



## Drug use among youth: National survey data support a common liability of all drug use

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### ABSTRACT

The prevalence of substance use disorders in adults is higher if substance use is initiated during adolescence, underscoring the importance of youth substance use prevention. We examined whether the use of one substance by adolescents is associated with increased risk for using any other substance, regardless of use sequences. In 2017 we examined data from 17,000 youth aged 12–17 who participated in the 2014 National Survey on Drug Use and Health, a sample of nationally representative data on substance use among the U.S. civilian, non-institutionalized population aged 12 or older. Descriptive analyses and multivariable logistic regression models were applied. After controlling for age, sex, and race/ethnicity, compared with youth without past-month marijuana use, youth with past-month marijuana use were 8.9 times more likely to report past-month cigarette use, 5.6, 7.9 and 15.8 times more likely to report past-month alcohol use, binge use, or heavy use (respectively), and 9.9 times more likely to report past-month use of other illicit drugs. The prevalence of past-month use of cigarettes, marijuana, and other illicit drugs was significantly higher among past-month alcohol users compared with youth without past-month alcohol use, and increased as intensity of alcohol use rose. Among past-month cigarette smokers, the prevalence of marijuana, other illicit drugs, and alcohol use were each significantly higher than youth without past-month cigarette use. Youth marijuana use, cigarette smoking, or alcohol consumption is associated with other substance use. This finding has importance for youth prevention, supporting a message no use by youth of any substance.

### 1. Introduction

The medicalization, legalization, and normalization of marijuana use has invigorated a debate on whether this substantial legal and social transformation will significantly modify current patterns of marijuana use and other potentially hazardous substances, especially among youth (D'Amico et al., 2015; Hall et al., 2016). Concurrent with these social and legal changes, scientific evidence is accumulating that initiation of marijuana, alcohol, and cigarette smoking during adolescence heightens susceptibility to addiction and other adverse consequences (Degenhardt et al., 2016; Jordan & Andersen, 2017; Khokhar et al., 2018; Meruelo et al., 2017; Tice, 2013). The heightened vulnerability of youth to addiction, other adverse consequences, and the lamentable rise in opioid use disorders and death (Madras, 2017) provide a compelling rationale to prevent youth substance use nationally as a public health priority. Research has examined many risk and protective factors for initiation and escalation to compulsive use. Effective prevention may be

optimized by addressing all substance use rather than focusing on individual substances.

As marijuana availability has risen with increasing legal and social acceptance, it becomes a public health imperative to examine factors that increase marijuana use including the alcohol and tobacco (nicotine) as well as other illegal for youth. More than 40 years ago, Kandel and Faust (Kandel & Faust, 1975) investigated adolescent involvement in drug use based on random and sequential sampling of students in New York State middle and high schools. Of over 8000 students surveyed, they reported that students who smoked cigarettes and drank alcohol rapidly progressed to marijuana use within 5–6 months, but of those who had not initiated use of tobacco or alcohol, fewer than one tenth as many had used marijuana. Progression to using other illicit drugs was much higher among marijuana users than non-marijuana users. A similar conclusion was drawn from the National Longitudinal Study of Adolescent Health report, based on a large comprehensive survey of adolescents in the United States (Moss et al., 2014). This

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survey examined the U.S. prevalence of various patterns of early adolescent (prior to age 16) use of alcohol, cigarettes, and marijuana. It concluded that early onset of use of alcohol, marijuana and cigarettes combined was more common than initiation of individual substances in early adolescence. A recent study examining prevalence of adolescent marijuana use by groups separated by their use of cigarettes, binge alcohol use and neither substance (Miech et al., 2017) provided additional evidence for the link between use of substances (Chadi & Levy, 2017).

The generalized risk factor for initiation of substance use, based partially on international surveys, has gained traction in recent years (Degehardt et al., 2009; Fergusson et al., 2006; Huizink et al., 2010; Mackesy-Amity et al., 1997; Vanyukov et al., 2012). According to this interpretation, early onset of any drug use is attributable to common liabilities, with the sequence of specific drugs used influenced by individual traits, local culture, and availability (Palmer et al., 2012). Regardless of which model is sustained with ongoing epidemiological or biological study, patterns of drug use are influential in shaping prevention strategies targeting youth.

The present study examined recent patterns of substance use among 12–17 year-old adolescents from the nationally representative survey data on substance use. We specifically examined whether among youth, use of one substance is associated with increased risk for using any other substance, and conversely, whether the non-use of one substance is associated with decreased risk for using other substances. Our population-based approach, which examined generalized risk for substance use among the most vulnerable cohort of substance users, youth aged 12–17, can inform current national public health youth prevention efforts.

## 2. Methods

### 2.1. Data source

We examined data from youth aged 12–17 who participated in the 2014 National Survey on Drug Use and Health (NSDUH), conducted by the Substance Abuse and Mental Health Services Administration (SAMHSA). NSDUH provides nationally representative data on substance use among the U.S. civilian, noninstitutionalized population aged 12 or older. The NSDUH data collection protocol was approved by the Institutional Review Board at RTI International. Data are collected by interviewers during in-person visits to households and non-institutional group quarters. The interview averages about an hour. Audio computer-assisted self-administered interviewing is used, providing respondents with a private, confidential way to record answers. Excluded from the surveys are persons without a household address (e.g., homeless persons not living in shelters, prisoners), active-duty military, and institutional residents. The annual weighted response rate of the 2014 NSDUH was 58.3%. Details regarding NSDUH methods are provided elsewhere.

### 2.2. Measures

The 2014 NSDUH collected data on past-month (prior to survey interview) and lifetime use of tobacco, alcohol, marijuana, and non-marijuana illicit drugs (e.g., cocaine, hallucinogens, heroin, and inhalants and nonmedical use of prescription pain relievers, sedatives, and stimulants) among all respondents. Patterns of alcohol use were questioned in greater depth as NSDUH collected past-month binge alcohol use (drinking five or more drinks on the same occasion (i.e., at the same time or within a couple of hours of each other) on at least 1 day in the past 30 days) and heavy alcohol use (drinking 5 or more drinks on the same occasion on each of 5 or more days in the past 30 days) among all respondents. In addition, NSDUH collected sociodemographic characteristics, such as age, sex, and race/ethnicity (non-Hispanic white, non-Hispanic black, Hispanic, or non-Hispanic other).

### 2.3. Statistical analyses

Analyses were conducted in four stages. First, descriptive analyses were conducted to estimate the prevalence of past-month and lifetime use of marijuana, illicit drugs other than marijuana, alcohol, and cigarettes among youths. Second, multivariable logistic regression models were applied to estimate age, sex, and race/ethnicity adjusted prevalence of past-month and lifetime use of (a) cigarettes, alcohol, and illicit drugs among youth by marijuana use status; (b) marijuana, other illicit drugs, and cigarettes among youth by level of alcohol use; and (c) marijuana, other illicit drugs and alcohol use among youth by status of cigarette use. It is important to adjust for age, sex, and race/ethnicity because the prevalence of substance use among youth varies by these factors. This study used SUDAAN (Research Triangle Institute, 2015) to account for the complex sample design and sampling weights of the NSDUH.

## 3. Results

### 3.1. Unadjusted prevalence of past-month and lifetime substance use

Based on the sampled 17,000 youth aged 12–17 years from the 2014 NSDUH data, we estimated that among youth in the U.S., the unadjusted prevalence of past-month use of marijuana, cigarettes, alcohol, or illicit drugs other than marijuana was 7.4%, 4.9%, 11.5%, or 2.6%, respectively. The unadjusted prevalence of lifetime use of marijuana, cigarettes, alcohol, or illicit drugs other than marijuana was 16.4%, 14.2%, 29.6%, or 13.4%, respectively.

### 3.2. Associations between marijuana use and use of other substances

Youth who used marijuana in the past month were much more likely to use cigarettes and alcohol, to binge drink, to drink heavily and use other illicit drugs compared to youth who did not use marijuana in the past month (Table 1). After adjusting for age, sex, and race/ethnicity, compared to their peers who reported not using marijuana, past month marijuana users were 8.9 times more likely to report past-month cigarette use (23.6% vs. 2.7%); 5.6 times more likely to report alcohol use (44.6% vs. 8.0%); 7.9 times more likely to report binge alcohol use (27.5% vs. 3.5%); 15.8 times more likely to report heavy alcohol use (5.9% vs. 0.4%); 9.9 times more likely to report illicit drug other than marijuana use (21.7% vs. 2.2%). Youth who never used marijuana in their lifetime reported far lower lifetime rates of cigarette, alcohol and non-marijuana illicit drug use (Table 1).

Associations between alcohol use and use of tobacco, marijuana, other illicit drugs

Youth who used alcohol in the past month were much more likely to use cigarettes, marijuana, and other illicit drugs than youth who chose not to use alcohol in the past month (Table 2). As the intensity of alcohol use increased, the prevalence of tobacco, marijuana and other illicit drug use increased in tandem with highest use recorded in heavy alcohol users. After adjusting for age, sex, and race/ethnicity, compared to youth who reported no past-month alcohol use, youth with past-month alcohol use but without past-month binge or heavy alcohol use were 5.8 times more likely to report past-month marijuana use (20.0% vs. 3.5%); 4.8 times more likely to report past-month illicit drug use other than marijuana (10.5% vs. 2.2%); and 3.8 times more likely to report past-month cigarette use (9.4% vs. 2.5%). By contrast, compared to youth who reported no past-month alcohol use, youth with past-month binge alcohol use but without heavy alcohol use were: 9.9 times more likely to report past-month marijuana use (34.3% vs. 3.5%); 7.6 times more likely to report past-month illicit drug use other than marijuana (16.4% vs. 2.2%); and 8.1 times more likely to report past-month cigarette use (20.4% vs. 2.5%). Furthermore, compared to youth who reported no past-month alcohol use, youth with past-month heavy alcohol use were: 15.7 times more likely to report past-month

**Table 1**  
Age, sex, and race/ethnicity adjusted past-month and lifetime prevalence of cigarette, alcohol, and illicit drug other than marijuana use among youth aged 12–17, by marijuana use status (n = 17,000<sup>a</sup>).

Past-month adjusted prevalence in the past month + Among past-month marijuana users	Cigarette use		Illicit drug other than marijuana use		Alcohol use		Binge alcohol use		Heavy alcohol use	
	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)
Among those who did not use marijuana	2.7 (0.16)	1.0	2.2 (0.14)	1.0	8.0 (0.28)	1.0	3.5 (0.19)	1.0	0.4 (0.06)	1.0
Among past-month marijuana users	23.6 (1.47)	8.9 (7.43–10.54)	21.7 (1.85)	9.9 (7.99–12.30)	44.6 (1.65)	5.6 (5.05–6.15)	27.5 (1.52)	7.9 (6.78–9.31)	5.9 (0.71)	15.8 (10.26–24.28)
Lifetime adjusted prevalence	Cigarette use		Illicit drug other than marijuana use		Alcohol use		Binge alcohol use		Heavy alcohol use	
	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)
Among never marijuana users +	5.9 (0.26)	1.0	8.2 (0.30)	1.0	20.8 (0.42)	1.0	7.3 (0.42)	1.0	20.8 (0.42)	1.0
Among lifetime marijuana users	49.6 (1.37)	8.4 (7.57–9.30)	39.0 (1.28)	4.8 (4.29–5.26)	73.0 (1.26)	3.5 (3.32–3.70)	73.0 (1.26)	3.5 (3.32–3.70)	73.0 (1.26)	3.5 (3.32–3.70)

Data source: the 2014 National Survey on Drug Use and Health, CBHSQ, SAMHSA.  
<sup>a</sup> SAMHSA requires that any description of overall sample sizes based on the restricted-use data files has to be rounded to the nearest 100 to minimize potential disclosure risk. AP = age, sex, and race/ethnicity adjusted prevalence; SE = standard error; ARR = adjusted risk ratio; CI = confidence interval.

marijuana use (54.0% vs. 3.5%); 16.8 times more likely to report past-month illicit drug use other than marijuana (36.2% vs. 2.2%); and 13.4 times more likely to report past-month cigarette use (33.5% vs. 2.5%). Similarly, youth who reported lifetime alcohol use report higher rates of marijuana, other illicit drug and cigarette use than their peers who have never used alcohol (Table 2).

3.3. Associations between tobacco use and use of alcohol, marijuana, other illicit drugs

The adjusted prevalence of marijuana, other illicit drug, and alcohol use was higher among youth who smoked cigarettes compared to youth who reported not using cigarettes (Table 3). After adjusting for age, sex, and race/ethnicity, past-month cigarette smokers were 7.0 times more likely to report marijuana use in the past month (36.8% vs. 5.3%); 7.7 times more likely to report other illicit drug use (20.7% vs. 2.7%); 4.2 times more likely to report alcohol use (39.7% vs. 9.5%); 6.1 times more likely to report binge alcohol use (26.7% vs. 4.4%); and 10.4 times more likely to report heavy alcohol use (5.8% vs. 0.6%). Adjusted lifetime marijuana, other illicit drug, and alcohol use were all greater among youth who report lifetime cigarette use (Table 3). After controlling for age, sex, and race/ethnicity, 54.8% of lifetime cigarette smokers reported lifetime alcohol use, and 68.6% reported lifetime marijuana use compared to 22.9% and 8.7% of their never-smoking peers.

4. Discussion

All nonmedical drug use is illegal for youth under age 18 in the United States. Our results suggest that the decision to abstain from any drugs is associated with a lower risk of the use of all other drugs. A steadily growing percentage of American youth are refraining from any alcohol, cigarette, marijuana and other drug use, demonstrating that a youth prevention goal of “no use” is indeed attainable (Levy et al., 1975–2014; Han et al., 2017). Yet use of substances among 12–17 year-olds (Substance Abuse and Mental Health Services Administration (SAMHSA), 2015) is substantial and persistent, even though regulatory oversight prohibits use of alcohol, tobacco, marijuana by minors, and abundant evidence shows that initiation of substance use at an earlier age heightens susceptibilities to substance use disorders and other adverse consequences. Many youth prevention messages are specifically focused on individual substances (e.g., cigarettes/tobacco or alcohol), particular risks for substance use (e.g., driving after drinking) and specific amounts of use (e.g., binge drinking), all of which, while important, are part of a larger pattern of youth substance use. As valuable as these prevention efforts are, our findings suggest their effectiveness as public health and prevention strategies may be amplified if linked to efforts to reduce all other youth drug use. For example, a strong predictor of earlier future substance use disorders is early initiation age of use of a substance (Chen et al., 2009; Keyes et al., 2016; Windle & Windle, 2012), including substance-specific use of alcohol (Brook et al., 2002; DeWit et al., 2000; Grant & Dawson, 1997), nicotine (Breslau et al., 1993; Hu et al., 2012), and marijuana (Chen et al., 2005; Ellickson et al., 2004). Importantly, polysubstance use with progression to a use disorder is far more common than use of a single substance and progression to problematic use (Moss et al., 2014; Vanyukov et al., 2012; Han et al., 2017; Sartor et al., 2014).

First drug use does not come out of nowhere (Hawkins et al., 1992). It has many meaningful and complex antecedents and current factors, as has been productively studied for decades. Our main point, in contrast is simple: the crucial step for youth is the decision to use any of the widely available “recreational” drugs. That single objective step greatly increases the likelihood of the use of other drugs, regardless of sequence. Sequence conceivably can be driven by social norms, availability, and/or price. From these data, we cannot conclude that the use of an initial drug primes the brain to drive use of other drugs, that

**Table 2**  
Age, sex, and race/ethnicity adjusted past-month and lifetime prevalence of marijuana, illicit drug other than marijuana use, and cigarette use among youth aged 12–17, by level of alcohol use (n = 17,000<sup>a</sup>).

Past-month adjusted prevalence	Marijuana use		Illicit drug other than marijuana use		Cigarette use	
	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)
Among youth without past-month alcohol use + Among past-month alcohol users without binge or heavy alcohol use	3.5 (0.19) 20.0 (1.51)	1.0 5.8 (4.83–6.98)	2.2 (0.14) 10.5 (1.57)	1.0 4.8 (3.51–6.73)	2.5 (0.16) 9.4 (1.11)	1.0 3.8 (2.87–4.92)
Among past-month binge alcohol users, but not heavy alcohol users	34.3 (2.14)	9.9 (8.39–11.76)	16.4 (1.94)	7.6 (5.81–10.00)	20.4 (1.66)	8.1 (6.58–10.03)
Among past-month heavy alcohol users	54.0 (4.79)	15.7 (12.67–19.37)	36.2 (5.33)	16.8 (12.23–23.18)	33.5 (4.07)	13.4 (10.12–17.69)

  

Lifetime adjusted prevalence	Marijuana use		Illicit drug other than marijuana use		Cigarette use	
	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)
Among never alcohol users + Among lifetime alcohol users	4.4 (0.27) 37.6 (0.91)	1.0 8.5 (7.41–9.66)	6.3 (0.27) 30.4 (0.97)	1.0 4.8 (4.31–5.33)	4.5 (0.26) 32.0 (0.97)	1.0 7.1 (6.21–8.14)

Data source: the 2014 National Survey on Drug Use and Health, CBHSA, SAMHSA.  
<sup>a</sup> SAMHSA requires that any description of overall sample sizes based on the restricted-use data files has to be rounded to the nearest 100 to minimize potential disclosure risk. AP = age, sex, and race/ethnicity adjusted prevalence; SE = standard error; ARR = adjusted risk ratio; CI = confidence interval.

initiation of “one drug” or “another drug” is the biological trigger. From these data we see that alcohol, cigarettes and marijuana are the three gateway drugs to other drugs for American youth. This conclusion builds on the work of Kandel (Kandel & Faust, 1975) and Palmer (Palmer et al., 2012) that explored initiation of single drug use as a link to progressive use of other unique drugs. Our data show that the risk of other drug use is elevated with any youth drug use, and is not specific to either the first drug used or the second or the third.

Our nationally representative data show unequivocally, that use of marijuana, alcohol, or cigarettes during early to middle adolescence, is associated with far higher rates of use of the remaining two drug categories, and of other illicit drugs. These findings have significant implications for future prevention, public health policies, and programs. Contrary to the idea that underage alcohol use is an innocuous rite of passage (Schwartz et al., 1999), alcohol use is associated with greater likelihood of using other substances, each of which poses unique risks to health, mental health, educational achievement, and social function.

Among past-month alcohol users without binge or heavy alcohol use, 20.0% used marijuana in the past month, 10.5% used cigarettes, and 9.4% used non-marijuana illicit drugs. The corresponding rates for youth without past-month alcohol use were far lower and ranged from 2.5% to 3.5%. Binge or heavy alcohol use did not preclude or substitute for use of other drugs, as the prevalence of tobacco, marijuana, or other illicit drugs was even higher among youth with more problematic alcohol consumption.

Past-month marijuana use among youth was associated with approximately 8-fold or higher rates of illegal use of binge and heavy alcohol use, cigarettes and other drugs, compared with youth who did not use marijuana. The longer term effects of marijuana with early initiation are increasingly apparent (Agrawal et al., 2004; Blanco et al., 2016; D’Souza et al., 2016). As anticipated by earlier research, alcohol and cigarette use by youth was positively correlated (Moss et al., 2014). Use of all three substances is less well-recognized, with marijuana often considered as an alternative or substitute for alcohol (Subbaraman, 2016), and thought to reduce alcohol consumption among youth. Our results show that adolescent marijuana users are using more alcohol, cigarettes and illicit drugs than adolescents who do not use marijuana.

Concerning the current opioid crisis, data from the National Monitoring of Adolescent Prescription Stimulants Study (N-MAPSS, 2008–2011 in 12–18 year-olds) showed that marijuana use, former smoking and recent alcohol use were associated with a 9.3-fold higher prevalence of non-medical use of prescription opioids (Osborne et al., 2017). Although it is likely that both environmental factors and individual characteristics are likely to contribute to drug use behavior, the specific effects of drug use itself need to be considered, including brain priming to “like” or “seek” the use of other drugs. Priming of the adolescent brain by one drug to use another drug is corroborated in preclinical research in rodents, which showed that tetrahydrocannabinol (THC), the main psychoactive constituent of marijuana, primed adolescent rats to seek heroin at higher rates after maturation to adulthood, long after the THC had cleared (Ellgren et al., 2007). Conceivably, use of a drug during adolescent brain development dysregulates the common dopamine reward pathway, thereby inducing the brain to seek larger drug-related dopamine surges rather than natural activity-related dopamine release (Huang et al., 2013). Poly-substance use cannot solely be attributable to molecular adaptations and subsequent priming, as other common risk factors and variables (e.g., psychiatric disorders, sociocultural and availability factors) also contribute to common use patterns (Wagner & Anthony, 2002).

Temporal and sequential surveys of individuals have provided evidence for several hypotheses on the sequence of substance use patterns (Mayet et al., 2016; van Leeuwen et al., 2011). Convergent theories have been used to explain patterns of substance use among youth (van Leeuwen et al., 2011). One theory is a substance-specific risk, also known as the gateway hypothesis, which outlines a specific progressive sequence of drug involvement, primed by one or more specific drugs

**Table 3** Age, sex, and race/ethnicity adjusted past-month and lifetime prevalence of marijuana, illicit drug other than marijuana use, and alcohol use among youth aged 12–17, by cigarette use status (n = 17,000<sup>a</sup>).

Past-month adjusted prevalence	Marijuana use			Illicit drug other than marijuana use			Alcohol use			Binge alcohol use			Heavy alcohol use		
	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	
Among those who did not smoke cigarettes in the past month+	5.3 (0.24)	1.0	2.7 (0.16)	1.0	9.5 (0.30)	1.0	4.4 (0.21)	1.0	0.6 (0.07)	1.0					
Among past-month cigarette smokers	36.8 (1.96)	7.0 (6.07–8.10)	20.7 (2.03)	7.7 (6.15–9.70)	39.7 (2.03)	4.2 (3.72–4.69)	26.7 (1.76)	6.1 (5.20–7.14)	5.8 (0.81)	10.4 (7.03–15.26)					
Lifetime adjusted prevalence	Marijuana use			Illicit drug other than marijuana use			Alcohol use								
	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	AP (SE)	ARR (95% CI)	
Among never cigarette smokers +	8.7 (0.32)	1.0	1.0	8.8 (0.29)	1.0	1.0	22.9 (0.44)	1.0							
Among lifetime cigarette smokers	54.8 (1.29)	6.3 (5.77–6.86)	6.3 (5.77–6.86)	40.0 (1.33)	4.5 (4.13–4.96)	68.6 (1.34)	3.0 (2.83–3.16)								

Data source: the 2014 National Survey on Drug Use and Health, CBHSQ, SAMHSA.  
<sup>a</sup> SAMHSA requires that any description of overall sample sizes based on the restricted-use data files has to be rounded to the nearest 100 to minimize potential disclosure risk. AP = age, sex, and race/ethnicity adjusted prevalence; SE = standard error; ARR = adjusted risk ratio; CI = confidence interval.

that function as a gateway for the use of other substances (Kandel & Kandel, 2015; Woodcock et al., 2015). Empirical data supporting the “gateway hypothesis” showed two transitions in the progression of substance use: initiation of legal substance use (alcohol, tobacco) progressing to marijuana use within 5–6 months, and then proceeding to use of less-common illicit drugs such as cocaine or heroin, with prevalence far greater among marijuana users (Kandel & Faust, 1975). Empirical evidence in support of this hypothesis is mixed (Mackesy-Amity et al., 1997), with criticism based on the contribution of environmental factors (access to drugs, poor parenting, and environment), or psychiatric disorders (Degehardt et al., 2009; Tarter et al., 2006; Tarter et al., 2012).

A second theory is a generalized risk for use across substances (Degehardt et al., 2009; Fergusson et al., 2006; Huizink et al., 2010) not patterned by sequential drug use. As a predictor of substance use disorder, the generalized risk factor concept assumes the influence of individual liability (e.g., risk-seeking behaviors, personality and psychiatric disorders, genetics) and environmental factors (e.g., peer influences, parenting practices). The concept also leans heavily on evidence that the liability for substance use disorders is similar for different substances, especially early initiation of use, heavy initial use, and genetic factors (Palmer et al., 2012).

Our data set is unable to resolve whether marijuana, or alcohol, or cigarette initiation primes youth to seek and consume other substances. Instead, the choice of either using or not using marijuana serves as a significant marker for an elevated risk of using alcohol, having binge or heavy alcohol use, cigarette smoking and consumption of other illicit drugs. Importantly, youth prevention efforts need to focus on all drugs as the empirical evidence underscores a generalized risk for substances consumed by youth, based on the use of any one of the three most common drugs: tobacco cigarettes, alcohol, and marijuana. In addition, our results suggest the value and importance for screening for all substances, particularly as use of one substance by an adolescent is likely to be associated with use of others. If a single screening question inquires on the use of tobacco or alcohol, a positive screen for one substance in an adolescent should routinely trigger screening for an array of substances.

This study has several limitations. NSDUH does not include youth that are homeless, living in shelters or residing in institutions. Furthermore, NSDUH does not identify the use of electronic cigarettes, which has become common among youth. Also, because of the cross-sectional nature of NSDUH data, this study could not establish temporal or causal relationships and long-term outcomes. Finally, NSDUH is a self-reported survey and is subject to recall and social desirability bias.

### 5. Conclusions

Since the majority of substance use disorders can be traced to initiation during adolescence, focusing on preventing substance use during adolescence is a public health imperative. This study's finding that among youth, use of any one substance significantly increases the prevalence of other substance use supports the inclusion of universal prevention interventions, which increase the percentage of adolescents making the choice to not use any of these addicting substances. This objective is both in the interest of adolescent health and of reducing the prevalence of addiction to any drug.

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### Conflict of interest

Drs. DuPont, Han and Ms. Shea have no conflicts to disclose. Dr. Madras has consulted for Guidepoint and RiverMend Health.

## Human participation protection

The data collection protocol of the National Survey on Drug Use and Health was approved by the Institutional Review Board at the RTI International.

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