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## Association of Cyberbullying Victimization and Substance Initiation: The Adolescent Brain Cognitive Development (ABCD) Study

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### Abstract

**Background:** Evidence shows that cyberbullying is an important risk factor for various adverse mental health outcomes, such as substance use. However, there is limited evidence from longitudinal studies that assessed whether cyberbullying victimization is associated with substance use initiation, especially among adolescent population.

**Methods:** Using data from the Adolescent Brain Cognitive Development Study, we assessed the association between cyberbullying victimization and substance use initiation among adolescents. In the cross-sectional analysis at year 2, multivariable logistic regressions were used to assess the association between cyberbullying victimization history and substance use initiation. Additionally, the association between year 2 cyberbullying victimization in the past 12 months/lifetime and year 3 substance use initiation was assessed using multivariable logistic regression.

**Results:** Adjusting for sociodemographic characteristics and the presence of depression/anxiety symptoms, lifetime history of cyberbullying victimization was significantly associated with substance use initiation (OR= 2.17, 95% CI: 1.68, 2.81). Recent cyberbullying victimization in the past 12 months was associated with two-times higher odds of initiating substances (OR= 2.31, 95% CI: 1.71, 3.12). In addition, both lifetime history of cyberbullying victimization and recent

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#### Author contributions

Dr. Shao carried out the data analyses, drafted the initial manuscript, and critically reviewed and revised the manuscript. Dr. Shao and Dr. Nagata conceptualized and designed the study. Dr. Shao and Dr. Al-shoaibi managed the study data. Dr. Nagata, Dr. Trompeter, Dr. Testa, Dr. Ganson and Dr. Baker critically reviewed and revised the manuscript. All authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

#### Declaration of Competing Interest

No conflict declared.

cyberbullying victimization at year 2 were associated with two times increased risk in substance use initiation at year 3 (OR = 2.22, 95% CI: 1.68, 2.93; OR = 2.34, 95% CI: 1.68, 3.26).

**Conclusion:** There is a significant relationship between cyberbullying victimization and substance use initiation among adolescents. Cyberbullying victims are at an increased risk of initiating substance use later in life.

### Keywords

Adolescent substance use; Alcohol initiation; Cyberbullying victimization; Substance use; Tobacco initiation

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## 1. Introduction

Cyberbullying (e.g. cyberstalking, often referred to a form of bullying occurring via the use of digital devices (University of Alabama at Birmingham, U.S.A. et al., 2021), is becoming increasingly prevalent among children and adolescents (Selkie et al., 2016, Zhu et al., 2021). The latest statistics from 2022 showed that about half of the adolescents aged between 13 and 17 reported having experienced at least one type of cyberbullying victimization such as cyberstalking, dissing and outing. Among those, about 28% experienced various types of cyberbullying simultaneously (Selkie et al., 2016). A growing body of research shows that cyberbullying is an important risk factor for various adverse health outcomes, particularly mental health conditions such as substance use disorder (Nixon, 2014, Pichel et al., 2022, Nagata et al., 2022). However, findings regarding the direct association between cyberbullying and substance use initiation remain mixed. Several recent studies found that cyberbullying victims were more likely to report use of substances such as alcohol and cannabis (Cénat et al., 2018, Boccio et al., 2022). In contrast, another cross-sectional study found a significant association between cyberbullying victimization and current cigarette smoking, but not between cyberbullying victimization and current alcohol use (Kritsotakis et al., 2017). More importantly, there is limited evidence from longitudinal studies that assessed whether cyberbullying victimization is associated with substance initiation, especially among adolescent population.

Using a diverse national longitudinal cohort sample of adolescents in the US, this study aimed to investigate both cross-sectional and longitudinal associations between cyberbullying victimization and substance initiation among early adolescents. We hypothesized that cyberbullying victimization would be significantly associated with substance initiation. Individuals with a recent history of cyberbullying victimization are more likely to initiate substance within the next year.

## 2. Methods

### 2.1. Study population

The Adolescent Brain Cognitive Development (ABCD) study is a multi-center prospective cohort study that enrolled 11,875 children aged 9–10 from 21 recruitment sites across the U.S. (Garavan et al., 2018). Participants were initially recruited between 2016 and 2018 at baseline, and then followed up annually. In addition, participants were invited

to mid-year phone interviews as part of the study protocol (Garavan et al., 2018). At year two of the study follow-up (2018–2020), participants aged between 10 and 14 years old were invited to complete survey questionnaires regarding their experience or perpetration of cyberbullying. Additionally, participants were invited to complete the Substance Use Introduction and Patterns survey. To assess the cross-sectional association between cyberbullying victimization and substance initiation at year 2, we included all participants (N = 10,335) at year 2 that completed both the cyberbullying and substance use patterns survey as the study population. To further assess the risk of substance initiation among those with a history of cyberbullying victimization using a prospective cohort study design, we included all those that had completed records of cyberbullying victimization at year 2 and substance use patterns at year 3. Currently, only half of the data from year 3 of the ABCD study were released due to the ABCD study data release schedule. Therefore, we included all individuals with a non-missing response for year 2 cyberbullying questionnaire and year 3 substance use pattern question for the analysis. The ABCD study obtained institutional review board (IRB) approval from the University of California, San Diego (UCSD) and the respective IRBs of each study site. Written assent was obtained from participants and written informed consent was obtained from their caregivers.

## 2.2. Cyberbullying victimization

At year 2, all participants completed a self-reported questionnaire on the experience of cyberbullying victimization. The questionnaire was designed based on the previously validated Cyberbully Scale (Stewart et al., 2014). A dichotomous variable indicating the lifetime history of cyberbullying victimization was defined based on the following question: “Have you ever been cyberbullied, where someone was trying on purpose to harm you or be mean to you online, in texts, or group texts, or on social media (like Instagram or Snapchat)?”. In addition, a dichotomous variable indicating recent cyberbullying victimization in the immediate past 12 months was captured by the question: “Has this happened in the past 12 months?”.

## 2.3. Substance initiation

At both year 2 and year 3, participants completed the ABCD Youth Substance Use Introduction and Patterns survey (Lisdahl et al., 2018). Information regarding the patterns of use for alcohol, tobacco products, and marijuana were collected. Participants were asked if they had a sip of alcohol such as beer, wine or liquor (rum, vodka, gin, whiskey); a puff from a tobacco or electronic cigarette, Juul, vape pens, e-hookah, cigar or pipe; a puff or eaten any marijuana, also called pot, grass, weed or ganja. Initiation of any type of substance use at either year 2 or year 3 was defined as participants having tried a sip of alcohol product, or a puff of tobacco product or a puff of marijuana and had not reported any substance use in previous years of study follow-up (Dai et al., 2022). New initiators of substance at year 3 were defined as those who did not report any substance use at year 2 and reported having initiated the substance listed above at year 3.

## 2.4. Covariates of interest

Demographic information including sex, age, and race/ethnicity was collected at year 2. Household income was defined as greater or less than 75,000 U.S. dollars based on the

approximate median U.S. household income. Parental education was defined as high school or less versus college or higher-level education. Presence of symptoms of depression or anxiety was captured based on the Child Behavior Checklist score reported at year 2. All covariates of interest were included in the models as potential confounders for the association between cyberbullying victimization and substance initiation.

## 2.5. Statistical analysis

In the cross-sectional analysis at year 2, multivariable logistic regressions were used to assess the association between year 2 lifetime cyberbullying history and year 2 substance initiation, as well as the association between year 2 cyberbullying victimization in the past twelve months and year 2 substance initiation.

To investigate whether history of cyberbullying victimization is a risk factor for substance initiation within the next year in the prospective cohort study from year 2 to year 3 of the ABCD study, the association between year 2 cyberbullying victimization in the past 12 months/lifetime and year 3 substance initiation were assessed using multivariable logistic regression. All models were adjusted for covariates of interest, ABCD study sampling weights (Heeringa and Berglund, 2020), and study site ID. All analyses were performed in RStudio (4.1.2).

## 3. Results

### 3.1. Characteristics of the study population

Among 10,335 eligible study participants that had completed records of both cyberbullying victimization and substance initiation at year 2 (mean age = 12), approximately 50% of individuals were female (49%), white (54%) and came from households with median incomes less than 75,000 U.S. dollars (45%). At year 2, the highest proportion of individuals reported having sipped an alcohol product (10%) whereas the lowest proportion of individuals reported having had a puff or eaten marijuana (0.2%). About 10% of the respondents reported having been cyberbullied in the past and of those, 6% reported having been cyberbullied in the past 12 months. Eligible study population at year 3 (mean age = 13) had a similar population demographic make-up as compared to those at year 2. Similarly, the highest proportion of respondents reported initiation of alcohol (13%) and lowest proportion of individuals reported initiation of marijuana (1%) (Table 1, Supplemental Table 1).

### 3.2. Association between cyberbullying victimization and substance initiation

Table 2 shows the cross-sectional association between cyberbullying victimization and substance initiation. Adjusting for sociodemographic characteristics and the presence of depression/anxiety symptoms, lifetime history of cyberbullying victimization was significantly associated with substance initiation (OR= 2.17, 95% CI: 1.68, 2.81). Recent cyberbullying victimization in the past 12 months was associated with two-times higher odds of initiating substances (OR= 2.31, 95% CI: 1.71, 3.12).

Table 2 shows the risk of substance initiation associated with cyberbullying victimization using a longitudinal study design. Adjusting for sociodemographic characteristics, the

presence of depression/anxiety at year 2, both lifetime history of cyberbullying victimization at year 2 and recent cyberbullying victimization were associated with two times increased risk in substance initiation at year 3 (OR = 2.22, 95% CI: 1.68, 2.93; OR = 2.34, 95% CI: 1.68, 3.26). Additional analyses were performed assessing the association between cyberbullying victimization and new initiation of substances within the next year. Results showed that a lifetime history of cyberbullying victimization was associated with a statistically significant higher risk of new initiation of substance (OR = 1.50, 95% CI: 1.03, 2.18) as compared to a recent 12-month history of cyberbullying victimization (OR = 1.51, 95% CI: 0.96, 2.39).

#### 4. Discussion

In this diverse national sample of adolescents aged between 9 and 13 years old, we found that both lifetime history of cyberbullying victimization and past 12-month experience of cyberbullying victimization were significantly associated with substance initiation among early adolescents. Additionally, individuals with a history of cyberbullying, in particular those with a recent history of cyberbullying victimization, were more likely to initiate substances at a later age.

Findings from our study confirmed evidence from previous studies that reported an association between cyberbullying victimization and various types of substance use (Pichel et al., 2022, Bottino et al., 2015, Yoon et al., 2019). More importantly, the findings build upon existing research reporting that adolescents with a history of cyberbullying victimization are more likely to initiate substance use compared to their peers.

One prevalent explanation for the association between cyberbullying victimization and substance use initiation is that cyberbullying victims might experience various mental health conditions (e.g., depression or anxiety), which might also lead to substance use initiation (Bottino et al., 2015). However, when adjusting for presence of symptoms of depression, we found that a significant association remained. Another possible theory linking cyberbullying victimization to substance initiation is normative social influence. Adolescents' behavior choices are often heavily moderated by social interactions and perceived social norms. Online social media and social network provides a platform for adolescents to gain acceptance from others, especially if such acceptance is not available in real-life settings. Adolescents that are more likely to engage in online activities to gain acceptance based on normative pressure are also more susceptible to cyberbullying victimization (Bastiaensens et al., 2016, Piccoli et al., 2020). Similarly, they are also more likely to engage in early substance initiation if they perceive it as a way to gain social approval or popularity (Fujimoto and Valente, 2012, Whitesell et al., 2013).

Our study has several important strengths. It is one of the first studies to explore both cross-sectional and longitudinal associations between cyberbullying victimization and substance initiation using a large national sample in the United States. Moreover, the ABCD study allows for high quality and comprehensive information on both cyberbullying history and substance use among adolescents across all waves of study follow-up. However, several limitations need to be acknowledged. First, because of the self-reporting nature of the

ABCD study questionnaires, there may be adolescents who have used substances but reported themselves as never users, which can lead to outcome misclassification. Second, due to the design of the questionnaire, the definition of cyberbullying can be relatively vague and broad, which might lead to exposure misclassification. Lastly, in the longitudinal cohort only half of the study population at year 3 was included due to unreleased data on the other half of the study participants at year 3. Given the age of study participants and low prevalence of substance initiation in our study population, future analyses using new waves of data from the ABCD study may be needed to confirm the study findings.

## 5. Conclusion

Our study showed that there is a significant relationship between cyberbullying victimization and substance initiation among adolescents. Cyberbullying victims are at an increased risk of initiating substance use within the next year. Pediatricians should consider educational and preventive measures for substance use initiation among those that reported experiences of cyberbullying victimization.

## Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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## Additional information

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## Role of funding source

The funders had no role in the design and conduct of the study; collection, management, analysis, and interpretation of the data; preparation, review, or approval of the manuscript; and decision to submit the manuscript for publication.

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**Table 1.**

Characteristics of the eligible study population at year 2 and year 3 of the Adolescent Brain Cognitive Development study.

	<b>Year 2 (N = 10335)</b>	<b>Year 3 (N = 6095)</b>
<b>Age (mean, sd)</b>	12 (0.7)	13 (0.6)
<b>N (%)</b>		
<b>Female</b>	4931 (48)	2888 (47)
<b>Race</b>		
<i>White</i>	5553 (54)	3553 (58)
<i>Latino</i>	1741 (17)	997 (16)
<i>Black</i>	1936 (19)	894 (15)
<i>Asian</i>	611 (6)	368 (7)
<i>Native American</i>	361 (4)	216 (4)
<i>Other</i>	129 (1)	66 (1)
<b>Parental education high school or less</b>	1613 (16)	807 (13)
<b>Household income less than \$75,000</b>	3986 (42)	2228 (39)
<b>Have tried a sip of a sip of alcohol such as beer, wine or liquor (rum, vodka, gin, whiskey)</b>	1030 (10)	680 (11)
<b>Have tried a puff from a tobacco or electronic cigarette, Juul, vape pens, e-hookah, cigar or pipe</b>	82 (0.8)	49 (1)
<b>Have tried a puff or eaten any marijuana, also called pot, grass, weed or ganja</b>	30 (0.3)	16 (0.3)
<b>Have ever been cyberbullied</b>	926 (9)	489 (8)
<b>Have been cyberbullied in the past 12 months</b>	611 (6)	324 (5)

**Table 2.**

Association between cyberbullying victimization and substance initiation at year 2 and Year 3 of the Adolescent Brain Cognitive Development study.

	<b>Lifetime History of Cyberbullying Victimization at Year 2 (OR, 95% Confidence Interval)</b>	<b>Past 12-month History of Cyberbullying Victimization at Year 2 (OR, 95% Confidence Interval)</b>
<b>Have tried a sip of alcohol, a puff of tobacco product or a puff of marijuana at Year 2<sup>*</sup></b>	2.17 (1.68, 2.81)	2.31 (1.71, 3.12)
<b>Have tried a sip of alcohol, a puff of tobacco product or a puff of marijuana at Year 3<sup>**</sup></b>	2.22 (1.68, 2.93)	2.34 (1.68, 3.26)
<b>Have tried a sip of alcohol, a puff of tobacco product or a puff of marijuana at Year 3<sup>***</sup></b>	1.86 (1.37, 2.51)	1.89 (1.31, 2.73)
<b>Only reported having tried a sip of alcohol, a puff of tobacco product or a puff of marijuana at Year 3<sup>****</sup></b>	1.50 (1.03, 2.18)	1.51 (0.96, 2.39)

<sup>\*</sup>Model adjusted for ABCD study sampling weights, age at year 2, sex, race/ethnicity, parental education level, household income, presence of symptoms of depression at year 2, and presence of symptoms of anxiety at year 2

<sup>\*\*</sup>Model adjusted for ABCD study sampling weights, age at year 2, sex, race/ethnicity, parental education level, household income, presence of symptoms of depression at year 2, and presence of symptoms of anxiety at year 2

<sup>\*\*\*</sup>Model adjusted for ABCD study sampling weights, age at year 2, sex, race/ethnicity, parental education level, household income, presence of symptoms of depression at year 2, presence of symptoms of anxiety at year 2, and substance initiation at year 2

<sup>\*\*\*\*</sup>Model adjusted for ABCD study sampling weights, age at year 2, sex, race/ethnicity, parental education level, household income, presence of symptoms of depression at year 2, and presence of symptoms of anxiety at year 2