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## TRAJECTORIES OF SUBSTANCE USE FREQUENCY AMONG ADOLESCENTS SEEN IN PRIMARY CARE: IMPLICATIONS FOR SCREENING

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### Abstract

**Objective**—Anticipating how adolescents' substance use may escalate is critical for primary care clinicians. We identified trajectories of use in a prospective cohort of adolescent primary care patients one year after a clinic visit.

**Study Design**—We recruited 12- to 18-year-olds from 9 New England practices between 2005–2008 and identified 5 trajectories of substance use. We first distinguished adolescents with no past-year use at a baseline clinic visit and at 12-month follow-up (trajectory A). For adolescents who used substances, we assessed past-90-day use at both timepoints, and identified the remaining 4 trajectories based on frequency of use. Trajectories included: <monthly use at both timepoints (trajectory B), <monthly use increasing to monthly (C), monthly use decreasing to <monthly (D), and monthly use at both timepoints (E). Using multiple logistic regression, we then examined associations with substance-involved parents, siblings, and peers.

**Results**—Among 860 adolescents (mean age 15.4 years; 60.9% female; 65.6% white non-Hispanic), more than half (52.7%) abstained (trajectory A). The remainder were classified into trajectories B (23.8%), C (9.5%), D (5.7%), and E (8.3%). Those who abstained were least likely

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### Contributors

Drs. Hadland and Harris designed the study and wrote the protocol for analysis with additional input from Ms. Copelas. Dr. Hadland undertook data management and statistical analyses with input from Dr. Harris. Dr. Hadland and Ms. Copelas conducted the literature review, and Dr. Hadland wrote the first draft of the manuscript. All authors contributed to and have approved the final manuscript.

to have substance-involved parents (adjusted odds ratio [AOR]=0.58; 95% confidence interval [95% CI]=0.46–0.72), siblings (AOR=0.49; 95% CI=0.40–0.60), or peers (AOR=0.44; 95% CI=0.37–0.52). Those increasing from <monthly use increasing to monthly were more likely to have substance-involved siblings (AOR=1.58; 95% CI=1.23–2.03) or peers (AOR=1.51; 95% CI=1.06–2.17).

**Conclusions**—Most adolescent primary care patients remained abstinent or infrequent users over one year, but 1 in 5 showed frequent use, with substance-involved siblings, and peers predicting escalation of use.

### Keywords

Adolescent; drug abuse; drinking behavior; primary health care; substance abuse detection

## INTRODUCTION

Substance use frequently begins in adolescence, with 1 in 3 high school students reporting past-month alcohol use and nearly 1 in 4 reporting past-month marijuana use.<sup>1</sup> Detecting and intervening on substance use early in the life course is critical to avert a worsening trajectory towards heavy use and associated harms.<sup>2</sup> Although light or moderate substance use in adolescence often persists as low-level use during adulthood,<sup>3,4</sup> some adolescent initiates show a steady rise in use with significant negative social and health outcomes continuing into adulthood.<sup>5,6</sup> Risk factors for heavier and more problematic use among adolescents and young adults include having peers who initiated substance use at a young age, as well as substance use by family members.<sup>7</sup> Elucidating the relative odds of adverse trajectories, and the risk markers that promote its likelihood, could help to inform screening and intervention efforts.

To that end, a number of studies have examined substance use trajectories among adolescents; however, the majority to date have followed school- or community-based cohorts of adolescents,<sup>5,8–10</sup> often focusing on a single substance to the exclusion of others.<sup>4,11–13</sup> Primary care practitioners, the usual source of health care for three-quarters of adolescents under 18 years,<sup>14</sup> are in a position to offer screening, brief intervention, and referral to treatment (SBIRT) for adolescent substance use.<sup>2</sup> Understanding the extent to which an adolescent's substance use may escalate during the year following a routine visit may help guide the clinician's follow-up schedule; by identifying adolescents at highest risk for escalation, a primary care clinician may choose to have one or several intervening visits between annual routine health maintenance visits.

There is currently a gap in knowledge surrounding the substance use trajectories of adolescents presenting for routine care. Current clinical practice guidelines recommend that adolescent providers ask about multiple substances, including co-occurring use of alcohol, marijuana, and other drugs.<sup>2,15,16</sup> Since adolescents often engage in more than one type of substance use,<sup>17</sup> it is important to account for use of *all* substances when characterizing their trajectories. Additionally, although many clinicians do not ask adolescents about use of substances by their parents, siblings, and peers,<sup>18</sup> understanding how role modeling may

shape adolescent patients' substance use trajectories would greatly inform primary care clinicians, who are in a position to ask about such influences.

In the present study, we sought to determine the prevalence of various substance use trajectories in a prospective cohort of adolescent primary care patients during the year following a routine visit. We defined trajectory groups based on frequency of any substance use (*i.e.*, alcohol, marijuana, or other drugs) to account for the high prevalence of polysubstance use during adolescence.<sup>19</sup> Since many clinicians see adolescents on an annual basis, we aimed to delineate the frequency of substance use at two assessments of adolescents' substance use separated by 12 months. To further inform primary care clinicians, we defined trajectories *a priori* using cutoffs of 'abstinence' vs. '< monthly' use vs. 'monthly' use at the two time points based on prior data highlighting that monthly use is a sensitive screen for adolescent substance use disorders.<sup>20</sup> We then characterized the demographic profiles of the trajectory groups to identify correlates of higher risk, and, recognizing that peer and family substance use patterns are well-established influences of substance use among adolescents,<sup>7</sup> we examined the effects of baseline reports of peer, sibling, and parent substance involvement on subsequent trajectories. We hypothesized that trajectories towards more frequent use would be associated with the presence of substance-involved peers, siblings, and/or parents.

## METHODS

As part of a large intervention trial described previously,<sup>21</sup> adolescents 12–18 years of age presenting for a routine primary care visit were recruited at 9 large primary care practices in New England from 2005 to 2008. Data for the present study included 860 (80.5%) of the 1068 treatment-as-usual control participants who completed both baseline and 12-month follow-up assessments. Participants who were retained at 12 months did not differ significantly from those who did not with regard to age, gender, or race/ethnicity, but were significantly more likely to have been recruited at a well-visit (84.6% vs. 46.2%,  $p<0.001$ ) and to have a parent who graduated college (46.2% vs. 34.7%,  $p=0.004$ ). On the other hand, those not returning for 12-month follow-up had higher rates of any lifetime drug use (34.6% vs. 21.4%,  $p<0.001$ ), and were more likely to report having substance-involved parents (20.7% vs. 14.8%,  $p=0.040$ ) and siblings (26.0% vs. 17.6%,  $p=0.006$ ). Informed assent (<18 years) or consent (=18 years) was obtained; parents gave parental permission in person or by phone for minors. Participants received a \$15 gift certificate for completing each of the two assessments. The study was approved by the Institutional Review Board at Boston Children's Hospital and at all clinic sites.

At the baseline visit and 12-month follow-up, participants completed "yes"/"no" items regarding any use of each substance during the past 12 months, and a confidential modified Timeline Followback (TLFB) calendar interview administered by a trained research assistant assessing past-90-day frequency of use separately for alcohol, marijuana, or other drugs.<sup>22,23</sup> The TLFB is a reliable measure of adolescent substance use that has been previously validated among adolescents,<sup>24</sup> and uses a structured interview with memory aids (including a calendar with probes about special events, such as birthdays or other holidays) to collect estimates of the number of days of substance use during the preceding 90 days. For these

analyses, we examined the number of days on which use of any substances (*i.e.*, alcohol, marijuana, or other substances, but not cigarettes) was reported. Substances were examined together as a single outcome since polysubstance use was common in the sample (*e.g.*, 78% of past-90-day marijuana users at baseline had also used alcohol) and since we were interested in overall use frequency across all substances.

To describe clinically meaningful trajectories of substance use in the sample, we began by identifying youth who had abstained from substances entirely during the past year as reported both at baseline and at 12-month follow-up (trajectory A). We then divided the remaining adolescents (*i.e.*, those who used any substances) into four additional mutually exclusive trajectories. Based on prior literature highlighting that monthly use is a sensitive and specific threshold for identifying substance use disorder among adolescents,<sup>20</sup> we sought *a priori* to develop clinically meaningful cutoffs readily applicable to pediatric practice. We delineated trajectories based on reported number of days use according to the TLFB approach, and we considered < 3 days of use of the preceding 90 days to represent “< monthly use” and 3 of 90 days to represent “monthly use”.

Using these cutoffs, we identified 4 additional trajectories, including adolescents who used < monthly at both baseline and the 12-month follow-up (trajectory B); adolescents who used < monthly at baseline but increased their use by the 12-month follow-up to monthly (trajectory C); adolescents who used monthly at baseline but decreased their use to < monthly at the 12-month follow-up (trajectory D); and adolescents who used monthly at both timepoints (trajectory E). To determine the relative contributions of alcohol, marijuana and other drugs to trajectories, we also identified past-90-day use of each substance separately.

We then examined sociodemographic characteristics in relation to trajectories, including age, gender, self-reported race/ethnicity (white Non-Hispanic, black non-Hispanic, and Hispanic/other), as well as perceived substance use of peers, siblings, and parents as assessed using items derived from the previously validated Personal Experience Inventory (PEI).<sup>25,26</sup> Internal consistency reliability, as demonstrated by Cronbach’s alpha,<sup>27</sup> was high in this sample for all three measures (peer use, 5 items, alpha=0.87; sibling use, 4 items, alpha=0.87; parent use, 4 items, alpha=0.86). Examples of PEI questions include: “Some kids I hang around with have trouble at school due to using alcohol or drugs” (peer use), “I have a brother or a sister who gets drunk or high” (sibling use), and “I have a parent whose use of alcohol or other drugs worries me” (parent use).<sup>26</sup> All PEI item responses used a 4-point Likert scale of “Strongly Disagree/Disagree/Agree/Strongly Agree”. As shown by the example items, these measures were designed to identify more problematic levels of substance use (*e.g.*, use that resulted in a sibling appearing “drunk” or “high,” or parental substance use that the adolescent found worrisome or warranted treatment). We generated separate dichotomous variables for peer, sibling, and parental use, and considered peer/sibling/parent use to be positive if the study participant gave an affirmative response (“Agree” or “Strongly Agree”) to any of the questions for that particular subscale.

We identified associations between sociodemographic variables (age, gender, and race/ethnicity) and peer/sibling/parent use with the 5 trajectories using logistic regression, and

then generated multivariable models that adjusted odds ratios (AOR) for age, gender, and race/ethnicity, with potential confounders identified based on the prior literature.<sup>11–13,28</sup> Pairwise comparisons for bivariate and multivariable models were determined *a priori* and included: (i) comparing youth who abstained from use (trajectory A) to all other users (trajectories B through E); (ii) among youth who used < monthly at baseline, comparing those who increased their use to monthly (trajectory C) to those who did not (trajectory B); and (iii) among youth who used monthly at baseline, comparing those who continued monthly use (trajectory E) to those who decreased to < monthly use (trajectory D).

Finally, recognizing that some adolescents might have been categorized as “monthly” users even if all their days of use were concentrated into a one-month period (while remaining abstinent for the remainder of the 90-day period), we conducted sensitivity analyses taking into account this possibility. We recategorized all adolescents whose 3 or more days of use in the preceding 90 days occurred solely during a one-month period from “monthly use” into “< monthly use”. Then, we resorted them into the trajectories listed above. After doing so, we repeated all study analyses and compared effect sizes and 95% confidence intervals to those obtained using the original trajectory categorizations.

Analyses were performed using SPSS version 19.0 (Armonk, NY: IBM Corp., 2010). Because the data distributions for past-90-day substance use frequency were highly skewed (i.e., the majority had no days of use), we report medians and interquartile ranges rather than means and standard deviations to minimize the effect of outlying values. All p values were two-sided and tests were considered significant at  $p < 0.05$ .

## RESULTS

Baseline characteristics of the sample ( $n=860$ ) are summarized in Table 1. The mean age was 15.4 years (standard deviation, 2.0 years), and as demonstrated, the majority of the 860 adolescents were female and non-Hispanic white, came from two-parent households, and had parents who did not complete college. The vast majority reported having substance-involved peers, and approximately one in four reported having substance-involved parents and siblings.

At baseline, nearly two-thirds of the sample (64.6%) reported no substance use in the past year. Alcohol was the most commonly used substance (33.3%), followed by marijuana (14.8%). A substantial proportion of those using alcohol had also used marijuana (38.1%), while nearly all marijuana users had also used alcohol (85.8%). Use of other substances was reported by 8 adolescents, and included ecstasy (2 participants), oxycodone (2 participants), unknown prescription pills (2 participants), clonazepam (1 participant), and cocaine (1 participant). At the 12-month follow-up, the percent abstaining in the past year declined to 59.3%, while the prevalence of past-year alcohol use rose to 38.8% and marijuana use to 19.1%. Again, polysubstance use was common, with 38.7% of alcohol users also reporting marijuana use, and 95.7% of marijuana users also using alcohol at the 12-month follow-up. Nearly one in four (23.0%) adolescents reported any past-90-day alcohol or drug use at baseline, and the percentage increased to 27.9% at 12 months. Median number of days of

any substance use during the 90 days preceding the baseline visit was 3 (interquartile range [IQR], 2–11), and 4 (interquartile range [IQR], 2–14) at the 12-month follow-up.

Table 2 shows median days of use at baseline and 12-month follow-up for the five substance use trajectories. Adolescents' substance use trajectories were most commonly attributable to their use of alcohol (as compared to marijuana); use of other substances was infrequent with zero median days of use at baseline and follow-up for all trajectories. Table 3 shows the profiles of adolescents across the trajectory groups. Trajectories differed significantly according to age; one- vs. two-parent households; parents' education level; any use of drugs other than marijuana; and parent, sibling and peer substance use patterns. Adolescents who abstained (trajectory A) had the greatest proportion of younger participants and were the most likely to come from two-parent households. Adolescents with monthly use at both visits (trajectory E) had the greatest proportion of older participants, were least likely to come from two-parent households, and were most likely to have a parent who graduated from college. Adolescents with monthly use decreasing to < monthly (trajectory D) were least likely to have a college-educated parent. Adolescents who abstained (trajectory A) were uniformly least likely to have parents, siblings, or peers who used substances. Adolescents with monthly use decreasing to < monthly (trajectory D) were most likely to have parents who used substances, and adolescents with monthly use at both visits (trajectory E) were most likely to have siblings who used substances; every participant in these trajectories D and E reported peers who used substances. No significant differences by gender or race/ethnicity were noted across trajectories.

Table 4 shows unadjusted and AORs for the associations between trajectories and the presence of substance-involved parents, siblings, and peers at baseline. Adolescents who abstained (trajectory A) were significantly less likely to report having parents, siblings, or peers who used substances when compared to adolescents who engaged in any level of substance use (trajectories B–E), even after adjustment for demographic differences. In comparison to all adolescents who used < monthly at baseline, those who had increased their use to monthly at the 12-month follow-up were more likely to have siblings and peers (but not parents) who used substances compared to those who did not increase to monthly. Having substance-involved parents, siblings, or peers at baseline did not appear to differentiate adolescents using monthly at baseline from those using < monthly at the 12-month follow-up.

In sensitivity analyses in which we reexamined all adolescents whose 3 or more days of substance use occurred entirely during a one-month period (while remaining abstinent for the remainder of the 90-day period), a total of 15 (1.7%) adolescents were recategorized. Four adolescents were recategorized from trajectory C to B, four adolescents from trajectory D to B, four adolescents from trajectory E to C, and three adolescents from trajectory E to D. Repeating all study analyses with participants reassigned to these new trajectories resulted in similar effect sizes, 95% confidence intervals, and statistical significance throughout (data available from authors).



## DISCUSSION

In this study, we determined the prevalence of 5 clinically significant trajectories of substance use during the 12 months following a routine medical visit among adolescents presenting to primary care. Using clinically relevant *a priori* cutoffs of abstinence *vs.* < monthly use *vs.* monthly use at a baseline visit and 12-month follow-up (thus emulating the typical annual well-care schedule for adolescents seen in primary care),<sup>20</sup> we found that more than half of all adolescents remained abstinent throughout the study. Adolescents who stayed abstinent tended to be younger, and were significantly less likely to report substance-involved parents, siblings, and peers. Conversely, among those who used < monthly at baseline, those who escalated to monthly use at 12-month follow-up were significantly more likely than those who did not escalate to have siblings and peers who used substances.

This study is novel in examining trajectories of adolescent substance use in primary care rather than in a school- or community-based setting.<sup>5,8–10</sup> Thus, our findings are directly applicable to practicing primary care practitioners, who are in a position to identify high-risk youth, provide counseling, and refer to formal substance use treatment as appropriate. Indeed, offering screening, brief intervention, and referral to treatment as a routine part of adolescent primary care was reaffirmed by the American Academy of Pediatrics in June, 2016.<sup>29</sup> Prior studies have identified risk factors for escalation to heavy substance use. Data from the National Longitudinal Survey of Adolescent Health (Add Health), a school-based prospective cohort, suggest that trajectories may differ between males and females, with females exhibiting use of alcohol, marijuana and cigarettes earlier in adolescence than males, but males demonstrating greater escalation in use later in adolescence.<sup>28</sup> Data on adolescent drinking drawn from a household-based surveys in Australia<sup>30</sup> and Germany<sup>13</sup> corroborate these gender differences. Although we did not observe statistically significant gender differences in trajectories, trajectories C and E (marked by intensification to frequent use and stable frequent use throughout, respectively) did have higher proportions of male participants than trajectories marked by lower and more stable use. Nonetheless, all substance use trajectories identified in our study had notable representation from both genders, highlighting that although there may be gender differences in substance use trajectories, clinicians should routinely screen both males and females since a substantial proportion of both genders may show concerning patterns of use.

Consistent with Add Health data,<sup>28</sup> we also observed significantly different trajectories by age, with heavy substance use more likely to be reported by older adolescents. Additionally, we observed that females, who comprised a greater proportion of the study sample (a finding consistent with typical health care utilization in the US),<sup>31</sup> were relatively less likely to intensify their substance use than males, and relatively more likely to engage in stable infrequent use or to curtail their heavy use; these findings are also consistent with Add Health data. Still, since we sampled adolescents ranging in age from 12 to 18 years over a one-year follow-up period, our data only capture a brief period in the overall trajectory of participants' substance use. Nonetheless, our data are highly informative to the practicing clinician who may be more concerned with the developing trajectory of substance use on the short term since this may help him or her determine an immediate plan of action for the year ahead.

Critically, even after adjustment for age, an independent association between trajectories and parent, sibling, and peer substance use persisted. Specifically, we found that even after accounting for age, adolescents who abstained from all substance use were significantly less likely to have parents, siblings, or peers who use substances. This finding has important implications for pediatric practice, because although current clinical practice guidelines recommend routinely screening all adolescents for substance use,<sup>2</sup> asking about adolescents' perceptions of use by family members is not yet recommended; asking about substance use among adolescents' peers, however, is recommended by NIAAA.<sup>32</sup> Our findings suggest that adolescents who do not have parents, siblings, and peers who use substances are much more likely to remain abstinent, a finding that may be helpful to the primary care clinician that asks about substance use among other influential people in an adolescent's life. Similarly, our results show that substance use by siblings and peers, who are more similar in age to adolescents than their parents, may be linked to greater escalation in substance use over a one-year period.

Mechanisms underlying the links between adolescents' trajectories and parent, sibling, and peer substance use patterns have been the focus of much study to date.<sup>33–37</sup> Earlier in adolescence, parents and older siblings are likely to shape opinions and expectations regarding substance use, as well as serve as direct role models who abstain or engage in light or heavy use.<sup>33</sup> Once peers begin to use (particularly in older years of adolescence, as the prevalence of substance use tends to naturally increase), peers are also likely to play a similarly influential role in adolescent substance use.<sup>34,38</sup> In particular, when parental monitoring and appropriate discipline are lacking, the relative influence of peers on adolescents' substance use may become more important.<sup>34</sup> Thus, it may be helpful for clinicians to ask parents about their own substance use as well as the degree to which they monitor their adolescent child. Although many practitioners may find it difficult to ask parents directly about their own substance use, data suggest that parents are open to being screened for substance use problems in the pediatric office.<sup>18</sup> Indeed, paper-based or computer-based questionnaires may be acceptable and could be readily implemented in most settings; nonetheless, future studies should examine the extent to which parents who use alcohol or other substances feel comfortable disclosing their use in the pediatric office setting.

There are several limitations to this study. First, although an important strength of this study is that it informs the practice of practicing clinicians since it examined adolescents presenting for routine primary care visits, the findings may not be generalizable outside the clinical environment or to youth who do not interface with primary care. The study sample included a greater proportion of females than males, which is typical of a primary care-based population due to greater primary care utilization, including for contraceptive services, by adolescent females.<sup>31</sup> Therefore, our sample may reflect differential selection biases for females vs. males, with our sample potentially having more higher risk females, and more lower risk males, compared to the general population. Second, although many baseline characteristics did not differ between adolescents who did and did not return for the 12-month follow-up, we cannot exclude the possibility that those lost to follow-up were more likely to develop heavy substance use. Third, we relied on self-report, and some adolescents may not have felt comfortable disclosing their substance use or sensitive information about



their family or peers; the result of such social desirability bias would have been to drive our results towards the null. Nonetheless, we used the TLFB interview, which has been previously validated among adolescents and therefore likely provides an accurate assessment of substance use frequency.<sup>24</sup> Similarly, although the PEI, from which we derived questions regarding substance use by parents, siblings, and peers, has been validated among adolescents,<sup>25,26</sup> it probes perceived substance use among family members and peers and thus relies on an adolescent's interpretation of others' substance use and related problems. Fourth, we cannot exclude the possibility of reverse causation – that is, that adolescents who used substances heavily were also in turn more likely to recognize substance use among their family members and peers.

Our findings serve to inform primary care practitioners that substance use by family members and peers may help distinguish which adolescents are likely to remain abstinent, as well as which youth are likely to escalate to heavy use during the year following a routine clinic visit. Given the high prevalence of substance use among adolescents,<sup>1,19,39</sup> it is clear that pediatric practitioners will continue to encounter many adolescents who use substances; predicting which patients are likely to remain abstinent, to use infrequently, or to use heavily may be aided by asking about substance use by adolescents' family members and peers. Indeed, practitioners might consider implementing closer follow-up for adolescents who have family members or peers who use substances, and offering earlier and more intense intervention for high-risk patients.

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**Table 1**Baseline demographics of participants ( $n = 860$ )

Characteristic	<i>n</i> (%)
Age	
12–14 years	295 (34.3)
15–16 years	265 (30.8)
17–18 years	300 (34.9)
Gender	
Male	336 (39.1)
Female	524 (60.9)
Race/ethnicity	
White non-Hispanic	564 (65.6)
Hispanic	81 (9.4)
Asian non-Hispanic	67 (7.8)
Black non-Hispanic	76 (8.8)
Other non-Hispanic	72 (8.4)
Parents at home	
Two parents	580 (68.6)
One parent, or other	265 (31.4)
Parents' highest education level	
College/university or higher	385 (44.8)
Did not complete college	448 (52.1)
Don't know	27 (3.1)
Parent substance use <sup>a</sup>	
Yes	203 (23.6)
No	657 (76.4)
Sibling substance use <sup>a</sup>	
Yes	226 (26.3)
No	634 (73.7)
Peer substance use <sup>a</sup>	
Yes	702 (81.6)
No	158 (18.4)
Lifetime substance use	
None	497 (57.8)
Alcohol only	179 (20.8)
Marijuana only	20 (2.3)
Alcohol and marijuana <sup>b</sup>	164 (19.1)

<sup>a</sup>Reported any “agree” response to scale items assessing youth-reported parent substance use, sibling substance use, and peer substance use<sup>25,26</sup>

<sup>b</sup>Of the 164 adolescents reporting lifetime use of alcohol and marijuana, 8 (4.8%) also reported lifetime use of other substances; no adolescents reported use of other substances without also reporting lifetime use of alcohol and marijuana

**Table 2**

Descriptions of substance use trajectories identified over one year following a routine clinic visit ( $n = 860$ ).

Trajectory <sup>a,b</sup>	<i>n</i> (%)	Description	Median days of use in past 90 days (IQR)					
			All substances		Alcohol		Marijuana	
			Baseline	12 months	Baseline	12 months	Baseline	12 months
A	453 (52.7)	Had not used in the past year at baseline or at 12-month follow-up	<b>0 (0 – 0)</b>	<b>0 (0 – 0)</b>	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)	0 (0 – 0)
B	205 (23.8)	Had used in the past year, but used < monthly at baseline and 12-month follow-up	<b>0 (0 – 0)</b>	<b>0 (0 – 1)</b>	0 (0 – 0)	0 (0 – 1)	0 (0 – 0)	0 (0 – 0)
C	82 (9.5)	Had used in the past year, but used < monthly at baseline, then increased to monthly use at 12-month follow-up	<b>0 (0 – 1)</b>	<b>6 (4 – 17)</b>	0 (0 – 1)	4.5 (3 – 7)	0 (0 – 0)	1 (0 – 3)
D	49 (5.7)	Used monthly at baseline, then reduced to < monthly use at 12-month follow-up	<b>7 (3 – 15)</b>	<b>0 (0 – 1)</b>	5 (3 – 8)	0 (0 – 1)	0 (0 – 4)	0 (0 – 0)
E	71 (8.3)	Used monthly at baseline and 12-month follow-up	<b>11 (4 – 23)</b>	<b>13 (5 – 26)</b>	4 (3 – 12)	8 (4 – 20)	2 (0 – 13)	1 (0 – 16)

<sup>a</sup>Substance use trajectories were defined by the total number of days of use of all substances, as reported in the column, “All Substances” and presented in bold

<sup>b</sup>Those who abstained from use reported zero substance use in the past year both at baseline and at 12-month follow-up; participants in all other trajectories (*i.e.*, B through E) reported some past-year use at baseline or 12-month follow-up even if they reported zero days of use in the past 90 days at either visit

Table 3

Characteristics of each substance use trajectory group ( $n = 860$ ).

Characteristic	$n$ (%)				$p$ value
	Trajectory A: Abstained at both timepoints ( $n = 453$ )	Trajectory B: < Monthly use at both timepoints ( $n = 205$ )	Trajectory C: < Monthly use increasing to monthly ( $n = 82$ )	Trajectory D: Monthly use decreasing to < monthly ( $n = 49$ )	Trajectory E: Monthly use at both timepoints ( $n = 71$ )
Age					< 0.001
12–14 years	242 (53.4)	40 (19.5)	8 (9.8)	3 (6.1)	2 (2.8)
15–16 years	138 (30.5)	74 (36.1)	20 (24.4)	14 (28.6)	19 (26.8)
17–18 years	73 (16.1)	91 (44.4)	54 (65.9)	32 (65.3)	50 (70.4)
Gender					0.093
Female	264 (58.3)	139 (67.8)	47 (57.3)	34 (69.4)	40 (56.3)
Male	189 (41.7)	66 (32.2)	35 (42.7)	15 (30.6)	31 (43.7)
Race/ethnicity					0.871
White non-Hispanic	290 (64.0)	139 (67.8)	51 (62.2)	34 (69.4)	50 (70.4)
Other	163 (36.0)	66 (32.2)	31 (37.8)	15 (30.6)	21 (29.6)
Parents at home <sup>b</sup>					0.007
Two parents	321 (72.3)	141 (69.5)	47 (59.5)	34 (69.4)	37 (52.9)
One parent, or other	123 (27.7)	62 (30.5)	32 (40.5)	15 (30.6)	33 (47.1)
Parents' highest education level <sup>b</sup>					0.033
College/university or higher	195 (43.1)	94 (45.9)	37 (45.1)	16 (32.7)	43 (60.6)
Did not complete college	246 (54.3)	103 (50.2)	43 (52.4)	30 (61.2)	26 (36.6)
Don't know	12 (2.6)	8 (3.9)	2 (2.5)	3 (6.1)	2 (2.8)
Any use of drugs other than marijuana					< 0.001
Yes	0 (0.0)	1 (0.5)	2 (2.4)	8 (16.3)	12 (16.9)
No	453 (100.0)	204 (99.5)	80 (97.6)	41 (83.7)	59 (83.1)
Parent substance use <sup>b</sup>					< 0.001
Yes	80 (17.7)	55 (26.8)	20 (24.4)	20 (40.8)	28 (39.4)
No	373 (82.3)	150 (73.2)	62 (75.6)	29 (59.2)	43 (60.6)
Sibling substance use <sup>b</sup>					< 0.001
Yes	56 (12.4)	61 (29.8)	39 (47.6)	28 (57.1)	42 (59.1)
No	397 (87.6)	144 (70.2)	43 (52.44)	21 (42.9)	29 (40.9)



Characteristic	(%) <i>n</i>					<i>p</i> value
	Trajectory A: Abstained at both timepoints ( <i>n</i> = 453)	Trajectory B: < Monthly use at both timepoints ( <i>n</i> = 205)	Trajectory C: < Monthly use increasing to monthly ( <i>n</i> = 82)	Trajectory D: Monthly use decreasing to < monthly ( <i>n</i> = 49)	Trajectory E: Monthly use at both timepoints ( <i>n</i> = 71)	
Peer substance use <sup>b</sup>						< 0.001
Yes	311 (68.7)	190 (92.7)	81 (98.8)	49 (100)	71 (100)	
No	142 (31.3)	15 (7.3)	1 (1.2)	0 (0.0)	0 (0.0)	

<sup>a</sup> At either baseline or follow-up visits

<sup>b</sup> Reported any “agree” response to scale items assessing youth-reported parent substance use, sibling substance use, and peer substance use<sup>25,26</sup>

<sup>c</sup> Data are missing where cells do not add to total

**Table 4**

Odds ratios (OR) for bivariate and multivariable<sup>a</sup> associations of parent, sibling and peer substance use patterns<sup>b</sup> with trajectories.

Characteristic	Unadjusted OR (95% CI)	Adjusted OR (95% CI)
<b>Abstained (A) vs. all others (B–E), <i>n</i> = 860</b>		
Parent substance use	<b>0.63 (0.53 – 0.76)</b>	<b>0.58 (0.46 – 0.72)</b>
Sibling substance use	<b>0.43 (0.36 – 0.51)</b>	<b>0.49 (0.40 – 0.60)</b>
Peer substance use	<b>0.36 (0.31 – 0.43)</b>	<b>0.44 (0.37 – 0.52)</b>
<b>Used &lt; monthly at baseline and increased to monthly (C) vs. did not increase to monthly (B), <i>n</i> = 287</b>		
Parent substance use	0.96 (0.71 – 1.30)	1.08 (0.78 – 1.49)
Sibling substance use	<b>1.43 (1.14 – 1.80)</b>	<b>1.58 (1.23 – 2.03)</b>
Peer substance use	<b>1.54 (1.09 – 2.18)</b>	<b>1.51 (1.06 – 2.17)</b>
<b>Used monthly at baseline and continued monthly (E) vs. reduced to &lt; monthly (D), <i>n</i> = 120</b>		
Parent substance use	1.11 (0.78 – 1.57)	1.17 (0.81 – 1.69)
Sibling substance use	0.89 (0.68 – 1.18)	0.84 (0.62 – 1.14)
Peer substance use	0.61 (0.33 – 1.12)	0.60 (0.31 – 1.15)

<sup>a</sup>Multivariable analyses adjusted for age, gender, race/ethnicity (white non-Hispanic vs. other)

<sup>b</sup>Reported any “agree”, “agree” response to scale items assessing youth-reported parent substance use, sibling substance use, and peer substance use<sup>25,26</sup>