003</td>
<td>8.8–28.8</td>
<td>0.000</td>
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<td>Suicidal or Self-Injury</td>
<td>15.5–29.5</td>
<td>0.087</td>
<td>17.9–28.5</td>
<td>0.004</td>
<td>11.5–17.2</td>
<td>0.004</td>
<td>19.2–16.8</td>
<td>0.001</td>
<td>11.0–37.8</td>
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<td>Anxiety Disorder</td>
<td>3.3–21.2</td>
<td>0.787</td>
<td>40.8–50.3</td>
<td>0.001</td>
<td>29.9–44.4</td>
<td>0.000</td>
<td>21.6–38.9</td>
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<td>29.3–28.3</td>
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<tr>
<td>Substance Use Disorder</td>
<td>Cannabis Use Disorder</td>
<td>9.7–24.7</td>
<td>0.198</td>
<td>25.5–36.5</td>
<td>0.001</td>
<td>19.3–25.3</td>
<td>0.001</td>
<td>21.6–25.3</td>
<td>0.001</td>
<td>19.3–21.7</td>
<td>0.001</td>
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<tr>
<td></td>
<td>Nicotine Use Disorder</td>
<td>29.5–10.6</td>
<td>0.003</td>
<td>11.7–19.1</td>
<td>0.002</td>
<td>13.9–21.7</td>
<td>0.001</td>
<td>13.9–21.7</td>
<td>0.001</td>
<td>13.9–21.7</td>
<td>0.001</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Alcohol Use Disorder</td>
<td>4.2–15.2</td>
<td>0.007</td>
<td>0–13.1</td>
<td>0.100</td>
<td>18.5–33.5</td>
<td>0.001</td>
<td>19.3–33.5</td>
<td>0.000</td>
<td>21.6–38.9</td>
<td>0.000</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Opioid Use disorder</td>
<td>63.3–63.3</td>
<td>1.000</td>
<td>0–41.8</td>
<td>1.000</td>
<td>0–28.7</td>
<td>1.000</td>
<td>0–28.7</td>
<td>1.000</td>
<td>0–28.7</td>
<td>1.000</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Other psychoactive substance use disorders</td>
<td>20.8–9.8</td>
<td>0.184</td>
<td>7.1–16.5</td>
<td>0.000</td>
<td>11.1–30.3</td>
<td>0.001</td>
<td>17.8–38.9</td>
<td>0.000</td>
<td>19.3–38.9</td>
<td>0.000</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Bold indicates p-value <.001.


Median adolescent visits and 95% confidence intervals were calculated for each study period and compared between 2017–2019 (pre-COVID-19) and 2020 (during COVID-19).
COVID-19, as well as seasonal variations in substance use, we investigated race/ethnicity because adolescent substance use disorder, hospital region, and setting (rural/urban). We considered dian household income quartile, disposition, underlying mental health disorders, including anxiety disorder (40.8%; \( p < .001 \)), depression disorder (18.8%; \( p = .001 \)), and substance use or addiction disorders (18.4%; \( p < .001 \)).

The primary outcome was the median number and inter-quartile range (IQR) of adolescent visits with diagnosis (primary or secondary) of a SUD, including alcohol, cannabis, nicotine, opioid, and other psychoactive substance use, during COVID-19 compared to pre-COVID-19. Given the changes in healthcare utilization during COVID-19 impacting the overall number of visits, we chose to compare the percent change in median weekly adolescent SUD visits to ensure consistent comparison. Covariates included age, sex, clinical setting (ED/IP), payer type, median household income quartile, disposition, underlying mental health disorder, hospital region, and setting (rural/urban). We investigated race/ethnicity because adolescent substance use patterns and treatment differ between racial/ethnic groups [9,10]. Due to different mitigation strategies over time during COVID-19, as well as seasonal variations in substance use, we defined our study periods as spring COVID-19 (03/15–05/31/2020), summer COVID-19 (06/01–08/31/2020), and fall COVID-19 (09/01/2020–12/31/2020) [11]. We defined our comparison periods as spring pre-COVID-19 (03/15–05/30, 2017–2019), summer pre-COVID-19 (06/01–08/31, 2017–2019), and fall pre-COVID-19 (09/01–12/31, 2017–2019).

We summarized the percent change in the median number of visits and IQR by categorical characteristics and compared between the two study periods (e.g., spring pre-COVID-19 [3/15–05/31/2017–2019] versus spring COVID-19 [3/15–05/31/2020]) using median regression, based on methods similar to a recent study [11]. We were unable to adjust for a hospital effect due to low weekly volumes at individual hospitals; \( p \)-values < .05 were considered statistically significant. The Institutional Review Board deemed the research of this nonhuman subject.

### Results

Adolescent visits overall decreased in the spring (−55.5% \( p < .001 \)), summer (−12.4%, \( p < .001 \)) and fall (−24.6%, \( p < .001 \)) periods compared to pre-COVID-19. There were 42,979 adolescent SUD visits overall (10,697 during COVID-19; 32,282 pre-COVID-19) with 256 annual weekly median adolescent SUD visits (interquartile range [IQR] 235, 280) pre-COVID-19 and 268 [IQR 245, 278] during COVID-19. The median number of weekly adolescent visits with a SUD increased by 14.3% during summer COVID-19 (median visits, [IQR]: 272 [268, 278]) compared to summer pre-COVID-19 (median visits: 237, IQR [216, 249]; \( p < .001 \)) but did not significantly change in spring (\( p = .091 \)) or fall (\( p = .65 \)) (Table 1 and Figure 1). During summer COVID-19 the patient characteristics associated with the greatest increase in median weekly visits included patients age 14–15 years (23%; \( p < .001 \)), non-Hispanic Black (26.5%; \( p < .001 \)), Hispanic (23.3%; \( p = .005 \)), and patients with underlying mental health disorders, including anxiety disorder (40.8%; \( p < .001 \)), depression disorder (18.8%; \( p = .001 \)), and substance use or addiction disorders (18.4%; \( p < .001 \)).

### Discussion

We found the median number of adolescent visits for SUD at children’s hospitals increased during summer COVID-19 compared to summer pre-COVID-19. Recent literature describes mixed findings regarding adolescent substance use during COVID-19 [5,6], with some studies finding increased alcohol and cannabis use among adolescents with current substance use and solitary substance use [4]. Our findings may be driven in part by differences in adolescent substance use patterns due to variation in mitigation strategies across the study periods, e.g., strict measures nationwide in spring, decreased measures but not yet back in school in summer, and return to remote or in-person school in fall.

Our findings also suggest increased problematic substance use among certain adolescents. Further study is needed to better understand the underlying drivers of these findings, with particular focus on younger adolescents, those of non-Hispanic Black and Hispanic race/ethnicity, and those with underlying mental health disorders. A recent study in younger adolescents (10–14-year-olds) found that while there was no substantial change in overall substance use during COVID-19, there was an increase in nicotine and misuse of prescription drugs. Importantly, this study found a correlation with underly-ling mental health as youth reporting “extreme” stress related to the pandemic were 2.4 times more likely to report any substance use [12]. Recent evidence shows the adverse impact of COVID-19 on adolescent mental health, including increased symptoms of depression, anxiety, and psychological distress [13,14]. Given our finding that adolescent SUD visits increased during summer COVID-19 among those with underlying mental health disorders, further study is needed to understand underlying drivers that can inform SUD interventions in this at-risk population.

Due to the use of administrative data, our findings are subject to misclassification bias and likely underestimate true SUD prevalence. Due to low weekly volumes at individual hospitals, we were unable to adjust for differences between hospitals. Given the ongoing COVID-19 pandemic and continued mitigation strategies, there is great concern that adolescents engaging in problematic substance use are at heightened risk for numerous adverse outcomes. Efforts to increase identification and treatment of adolescent SUDs at children’s hospitals are critical to offsetting heightened risk for poor health outcomes.

### Supplementary Data

Supplementary data related to this article can be found at http://doi.org/10.1016/j.jadohealth.2021.12.024.
References


