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# Pandemic-Related Changes in the Prevalence of Early Adolescent Alcohol and Drug Use, 2020–2021: Data From a Multisite Cohort Study

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A B S T R A C T

**Purpose:** Evaluate changes in early adolescent substance use from May 2020 to May 2021 during the coronavirus disease 2019 pandemic using data from a prospective nationwide cohort: the Adolescent Brain Cognitive Development Study.
**Methods:** In 2018–2019, 9,270 youth aged 11.5–13.0 completed a prepandemic assessment of past-month alcohol and drug use, then up to seven during-pandemic assessments between May 2020 and May 2021. We compared the prevalence of substance use among same-age youth across these eight timepoints.
**Results:** Pandemic-related decreases in the past-month prevalence of alcohol use were detectable in May 2020, grew larger over time, and remained substantial in May 2021 (0.3% vs. 3.2% pre-pandemic, $p$ <.001). Pandemic-related increases in inhalant use ($p$ = .04) and prescription drug misuse ($p$ < .001) were detectable in May 2020, shrunk over time, and were smaller but still detectable in May 2021(0.1%-0.2% vs. 0% pre-pandemic). Pandemic-related increases in nicotine use were detectable between May 2020 and March 2021 and no longer significantly different from prepandemic levels in May 2021 (0.5% vs. 0.2% prepandemic, $p$ = .09). There was significant heterogeneity in pandemic-related change in substance use at some timepoints, with increased rates among youth identified as Black or Hispanic or in lower-income families versus stable or

**IMPLICATIONS AND CONTRIBUTION**

Compared to prepandemic, in May 2021, fewer teens in early adolescence used alcohol and more used inhalants or misused prescription drugs. Data indicated persistent and heterogeneous pandemic-related changes in early adolescent substance use, with adverse impacts being largest among Black, Hispanic, or low-income youth.

**Conflicts of interest:** The authors have no conflicts of interest to declare.
**Disclaimer:** A listing of participating sites and a complete listing of the study investigators can be found at https://abcdstudy.org/Consortium_Members.pdf. ABCD consortium investigators designed and implemented the study and/or provided data but did not necessarily participate in the analysis or writing of this report. The views and opinions expressed in this manuscript are those of the authors only and do not necessarily represent the views, official policy or position of the U.S. Department of Health and Human Services or any of its affiliated institutions or agencies.

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decreased rates among youth identified as White or in higher-income families.
**Discussion:** Among youth ages 11.5–13.0 years old, rates of alcohol use remained dramatically reduced in May 2021 relative to prepandemic and rates of prescription drug misuse and inhalant use remained modestly increased. Differences remained despite the partial restoration of pre-pandemic life, raising questions about whether youth who spent early adolescence under pandemic conditions may exhibit persistently different patterns of substance use.


A handful of studies have examined changes in alcohol and drug use among adolescents during the coronavirus disease 2019 (COVID-19) pandemic, finding unchanged [1] or decreased [2–5] prevalence of alcohol, binge drinking, cannabis use, cigarette, and e-cigarette use during the pandemic. Other studies have found an increased frequency of hospital visits for substance use disorders [6] and deaths from drug overdoses [7] among adolescents. Today, three gaps in the emerging evidence must be filled to guide an effective public health response. The first gap is the lack of extended follow-up and limited temporal resolution when identifying pandemic-related changes, despite the pandemic's evolving nature [8]. Almost all published studies have reported on the pandemic's impact in its first several months, during 2020, leaving the pandemic's subsequent impact unclear. Moreover, all published studies have examined changes at a single timepoint during the pandemic. Documenting how pandemic-related changes in substance use unfolded across different phases of the pandemic and into 2021 could inform expectations of whether changes will persist or remit as the pandemic continues.

The second gap is a limited focus on early adolescence [8], spanning ages 10–13 years. A study of 11–12-year-old youth in May 2020 found that, compared to prepandemic, fewer were using alcohol and more were using nicotine or misusing prescription drugs [9]. The finding of increased use of some drugs contrasts with the evidence reviewed above for older adolescents, perhaps indicating a differential impact of the pandemic in this age range.

The third gap is limited investigation of how the pandemic's effect varies across the population [8]. Two studies have failed to find significant differences by sex [2,3] while another study found larger decreases in substance use among males [5]. Studies of Norwegian [5] and Icelandic [3] teens ages 13–18 years old found larger reductions in alcohol and nicotine product use among older adolescents [3]. No study has investigated potential differences in substance use among racial/ethnic or sexual orientation minority youth. Racial/ethnic minority groups have suffered disproportionate disease burden [10], economic hardship [11], and other stressors [12], and sexual orientation minority groups have suffered disproportionate psychiatric distress and barriers to care [13]—these disproportionate burdens may contribute to disproportionate changes in substance use [14]. Likewise, despite evidence of larger adverse impacts of the pandemic among economically vulnerable populations [15], no study has investigated whether changes in adolescent substance use vary by household income.

The current study evaluated pandemic-related changes in the past-month prevalence of alcohol and drug use using data from a cohort of United States youth serially assessed at seven timepoints during the COVID-19 pandemic: the Adolescent Brain and Cognitive Development (ABCD) Study. We extend a previous analysis [9] of data at a single timepoint in May 2020 to incorporate seven timepoints spanning through May 2021. We hypothesized that previously documented pandemic-related changes in the prevalence of alcohol and drug use in the ABCD Study sample would persist to May 2021. Persistence of changes was found in a previous study of eighth graders spanning 2020–2021 [4]. We hypothesized that any adverse impacts of the pandemic on adolescent substance use would be greater among youth identifying as a racial/ethnic minority, as a sexual orientation minority, and/or living in households with lower income. This hypothesis followed from empirical evidence that these groups have experienced more stressors and barriers to care during the pandemic, which in turn could lead to more substance use [16,17].

## Methods

### *Sample*

From 2016–2018, the ABCD Study [18] recruited 11,880 youth aged 9–10 at 21 study sites across the United States. Recruitment occurred primarily through schools, and the sample was intended to reflect the sociodemographics of the United States [19]. At study entry, 48% of youth were female; 52% identified as White, 20% as Hispanic, 15% as Black, 2% as Asian, and 11% as another racial/ethnic identity. 68% of parents were married. Both parents were in the labor force in 49% of families, and no parent was in the labor force in 6% of families. 59% of youth had $\geq$1 parent with a bachelor's degree. 57% of families had an annual household income above $75,000. The mean household size was 4.7 people. Participants have been followed prospectively since initial recruitment with annual assessments. The most recently completed and publicly released assessment wave was the 2-year follow-up assessment, at which 88% of participants had been retained. To date, 127 participants have withdrawn from the study [20]. All procedures were conducted in accordance with the ethical standards of the 1964 Helsinki Declaration and its later amendments and were approved by an institutional review board.

### *Longitudinal design and measurement of substance use*

Our analyses combine prepandemic data from the ongoing main ABCD Study protocol with during-pandemic data from a rapidly implemented pandemic-focused survey protocol that began in May 2020. Figure 1 depicts how data from each protocol was combined to form the analytic sample.

*During-pandemic assessments*

Beginning in May 2020, all ABCD Study participants were invited to complete up to seven web-based surveys measuring the impact of the pandemic on them and their families. 38%–48% of eligible participants completed each survey wave. Survey waves were spaced 5–11 weeks apart: wave 1 (May 16, 2020), wave 2 (June 23, 2020), wave 3 (August 4, 2020), wave 4 (October 8, 2020), wave 5 (December 13, 2020), wave 6 (March 2, 2021), and wave 7 (May 17, 2021). Table 1 provides information on the national state of the pandemic at the time of each survey wave (e.g., case rates, percentage of families who were socially distancing).

At each survey wave, youth reported the number of days in the past month on which they: (1) drank alcohol; (2) smoked cigarettes; (3) used an electronic nicotine delivery system; (4) smoked a cigar/hookah/pipe; (5) used smokeless tobacco/chew/snus; (6) used a cannabis product (flower/concentrate/edible); (7) used prescription drugs in a way not prescribed; or (8) used inhalants. Items were modeled on the prepandemic ABCD Study assessments [26] and the Monitoring the Future Study 2020 interview [27]. The response scale ranged from 0 days to 10 + days; responses were dichotomized into no use versus any use to match the response scale at the assessments completed prepandemic. Responses were collapsed across items (1)–(8) to form an indicator of use of any substance. Responses were collapsed across items (2)–(5) to form a single indicator of nicotine use. Dependent variables included use of each substance category as well as of any substance.

*Prepandemic assessment*

Youth had been followed for 2–4 years prepandemic. For comparison to during-pandemic assessments, we drew data from an assessment wave (18-month follow-up [26]) that measured youth substance use on the same timescale (past-month use), with comparable item wording, and at an age range overlapping with that assessed at each during-pandemic timepoint. Between February 2018 and March 2019, when the youth were 11–12 years old, all had been invited to complete a phone interview at which they reported on their past-month alcohol and drug use. Youth verified they were in a private setting before the interview began. Items were modeled on the Monitoring the Future Study's [4] questions about monthly use, with updates to wording to address changes in nicotine and cannabis products (e.g., advent of vaping). 93% of participants completed the interview.

*Comparisons of longitudinal data*

Developmental increases in drinking and drug use are expected during early adolescence. Thus, maturation and pandemic effects will be confounded in longitudinal data: an apparent increase in substance use at measurements before versus during the pandemic, or in earlier versus later phases of the pandemic, could be explained by the maturation of the sample. To control for maturation effects, we used an age-period design [28] that we have used to study pandemic effects on substance use in two previously published studies [9,29]. The age-period design leveraged the fact that the ABCD Study participants span a 4-year range of ages on any given calendar date, given that recruitment spanned 2016 to 2018, and all youth were 9–10 years old at study entry. Given a mixed-age cohort, we can compare the substance use of participants that reach the same age on different calendar dates, either before or during the pandemic (e.g., a 12-year-old assessed in 2019 vs. a 12-year-old assessed in 2021). If we compare same-age youth across timepoints, maturation can no longer explain any differences in the rates of substance use across timepoints. First, we restricted the data as necessary to have observations of youth across a similar age range at every timepoint, spanning 11.5–13.0 years old, ensuring that we could properly adjust for maturation (Figure 1 shows the number of observations excluded at each timepoint) [30]. Next, we adjusted

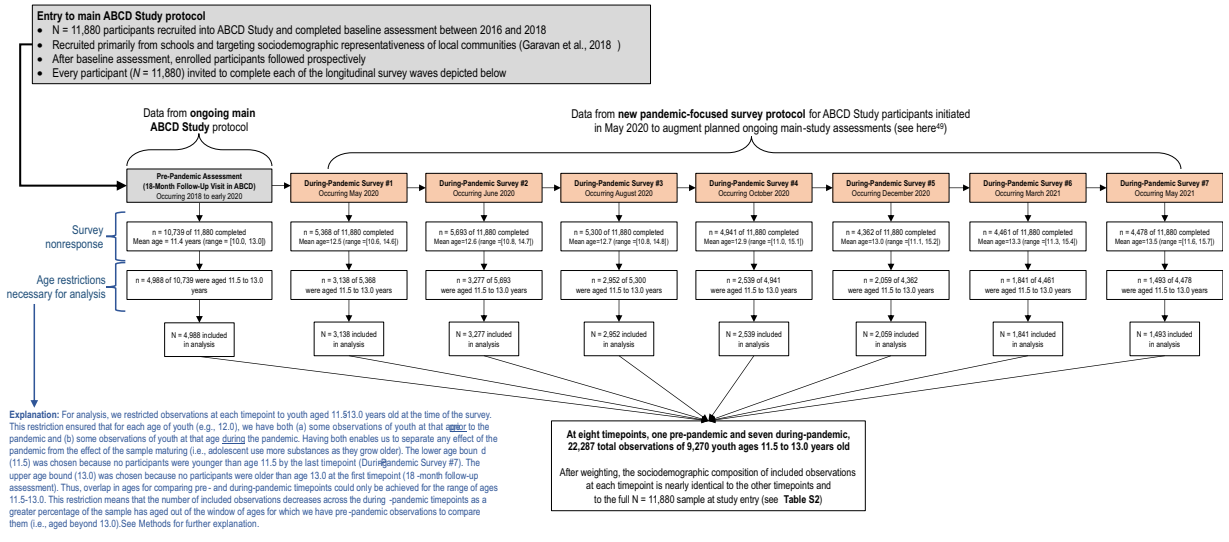


**Figure 1.** Selection of observations for analysis from within ongoing main ABCD study longitudinal design and subsequently established pandemic-focused survey protocol. *Note*. Depicts how the observations included in the analysis at each timepoint (bottom row of eight boxes) were derived from the ABCD Study protocols [21].

**Table 1**
Context of the COVID-19 pandemic at each survey wave

| Variable | Survey wave | | | | | | |
|---|---|---|---|---|---|---|---|
| | May 2020 | June 2020 | Aug. 2020 | Oct. 2020 | Dec. 2020 | Mar. 2021 | May 2021 |
| Number of observations | 3,138 | 3,277 | 2,952 | 2,539 | 2,589 | 1,841 | 1,493 |
| Mean age of participants (years) with included data | 12.3 | 12.3 | 12.3 | 12.4 | 12.4 | 12.4 | 12.5 |
| Date of initiation of survey dissemination | May 16 | July 23 | Aug. 4 | Oct. 8 | Dec. 13 | Mar. 2 | May 17 |
| **ABCD data** | | | | | | | |
| Percent of youth reporting full-time in-person schooling[a,b] | 0.5% | 0.7% | 1.9% | 19.1% | 17.6% | 29.2% | 44.1% |
| Percent of families who engaged in social distancing[b] | 85% | 78% | 80% | 79% | 79% | 75% | 61% |
| Percent of families who avoided visiting family or friends[b] | 59% | 43% | 45% | 42% | 60% | 44% | 23% |
| **Geocoded ABCD data[c]** | | | | | | | |
| Case rates in participants' counties (per 100,000)[d] | 6.1 | 12.2 | 18.1 | 14.7 | 62.2 | - | - |
| Death rates in participants' counties (per 100,000)[d] | 0.37 | 0.13 | 0.27 | 0.18 | 0.68 | - | - |
| Unemployment rates in participants' counties[e] | 12.4% | 10.4% | 7.9% | 6.0% | 6.0% | - | - |
| **U.S. National data** | | | | | | | |
| Number of new cases (7-day rolling average)[f] | 24,301 | 22,058 | 57,972 | 46,939 | 212,859 | 63,506 | 30,935 |
| Number of new deaths (7-day rolling average)[f] | 1,418 | 765 | 1,144 | 682 | 2,616 | 1,740 | 548 |
| Percent of persons age ≥ 18 years old who have completed a vaccination series[g] | - | - | - | - | - | - | 47.3% |
| Percentage of persons ages 12–17 years old who have completed a vaccination series[g] | - | - | - | - | – | 0.1% | 7.4% |
| Percent of employed adults with children working exclusively in-person[g] | 61.1% | 65.3% | 73.0% | 74.4% | 74.1% | 77.3% | 82.2% |

These data are provided to give descriptive context about the national state of the pandemic at the time of each survey wave—these data were not analyzed in this manuscript. Number of observations is the number of participants at each survey wave contributing data to regression models. Regression models adjusted for the mean differences in age of participants across survey waves (see Methods). Hyphens in table cell indicate that data was not available. ABCD data and Geocoded ABCD data were weighted to be sociodemographically representative of children in the United States Census (see Methods).

[a] Reported by youth on the web-based surveys during the COVID-19 pandemic. Values indicate proportion of youth who selected "in-person" as their response to a multiple choice survey item asking, "In the past week, [how] was your schooling taking place?" At May, June, or August 2020 surveys, youth may have been on summer vacation from school.

[b] Reported by parents on the web-based surveys during the COVID-19 pandemic. Values indicate proportion of parents who checked boxes indicating whether in the past week their family had "engaged in social distancing" or "avoided visiting family or friends outside our immediate family."

[c] Geocoded ABCD data have only been publicly released for survey waves 1–5.

[d] Source: Johns Hopkins Coronavirus Resource Center COVID-19 Data Dashboard [22]. Data at the level of county and day.

[e] Source: Bureau of Labor Statistics (BLS) Local Area Unemployment Statistics (LAUS) [23]. Data at the level of county and month.

[f] Source: Center for Disease Control (CDC) COVID Data Tracker [24]. Data at the level of nation and day. The CDC COVID Data Tracker does not include adult vaccination data for all states prior to December 14, 2020.

[g] Source: Bureau of Labor Statistics (BLS) Current Population Survey (CPS) [25]. Data at the level of nation and month.

for age-at-observation in all analyses to account for maturation effects.

There were eight timepoints—the prepandemic visit plus the seven during-pandemic web-based surveys—with the following number of participants at each (Figure 1): prepandemic (n = 4,988), May 2020 (n = 3,138), June 2020 (n = 3,277), August 2020 (n = 2,952), October 2020 (n = 2,539), December 2020 (n = 2,059), March 2021 (n = 1,841), May 2021 (n = 1,493). The number of participants decreases at later timepoints because a greater proportion of the sample had aged beyond the age range that could be compared to the prepandemic observations (i.e., is older than 13.0 years). At least one observation was contributed by 9,270 youths, with a mean of 2.4 observations per youth (standard deviation = 1.8, range = [1,8]). Both the prepandemic observations and ≥1 during-pandemic observations were contributed by 1,457 youths. In each during-pandemic wave, 57%–69% of participants were present in the subsequent wave. Table A1 compares the sociodemographic characteristics of participants in the analytic sample at each timepoint. Small differences (<5 percentage points) between timepoints in youth racial/ethnic identity, household income, parent education, and parent marital status of participants were accounted for during analysis via weighting (see *Analytic plan* below).

### *Measurement of putative moderators of pandemic-related change in substance use*

We tested four putative moderators: youth sex, youth identification as a sexual orientation minority, youth racial/ethnic identification, and household income prepandemic. Youth's sex assigned at birth and racial/ethnic identification were reported by caregivers at study entry. Caregivers answered two questions to assess race/ethnicity: "What race do you consider the child to be? (check all that apply)", followed by "Do you consider the child Hispanic/Latino/Latina?" Responses across the two items were recoded into a five-level variable designed to map onto United States Census categories—non-Hispanic White, non-Hispanic Black, Hispanic, Asian, or other racial/ethnic identity [31]. Youth identification as a sexual orientation minority was derived from their responses to the question "Are you gay or bisexual?" at each longitudinal assessment within the ABCD Study protocol [32] (ages 9–13 years). Youth replying "yes" or "maybe" at any assessment were included in the sexual orientation minority group [32]—12% of participants. Youth responses of "I don't know" were excluded when determining membership in the sexual orientation minority group [33]. For each participant, prepandemic household income was drawn from the ABCD

Study annual assessment completed most recently before March 19, 2020. Caregivers reported annual household gross income from all sources on a 10-point scale listing income ranges. Responses were recoded to the center of the stated range. 30% of families reported annual income of less than $50,000, 28% of $50,000–$100,000, and 43% of more than $100,000.

### *Analytic plan*

Analyses were conducted in R v4.2.1. Data were weighted to address survey nonresponse and improve sample representativeness (see the supplement for details). Response rates were lower for the during-pandemic survey waves (Figure 1), as expected given they occurred during a more chaotic period during family's lives (i.e., the pandemic). Thus, it was important to ensure that differential sample composition across timepoints did not confound our findings. Following recommended practice for survey analysis [34], we estimated the inverse probability of nonresponse weights [35] to ensure that the analytic sample at each timepoint was similar to the full ABCD Study sample on both key risk factors for substance use (family history of alcohol and drug use, diagnosis with an externalizing spectrum disorder, prepandemic history of alcohol or drug use) and sociodemographic characteristics (youth sex and race/ethnicity; family income, structure, and employment; Census region; and household size). Table A2 confirms that after applying the nonresponse weights, the composition of the analytic sample at every longitudinal timepoint was nearly identical to the full ABCD Study sample on both the key risk factors for substance use and the sociodemographic characteristics. Thus, we could safely proceed to compare the rates of substance use across timepoints.

Next, we multiplied the nonresponse weights by preconstructed baseline weights to create product weights that would ensure the analytic sample at each timepoint was representative of those aged 9–10 years old in the United States Census' Bureau's American Community Survey (2011–2016) on the same sociodemographic characteristics listed above [31]. After weighting, the analytic sample at each timepoint had a similar sociodemographic composition to the Census data, differing by $< 1$ percentage point on all variables.

We fit regressions in the survey package [36] using the logistic link function and clustering observations on study site, family, and youth to account for repeated observations and nonindependence. A regression was fit for each dependent variable. Timepoint was entered as seven dummy variables contrasting each during-pandemic timepoint with the prepandemic timepoint as the reference level. Age-at-observation was included as a covariate to adjust for maturation between timepoints. Parents' marital status and education were included as covariates known to predict early adolescent substance use [9]. Data were weighted with the product weight.

Tests of moderation were conducted separately for each putative moderator. To reduce the number of tests, we focused on moderating the change in a single dependent variable: past-month use of any substance. We compared models with and without terms for the interaction between the timepoint and the putative moderator using likelihood ratio tests [37]. When that overall test was significant, we applied a multiple testing correction [38] for contrasts at individual timepoints. Data were weighted with the nonresponse weight.

## Results

See Table 1 for pandemic-related context when interpreting findings across timepoints. Table 2 reports estimates from regression models. Figures 2 and 3 graph the model-estimated past-month prevalence of alcohol and drug use at each of the eight timepoints. For graphing, the youth age was set at 12.5 years old to capture the mean prevalence of past-month substance use among 12-year-olds. All regression models adjusted for age-at-observation, so the estimates being graphed in Figures 2 and 3 should not be interpreted as individual-level longitudinal trajectories or developmental changes in substance use—rather they reflect differences between same-age youth on different calendar dates.

Consistent with the age range of participants, the estimated past-month prevalence of use across timepoints was $\leq$3.2% for alcohol, $\leq$1.1% for nicotine, and $\leq$0.4% for other categories. Most endorsements of alcohol or drug use (77%) were for 1–2 days of use in the past month. See Figure 2. The rate of alcohol use was significantly lower than the prepandemic level at all seven during-pandemic timepoints, with the decrease growing larger over time (relative risks [RRs] = 0.1–0.5, *ps*=<0.001–0.008 across timepoints). The rate of nicotine use was significantly higher than the prepandemic level at the first six timepoints, from May 2020 to March 2021 (RRs = 3.3–7.1, *ps* = <0.001–0.02) and was no longer significantly different from prepandemic in May 2021 ($p = .09$). The rate of prescription drug misuse (*ps*<0.001) and inhalant use (*ps* = 0.007–0.13) was significantly higher than the prepandemic level at nearly all during-pandemic timepoints, including the final timepoint in May 2021. The rate of cannabis use was not significantly different from the prepandemic level at any of the during-pandemic timepoints (*ps* = 0.36–0.98). Reflecting offsetting changes across the substance categories, the rate of *any* substance use did not differ significantly from the prepandemic level at the first six timepoints before being significantly lower (RR = 0.5, $p = .04$) in May 2021.

Table A3 reports estimates from regression models with interactions. When predicting youth use of any substance, tests of the interaction between timepoint and youth sex ($p = .45$) and youth identification as a sexual orientation minority ($p = .53$) were not statistically significant. There was a statistically significant interaction between timepoint and youth racial/ethnic identification ($p = .01$). See Figure 3, Panels A-D. After adjusting contrasts at individual timepoints for multiple testing, there were five significant contrasts ($p < .05$). Pre-COVID, adjusting for parent education, marital status, and household income, both Black and Hispanic youth were less likely than White youth to report past-month substance use. While the rate of any substance use fell throughout the pandemic among White youth, it grew during the initial phase of the pandemic among Black and Hispanic youth and returned to near the pre-COVID level by May 2021. Compared to White youth, the degree of change from pre-COVID was significantly greater for Black youth in June 2020 and for Hispanic youth in June 2020, August 2020, March 2021, and May 2021 (*ps*<0.05).

There was also a significant interaction between timepoint and prepandemic household income ($p = .03$). See Figure 3, Panel E. After adjusting contrasts at individual timepoints for multiple testing [38], the degree of change from pre-COVID was significantly moderated by household income at four timepoints spanning June 2020 to December 2020 (*ps*<0.05). Pre-COVID, youth from higher-income families were more likely than

**Table 2**
Regression models for testing impact of COVID-19 pandemic on prevalence of alcohol and drug use

| Term | Odds of youth using in the past month: | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Any substance | | | | Alcohol | | | | Nicotine | | | | Cannabis | | | | Prescription drugs[a] | | | | Inhalants[b] | | | |
| | OR | Coef. | SE | *p* | OR | Coef. | SE | *p* | OR | Coef. | SE | *p* | OR | Coef. | SE | *p* | OR | Coef. | SE | *p* | OR | Coef. | SE | *p* |
| (Intercept) | - | −3.57 | 0.16 | <.001 | - | −3.40 | 0.12 | <.001 | - | −6.52 | 0.43 | <.001 | - | −7.60 | 0.80 | <.001 | - | −21.78 | 0.33 | <.001 | - | −9.52 | 1.03 | <.001 |
| Age-at-observation | 1.7 | 0.51 | 0.13 | .002 | 2.1 | 0.76 | 0.16 | <.001 | 1.7 | 0.54 | 0.27 | .07 | 5.4 | 1.69 | 0.78 | .054 | - | 0.16 | 0.38 | .68 | 1.6 | 0.46 | 0.51 | .38 |
| COVID: May 2020 | 1.2 | 0.15 | 0.18 | .42 | 0.4 | −0.83 | 0.20 | .002 | 7.0 | 1.95 | 0.46 | .001 | 1.5 | 0.38 | 0.80 | .65 | - | 16.38 | 0.35 | <.001 | 42.4 | 3.75 | 1.13 | .007 |
| COVID: June 2020 | 1.0 | −0.00 | 0.16 | .99 | 0.4 | −0.94 | 0.15 | <.001 | 6.7 | 1.90 | 0.43 | <.001 | 1.2 | 0.14 | 1.13 | .90 | - | 15.65 | 0.47 | <.001 | 23.8 | 3.17 | 1.24 | .03 |
| COVID: August 2020 | 1.2 | 0.20 | 0.23 | .39 | 0.5 | −0.64 | 0.20 | .008 | 7.4 | 2.01 | 0.47 | .001 | 0.8 | −0.21 | 0.93 | .83 | - | 16.16 | 0.53 | <.001 | 7.8 | 2.06 | 1.25 | .13 |
| COVID: October 2020 | 1.1 | 0.06 | 0.21 | .76 | 0.4 | −0.83 | 0.24 | .006 | 6.2 | 1.83 | 0.45 | .002 | 2.4 | 0.86 | 0.90 | .36 | - | 16.15 | 0.35 | <.001 | 28.6 | 3.35 | 1.24 | .02 |
| COVID: December 2020 | 0.9 | −0.11 | 0.19 | .59 | 0.3 | −1.06 | 0.32 | .006 | 4.9 | 1.59 | 0.44 | .004 | 1.6 | 0.46 | 1.01 | .66 | - | 15.99 | 0.36 | <.001 | 13.7 | 2.61 | 1.19 | .051 |
| COVID: March 2021 | 0.7 | −0.36 | 0.21 | .12 | 0.2 | −1.48 | 0.37 | .002 | 3.6 | 1.29 | 0.48 | .02 | 1.0 | 0.01 | 0.66 | .98 | - | 15.59 | 0.52 | <.001 | 20.1 | 3.00 | 1.18 | .03 |
| COVID: May 2021 | 0.5 | −0.63 | 0.27 | .04 | 0.1 | −2.53 | 0.40 | <.001 | 3.5 | 1.27 | 0.67 | .09 | 2.8 | 1.04 | 1.13 | .38 | - | 15.63 | 0.71 | <.001 | 18.8 | 2.93 | 1.27 | .04 |

Reports six logistic regression models, one for each dependent variable. Coefficients and standard errors are in the log-odds metric. Age at observation was centered at 12.5 years old and scaled in years. The value of 12.5 years was chosen to reflect the average 12-year-old, given that 12-year-olds range in age from 12.0 to 12 .$\overline{9}$ years. Fixed effects for parent education and marital status are omitted. Each model included 22,287 observations of 9,270 youth. Data were weighted to be sociodemographically representative of children in the United States Census (see Methods).
Coef. = coefficient; OR = odds ratio (exponentiated coefficient); SE = standard error; $p$ = $p$-value.

[a] Odds ratios are omitted for the dependent variable of prescription drugs. The model-estimated prevalence of prescription drug misuse pre-COVID was nearly zero (see Figure 2), leading to the very large odds ratios implied by the reported coefficients. As a sensitivity analysis, we re-fit the model for prescription drugs using a linear (vs. logistic) link function and obtained a similar pattern of findings as reported in the table. The coefficient on all timepoint terms was positive; $p$-values for the coefficients ranged from .007 to .08 at the timepoints from May 2020 to March 2021, and the $p$-value for the coefficient on the May 2021 timepoint equaled .22.

[b] As for the dependent variable of prescription drugs, the model-estimated prevalence of inhalant use pre-COVID was nearly zero (see Figure 2), leading to the very large odds ratios listed. As a sensitivity analysis, we refit the model for prescription drugs using a linear (vs. logistic) link function. Using the linear link function, the difference from prepandemic was only statistically significant in May 2020 ($p$ = .04); $p$ values ranged from .18−.61 at the remaining timepoints.

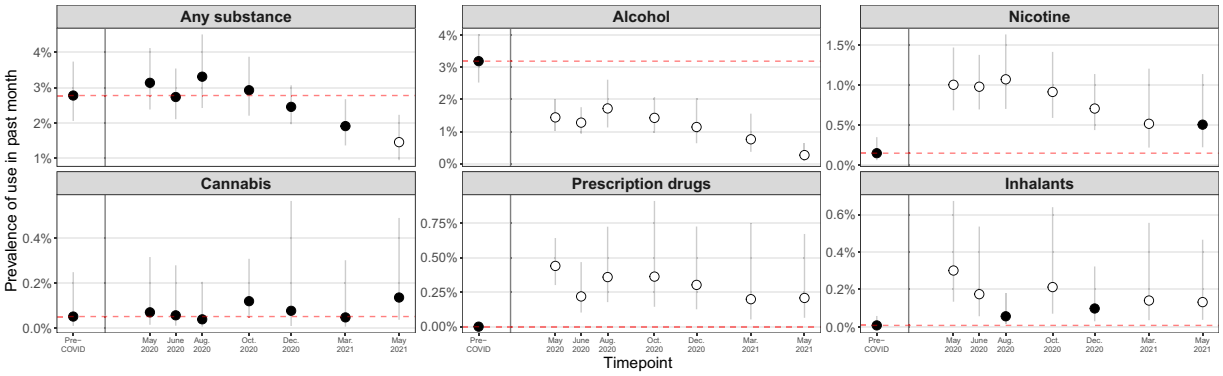


**Figure 2.** Model-estimated past-month prevalence of use of alcohol and drugs by timepoint. *Note.* Table 2 reports the corresponding regression models. Prevalences of use were estimated for participants aged 12.5 years old (i.e., the average age of 12-year-olds) at each timepoint. Timepoint was modeled as an eight-level categorical variable. White dots indicate timepoints that are significantly different from pre-COVID levels ($p < .05$); black dots indicate that timepoints are not. Horizontal, dashed red lines indicate the pre-COVID prevalence, for comparison. Vertical bars indicate asymptotic 95% confidence intervals about the mean. Data were weighted with the product weight (see Analytic plan).

those from lower-income families to report past-month use of any substance. This pattern reversed from June 2020 to December 2020, with youth from lower-income families reporting greater rates of any substance use. While rates of use among higher-income families had fallen or were stable compared to prepandemic, rates among lower-income families had risen.

## Discussion

We examined pandemic-related changes in the past-month prevalence of alcohol and drug use using data collected from 9,270 youth ages 11.5–13.0 years old at 21 sites across the United States. Between May 2020 and May 2021, adolescents experienced a partial return to life prepandemic: fewer families were engaging in social distancing, more youth were completing schooling in-person, and more parents were working exclusively outside the home (Table 1). Nonetheless, three of the four differences in substance use compared to prepandemic that were detectable in May 2020—fewer youth using alcohol, more youth misusing prescription drugs, and more youth using inhalants—persisted at follow-up in May 2021.

In a nationwide sample of United States eighth graders [4], past-month rates of alcohol, cannabis, and cigarette use were lower in spring 2021 than in 2020, prepandemic. Our findings in slightly younger youth are consistent in that we also found that changes persisted into spring 2021 and that the rate of alcohol use decreased. However, we found increased (vs. decreased) prevalence of nicotine product use and we found unchanged (vs. decreased) prevalence of cannabis use. Neither the sample of eighth graders [4] nor any previously published analysis has investigated the evolution of pandemic-related changes across multiple timepoints, so comparison to previous findings along that dimension is not possible.

The increase in nicotine use, prescription drug misuse, and inhalant use shrank as the pandemic continued beyond the acute phase in May 2020, with the increase in nicotine use no longer being statistically significant in May 2021. This pattern is consistent with the hypothesis that the remaining pandemic-related increases will continue to shrink as adolescents return closer to the structure of their daily lives before the pandemic (e.g., returning from 44% completing schooling in-person in May 2021 to 100% doing so [Table 1]). In contrast, the magnitude of the decrease in the rate of alcohol use grew steadily larger as the

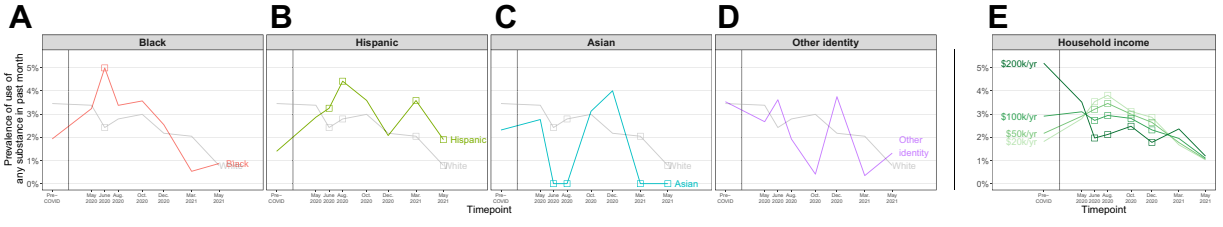


**Figure 3.** Model-estimated past-month prevalence of substance use by timepoint, by youth racial/ethnic identification, or prepandemic household income. *Note.* Table A3 reports the corresponding regression models. Prevalences of use were estimated for participants aged 12.5 years old (i.e., the average age of 12-year-olds) at each timepoint. Data were weighted with the nonresponse weight (see Analytic plan). Panels A–D graph estimates for a minority racial/ethnic group (colored lines unique to each panel) against estimates for the reference group of White youth (gray line reproduced across panels). Points with a box around them indicate timepoints at which those identified as the minority racial/ethnic group (Black, Hispanic, Asian, or other racial/ethnic identity) had changed from Pre-COVID to a degree significantly different from the change by those identified as White ($p < .05$ after adjustment for multiple testing [38]). Among participants identified as Asian, statistically significant contrasts are likely due to near-zero predicted prevalences and the implied near-infinite odds ratio: these contrasts were not statistically significant when tested in linear (vs. logistic) models. Thus, we do not interpret these contrasts in the text of manuscript. Panel E graphs estimates for youth at different levels of household income. Household income was modeled as a continuous variable; graphed are the estimated prevalences at four levels of income ($20,000, $50,000, $100,000, and $200,000). Points with boxes around them indicate timepoints at which household income significantly moderated the change in prevalence of any substance use relative to pre-COVID ($p < .05$ after adjustment for multiple testing [38]).

pandemic continued beyond the acute phase in May 2020, reaching a minimum rate in May 2021. In May 2021, 12-year-olds were less than one-tenth as likely to report past-month alcohol use as in May 2020. Our analyses do not explain why reductions in alcohol use occurred, but it seems plausible that entering early adolescence before versus during the pandemic could yield different socialization toward alcohol use [39]. For example, many United States youth in the fifth grade in the 2019-2020 school year spent none of the sixth grade and much of the seventh grade not attending any schooling in person [25], likely reducing the capacity of the middle school peer environment to socialize their thoughts, feelings, and behaviors around alcohol use. Likewise, they likely experienced fewer opportunities to drink in social contexts, such as spending time with friends after school or attending social gatherings [40].

We did not find evidence that the pandemic-related change in substance use varied by sex [2,3] or by sexual orientation minority status. We did find evidence of larger adverse impacts of the pandemic (i.e., increases in substance use) at some timepoints among youth who identified as Black or Hispanic and whose families had lower income, which consistent with a conceptualization of the COVID-19 pandemic as a syndemic [14,41], interacting with and exacerbating pre-existing inequities in the health risks and resources. For example, Black, Hispanic, and low-income parents were more likely to be front-line workers working outside the home [11], which may have reduced capacity to monitor youth who were completing their schooling online at home. Likewise, the greater disease burden experienced by Black, Hispanic, and low-income families may have placed these youth at greater risk for maladaptive coping through substance use in response to the hospitalization or death of a family member. Furthermore, national data indicates that Black and Hispanic adults in the United States were more likely to increase drinking during the pandemic [42], so parental drinking may have increased for adolescents in these groups. Future studies should investigate such mechanisms. Black, Hispanic, and low-income adolescents may especially benefit from supports around substance use as they emerge from the pandemic context [43]. However, findings should be viewed with caution-this was a single study, and findings have not yet been replicated. Our pre-COVID finding of a positive association between household income and substance use is not typical of the broader literature [44–46], and multiple moderators were examined.

This study had limitations. First, we examined the prevalence of primarily isolated use occasions (1–2 times per month) among youth in early adolescence (aged 11.5–13.0 years): the effect of the pandemic may differ in older youth who drink or use drugs regularly [2,3,47]. Second, the effect of the pandemic cannot be separated from the effects of concurrent events or unrelated secular trends, which must be considered when interpreting our findings. For example, the increases in substance use among Black youth in summer 2020 could be driven in part by the high-profile killings of Black individuals and associated civic activities [48]. Likewise, adolescents' perceptions of the harms of cannabis use had been decreasing in the years leading up to the pandemic [4], so continued decreases in perceived harm from 2020–2021 could confound any effect of the pandemic on cannabis use. Third, youth completed the prepandemic survey via phone interview and the during-pandemic surveys via the web, potentially introducing differences. However, we found both increase and decrease across substance categories, arguing against mode-of-assessment effects as a sole explanation of the pandemic-related changes. Fourth, alcohol and drug use was self-reported and not validated against toxicology—under-reporting may have occurred [49]. Fifth, past-month rates of cannabis, prescription drug, and inhalant use were very low, so the estimates for these drug classes should be viewed with caution. Finally, we identified the sexual orientation minority group via youth endorsement of being gay or bisexual, a procedure that may not have included all youth who identify as a sexual orientation minority [32] and that did not allow for evaluating potential differences among specific sexual orientations. Thus, the associated findings should be regarded with caution pending replication with more detailed measurements of sexual orientation that are planned for future ABCD assessments [32].

The current study comprises the longest follow-up of adolescent substance use during the COVID-19 pandemic published to date. We leveraged a mixed-age, prospective cohort to rigorously distinguish pandemic-related changes from the expected developmental increases in drinking and drug use. We characterized variability in pandemic-related changes across the population and evaluated changes in multiple drug classes. The large sample size, multisite recruitment, and racial/ethnic diversity all enhance the generalizability of findings. Continued follow-up will be necessary to anticipate the long-term impact of the COVID-19 pandemic on adolescents' alcohol and drug use.

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The code for the analysis is available from the first author upon request. Dr. Gayathri Dowling was substantially involved in all of the cited grants.

## Supplementary Data

Supplementary data related to this article can be found at 10.1016/j.jadohealth.2023.02.040.

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