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Inhalant initiation and the relationship of inhalant use to the use of other substances

Stephen R. Shamblen[1,3] and **Ted Miller**[2]

[1] Pacific Institute for Research and Evaluation—Louisville Center

[2] Pacific Institute for Research and Evaluation—Calverton Center

Abstract

Conventional wisdom suggests that inhalant use is primarily isolated to youthful experimentation; however, a growing body of evidence suggests that inhalant use (1) occurs after use of common substances of experimentation (e.g., alcohol, marijuana), (2) can persist into later life, and (3) is associated with severe consequences. The current study examined the sequencing of substances relative to inhalants and the post-initiation correlates of inhalant use between youth and young adulthood in nationally representative Add Health data. Analyses examined the relationship of substance of initiation to use of other substances, as well as an examination of the relationship between substance use and consequences. The analyses suggest that (1) those initiating their substance use careers with inhalants often go on to use hard drugs, (2) inhalant use likely occurs after alcohol and marijuana use, and (3) inhalant use during adolescence was associated with health and criminal consequences in both adolescence and young adulthood.

Inhalant use is defined as the intentional inhalation of volatile solvents, nitrates, gases, or aerosols for their euphoric effects. Inhalable products are often readily available to youth (Beauvais & Oetting, 1998). In 2009, 9% of 8th graders, 6% of 10th graders, and 4% of 12th graders had used inhalants in the past year (Johnston, O'Malley, Bachman, & Schulenberg, 2009). Although inhalant use is commonly considered a problem that is isolated to youthful experimentation, it often persists. A widely cited review (Beauvais & Oetting ,1998) observes that: (1) approximately half of lifetime inhalant users show signs of more frequent continued use; (2) even children under the age of 12 experiment with inhalants; (3) inhalant use among youth is episodic, waxing and waning as youth identify additional substances as abusable inhalants; and (4) inhalant use tends to be the most prevalent in small, socially isolated and economically disadvantaged populations of youth (e.g., Indian reservations). A comprehensive analysis of inhalant use among adults using the National Survey on Drug Use and Health (Wu & Ringwalt, 2006) found that 9.7% of adults ages 18 and over have used inhalants in their lifetime; however, only .5% of adults used inhalants in the past year.

Inhalant use can have substantial medical and psychological consequences including “addiction to other substances, major depression, suicide, and impaired learning and memory” (Ridenour, 2005). Relatively little is known, however, about criminal behaviors and social problems that are comorbid with inhalant use. Inhalant use is associated with gambling (Proimos, DuRant-Dagger, Pierce, & Goodman, 1998) and school dropout (Bates, Plemons, Jumper-Thurman, & Beauvais, 1997). Among people in substance abuse treatment, Shamblen and Springer (2007) found that those who had tried inhalants had rates of non-impaired driving arrests, incarceration, medical hospitalizations, and psychological

[3]All correspondence should be sent to the first author by mail (1300 S. 4th Street, Ste. 300; Louisville, KY 40208) or (sshamblen@pire.org)..

disorders comparable to those who had tried cocaine and heroin. The rates for alcohol and marijuana users were lower; although, the article did not test if the differences were significant. Although the prevalence of inhalant use is relatively low compared to alcohol and marijuana use, the consequences of even short term inhalant use are likely more severe (Kolecki & Shih, 2004; Ridenour, 2005).

This article uses nationally representative longitudinal data to estimate the harms associated with inhalant use. We applied statistical controls to apportion the harm among substances, because inhalant users often use other drugs. One aspect of harm we explore is whether youth who initiate substance abuse with inhalants are more likely to progress to hard drugs than youth who initiate with alcohol and cocaine. The literature on that topic is mixed.

Existing studies of co-occurring use of inhalants provide some insight into the sequencing of substances used. Inhalant use is correlated with the use of marijuana and injectable drugs (Dinwiddle, 1998). Among poly substance users in the 2003 National Survey on Drug Use and Health (NSDUH) who had used inhalants, fewer than 25% used marijuana, alcohol, or tobacco at a younger age than inhalants; however, more than 50% of combination users who used injectable drugs, cocaine, or methamphetamines used inhalants at the same or younger age (Ding, Chang, & Southerland, 2009). Another retrospective analysis compared young adults who used inhalants early (i.e., before age 18), those who used marijuana early, and those who used neither early. Early inhalant users were more than twice as likely to have consumed five or more drinks in one drinking episode (Bennett, Walters, Miller, & Woodall, 2000). Among adults, 50% of those who had used four illicit drugs had used inhalants (Wu & Ringwalt, 2006) and those in substance use treatment who had used inhalants in their lifetime were more than five times as likely to have used injectable drugs (Dinwiddle, Reich, & Cloninger, 1991). These sequences may not reflect causation, but rather the drug use patterns of poly-substance-using youth.

We hypothesized that (1) inhalant use would be associated with prior use of more commonly used substances like alcohol and marijuana (suggesting inhalant use follows alcohol and marijuana use) and that (2) inhalant use has relatively severe consequences (e.g., elevated crime and impaired health).

Method

Secondary Data

The present study used the first three waves of the Add Health data set (AHDS), a national longitudinal data set that follows youth from adolescence into adulthood (Harris & Udry, 2009). The AHDS comprises a two-staged stratified random sample, where US high schools were first sampled and then youth within schools were sampled. It is a cohort sequential design with youth participating in four waves of data collection. AHDS asked about lifetime use and age of initiation for alcohol, marijuana, cocaine, inhalants, and injectable drugs, as well as several health and criminal outcomes associated with substance use. We used only the first three waves, because the AHDS only collected data on inhalant use through wave 2. Despite this limitation, the data allow us to examine whether earlier inhalant use predicts later consequences.

Participating students were in grades 7–12 (M_{age}=16.49) at wave one (n=6503), were in grades 8–12 (M_{age}=16.95) at wave two (n=4833, 26% attrition from wave 1), and were ages 18–26 (M_{age}=22.79) at wave three (n=4881, 25% attrition from wave 1). Data for wave one were collected in 1994–1995, data for wave two in 1995–1996, and the data for wave three in 2001–2002. The data were almost exclusively collected in the homes of the participants using computer assisted self-interviewing to increase privacy. As the data are based on a

specific sampling design, we applied sample weights in our analyses taking sample strata into account and we used a statistical package that accounted for design effects when computing standard errors.

Participants examined in the analyses reported were well balanced on gender (51% male, 52% unweighted). They were primarily Caucasian (77%, 70% unweighted), with Latinos (11%, 10% unweighted) and African-Americans (17%, 25% unweighted) also well-represented. Attrition at waves 2 or 3 was more likely for those who were male, OR=1.34, F(1, 6372)=24.95, p<.01 and African-American, OR=1.16, F(1, 6372)=4.85, p=.03, and less likely for those who were Caucasian, OR=.68, F(1, 6372)=38.27, p<.01. The magnitude of the differences; however, was unimpressive. We accounted for differential attrition statistically by including demographic covariates in our models.

Measures

Demographic measures used were dichotomous indicators for white, black, and Hispanic (all 1=yes vs.0= no). Participants could check multiple yes responses. Age was calculated as the difference in days between when the survey was completed and self-reported birth date. Among other questions about substance use, participants were asked about whether they used a number of substances in their lifetime (inhalants, alcohol, marijuana, injectable drugs, and cocaine, which can overlap with injectable use) at each of the three waves of the study and they were asked about the age they first used these substances in the first two waves of the study. The exception was that participants were not asked about use of inhalants at wave three. These data were used to determine the substance with which each participant initiated substance use. Importantly, the survey asked “have you ever tried or used inhalants, such as glue or solvents.” Conceivably, some nitrous oxide and nitrite (popper) users might have replied “no.” Nevertheless, we find it implausible that inhalant users would not know that commonly used inhalants (e.g., nitrous oxide) are inhalants.

Participants were also asked about whether several health and criminal consequences typically associated with substance use had occurred at each of the three waves of the study. Participants were asked in the health items if they ever had a sexually transmitted disease (told by a nurse or doctor that they had chlamydia, syphilis, gonorrhea, HIV/AIDS, genital herpes, genital warts, trichomoniasis, hepatitis B, bacterial vaginosis, non-gonococcal vaginitis), whether a suicide attempt in the past 12 months required they see a doctor or nurse, and the state of their general health. All items were asked using a yes/no response format, except for the general health item, which used an excellent, very good, good, fair, and poor response scale. We performed a preliminary analysis on general health treating it as a continuous variable, but sparse responses, identical decisions about statistical significance when treating it as dichotomous or continuous, and a desire for a coherent presentation strategy led us to present the dichotomous variable. We also explored an eating disorder question, but found it too sparse to analyze and we explored an unhealthy body mass index, but do not report on it here, because it was not associated with substance use.

Participants were asked in the criminal behavior items if they had ever been expelled from school, and the past 12 month frequency of four other groups of criminal behaviors: “deliberately damage property that didn't belong to you”; “steal something worth more than $50”; “physical fight in which you were injured and had to be treated by a doctor or nurse” or “use or threaten to use a weapon to get something from someone”; and “sell marijuana or other drugs”. The response scale for expulsion was a yes/no response scale; however, the remainder of the items used a never, 1 or 2 times, 3 or 4 times, or 5 or more times response scale. These items were heavily left censored, so we dichotomized them to represent whether the behavior ever occurred in the past 12 months.

Analysis

The analyses for the present study all used the complex survey sampling modules in PASW 18 (Norusis, 2010) for performing the cross-tabs and logistic regressions reported. The first set of descriptive analyses examined lifetime substance use of each of the five substances of interest at each wave, conditional upon having initiated with a particular substance. Participants could be considered as having initiated with two substances if they used more than one substance at their age of substance use initiation.

As use of any given substance likely positively covaries with the use of other substances, we used logistic regression to control for the effects of the prior substance use pattern when examining the factors influencing the use of a specific substance at wave two or wave three. We were unable to examine cocaine and injectable substance use as dependent measures in these analyses, due to their very low base rate of occurrence. Our first set of logistic regressions examined whether lifetime use of inhalants at wave two, alcohol at waves two and three, and marijuana at waves two and three were predicted by (a) having initiated with any of the five substances examined, (b) whether the five substances were used, but not the substance of first initiation, and (c) five potential demographic confounds (gender, Caucasian race, African-American race, Latino Ethnicity, and age at wave one). As the results were more substantively interpretable, we also examined whether the lifetime use of inhalants at wave two, alcohol at waves two and three, and marijuana at waves two and three were predicted by use of any of the substances, except the dependent measure, at wave two and by the five potential demographic confounds specified in the prior set of logistic regressions.

The first set of analyses looks at having initiated with a substance as a predictor of later use of other substances, controlling for having ever used other substances and other potential confounders. The second set of analyses examines the relationship of earlier use of each substance in one's lifetime to later use of another substance, controlling for potential confounders. Thus, we distinguish between the relationships associated with initiating with a substance from those associated with having used that substance.

A set of parallel logistic regressions examined whether having initiated with a substance and having used a substance by wave two were related to eight consequences commonly associated with substance use that the ADHS measured. Our third set of logistic regressions examined whether our three health consequences (ever had STD, suicide attempt, and general health) and our five criminal consequences (expelled, damaged property, stole something greater than $50, injured in fight or threatened with a weapon, and sold drugs) were predicted by (a) having initiated with any of the five substances examined, (b) whether the five substances were used, but not the substance of first initiation, and (c) five potential demographic confounds (gender, Caucasian race, African-American race, Latino ethnicity, and age at wave one). Also, a fourth set of logistic regressions examined whether these health and criminal behavior consequences were predicted by (a) use of any of the substances, except the dependent measure, at wave two and (b) the five potential demographic confounds specified in the prior set of logistic regressions. Again, the fourth set of regressions was more substantively interpretable than the third set of regressions, which is likely a function of multicollinearity when including indicators of both initiating with a substance and having used the substance (but not first) as predictors in the same model. As with the prior models, these analyses differentiate between the relationships associated with initiating with a particular substance versus previous use of it. The third and fourth sets of models produced nearly identical patterns of results. We only report the fourth set of models.

Results

As the first column of data in Table 1 shows, alcohol was used more frequently than other substances at all waves, followed by marijuana, inhalants, cocaine, and injectable drugs. The use of all substances increased across the three waves with almost all respondents having used alcohol by wave three.

Table 1 also shows the use of other substances, given the substance(s) that the respondent used first. Participants who initiated with a particular substance often used all substances we analyzed that had a higher prevalence of use and less severe consequences. By wave three, among those who initiated substance use with inhalants, 88% had used alcohol, 82% had used marijuana, and 40% had used cocaine, but only 9% had used injectable substances.

Our regression analyses presented in Table 2 accounted for covariation between the use indicators for multiple substances. These analyses look at the substances with which participants initiate substance use. Those initiating with inhalant use generally did not follow a conventional pattern of using alcohol or marijuana. Respondents initiating with alcohol and marijuana follow a more conventional pattern of only using alcohol or marijuana. More specifically, no evidence suggested participants initiating with inhalant use were prone to use alcohol (OR_{W2}=1.07, OR_{W3}=1.38) or marijuana (OR_{W2}=.46, OR_{W3}=1.81). Although not based on model estimates due to low baserates, as can be seen in Table 1, those initiating with inhalants had proportions of subsequent cocaine (40%) and injectable (9%) use at wave three that were much higher than those initiating with alcohol or marijuana, and only rivaled by those initiating with cocaine or injectables. Those initiating with alcohol, marijuana, or cocaine had a much more conventional pattern of use, where initiating with alcohol meant subsequent inhalant use was less likely (OR_{W2}=.46), initiating with marijuana meant subsequent alcohol use was more likely (OR_{W2}=6.10, OR_{W3}=3.81), and initiating with cocaine meant subsequent marijuana use was more likely (OR_{W2}=4.00, OR_{W3}=3.62).

Table 3 shows a similar pattern in the relationships between substance use by wave two and use of other substances at waves two and three. Having used any of the substances examined by wave two was related to a higher likelihood of inhalant use by wave two. For inhalant users; elevated odds of alcohol use (OR_{W2}=1.90) were smaller than the excess odds of using illegal drugs like marijuana (OR_{W2}=3.51), cocaine (OR_{W2}=6.35), or injectables (OR_{W2}=3.46). Similarly, use of inhalants by wave two was related to higher increases in the odds of using marijuana (OR_{W2}=3.34, OR_{W3}=3.31) than alcohol (OR_{W2}=1.90, OR_{W3}=1.51).

Table 4 shows that almost all of the health and criminal behavior consequences increased in prevalence over the course of time. This includes sexually transmitted disease, suicide attempts requiring treatment, not being in very good or excellent health, theft greater than $50, injury in fights or threats with weapons, and drug sales. The prevalence of ever having been expelled from school and damaging property only increased between waves one and two. The proportion experiencing specific consequences varied with the substance used initially. Consequences were generally most likely for those initiating with injectables, followed in turn by those initiating with cocaine, inhalants, marijuana, alcohol, and lowest, for abstaining.

When partialing relationships due to using other substances, the logistic regression analyses presented in Table 5 generally suggested that adolescent use of most substances was associated with adverse events in adolescence (wave two) and adulthood (wave three). Adolescent use of inhalants was related to experiencing negative consequences even when partialling out relationships with adolescent use of other substances. These included an increased likelihood of ever having an STD (OR_{W2}=1.88), having a suicide attempt that

required treatment (OR_{W2}=2.32, OR_{W3}=2.21), damaging property (OR_{W2}=2.71, OR_{W3}=3.13), stealing something worth more than $50 ($OR_{W2}$=1.85, OR_{W3}=1.67), being injured in a fight or threatening with a weapon (OR_{W2}=2.41, OR_{W3}=1.83), and selling drugs during adolescence and adulthood (OR_{W2}=1.86, OR_{W3}=1.81).

Discussion

Nationally, inhalant use is usually indicative of poly-substance use and is associated with relatively severe consequences. Accounting for inhalant use being regionally concentrated, we found that youth inhalant users tend to have different substance use *careers* than youth who follow a more conventional substance use pattern of initiating with alcohol or marijuana. Youth who start with alcohol or marijuana stay with alcohol and marijuana. Youth who start with inhalants are less likely to move toward alcohol; they gravitate toward harder drugs. Furthermore, inhalant use during adolescence was associated with health (suicide) and criminal (property damage, theft, injury, and drug trafficking) consequences in both adolescence and young adulthood. Thus, if we conceptualize harm progressing to the use of substances with more severe consequences or consequences directly related to substance use, then the pattern of results clearly suggest that inhalants account for unique variability in harm.

Converging lines of evidence suggest that inhalant use most often occurs after initiation of alcohol and marijuana. Similar to 75% of inhalant users in NSDUH using alcohol or marijuana at the same or younger age (Ding et. al., 2009), most inhalant users in our sample at wave one had used alcohol (68%) and marijuana (55%) at an earlier age. Alcohol use likely precedes marijuana use, as proportionally more participants who initiated with alcohol had not yet used marijuana (83%) relative to the converse (20%); and marijuana use likely precedes inhalant use, as proportionally more participants who initiated with marijuana had not yet used inhalants (91%) relative to the converse (46%). Participants who *progress* to inhalant use keep using the previously used substances.

Relative to non-users, prior studies found early inhalant users had twice the odds of drinking to intoxication (Bennett et. al., 2000). Similarly, early initiators of inhalants in our sample had close to twice the odds of alcohol use relative to non-users at waves two (OR=1.90) and three (OR=1.51). Inhalant use was even more strongly associated with use of other illicit drugs.

Although few studies have quantitatively analyzed the specific health and criminal consequences that are comorbid with inhalant use and no studies analyzed the same consequences reported here, both available evidence and the current study suggest a similar magnitude of association for the effects of inhalants on consequences. Specifically, Proimos et.al. (1998) found the odds of gambling were 1.25 times greater for those who had used inhalants more than 3 times. Early initiators of inhalant use (< age 13) had about three times the odds of experiencing psychological disorders (OR=2.97 for lifetime mood disorder and OR=3.12 for lifetime personality disorder; Wu & Howard, 2007). These odds ratios are generally in line with the magnitude of our significant findings, where associations of wave two inhalant use with wave two consequences ranged between 1.85 and 2.71 and with wave three consequences ranged between 1.67 and 3.13.

A possible implication of these findings is that when youth initiate substance use, using inhalants early in one's substance use career may cross a threshold of using dangerous substances, where crossing this threshold makes it easier to use even more dangerous substances (e.g., cocaine, heroin). Those who take a more conventional course of substance use starting with alcohol or marijuana likely have a different experience, as alcohol and

marijuana are more commonly used, even by adults in the youth's social network, leading to the perception that these substances are less dangerous. This hypothesis is highly speculative, and awaits confirmation in future research.

These findings also have implications for prevention programs targeting inhalant use. In research adapting the LifeSkills program (Spoth, Randall, Trudeau, Shin, & Redmond, 2008) to Alaskan communities where inhalant use is high, a combination of a school curriculum that involved parents, as well as an environmental strategy that involved attempting to change the policies/practices of schools, retailers, and parents successfully reduced inhalant use (Gruenewald, Johnson, Shamblen, Ogilvie, & Collins, 2009; Johnson, Shamblen, Ogilvie, & Collins, 2009). These prevention efforts are clearly on target for reducing inhalant use through a reduction in availability; however, to truly remedy the harms of inhalant use, indicated prevention efforts may be necessary to reduce the likelihood of inhalant use leading to the use of substances with even greater harms.

One limitation of this research is that the survey did not clearly ascertain what substance individuals used first. Instead it ascertained the year of substance initiation. We were forced to use dichotomous substance use variables rather than richer quantity-frequency variables, because Add Health used different response scales for the same constructs/substances across years and the data on all substances except alcohol and marijuana were heavily left-censored. We also were unable to examine inhalant use during adulthood, as the Add Health survey discontinued the inhalant use item after the second wave. Finally, as is the case with all correlational studies, the relationships presented here must be considered as suggestive, as opposed to causal. However, the Add Health data set provides a credible basis for establishing these relationships as (a) the sample is nationally representative of the underlying US population and (b) the link of substance use to criminal and health consequences has been well established.

Despite these limitations, these nationally representative data clearly suggest that inhalant use is not typically a substance of youthful experimentation. Rather, inhalants are (a) a substance relatively few youth use (5.74% at wave one and 7.35% at wave two), but that users typically initiate early in their substance abuse career, (b) a substance that is related to the use of other substances typically associated with severe harms (e.g., injectables, cocaine), and (c) a strong predictor that individuals will experience negative health and criminal consequences. Youth initiating substance use with inhalants were the third most likely to experience negative health and criminal consequences, exceeded only by the small number of youth initiating with cocaine or injectables.

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Table 1

Lifetime substance use at each wave by substance of initiation.

	Overall		Inhalants First		Alcohol First		Marijuana First		Cocaine First		Injectables First	
	%	n	%	n	%	n	%	n	%	n	%	n
Inhalant W1	5.74	355	75.32	182	3.42	103	8.53	140	32.91	59	48.27	4
Inhalant W2	7.35	346	99.03	194	4.55	103	10.55	134	40.77	46	51.72	5
Alcohol W1	55.71	3,560	67.67	179	66.5	2,105	81.24	1,430	91.3	157	83.18	9
Alcohol W2	64.11	3,062	76.67	156	79.44	1,886	87.9	1,179	92.91	107	91.54	10
Alcohol W3	86.45	4,190	88.17	167	100	2,499	93.01	1,214	94.29	116	86.48	6
Marijuana W1	25.7	1,578	54.79	128	17.33	520	70.61	1,184	93.09	139	90.36	8
Marijuana W2	33.45	1,567	61.56	119	22.49	512	95.46	1,263	88.7	100	86.55	9
Marijuana W3	55.79	2,649	81.87	149	37.86	911	98.76	1,282	93.83	114	86.48	6
Cocaine W1	3.49	210	16.66	41	1.17	35	3.33	58	98.64	162	82.28	8
Cocaine W2	4.43	210	27.29	49	2.13	53	6.67	87	94.34	108	78.17	8
Cocaine W3	13.13	595	40.34	64	8.5	197	20.75	266	96.39	117	78.50	5
Injectable W1	0.66	36	3.35	6	0.21	5	0.52	9	11.06	20	91.54	10
Injectable W2	1.06	46	8.73	15	0.5	11	1.31	18	14.3	16	92.37	11
Injectable W3	1.92	89	8.23	13	1.1	27	2.74	36	14.45	19	100	8

Note: Unweighted sample sizes and weighted percentages are reported.

Table 2

Substance of initiation as a predictor of use of other substances.

	Inhalant		Alcohol		Marijuana	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**	**F**	**OR (95% CI)**
			Wave Two			
Model	F(13, 4171)=25.89, p<.001		F(13, 4171)=34.89, p<.001		F(13, 4171)=61.26, p<.001	
Nagelkerke Pseudo r²	.25		.28		.53	
df for Parameter Estimates	1, 4183		1, 4183		1, 4183	
Inhalants Used, Not First	-	-	13.82**	8.22 (2.71, 24.95)	34.46**	6.42 (3.45, 11.94)
Alcohol I Used, Not First	12.65**	3.24 (1.69, 6.19)	-	-	553.67**	84.32 (58.28, 122.02)
Marijuana Used, Not First	62.94**	7.16 (4.40, 11.65)	54.81**	40.38 (15.16, 107.53)	-	-
Cocaine Used, Not First	41.77**	6.91 (3.85, 12.43)	.06	.89 (.36, 2.21)	34.44**	17.67 (6.77, 46.14)
Injectables Used, Not First	12.38**	8.42 (2.57, 27.58)	.91	.51 (.13, 2.04)	2.11	4.47 (.59, 33.67)
Inhalants Initiated First	-	-	.08	1.07 (.66, 1.74)	2.96+	.46 (.19, 1.11)
Alcohol Initiated First	5.05*	.62 (.41, .94)	-	-	10.14*	1.52 (1.17, 1.96)
Marijuana Initiated First	.00	1.00 (.51, 1.93)	261.36**	6.10 (4.90, 7.60)	-	-
Cocaine Initiated First	.72	1.42 (.63, 3.17)	.07	1.14 (.43, 3.00)	5.34*	4.00 (1.23, 12.96)
Injectables Initiated First	1.53	.27 (.03, 2.15)	.03	1.24 (.11, 14.39)	.00	1.04 (.03, 42.03)
			Wave Three			
Model			F(13, 3193)=11.67, p<.001		F(12, 3205)=37.26, p<.001	
Nagelkerke Pseudo r²			.15		.43	
df for Parameter Estimates			1, 3205		1, 3216	
Inhalants Used, Not First	-	-	4.84*	9.41 (1.28, 69.38)	38.75**	14.29 (6.18, 33.01)
Alcohol I Used, Not First	-	-	-	-	307.51**	72.85 (45.10, 117.66)
Marijuana Used, Not First	-	-	16.46**	18.17 (4.47, 73.76)	-	-
Cocaine Used, Not First	-	-	3.14+	.42 (.16, 1.10)	13.38**	45.16 (5.86, 348.13)
Injectables Used, Not First	-	-	.61	.52 (.10, 2.74)	-	-
Inhalants Initiated First	-	-	.95	1.38 (.72, 2.66)	1.80	1.81 (.76, 4.31)

	Inhalant		Alcohol		Marijuana	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**	**F**	**OR (95% CI)**
Alcohol Initiated First	-	-	-	-	18.21 **	1.73 (1.35, 2.23)
Marijuana Initiated First	-	-	62.65 **	3.81 (2.74, 5.31)	-	-
Cocaine Initiated First	-	-	3.49 +	.37 (.13, 1.05)	4.50 *	3.62 (1.10, 11.88)
Injectables Initiated First	-		.27	.52 (.05, 5.96)	.01	.94 (.19, 4.74)

Note: An intercept, participant age at W1, and dummy variables representing gender, Caucasian race, African-American race, and Latino ethnicity also were included in the model. The full table is available upon request from the first author.

** $p < .01$,

* $p < .05$,

+ $p < .10$

Table 3

Substance use as a predictor of use of other substances.

	Inhalant		Alcohol		Marijuana	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**	**F**	**OR (95% CI)**
			Wave Two			
Model	F(9, 4664)=33.26, p<.001		F(9, 4664)=59.62, p<.001		F(9, 4664)=56.19, p<.001	
Nagelkerke Pseudo r²	.21		.28		.32	
df for Parameter Estimates	1, 4672		1,4672		1,4672	
Inhalant W2	-	-	9.87 *	1.90 (1.27, 2.84)	60.89 **	3.34 (2.47, 4.52)
Alcohol W2	10.29 *	1.90 (1.28, 2.81)	-	-	349.83 **	9.23 (7.31, 11.65)
Marijuana W2	60.90 **	3.51 (2.56, 4.81)	356.56 **	9.23 (7.33, 11.63)	-	-
Cocaine W2	84.92 **	6.35 (4.29, 9.41)	.35	1.23 (.62, 2.42)	62.07 **	12.91 (6.83, 24.40)
Injectable W2	9.33 *	3.46 (1.56, 7.67)	.15	.80 (.26, 2.49)	1.74	2.41 (.65, 8.94)
			Wave Three			
Model			F(9, 3686)=16.98, p<.001		F(9, 3697)=46.80, p<.001	
Nagelkerke Pseudo r²			.13		.23	
df for Parameter Estimates			1, 3694		1, 3705	
Inhalant W2	-	-	1.88	1.51 (.84, 2.70)	32.32 **	3.31 (2.19, 5.00)
Alcohol W2	-	-	-	-	292.71 **	4.56 (3.83, 5.42)
Marijuana W2	-	-	76.36 **	6.41 (4.22, 9.72)	-	-
Cocaine W2	-	-	5.48 *	.41 (.19, .87)	25.09 **	11.10 (4.33, 28.46)
Injectable W2	-		.04	.84 (.15, 4.65)	15.39 **	64.83 (8.06, 521.36)

Note: An intercept, participant age at W1, and dummy variables representing gender, Caucasian race, African-American race, and Latino ethnicity also were included in the model. The full table is available upon request from the first author.

** $p < .01$,

* $p < .05$,

+ $p < .10$

Table 4

Substance with which participant initiated by substance-related consequences at each wave.

	Wave	Overall		Inhalants First		Alcohol First		Marijuana First		Cocaine First		Injectables First	
		%	n	%	n	%	n	%	N	%	n	%	n
	1	2.36	175	4.93	10	2.17	74	3.91	86	9.28	15	19.14	2
	2	3.87	203	10.37	18	3.48	88	6.25	96	13.05	15	19.14	2
Ever Had STD	*3*	9.72	519	14.35	27	8.98	253	16.34	220	18.59	24	0	0
	1	1.02	66	4.33	13	0.81	24	1.96	32	6.19	12	32	4
	2	1.64	82	6.38	16	1.44	33	3.3	44	7.57	10	32	4
Suicide Attempt that Required Treatment	*3*	2.63	129	5.84	13	2.32	55	4.11	51	8.33	13	34.4	4
	1	32.42	2,041	43.39	104	30.92	959	36.53	625	55.2	92	57.59	7
	2	44.44	2,079	54.87	106	43.63	1,004	50.5	660	62.23	74	57.59	7
Not in Very Good or Excellent Health	*3*	46.66	2,221	58.03	103	44.69	1,092	51.81	668	57.61	74	51.61	5
	1	4.78	299	7.8	17	4.27	126	6.97	119	13.86	25	9.94	1
	2	5.78	269	8.84	17	5.28	121	9.07	114	20.29	22	9.16	1
Expelled from School	*3*	5.38	201	9.33	14	5.23	96	8.59	83	17.88	15	0	0
	1	18.69	1,140	39.01	97	16.85	502	27.73	479	43.11	75	67.76	8
	2	27.24	1,240	50.76	103	25.4	575	38.62	495	48.46	59	67.76	8
Damaged Property	*3*	26.4	1,222	48.87	92	24.18	578	35.48	437	42.67	58	63.09	5
	1	5.05	324	14.99	36	4.36	136	8.11	148	28.39	47	74	8
	2	8.35	391	24.06	47	6.9	167	14.22	183	38.68	42	74.83	9
Stole Something Greater than $50	*3*	8.92	417	21.63	38	7.61	183	13.71	177	31.44	38	74.4	6
	1	4.05	262	14.73	33	3.43	104	6.13	117	16.6	28	74	8
	2	6	353	20.06	47	5.44	154	9.41	161	19.17	28	74.83	9
Injured in Fight or Threatened with Weapon	*3*	7.12	349	20.68	37	6.27	157	10.36	142	21.14	27	74.4	6
	1	7.47	457	23.05	56	5.46	159	15.01	260	52.38	89	66.67	7
	2	11.34	527	28.94	56	8.82	197	25.02	335	59.14	67	67.5	8
Sold Drugs	*3*	14.47	676	30.86	55	10.99	261	27.2	351	44.06	57	76.09	6

Note: Unweighted sample sizes and weighted percentages are reported.

Table 5

Substance use as a predictor of health and criminal behavior consequences.

	Ever Had STD		Suicide Attempt that Required Treatment		Not in VG or Excel. Health	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**	**F**	**OR (95% CI)**
				Wave 2		
Model	F(10, 4656)=24.63, p<.001		F(10, 4663)=11.08, p<.001		F(10, 4663)=13.33, p<.001	
Nagelkerke Pseudo r²	.21		.15		.05	
df for Parameter Estimates	1, 4665		1, 4672		1, 4672	
Lifetime Inhalant Use W2	5.32*	1.88 (1.10, 3.22)	6.68*	2.32 (1.23, 4.40)	3.69+	1.30 (1.00, 1.70)
Lifetime Alcohol Use W2	2.44	1.46 (.91, 2.33)	1.33	1.52 (.75, 3.08)	7.54*	1.24 (1.06, 1.45)
Lifetime Marijuana Use W2	18.16**	2.35 (1.59, 3.49)	31.51**	4.98 (2.84, 8.72)	16.39**	1.40 (1.19, 1.64)
Lifetime Cocaine Use W2	5.16*	2.05 (1.10, 3.81)	4.76*	2.32 (1.09, 4.94)	5.82*	1.56 (1.09, 2.23)
Lifetime Injectable Use W2	7.30*	4.09 (1.47, 11.37)	1.48	2.01 (.65, 6.19)	.23	1.20 (.57, 2.51)
				Wave 3		
Model	F(10, 3683)=25.48, p<.001		F(10, 3685)=8.31, p<.001		F(10, 3685)=10.08, p<.001	
Nagelkerke Pseudo r²	.17		.10		.05	
df for Parameter Estimates	1, 3692		1, 3694		1, 3694	
Lifetime Inhalant Use W2	.52	1.17 (.77, 1.78)	5.69*	2.21 (1.15, 4.22)	1.03	1.17 (.86, 1.59)
Lifetime Alcohol Use W2	3.82+	1.38 (1.00, 1.90)	1.81	1.43 (.85, 2.42)	14.60**	1.39 (1.17, 1.64)
Lifetime Marijuana Use W2	38.38**	2.58 (1.91, 3.48)	8.94*	2.07 (1.28, 3.32)	11.25*	1.37 (1.14, 1.64)
Lifetime Cocaine Use W2	4.55*	1.70 (1.04, 2.76)	2.93+	2.06 (.90, 4.69)	3.73+	1.53 (.99, 2.37)
Lifetime Injectable Use W2	1.67	1.87 (.72, 4.85)	2.62	3.53 (.77, 16.30)	.00	.97 (.38, 2.50)

	Expelled from School		Damaged Property		Stole Something Greater than $50	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**	**F**	**OR (95% CI)**
				Wave 2		
Model	F(10, 4660)=17.50, p<.001		F(10, 4663)=35.43, p<.001		F(10, 4663)=29.11, p<.001	
Nagelkerke Pseudo r²	.16		.17		.19	
df for Parameter Estimates	1, 4669		1, 4672		1, 4672	
Lifetime Inhalant Use W2	.87	.76 (.43, 1.35)	46.21**	2.71 (2.03, 3.61)	11.43*	1.85 (1.29, 2.64)

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	Expelled from School		Damaged Property		Stole Something Greater than $50	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**	**F**	**OR (95% CI)**
Lifetime Alcohol Use W2	9.09 *	1.87 (1.24, 2.81)	51.20 **	2.13 (1.73, 2.63)	14.89 **	2.01 (1.41, 2.86)
Lifetime Marijuana Use W2	20.10 **	2.30 (1.60, 3.30)	56.87 **	2.02 (1.68, 2.43)	58.19 **	3.02 (2.28, 4.02)
Lifetime Cocaine Use W2	13.00 **	2.71 (1.58, 4.67)	.62	.86 (.58, 1.26)	14.72 **	2.28 (1.50, 3.48)
Lifetime Injectable Use W2	1.15	1.75 (.63, 4.85)	6.84 *	2.74 (1.29, 5.83)	36.91 **	9.73 (4.67, 20.27)
			Wave 3			
Model	F(10, 3685)=14.45, p<.001		F(10, 3685)=30.56, p<.001		F(10, 3685)=20.87, p<.001	
Nagelkerke Pseudo r²	.16		.19		.17	
df for Parameter Estimates	1, 3694		1, 3694		1,3694	
Lifetime Inhalant Use W2	.05	.93 (.51, 1.72)	45.45 **	3.13 (2.24, 4.35)	6.36 *	1.67 (1.12, 2.48)
Lifetime Alcohol Use W2	11.28 *	2.27 (1.41, 3.67)	39.31 **	1.99 (1.61, 2.47)	13.86 **	1.86 (1.34, 2.58)
Lifetime Marijuana Use W2	18.05 **	2.44 (1.62, 3.69)	40.18 **	1.92 (1.57, 2.34)	35.69 **	2.41 (1.81, 3.22)
Lifetime Cocaine Use W2	5.53 *	2.23 (1.14, 4.35)	.14	.92 (.58, 1.45)	12.39 **	2.39 (1.47, 3.89)
Lifetime Injectable Use W2	.26	.68 (.16, 2.93)	8.92 *	5.12 (1.75, 14.97)	20.07 **	11.39 (3.93, 33.02)

	Injured in Fight or Threatened with Weapon		Sold Drugs	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**
		Wave 2		
Model	F(10, 4663)=27.54, p<.001		F(10, 4663)=51.33, p<.001	
Nagelkerke Pseudo r²	.19		.39	
df for Parameter Estimates	1, 4672		1, 4672	
Lifetime Inhalant Use W2	21.82 **	2.41 (1.67, 3.49)	12.24 **	1.86 (1.32, 2.64)
Lifetime Alcohol Use W2	27.54 **	2.96 (1.97, 4.44)	31.91 **	3.73 (2.36, 5.88)
Lifetime Marijuana Use W2	19.63 **	2.01 (1.48, 2.73)	210.79 **	10.41 (7.59, 14.28)
Lifetime Cocaine Use W2	12.61 **	2.29 (1.45, 3.61)	39.66 **	3.41 (2.33, 5.00)
Lifetime Injectable Use W2	21.82 **	5.86 (2.79, 12.32)	14.29 **	5.48 (2.27, 13.24)
		Wave 3		
Model	F(10, 3685)=18.25, p<.001		F(10, 3685)=42.21, p<.001	
Nagelkerke Pseudo r²	.15		.30	
df for Parameter Estimates	1, 3694		1, 3694	

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	Injured in Fight or Threatened with Weapon		Sold Drugs	
	F	**OR (95% CI)**	**F**	**OR (95% CI)**
Lifetime Inhalant Use W2	8.40 *	1.83 (1.22, 2.75)	10.04 *	1.81 (1.26, 2.62)
Lifetime Alcohol Use W2	20.14 **	2.37 (1.63, 3.46)	37.41 **	2.73 (1.98, 3.76)
Lifetime Marijuana Use W2	13.76 **	1.80 (1.32, 2.45)	153.38 **	4.75 (3.72, 6.09)
Lifetime Cocaine Use W2	10.59 *	2.31 (1.40, 3.83)	12.37 **	2.22 (1.42, 3.45)
Lifetime Injectable Use W2	15.34 **	8.25 (2.87, 23.71)	10.06 *	7.94 (2.21, 28.56)

Note: An intercept, participant age at W1, and dummy variables representing gender, Caucasian race, African-American race, and Latino ethnicity also were included in the model. The full table is available upon request from the first author.

** $p < .01$,

* $p < .05$,

+ $p < .10$