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Association of Cyberbullying Involvement with Subsequent Substance Use among Adolescents

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Abstract

Purpose: Adolescent involvement in cyberbullying is common and involves several roles (witness, perpetrator, or victim). Whether different cyberbullying roles are differentially associated with substance use is unknown. The current study examined the associations of adolescent cyberbullying involvement with use and polyuse of various substances.

Methods: A longitudinal cohort of students in Los Angeles, California ($N = 2,768$) completed surveys at baseline (10th grade, 2014, M age = 15.5) and 12-month follow-up (11th grade, 2015). Five mutually exclusive cyberbullying roles were identified at baseline—no involvement; witness only; witness and victim; witness and perpetrator; and witness, victim, and perpetrator. Past-6-month use of nine substances was assessed at baseline and follow-up. Responses were categorized into a trichotomous past-6-month polysubstance use index (1, 2, 3 substances).

Results: Most students (52.2%) experienced one or zero cyberbullying roles. Relative to no involvement, all cyberbullying roles, including witnessing only, were associated with increased odds of using most substances and polysubstance use at follow-up, after adjusting for

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Authors' Contributions
Y.Y. conceptualized and designed the study, guided data analyses, interpreted the results, drafted and wrote the manuscript, and revised the manuscript. **J.O.L.** participated in the design and the data analysis of the study, contributed to interpretation and revision of the manuscript. **J.C., M.S.L., R.K. and N.R.R.** assisted in conceptualization of the study design and revised the manuscript. **A.M.L.** supervised the design and the data analysis of the study, contributed to the interpretation of findings, and revised the manuscript. In addition, all authors have been involved in drafting the manuscript and providing critical feedback and helped shape the research. All authors read and approved the final manuscript.

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Conflict of Interest

The authors declare that they have no competing interest.

sociodemographics and baseline substance use (*ORs*: 1.44 [95% CI: 1.18, 1.76] to 5.24 [2.73, 10.05]). Relative to the witness-only role, students involved in all three roles were at greater odds of using several substances at follow-up (*ORs*: 1.47 [1.05, 2.05] to 2.96 [1.60, 5.50]).

Conclusions: Cyberbullying involvement, even witnessing, may be associated with future substance use in adolescence. All cyberbullying roles warrant consideration in understanding and preventing youth substance use.

Keywords

Cyberbullying; Cyberbullying roles; Substance use; Polysubstance use

Introduction

Substance use during midadolescence (ages 15–17) is associated with numerous adverse social and health outcomes later in life [1]. Understanding risk factors for substance use during this developmental period could inform targets for substance use prevention, with life-long health benefits.

Involvement in traditional bullying—intentional and repeated aggressive or negative behavior intended to harm another verbally, emotionally, or physically—as a victim or perpetrator is a well-studied risk factor for substance use among youth [2]. Substance use may reflect a maladaptive coping mechanism in response to the psychological distress caused by bullying [3].

Cyberbullying is a recent form of bullying involving use of digital media platforms, such as group text messages and social network websites, to intentionally harass, humiliate, or threaten others in a repetitive and hostile manner [4]. From 2005 to 2016, significant increases in cyberbullying perpetration (from 3.8% to 13.3%) and victimization (from 5.3% to 15.0%) occurred among U.S. youth [5,6]. Because cyberbullying can reach wide audiences and takes place in a virtual space where interactions are not bounded by time (e.g., some social media posts may never be deleted), adverse psychosocial consequences of cyberbullying may be even more heightened compared to those stemming from traditional bullying [7]. Further adverse consequences may take different forms, depending on cyberbullying roles played by adolescents [8,9]. For example, cyberbullying perpetrators had increased rates of substance use [9,10] compared with uninvolved peers, whereas cyberbullying victims were associated with somatic symptoms [8] and emotional and peer problems [11]. Importantly, youth who experience multiple bullying roles are an especially concerning group compared to those who have only experienced a single type of bullying; the former is characterized by depression [10], restlessness, and impulsiveness [12]. This can be further explained with the cumulative risk model, in that an accumulation of multiple risk factors can affect adolescents' developmental outcomes, including substance use problems [12]. Based on the cumulative risk model, simultaneous exposure to different cyberbullying roles (e.g., victimization, perpetration, and witness) may be particularly harmful to youths' problematic behavior [13].

Although studies have assessed relationships between cyberbullying and substance use, to our knowledge, there are some limitations. First, existing studies have mostly examined the link between traditional bullying and substance use [16], with a few minor exceptions [17,18]. Second, few studies have examined the associations between cyberbullying and substance use, predominately with cross-sectional samples [17,18]; longitudinal evidence of this association is scant [19] and incomplete. Third, previous cross-sectional studies of cyberbullying [3,18] have not comprehensively evaluated its potential damaging impacts on use of substances that have recently gained popularity and public health significance, such as e-cigarettes, alternative cannabis products (e.g., edibles), and prescription opioids [20,29]. Fourth, no identified studies have examined the impact of cyberbullying on problematic substance use patterns such as use of multiple substances (i.e., polyuse). Fifth, previous research has not investigated whether witnessing cyberbullying (e.g., observing social media posts between two youths without being a target or perpetrator) is associated with later substance use. Merely witnessing cyberbullying, the most common form of cyberbullying exposure [17], may increase distress—for example, by not being able to stand up for victims—which could in turn increase substance use risk [21]. By intervening in the situation directly or indirectly [19], witnesses might model dissenting behaviors [14] or encourage the perpetrator and join in with the victimization, which can make perpetrators more aggressive and exacerbate the consequences [15]. Sixth, although various cyberbullying experiences—being a victim, perpetrator, or witness—tend to co-occur among youth [22], whether certain configurations of cyberbullying roles are differentially associated with substance use is unknown. Involvement in cyberbullying in multiple roles (e.g., being a victim, perpetrator, and witness) might generate even more damaging impacts on substance use relative to experiencing one role in isolation [23].

Given that research in this area is scarce and results have been mixed, this longitudinal cohort study of Los Angeles high school students estimated associations between different cyberbullying roles and subsequent use and polyuse of various substances, including those that have recently gained popularity among youth. Specifically, supplementing the limitations of previous work on the impact of cyberbullying on substance use behavior, the current study investigated whether: (a) witnessing cyberbullying only, without being a victim or perpetrator, is associated with risk of substance use and polyuse; (b) involvement in three cyberbullying roles (i.e., being a witness, victim, and perpetrator) is associated with incrementally higher risk of substance use and polyuse than one or two roles; and (c) cyberbullying is associated with increased use of substances, including those that have recently gained popularity.

To answer these questions, we first identified five cyberbullying experiences—(a) witness only, (b) witness and victim, (c) witness and perpetrator, (d) witness, victim, and perpetrator, and (e) no involvement—and then investigated the association of these cyberbullying roles with use of nine substances and polysubstance use a year later among youth.

Method

Participants and procedures

Data were from the Happiness & Health Study—a longitudinal cohort survey of substance use and mental health among high school students in the Los Angeles, California, metropolitan area [35]. Ten public high schools were selected based on their adequate representation of diverse demographic characteristics. The average percentage of students eligible for free lunch in each school (i.e., student's parental income < 185% of the national poverty level) across the 10 schools was 31.1% ($SD = 19.7$, range: 8.0%–68.2%). Of the 4,100 eligible students, 3,396 students (82.8%) and their parents provided active written or verbal assent and consent, respectively, and agreed to participate in the study during 9th grade. Data collection consisted of paper-and-pencil surveys distributed once every 6 months on-site at schools; students not available during data collection completed abbreviated phone or web surveys.

This study used fall 10th-grade (baseline, 2014) and fall 11th-grade (12-month follow-up, 2015) survey data. Of the 3,396 cohort enrollees, 3,277 (96.5%) completed the fall 10th-grade survey. Of those participants, 2,918 (89.0%) completed the cyberbullying assessment module administered only to youth in class for the full-length survey. Participants with a rare configuration of cyberbullying involvement were excluded (victim only: $n = 38$; perpetrator only: $n = 10$). Among the remaining 2,871 participants, 2,768 (96.4%) provided substance use data at 12-month follow-up, constituting the analytic sample. Figure 1 depicts study accrual. The number of observations for each study variable is provided in Supplementary Table 1. Students were informed that their responses would be confidential. Each participating school received \$2,500 for its general activity fund; students were not individually compensated but received small incentives, such as key chains. The study was approved by the University of Southern California Institutional Review Board.

Measures

Cyberbullying.—The Cyberbullying and Online Aggression Survey Instrument, which has shown adequate psychometric properties in prior work [25], includes a definition of cyberbullying (i.e., when someone repeatedly harasses, mistreats, or makes fun of another person online or while using cell phones or other electronic devices), followed by three items assessing lifetime frequency of being a victim, witness, or perpetrator of cyberbullying based on a forced choice (“never,” “once,” “a few times,” “several times,” and “many times”). As recommended [25], we dichotomized each item (never or once vs. a few times, several times, or many times). Using these three dichotomized indicators, we classified cyberbullying involvement into five mutually exclusive roles—no involvement; witness only; witness and victim only; witness and perpetrator only; and witness, victim, and perpetrator. We excluded participants with rare configurations (e.g., victim or perpetrator only: $n = 47$) from analyses due to small sample size. For descriptive purposes, we also report lifetime frequency of involvement in each cyberbullying role operationalized as a five-level continuous variable based on each item's rating (0 = *never*, 1 = *once*, 2 = *a few times*, 3 = *several times*, 4 = *many times*).

Past-6-month substance use.—At baseline and follow-up, past-6-month use of nine substances was measured, using items based on the Youth Behavior Risk Surveillance Survey and the Monitoring the Future Questionnaire [23]. Respondents were asked whether they had used each substance without a doctor’s advice or to get “high”: alcohol (one full drink of alcohol), combustible cigarettes (even a few puffs), combustible marijuana (smoking marijuana), edible marijuana (food or drinks containing THC), cigar (including big and little cigars or cigarillos), e-cigarettes (electronic device to vape nicotine or flavorings without cannabis), prescription stimulants (e.g., methylphenidate), and prescription opioids (e.g., hydrocodone). In addition, a trichotomous polysubstance use measure was created for users based on the total number of substances used during the previous 6 months (1, 2, 3).

Covariates.—To account for the influence of sociodemographic differences in cyberbullying or the carryover of precyberbullying substance use from baseline to follow-up, covariates included substance use at baseline, age, sex (male vs. female); race and ethnicity (nominal variable; see Table 1 for categories), and parental education (high school graduate or higher degree vs. lower than high school graduate) [24].

Analytic approach

Logistic regression models were used to estimate the association between baseline cyberbullying role classification and respective substance use outcome at 12-month follow-up. Separate models were tested for each substance and adjusted for sociodemographic covariates and baseline use of the respective substance. For the polysubstance use outcomes, multinomial logistic regression was used to estimate the association between cyberbullying roles and use of two substances (vs. one substance as reference) and three substances (vs. one). For each outcome, we first compared each of the four cyberbullying roles (i.e., four dummy variables) to the noninvolved reference group. Next, to examine whether involvement in all three roles (i.e., witness, victim, and perpetrator) was associated with differential substance use risk compared to single or dual cyberbullying involvement, we repositioned the models using the each cyberbullying role (i.e., witness, witness and victim, witness and perpetrator) as reference categories and compared them to the witness, victim, and perpetrator group. Given potential gender differences in substance use risk and vulnerability to cyberbullying, we conducted exploratory analyses of gender and cyberbullying interaction effects, which yielded no significant interaction effects and precluded reporting of gender-stratified effects. All analyses were conducted in Mplus version 8 [27]. Because data were clustered in schools, the complex analysis option was used to adjust parameter standard errors for interdependence in the data [26]. Missingness was managed with full information likelihood estimation [28]. To maintain the study-wise false discovery rate at .05, the Benjamini-Hochberg method was used to correct p -values for multiple tests [29].

Results

Descriptive analyses

The sample was 53.5% female and racially and ethnically diverse, with a mean baseline age of 15.52 ($SD = 0.52$) years (see Table 1). In this sample, 47.8% ($n = 1,324$) of participants reported not being involved in cyberbullying in any role and 32.8% ($n = 907$) had witnessed cyberbullying but had not been a victim or perpetrator. Some participants experienced more than one cyberbullying role—10.3% ($n = 286$) were a witness and victim, 2.3% ($n = 64$) were a witness and perpetrator, and 6.7% ($n = 187$) were a witness, victim, and perpetrator.

Except for age and parental education, chi-square results indicate that all baseline sociodemographic characteristics and substance use differed by baseline cyberbullying roles (see notes in Table 1). Groups involved in more (vs. fewer) cyberbullying roles reported higher lifetime frequency of cyberbullying involvement.

Primary analyses

Prevalence of substance use at follow-up by cyberbullying witness group is reported in Table 2. Using these outcome data, we first estimated odds of substance use at follow-up for each baseline cyberbullying role relative to the noninvolved group, controlling for age, sex, race and ethnicity, parental education, and baseline use of the respective substance (Table 3). For most substance use outcomes, adolescents who experienced any baseline cyberbullying, including only witnessing, were at increased odds of past-6-month substance use at follow-up (ORs : 1.44 [95% CI: 1.18, 1.76] to 5.24 [2.73, 10.05]) compared to those with no baseline cyberbullying involvement. For example, the prevalence of follow-up past-6-month alcohol use was higher in the witness and victim group (37.2%) compared to the noninvolved group (21.0%), which corresponded to an adjusted odds ratio of 1.91 (1.37, 2.36). The various roles of cyberbullying involvement (vs. noninvolved) were associated with follow-up use of substances of emerging popularity, including e-cigarettes (ORs : 2.05 [1.49, 2.83] to 3.45 [2.24, 5.31]) and edible marijuana (ORs : 1.97 [1.35, 2.87] to 3.23 [1.79, 5.81]). Youth experiencing any cyberbullying (vs. noninvolved) were also at increased odds of using three or more (vs. one) substances (ORs : 1.39 [1.03, 1.88] to 2.74 [1.72, 4.36]). Witnessing or being a witness and victim of cyberbullying (vs. noninvolved) were significantly associated with increased odds of using two (vs. one) substances (ORs : 2.04 [1.40, 2.99] to 2.77 [1.67, 4.58]).

Next, we estimated odds of substance use at follow-up using each baseline cyberbullying role (i.e., witness and victim, witness and perpetrator) relative to the witness-only group (Table 3). Being a witness and victim were associated with increased odds of cigarette, cigar, and e-cigarette use at follow-up (ORs : 1.70 [1.08, 2.65] to 2.07 [1.14, 3.75]), and being a witness and perpetrator increased the odds of using alcohol and edible marijuana use at follow-up (ORs : 1.91 [1.14, 3.20] to 2.13 [1.16, 3.88]), compared to witness-only youth. Adolescents who experienced both witness and victim roles and witness and perpetrator roles (vs. witness only) were also at increased odds of using three or more (vs. one) substances (ORs : 1.49 [1.04, 2.14]) and (ORs : 2.24 [1.21, 4.14]).

Finally, we estimated odds of substance use at follow-up using each baseline cyberbullying role, using one or two roles as reference groups compared to adolescents involved in all three cyberbullying roles (Table 4). Compared to being a witness only, being a witness, victim, and perpetrator at baseline were associated with increased odds of using eight of the nine substances assessed (*ORs*: 1.47 [1.05, 2.05] to 2.96 [1.60, 5.50]) and using three or more (vs. one) substances (*OR* = 2.67 [1.23, 5.82]). Students who were a witness, victim, and perpetrator of cyberbullying (vs. witness and victim only) were at increased odds of nonmedical prescription opioid (*OR* = 2.39 [1.23, 4.62]) and stimulant (*OR* = 2.17 [1.05, 4.51]) use at follow-up, but not use of other substances or polysubstance use.

Discussion

This is the first study to demonstrate that merely witnessing cyberbullying, without being a perpetrator or a direct victim, may be associated with increased risk of future substance use in adolescence. Most previous studies on cyberbullying and substance use have focused on victimization and perpetration [17,18], overlooking youth who experience cyberbullying only as a witness—the most common cyberbullying role in other samples of adolescents and the current sample of 10th graders. Witnessing cyberbullying may generate psychological distress, as shown in studies regarding the psychological effects of witnessing episodes of face-to-face bullying involving others [21]. Such distress could translate into maladaptive behaviors, including substance use, in response to being exposed to expressions of hostility directed toward peers on digital media platforms [30].

This study also provides new results indicating that cyberbullying is associated with use and polyuse of substances that are increasingly popular among youth, including e-cigarettes, marijuana edibles, and prescription opioids. E-cigarette use has exponentially increased among youth this decade [20] and is linked to subsequent risk of initiating use of combustible cigarettes [24]. As more regions of the United States have legalized recreational cannabis use, the manufacture of commercially available cannabinoid-infused edibles (e.g., candies treated with cannabinoid extracts), which might appeal to youth [24,31], has increased. Misuse of prescription opioids has recently increased in the United States and is a leading cause of accidental death in adolescence [32]. Polysubstance use is of appreciable prevalence among youth and associated with more extensive health consequences relative to using one drug [33]. The current findings suggest that prevention efforts to reduce concerning recent trends of adolescent use and polyuse of emerging substances should consider the role of cyberbullying.

This study provides new evidence that mutual involvement in three cyberbullying roles (i.e., witness, victim, and perpetrator) compared to the witness-only group might be linked with compounding increases in substance use risk relative to single or dual cyberbullying roles. This finding is partially consistent with previous studies reporting that adolescents who are both a perpetrator and victim of in-person face-to-face bullying are more likely to engage in risky drinking and cannabis use [34] compared to those who are victims only [19]. If each role of cyberbullying involvement confers distinct psychosocial consequences (e.g., witnessing produces sadness, victimization produces embarrassment and fear, and

perpetration produces guilt), compounding increases in risk of substance use as an outcome of multiple cyberbullying roles is plausible.

Findings should be considered in light of study limitations. First, all measures relied on adolescent self-report, creating the possibility of reporting errors or biases. Particularly for cyberbullying perpetration, self-report may be limited due to heightened social desirability or lack of insight into their behavior [35]. Although assuring students of the anonymity of their responses, a measure adopted in our study, has been shown to improve accuracy of reports [36], youth may still underreport their perpetration behavior. Second, some configurations were rare and thus could not be investigated, leaving it unclear whether, for example, only being a victim was associated with substance use compared to other roles of cyberbullying. Of note, to address possible biases associated with this exclusion, we reran all models including the victimization or perpetration groups. All substantive findings remained the same. Third, this first prospective study of roles of cyberbullying involvement and substance use employed a parsimonious approach to operationalizing exposures and outcomes, which distinguished presence (vs. absence) of various roles of cyberbullying and substance use. Future work focusing on the frequency of cyberbullying involvement or substance use is warranted. Fourth, given the dataset, the study could not control for cyberbullying involvement between baseline and follow-up. Because substance use at follow-up could be due to cyberbullying that occurred anytime between baseline (fall 10th grade) and follow-up (fall 11th grade), cyberbullying experiences in either the elapsing assessment time or concurrent assessment period may have influenced the study results. Fifth, students who engage in cyberbullying can be also involved with traditional bullying [37] and thus, the damaging impacts of cyberbullying on substance use reported in this study may reflect the impacts of both cyberbullying and traditional bullying exposure. However, because a traditional bullying measure was not assessed in this sample, we could not control for this issue [38]. Still, given that individuals involved in traditional forms of harassment tend to become involved in cyberharassment [39] and a high correlation has also been found between traditional and cyberbullying [40], future longitudinal research incorporating both types of bullying is needed to better understand their predictive associations with youth substance use. Sixth, like all observational studies, causal inferences cannot be made and the possibility of unobserved confounding influences on the associations identified in this investigation cannot be ruled out. The aim of this study was to estimate patterns of associations across different cyberbullying roles with different forms of substance use, rather than isolating the causal mechanisms of the associations. Covariates were restricted to demographic factors and baseline substance use. Additional covariates required to distinguish between causal and noncausal confounding associations were not considered. For example, being involved in cyberbullying may be a proxy of increased connections to a network of delinquent peers involved in substance use. Having friends who use substances might have influenced study participants' substance use behaviors. Additionally, youth involved in cyberbullying may be more likely to be exposed to other digital content, including marketing from substance use retailers or other prosubstance messages, which might lead to increased risk of substance use. Future work attempting to test the causal nature of these associations should broadly consider what confounding factors might exist, which was outside of the scope of this study.

Our study has important implications. It provided empirical support that all roles of cyberbullying, including merely witnessing, were associated with substance use at 12-month follow-up. In addition, risk may be compounded with multirole involvement. Given the urgent need to address the persistently high prevalence of substance use behaviors among adolescents, this study highlights the need for effective interventions to reduce the high prevalence of cyberbullying in adolescents. Witnessing cyberbullying while being neither a victim nor perpetrator constituted approximately a third of this sociodemographically diverse sample of 10th-grade students in Los Angeles and implied risk of future substance use and polyuse. To account for the impact of substance use prior to cyberbullying, our study adjusted for substance use behaviors at baseline, with results indicating that cyberbullying at baseline can contribute to substance use at 12-month follow-up, regardless of prior substance use behaviors. This should prompt awareness of cyberbullying dynamics and the harmful consequences of unsafe online interactions, because witnessing or having multiple involvements in cyberbullying may be more difficult to capture. In addition, cyberbullying interventions should expand to detect and reduce exposure to cyberbullying as a witness (in addition to preventing perpetration and victimization), which could reduce youth substance use. Additionally, youth who are witnesses, victims, and perpetrators of cyberbullying may reflect a subgroup at particularly high risk of substance use. Future research should examine whether these associations are causal, which would inform whether targeting cyberbullying in prevention efforts would have a direct impact on youth substance use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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IMPLICATIONS AND CONTRIBUTIONS

This study involved detailed comparisons of substance use across five unique cyberbullying roles among adolescents. The evidence demonstrates that merely witnessing cyberbullying online is associated with increased risk of substance and polysubstance use. Such knowledge can inform prevention efforts targeting cyberbullying and substance use among youth.

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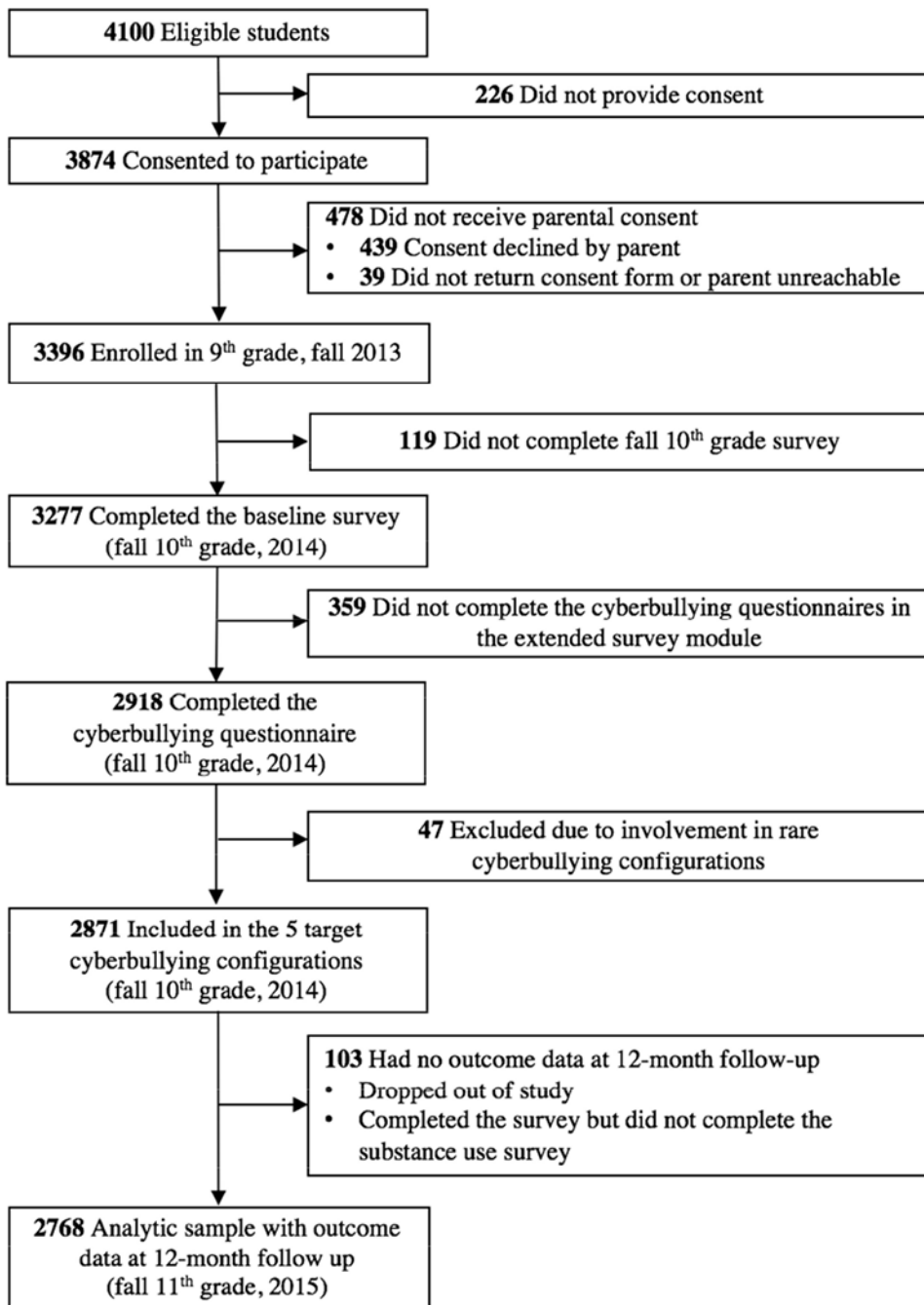


Figure 1. Flow of Adolescents in Study to Assess Cyberbullying Involvement at fall 10th-grade and Substance Use at fall 11th-grade

Table 1. Descriptive statistics of study variables at baseline in overall sample and by cyberbullying roles at baseline (*n*, %)

	Overall Sample (<i>N</i> = 2,768)	Cyberbullying roles					Overall Group Contrast <i>p</i>
		Noninvolved (<i>n</i> = 1,324)	Witness Only (<i>n</i> = 907)	Witness and Victim (<i>n</i> = 286)	Witness and Perpetrator (<i>n</i> = 64)	Witness, Victim, and Perpetrator (<i>n</i> = 187)	
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
Female sex, <i>n</i> (%)	1,480 (53.5)	635 (48.0)	559 (61.6) ^{ab}	202 (70.6) ^{ab}	27 (42.2)	86 (46.0)	< .001 ^c
Race/ethnicity, <i>n</i> (%)							< .001 ^c
Hispanic	1,301 (47.0)	682 (52.6) ^b	415 (46.3) ^{ab}	102 (36.3) ^a	35 (54.7) ^b	67 (37.0) ^a	
Asian	501 (18.1)	225 (17.4) ^b	177 (19.8)	44 (15.7) ^b	9 (14.1)	46 (25.4) ^a	
White	444 (16.0)	179 (13.8)	153 (17.1) ^a	74 (26.3) ^{ab}	5 (7.8)	33 (18.2)	
Multiracial	175 (6.3)	70 (5.4)	64 (7.1)	25 (8.9) ^a	4 (6.3)	12 (6.6)	
Black	119 (4.3)	64 (4.9)	29 (3.1) ^a	12 (4.3)	5 (7.8)	10 (5.5)	
Native Hawaiian	108 (3.9)	47 (3.6)	28 (3.1)	14 (5.0)	5 (7.8)	11 (6.1)	
Other	41 (1.5)	19 (1.5)	14 (1.6)	5 (1.8)	1 (1.6)	2 (1.1)	
American Indian	29 (1.0)	10 (0.8)	14 (1.6)	5 (1.8)	0 (0.0)	0 (0.0)	
Parent graduated high school, <i>n</i> (%)	1,687 (60.9)	766 (69.5)	567 (70.7)	189 (72.4)	46 (74.2)	119 (71.3)	.83 ^c
Age (years), <i>M</i> (<i>SD</i>)	15.5 (0.5)	15.5 (0.6)	15.5 (0.4)	15.5 (0.4)	15.5 (0.4)	15.5 (0.4)	.66 ^d
Baseline past-6-month substance use, <i>n</i> (%)							
Alcohol	742 (26.8)	258 (19.7) ^b	293 (32.8) ^{ab}	90 (31.6) ^{ab}	27 (42.2) ^a	74 (40.2) ^a	< .001 ^c
E-cigarettes	422 (15.2)	146 (11.1) ^b	153 (17.1) ^{ab}	58 (20.4) ^{ab}	15 (23.8) ^a	50 (27.2) ^a	< .001 ^c
Marijuana (combustible)	402 (14.5)	139 (10.6) ^b	144 (16.1) ^{ab}	51 (17.9) ^{ab}	15 (23.4) ^{ab}	53 (28.8) ^a	< .001 ^c
Hookah	279 (10.1)	89 (6.8) ^b	101 (11.3) ^{ab}	41 (14.5) ^a	15 (23.4) ^a	33 (18.0) ^a	< .001 ^c
Marijuana (edible)	207 (7.5)	66 (5.0) ^b	69 (7.7) ^{ab}	28 (9.8) ^{ab}	11 (17.2) ^a	33 (18.0) ^a	< .001 ^c
Cigarettes	195 (7.0)	62 (4.7) ^b	62 (6.9) ^b	32 (11.2) ^a	10 (15.6)	29 (15.8) ^a	< .001 ^c

	Cyberbullying roles						Overall Group Contrast <i>p</i>
	Overall Sample	Noninvolved	Witness Only	Witness and Victim	Witness and Perpetrator	Witness, Victim, and Perpetrator	
	(<i>N</i> = 2,768)	(<i>n</i> = 1,324)	(<i>n</i> = 907)	(<i>n</i> = 286)	(<i>n</i> = 64)	(<i>n</i> = 187)	
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
Prescription painkillers	141 (5.1)	42 (3.2) ^b	47 (5.3) ^{ab}	24 (8.4) ^a	7 (10.9) ^a	21 (11.4) ^a	< .001 ^c
Cigars	81 (2.9)	21 (1.6) ^b	29 (3.2) ^{ab}	14 (4.9) ^a	6 (9.5) ^a	11 (6.0) ^a	< .001 ^c
Prescription stimulants	81 (2.9)	24 (1.8) ^b	24 (2.7) ^b	12 (4.2) ^{ab}	5 (7.8) ^a	16 (8.7) ^a	< .001 ^c
Number of substances used							
0	1745 (63.7)	954 (72.7) ^b	519 (58.1) ^{ab}	159 (55.8) ^a	25 (39.1) ^a	88 (47.8) ^a	< .001 ^c
1	385 (14.1)	151 (11.5)	146 (16.3) ^a	41 (14.4)	17 (26.6) ^{ab}	30 (16.3)	.001 ^c
2	224 (8.2)	89 (6.8)	87 (9.7) ^a	29 (10.2)	4 (6.3)	15 (8.2)	.09 ^c
3	386 (14.1)	119 (9.1) ^b	142 (15.9) ^{ab}	56 (19.6) ^{ab}	18 (28.1) ^a	51 (27.7) ^a	< .001 ^c
Lifetime cyberbullying frequency ^e , <i>M</i> (<i>SD</i>)							
Witness	1.5 (1.3)	0.2 (0.4) ^b	2.4 (0.7) ^{ab}	2.9 (0.8) ^{ab}	3.1 (0.7) ^a	3.2 (0.8) ^a	< .001 ^d
Perpetration	0.3 (0.7)	0.0 (0.1) ^b	0.1 (0.3) ^{ab}	0.3 (0.4) ^{ab}	2.2 (0.5) ^{ab}	2.5 (0.8) ^a	< .001 ^d
Victimization	0.5 (1.0)	0.0 (0.2) ^b	0.2 (0.4) ^{ab}	2.5 (0.7) ^{ab}	0.3 (0.4) ^{ab}	2.6 (0.8) ^a	< .001 ^d

^aPairwise significant differences between respective group and noninvolved group (uncorrected *p* < .05).

^bPairwise significant differences between respective group and the witness, victim, and perpetrator group (uncorrected *p* < .05).

^cCalculated using the χ^2 test.

^dCalculated using analysis of variance.

^eQuantitative estimate of frequency of involvement in respective form of cyberbullying (0 = never, 1 = once, 2 = a few times, 3 = several times, 4 = many times).

Table 2. Prevalence of substance use and poly-use at follow-up by baseline cyberbullying roles (*n*, %)

	Cyberbullying roles					<i>p</i>
	Overall Sample (<i>N</i> = 2,768)	Nominvolved (<i>n</i> = 1,324)	Witness (<i>n</i> = 907)	Witness and Victim (<i>n</i> = 286)	Witness and Perpetrator (<i>n</i> = 64)	
	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	<i>n</i> (%)	
Follow-up past-6-month substance use						
Alcohol	779 (28.1)	278 (21.0) ^b	289 (31.9) ^{ab}	106 (37.2) ^a	29 (45.3) ^a	77 (41.2) ^a <.001 ^c
E-cigarettes	262 (9.5)	74 (5.6) ^b	96 (10.6) ^{ab}	44 (15.4) ^a	11 (17.2) ^a	37 (19.8) ^a <.001 ^c
Marijuana (combustible)	471 (17.0)	157 (11.9) ^b	180 (19.9) ^{ab}	67 (23.5) ^a	18 (28.1) ^a	49 (26.2) ^a <.001 ^c
Hookah	177 (6.4)	58 (4.4) ^b	60 (6.6) ^{ab}	28 (9.8) ^a	5 (7.8)	26 (13.9) ^a <.001 ^c
Marijuana (edible)	324 (11.7)	102 (7.7) ^b	120 (13.3) ^{ab}	42 (14.7) ^{ab}	16 (25.0) ^a	44 (23.5) ^a <.001 ^c
Cigarettes	189 (6.8)	56 (4.2) ^b	64 (7.1) ^{ab}	33 (11.5) ^a	7 (10.9) ^a	29 (15.3) ^a <.001 ^c
Prescription painkillers	125 (4.5)	33 (2.5) ^b	48 (5.3) ^{ab}	17 (5.9) ^{ab}	6 (9.4) ^a	21 (11.2) ^a <.001 ^c
Cigars	99 (3.6)	29 (2.2) ^b	31 (3.4) ^b	19 (6.6) ^a	3 (4.7)	17 (9.1) ^a <.001 ^c
Prescription stimulants	78 (2.8)	23 (1.7) ^b	25 (2.8) ^b	13 (4.6) ^{ab}	2 (3.1) ^b	15 (8.1) ^a <.001 ^c
Number of substances used						
0	1,753 (63.3)	957 (72.3) ^b	526 (58.0) ^{ab}	147 (51.4) ^a	31 (48.4) ^a	92 (49.2) ^a <.001 ^c
1	422 (15.2)	180 (13.6)	154 (17.0) ^a	49 (17.1)	10 (15.6)	29 (15.5) .22 ^c
2	203 (7.3)	61 (4.6)	90 (9.9) ^a	32 (11.2) ^a	5 (7.8)	15 (8.0) <.001 ^c
3	390 (14.1)	126 (9.5) ^b	137 (15.1) ^{ab}	58 (20.3) ^{ab}	18 (28.1) ^a	51 (27.3) ^a <.001 ^c

Data expressed as *n* (%).

^aPairwise significant differences between respective group and nominvolved group (uncorrected *p* < .05).

^bPairwise significant differences between respective group and the witness, victim, and perpetrator group (uncorrected *p* < .05).

^cCalculated using the χ^2 test.

Table 3.

Estimates of association of baseline roles of cyberbullying involvement (vs. noninvolved) and 2 roles (vs. witness-only) with substance use at follow-up (OR/CIs)

	Baseline cyberbullying roles					
	Witness Only vs. Noninvolved	Witness and Victim vs. Noninvolved	Witness and Perpetrator vs. Noninvolved	Witness, Victim, and Perpetrator vs. Noninvolved	Witness and Victim vs. witness-only	Witness and Perpetrator vs. witness-only
Follow-up past-6-month substance use						
Alcohol	1.44 (1.18, 1.76)	1.91 (1.37, 2.36)	2.29 (1.42, 3.98)	2.11 (1.51, 2.93)	1.19 (1.14, 3.20)	1.91 (1.14, 3.20)
Cigarettes	1.82 (1.27, 2.61)	2.92 (1.89, 4.52)	2.19 (0.97, 4.97)	3.44 (2.15, 5.51)	1.70 (1.08, 2.65)	1.61 (0.70, 3.69)
Hookah	1.33 (0.94, 1.90)	1.74 (1.10, 2.75)	1.09 (0.47, 2.57)	2.66 (1.66, 4.28)	1.50 (0.93, 2.41)	1.22 (0.47, 3.16)
Cigars	1.66 (1.00, 2.75)	3.33 (1.88, 5.91)	1.66 (0.55, 4.99)	3.92 (2.13, 7.20)	2.07 (1.14, 3.75)	1.27 (0.37, 4.31)
E-cigarettes	2.05 (1.49, 2.83)	2.85 (1.90, 4.28)	2.97 (1.51, 5.80)	3.45 (2.24, 5.31)	1.52 (1.03, 2.24)	1.73 (0.87, 3.44)
Marijuana (combustible)	2.02 (1.57, 2.58)	2.54 (1.81, 3.55)	2.49 (1.39, 4.45)	2.03 (1.37, 3.00)	1.23 (0.89, 1.70)	1.54 (0.87, 2.72)
Marijuana (edible)	2.01 (1.53, 2.64)	1.97 (1.35, 2.87)	3.23 (1.79, 5.81)	3.11 (2.08, 4.65)	1.12 (0.76, 1.65)	2.13 (1.16, 3.88)
Prescription stimulants	1.60 (0.90, 2.83)	1.92 (0.92, 4.01)	1.40 (0.37, 5.20)	5.24 (2.73, 10.05)	1.65 (0.83, 3.28)	1.18 (0.27, 5.14)
Prescription painkillers	2.04 (1.31, 3.18)	1.75 (0.97, 3.17)	2.78 (1.10, 7.07)	4.21 (2.37, 7.47)	1.08 (0.60, 1.91)	2.01 (0.82, 4.92)
Polysubstance use						
2 (vs. 1) substances	2.04 (1.40, 2.99)	2.77 (1.67, 4.58)	1.48 (0.52, 4.20)	1.86 (0.96, 3.57)	1.25 (0.80, 1.96)	1.02 (0.38, 2.71)
3 (vs. 1) substances	1.39 (1.03, 1.88)	1.99 (1.31, 3.03)	2.60 (1.30, 5.19)	2.74 (1.72, 4.36)	1.49 (1.04, 2.14)	2.24 (1.21, 4.14)

Note. Logistic regressions adjusted for sociodemographic factors and baseline past-6-month use status of respective substance use outcome. Reference group for polysubstance use was use of 1 substance. Bold indicates statistical significance following application of the Benjamini-Hochberg adjustment for multiple comparisons to control study-wise false discovery rate at .05.; Outcomes (past-6-month substance use) are presented in the first column, and predictors (cyberbullying roles) are presented in the first row.

Estimates of association of baseline involvement in 3 (vs. 1 or 2) roles of cyberbullying with substance use at follow-up (OR/CIs)

Table 4.

	Baseline Witness, Victim, and Perpetrator vs. Other roles		
	Witness Only (Reference)	Witness and Victim (Reference)	Witness and Perpetrator (Reference)
Follow-up past-6-month substance use			
Alcohol	1.47 (1.05, 2.05)	1.11 (0.75, 1.63)	0.92 (0.52, 1.63)
Cigarettes	1.90 (1.20, 3.00)	1.18 (0.71, 1.98)	1.51 (0.67, 3.41)
Hookah	1.97 (1.23, 3.14)	1.50 (0.87, 2.59)	2.38 (0.96, 5.87)
Cigars	2.31 (1.28, 4.18)	1.18 (0.61, 2.27)	2.36 (0.75, 7.42)
E-cigarettes	1.65 (1.09, 2.50)	1.18 (0.73, 1.90)	1.14 (0.55, 2.34)
Marijuana (combustible)	1.00 (0.68, 1.49)	0.80 (0.51, 1.25)	0.81 (0.42, 1.57)
Marijuana (edible)	1.67 (1.11, 2.50)	1.55 (0.96, 2.48)	0.94 (0.49, 1.82)
Prescription stimulants	2.96 (1.60, 5.50)	2.17 (1.05, 4.51)	3.32 (0.86, 12.85)
Prescription painkillers	2.05 (1.20, 3.52)	2.39 (1.23, 4.62)	1.29 (0.52, 3.21)
Polysubstance use			
2 (vs. 1) substances	0.91 (0.48, 1.70)	0.67 (0.32, 1.32)	1.24 (0.39, 3.89)
3 (vs. 1) substances	2.67 (1.23, 5.82)	1.36 (0.79, 2.34)	1.03 (0.47, 2.25)

Note. Logistic regression adjusted for sociodemographic factors and baseline past-6-month use status of respective substance use outcome. Reference group for polysubstance use was use of 1 substance. Bold indicates statistical significance following application of the Benjamini-Hochberg adjustment for multiple comparisons to control study-wise false discovery rate at .05.; Outcomes (past-6-month substance use) are presented in the first column, and predictors (cyberbullying roles) are presented in the first row.