

Inhalant use among incarcerated adolescents in the United States: Prevalence, characteristics, and correlates of use[☆]

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Abstract

Objective: To characterize patterns and correlates of inhalant use among incarcerated youth.

Method: Residents ($N=723$) of 27 Missouri Division of Youth Services facilities completed interviews assessing substance use, psychiatric symptoms, antisocial traits, trauma, suicidality, and criminality.

Results: Participants averaged 15.5 (S.D. = 1.2) years of age, were ethnically diverse, and predominantly male. More than one-third (36.9%) reported lifetime inhalant use; 47.9% of users had tried four or more inhalant products. Comparatively high rates of use were observed for Hispanic and small town/rural youth. Commonly abused agents included gasoline (22%), permanent markers (15%), computer “air duster,” (15%) and spray paint (12%). Inhalant users evidenced significantly higher levels of criminal behavior, antisocial attitudes, current psychiatric symptoms, earlier onset of offending and substance use, and more extensive histories of head injury, kidney disease, hormonal problems, mental illness, suicidality, trauma, and substance-related problems than nonusers. In multiple logistic regression models, race/ethnicity, geographic area of residence, fearlessness, suicidality, and polydrug use distinguished inhalant users and nonusers. Measures of cognitive impairment, impulsivity, fearlessness, blame externalization, polydrug use, and substance-related problems were positively associated with lifetime frequency of inhalant use.

Conclusions: Inhalant use was widespread in this sample and associated with serious physical and mental health impairments.

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1. Introduction

Inhalant use is among the most prevalent, pernicious, and poorly understood forms of adolescent drug use (Lubman et al., 2006). The most commonly abused inhalants among U.S. adolescents are glue, shoe polish, toluene, lighter fluid, and gasoline (Wu et al., 2004), although varied mixtures of chemicals are found in scores of commercially available and widely

abused products. Inhalant users may inhale vapors from a rag soaked with a substance, a bag into which a substance has been deposited, or directly from a container. Intoxication is marked by slurred speech, ataxia, stupor and other signs similar to alcohol intoxication (American Psychiatric Association (APA), 2000). Some users who repeatedly administer inhalants in order to maintain a preferred level of intoxication develop inhalant use disorders (Anthony et al., 1994).

Serious neuropsychiatric and social problems can attend inhalant use. In clinical studies, recurrent inhalant use is associated with conditions such as Parkinsonism, cerebellar ataxia, encephalopathy, trigeminal neuropathy, hepatotoxicity, heptorenal syndrome, delayed neurological recovery, and deaths due to

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drug actions and accidents (e.g., Byard et al., 2006; Doring et al., 2002; Finch and Lobo, 2005; Hahn et al., 2006). Neurological findings in inhalant abusers can include cerebral atrophy, thinning of the corpus callosum, and lesions of the pyramidal tract/cranial nerve signs (e.g., Yamanouchi et al., 1995). Long-term learning, memory, and attentional impairments can follow even a single exposure to an inhalant (Stollery, 1996). Prior studies have also identified significant associations between inhalant use and delinquency, conduct disorder, polydrug use, depression, suicidality, paranoid psychoses, impulse control and anxiety disorders (e.g., Kelly et al., 2002; Sakai et al., 2004).

Wu et al. (2004) estimated rates of inhalant use for 12–17 year-olds in the U.S. using data obtained from the 2000/2001 administrations of the National Household Survey on Drug Abuse. Approximately, 9% of the 36,850 respondents reported inhalant use. Lifetime inhalant use prevalence rates did not differ significantly by gender or family income. American Indian and multiracial youth had comparatively high rates of inhalant use, as did youth from non-metropolitan areas, polydrug users, and respondents with a history of antisocial behavior, foster care placement or mental health treatment. One of the study's limitations, Wu et al. (2004) acknowledged, was its systematic exclusion of incarcerated/institutionalized youth who may be at high risk for inhalant use and related consequences.

Large studies of clinical and juvenile justice populations incorporating comprehensive face-to-face assessments of inhalant use are rare. Sakai et al. (2004) examined 847 youth referred to a university residential/day treatment program for substance use and behavior disorders. Approximately 18% of youth reported lifetime inhalant use (i.e., glue, toluene, gasoline, paint, paint thinner, or Freon). Inhalant users did not differ significantly from nonusers with regard to age or gender, but users were significantly more likely to evince a lifetime history of major depression (23% vs. 12%), previous suicide attempt (27% vs. 15%), and conduct disorder (93% vs. 81%). Inhalant users were also significantly more likely than nonusers to evidence other substance use disorders and to report a history of neglect and physical or sexual abuse.

Incarcerated youth are thought to be at high risk for inhalant use (Mackesy-Amiti and Fendrich, 1999). However, studies of delinquent youth conducted to date have generally relied on small samples (e.g., Jacobs and Ghodese, 1988) and/or employed limited assessments of inhalant use and associated psychiatric syndromes (e.g., McGarvey et al., 1999).

McGarvey et al. (1996) evaluated youth ($N=619$) incarcerated within juvenile correctional facilities in Virginia and reported that 14.6% of the sample had used inhalants. However, it was not clear how youth were sampled, no refusal rate for study recruitment efforts was presented, and the inhalant use assessment was limited to a few agents and included amyl nitrite. Nitrite inhalants, nitrous oxide, and volatile solvents have different profiles of effects and show different patterns of use, so it is important to distinguish among them in research (Balster, 1998).

This report presents findings from one of the largest and most extensive assessments of inhalant use heretofore conducted with incarcerated youth. Specific aims of the project were to: (1)

examine the epidemiology of inhalant use in a state population of incarcerated youth including the lifetime prevalence, types, perceived effects, and modes of inhalant use, (2) assess patterns of inhalant use including reasons for starting and stopping use, places and times inhalants were most commonly used, subjective experiences of intoxication in association with inhalant use, prevalence of polyinhalant use, inhalant use by respondents' friends and siblings, and the perceived dangerousness of inhalants, severity of lifetime problem with inhalants, and estimated likelihood that inhalants would be used following release, (3) compare lifetime inhalant users to nonusers with regard to demographic characteristics, current and lifetime psychiatric symptoms, substance use and related problems, suicidality, trauma history, and antisocial behavior and traits, and (4) examine factors that predict frequency of lifetime inhalant use within the sample of lifetime inhalant users.

2. Methods

2.1. Study sample

Residential rehabilitation services of the Missouri Division of Youth Services (DYS) are provided at 27 facilities statewide. Facilities range in size from 8 to 102 beds. DYS is the legal guardian of residents ages 13–17 committed to its care by the state's juvenile courts. The DYS client population is representative of incarcerated youth nationally with regard to the age, gender and number of state youth incarcerated per 100,000 adolescents (Sickmund, 2002).

The 4 DYS regions were targeted for interviewing in sequential order. Residential facilities within each region were interviewed sequentially. All residents at a facility were recruited for participation at the time interviewing at that facility commenced. The recruitment protocol ensured that no youths who had completed the interview at one facility were reinterviewed at another facility. Interviewing was completed over a 3-month period in 2004. Youth completed the interview in one 30–90 min session, the length depending principally on the respondent's inhalant use history. Youth were allowed brief breaks during the interview if they became fatigued, but were always under the observation of a project interviewer consistent with DYS policy.

All current DYS residents ($N=740$) were eligible to participate in the study. Ten youths were on furlough at the time of interviewing and two youths were transferred to another facility while interviewers were at the facility, but before they could be interviewed. Of the 728 youth available to interview, all agreed to participate. However, 5 interviews were discontinued; 4 youth displayed signs or reported symptoms of psychosis and one youth chose not to continue. The 723 youth who completed the interview constituted 97.7% of DYS residents at the time interviewing was conducted, 99.3% of residents available for interviewing, and approximately 55.0% of youth committed to DYS care in the prior year. Thus, the present study is virtually a census of the population of DYS residents at the time the study was undertaken and a large, representative sample of DYS annual residents.

Interviews were conducted by 15 graduate social work student interviewers; 7 core interviewers completed 530 (73.3%) interviews. Interviewers completed an intensive 1-day training session and an interview editor was on-site at each facility as youth were interviewed to minimize interviewer errors. Interviews were conducted in large rooms at each facility that provided private areas where confidential one-on-one interviews could be conducted. Before each interview commenced, interviewers ensured that they and the respondent were comfortable that their responses could not be overheard. Youth signed informed assent forms and were provided with \$10.00 to their facility monetary accounts (and a receipt for such) for completion of the interview. The informed assent form and interview protocol provided residents with detailed information about the study, the name and contact telephone number for a non-study or university-affiliated advocate who they could call for more information about the study (DYS agreed to allow youth use telephones for this purpose at any time during business hours), assured youth that they were not required to participate,

could cease participation in the interview at any point, and that their legal status would not be affected whatsoever by their participation or nonparticipation in the study. Because DYS was the legal guardian of all youth, DYS provided formal permission for youths to participate in the study. The informed consent and study protocols were approved by the Missouri DYS IRB, the Washington University Human Studies Committee IRB (operating in strict accordance with the governing regulations for research on prisoners), the project was officially certified by the federal Office of Human Research Protections, and was granted a Certificate of Confidentiality by the National Institute on Drug Abuse. All youth were provided with a thorough description of their privacy rights and a copy of a Washington University brochure, “Your Privacy Matters. . .” and with a copy of the informed assent agreement.

2.2. Measures

All youth completed the *Volatile Solvent Screening Inventory* (VSSI), an approximately 45-min interview assessing demographic characteristics, medical history, lifetime/annual use of 65 inhalants, other drug use and substance-related problems, current psychiatric symptoms, thoughts of suicide/actual suicide attempts, trauma history, antisocial traits and criminal activity. Youth reporting any lifetime use of an inhalant *in an effort to get high* also completed the *Comprehensive Solvent Assessment Interview* (CSAI), a schedule evaluating reasons for starting and stopping inhalant use, typical modes, locations, contexts and subjective effects of inhalant use, adverse consequences/high-risk behaviors occurring in association with acute inhalant intoxication, perceived risks of inhalant use, estimated likelihood that inhalants will be used in the future, sibling and friend’s use of inhalants, and DSM-IV Inhalant Abuse and Dependence criteria. No psychometric data are currently available regarding the composite VSSI and CSAI measures; all other measures used in this study have substantial empirical support vis-à-vis reliability and validity. The VSSI, CSAI, and extensive analyses and findings supplementary to this report can be found in the online version of this report.¹

The following measures were used in the analyses reported below.

2.2.1. Volatile solvent screening inventory (VSSI).

2.2.1.1. Demographic factors. Gender, age, self-reported racial status, grade (current or last completed), family receipt of public assistance, and geographical area of family residence (i.e., urban, suburban, small town, rural) were recorded for each youth.

2.2.1.2. Medical history. Respondents were asked to indicate whether (yes or no) they had ever experienced a head injury that caused a period of extended unconsciousness, been diagnosed with a mental disorder by a psychiatrist or other doctor, “heard voices of people who were not actually there,” or had ever suffered from major illness or injury around the time of their birth, kidney disease, hormonal disorders, blood disorders, or neurological problems such as a brain infection, brain tumor, or brain disease. Respondents were also asked to report all current medications they were taking. Due to confidentiality and logistical concerns, youths’ self-reports of medical conditions were not validated against official medical records, parental reports, or agency data. It is possible that some youth may have perceived a benefit in association with reporting medical disorders, from which they did not, in actuality, suffer or otherwise reported such disorders invalidly. Thus, the medical history self-report data should be interpreted cautiously.

2.2.1.3. Inhalant use. Respondents were questioned about their use of 55 inhalants. For each inhalant, youth were asked, “Have you ever inhaled or ‘huffed’ [inhalant] through your nose or mouth in an effort to get high?” Most youth were familiar with the term “huffing” and few respondents evidenced any difficulty in understanding the meaning of the inhalant use questions. Interviewers were carefully trained to record only inhalant use occurring in conjunction

with an acknowledged intention to get high. Among the inhalants assessed were 5 categories of paint-related products (e.g., paint thinner), 5 types of glues or cements (e.g., airplane or model glue), 1 shoe product (i.e., shoe shine/polish), 5 gases (e.g., propane), 9 types of aerosols (e.g., air freshener), 6 types of cleaning agents (e.g., spot remover), and 24 miscellaneous volatile solvents including nail polish, nail polish remover, correction fluid, gasoline, permanent markers, and carburetor cleaner. Respondents who reported any use of one or more of these 55 inhalants with the intention of getting high were considered lifetime inhalant users. Inhalation of nitrites, nitrous oxide, and other gases (e.g., helium, bottled oxygen) was not, for the purposes of this investigation, considered inhalant use consistent with current diagnostic practices (American Psychiatric Association, 2000).

If youth reported lifetime use of a specific inhalant product, they then were asked whether they actually got high when they used the inhalant (yes or no), the number of days of use of the inhalant product in their lifetime (<5, 5–10, 11–99, ≥100), the frequency of their use of the product in the year preceding incarceration (once, 2–4 times, 5–10 times, once a month, every 2–3 weeks, once a week, 2–3 times a week, once a day, and 2–3 times a day), and to indicate which one of five modes of inhalant use (spray the substance directly into your nose or mouth, sniff or inhale from a plastic bag placed over your nose, mouth, or head, sniff or inhale from a cloth or clothing saturated with the substance and placed over your nose, mouth, or head, sniff or inhale from a container, such as a jar or bottle or balloon filled with gas, other) best reflected how they most often used the inhalant. Lifetime total frequency of inhalant use was computed by summing the lifetime frequency of use measures across all inhalants ever used by each inhalant user.

2.2.1.4. Other substance use. Use of 20 categories of psychoactive substances was assessed. For each psychoactive agent, youth reported whether or not they had ever used the drug (yes or no), their age at first use of the drug, and the number of days in their lifetime (<5, 5–10, 11–99, ≥100) they had used the drug, and their frequency of use of the drug in the year prior to incarceration (once, 2–4 times, 5–10 times, once a month, every 2–3 weeks, once a week, 2–3 times a week, once a day, and 2–3 times a day).

2.2.1.5. Substance-related problems. Lifetime substance-related problems were assessed with the 8-item Alcohol/Drug Use Scale of the Massachusetts Youth Screening Instrument—2nd Version (MAYSI-2, Grisso and Barnum, 2000) developed for use with juvenile justice populations. Youth responded “yes” or “no” to questions about whether they had ever been drunk or high at school, had used alcohol and drugs at the same time, had ever been so drunk or high they could not remember what happened, used alcohol or drugs to help them feel better, had gotten into trouble while high or drinking, (if yes) whether or not that trouble had been fighting, had done anything they wished they had not while drunk or high, or had their parents think they drink too much. Scores could range from 0 to 8. Grisso and Barnum (2000) found the scale to be internally consistent ($\alpha = .86$) in their norming sample; the α coefficient in this study was .83.

2.2.1.6. Suicidal ideation and attempts. Youth completed the 5-item MAYSI-2 *Suicide Ideation* scale, which requires youth to respond “yes” or “no” to questions assessing whether or not they have ever wished they were dead, have felt like life was not worth living, have felt like hurting themselves, have felt like killing themselves, and have ever given up hope for their life. Grisso and Barnum (2000) reported a α reliability of .83; the α coefficient in this study was .91. Youth were also asked to report whether or not they “had ever actually tried to kill themselves” (yes or no).

2.2.1.7. Lifetime trauma. All respondents completed a 4-item *Traumatic Experiences* scale adapted from the MAYSI-2 ($\alpha = .69$ in the current study). Youth were asked to indicate whether or not (yes or no) they had ever seen someone severely injured or killed in person (not in the movies or on TV), had a lot of bad thoughts or dreams about a bad or scary event that happened to you, had ever been badly hurt, or been in danger of getting badly hurt or killed, and had ever in their whole lives had something very bad or terrifying happen to them.

¹ Supplementary materials can be viewed by accessing the online version of this paper at <http://dx.doi.org> by entering doi:10.1016/j.drugalcdep.2007.08.023.

2.2.1.8. Current psychiatric symptoms. All respondents completed the Brief Symptom Inventory (BSI), consisting of 53 items assessing the extent to which youth were “bothered or disturbed” (0 = not at all; 4 = extremely) by a variety of thoughts or feelings “over the last 7 days including today” (Derogatis, 1993). The BSI yields a global index of overall current psychiatric distress (possible range = 0–212, $\alpha = .96$ in current study) and scores for 9 primary symptom dimensions: Somatization, Obsessive–Compulsive, Interpersonal Sensitivity, Depression, Anxiety, Hostility, Phobic Anxiety, Paranoid Ideation, and Psychoticism. Raw scale total scores were used; subscale α reliabilities ranged from .70 to .83.

2.2.1.9. Antisocial traits. Youth completed the *Antisocial Process Screening Device* (APSD, Vitacco et al., 2003), a 20-item scale assessing features of juvenile psychopathy. Respondents were read 20 statements and asked to indicate to what extent each statement describing characteristic attitudes or behaviors was true of them (0 = not at all true, 1 = sometimes true, 2 = definitely true). The APSD yields a total score and three subscale scores assessing Impulsivity ($\alpha = .67$), Callous-Unemotional Traits ($\alpha = .35$), and Narcissism ($\alpha = .75$). The alpha reliabilities of the Callous/Unemotional Traits scale and several of the scales discussed below were low, calling into question the scalability of these measures. Findings are presented for readers’ edification, but should be interpreted cautiously for these measures.

Study participants also completed the 56-item *Psychopathic Personality Inventory Short-Version* (PPI-SV; Lilienfeld and Andrews, 1996). Youth were asked to decide to what extent each of the personality characteristics described in each statement were false or true as applied to them (1 = false, 2 = mostly false, 3 = mostly true, 4 = true). Total scores could range from 56 to 224 ($\alpha = .76$). The eight subscales of the PPI-SV include Machiavellian Egocentricity, Social Potency, Coldheartedness, Carefree Nonplanfulness, Fearlessness, Blame Externalization, Impulsive Nonconformity, and Stress Immunity (α 's = .55–.73).

2.2.1.10. Delinquent behavior. The Self-Report of Delinquency (SRD, Elliott et al., 1989) was used to assess how many times in the year before they were incarcerated youth engaged in 7 nonviolent and 10 violent crimes. Responses could range from 0 (never) to 8 (2–3 times a day) for each item. Total SRD scale scores could range from 0 to 136 ($\alpha = .84$), while the ranges of possible scores were 0–56 ($\alpha = .81$) and 0–80 ($\alpha = .73$) for the nonviolent and violent offense subscales, respectively. Youth also reported the age at which they first committed a criminal offense, had contact with the police, and were first referred to juvenile court. A 4-item victimization index ($\alpha = .76$) was used to assess frequency of personal experiences of criminal victimization in the year prior to incarceration. The response format for the victimization scale was identical to that used for SRD. Total scores could range from 0 to 32.

2.2.2. Comprehensive solvent assessment interview.

2.2.2.1. Reasons for starting and stopping inhalant use. Lifetime inhalant users were presented with a list of 20 reasons for starting inhalant use and were asked to think of a time when they were using inhalants and indicate to what extent they “strongly disagree (0), disagree (1), neither agree nor disagree (2), agree (3), or strongly agree (4), that each statement was an important reason why they started using inhalants.” Using the same response format, inhalant users were also asked to “think of a period of time when you were *not* using inhalants” and to indicate their level of agreement with each of 15 statements reflecting potential reasons for stopping inhalant use.

2.2.2.2. Perceived risks, problems, availability, and likelihood of future use of inhalants. Inhalant users were asked to indicate how much they think people risk harming themselves (0 = no risk; 3 = great risk) if they use inhalants once or twice and if they use inhalants regularly and whether they had ever had a problem with inhalants (0 = no, 1 = yes, a small problem, 2 = yes, a moderate problem, and 3 = yes, a big problem). Perceived availability of inhalants was evaluated by asking youth to report how difficult they thought it would be for them to get inhalants if they were not incarcerated (0 = probably impossible; 5 = very easy). Perceived future likelihood of inhalant use was assessed by asking youth,

“During the next year (after you are released from custody) how likely are you to use inhalants? (0 = No chance; 4 = I’m sure to).

2.2.2.3. Sibling and peer inhalant use. Inhalant users were asked, “How many of your friends use inhalants?” (0 = none; 4 = all) and, if they reported having any siblings, “How many of your brothers or sisters use inhalants?” (0 = none; 3 = 3 or more).

2.2.2.4. Contexts of use. Inhalant users were asked to select one of six *locations* where they “most often used inhalants,” one of five *time periods* during which they most often used inhalants, and to rate 15 different intrapersonal states/interpersonal contexts in terms of how often (0 = never; 3 = almost always) they used inhalants in those situations. Inhalant users also completed a 21-item scale asking them to indicate how often (0 = never; 4 = almost always) they used inhalants in each of the stated contexts.

2.3. Data analysis

Bivariate and adjusted comparisons of lifetime inhalant users and nonusers were conducted using χ^2 and logistic regression procedures for categorical variables and *t*-tests, *F*-tests, and multiple linear regression for continuous variables. Significant omnibus *F*-tests were followed by post hoc mean contrasts controlling for Type I error. Homogeneity of variance assumptions were tested and degrees of freedom adjusted as appropriate. Effect sizes were computed and presented as either odds ratios or Cohen’s *d* (Cohen et al., 2003) depending upon the analyses. We have focused on findings significant at the $p < .01$ level, to reduce the likelihood of Type I error.

3. Results

3.1. Characteristics of incarcerated youth

Table 1 provides a description of the study sample. Respondents averaged 15.5 (S.D. = 1.2) years of age and were racially diverse. Most participants were male, and lived in urban or small town areas. A substantial minority (40.3%) reported that their families currently received public assistance.

Histories of head injuries and mental illness were reported by many youth. A substantial percentage (42.3%) of youth was currently taking prescribed psychotropic medication. More than one-third of the sample (37.2%) was taking medication for Attention Deficit-Hyperactivity Disorder; 23.1% was taking antidepressants, and 12.4% and 10.0%, respectively, were taking mood stabilizers and antipsychotics. Most DYS residents had been incarcerated for ≤ 1 year; 12.2% had served 1–2 years, and 4.6% had served 2–5 years.

3.2. Lifetime inhalant use

3.2.1. Prevalence. The lifetime prevalence of inhalant use in the total sample was 36.9%. Of the 267 users, 47.9% had tried 4 or more inhalant products, whereas 20.2%, 16.1%, and 15.7% had used 1, 2, or 3 inhalants, respectively. The mean number of inhalants used by lifetime inhalant users was 4.8 (S.D. = 4.1; median = 3.0, range = 1.0–24.0). Although inhalant use was more prevalent among girls (43.6%) than boys (35.9%), and girls who had used inhalants had tried, on average, 5.0 different inhalants (S.D. = 4.1, median = 3.0, range = 1.0–16.0), whereas boys who had used inhalants had used an average of 4.7 (S.D. = 4.1, median = 3.0, range = 1.0–24.0), these differences were not statistically significant.

Table 1
Demographic and health characteristics of 723 adolescents incarcerated in 27 Missouri division of youth services residential facilities^a

Demographics	
Age N (%)	
11–12	9 (1.2)
13–14	120 (16.6)
15–16	472 (65.3)
17–18	114 (15.8)
19–20	8 (1.1)
Gender N (%)	
Male	629 (87.0)
Female	94 (13.0)
Geographic area of family residence N (%)	
Urban	283 (39.1)
Suburban	100 (13.8)
Small Town	286 (39.6)
Rural	54 (7.5)
Race N (%)	
African American	238 (33.0)
Caucasian	400 (55.4)
Latino/Latina	28 (3.9)
Bi/Multi-Racial	56 (7.7)
Current/last completed grade N (%)	
5th–6th	19 (2.6)
7th–8th	149 (20.7)
9th–10th	444 (61.6)
11th–12th	109 (15.1)
Medical history ^b	
Head injury with extended period of unconsciousness N (%)	
Yes	132 (18.3)
No	588 (81.7)
History of mental illness diagnosed by psychiatrist or other physician N (%)	
Yes	370 (51.4)
No	350 (48.6)
Major perinatal injury or illness N (%)	
Yes	49 (6.8)
No	671 (93.2)

^a There were 3 missing values for the history of head injury, mental illness, and perinatal illness or injury variables, and 2, 1, and 1 missing values for the grade, race, and history of hormonal disorders measures.

^b Brain infection, tumor, or disease (2.1%), kidney disease (0.8%), hormonal disorders (1.1%), and blood disorders (3.2%) were reported by few youth.

3.2.2. *Use of specific inhalants.* Lifetime prevalence rates for use of 31 inhalants are presented in Table 2 (24 inhalants with lifetime prevalence rates of <1.0% are listed in a footnote to Table 2). For each inhalant listed in Table 2, the proportion of users of the inhalant who reported actually getting high when they used the inhalant and the predominant modality of use are indicated.

Gasoline, permanent markers, computer duster spray, spray paint, nail polish remover, nail polish, paint thinner, air freshener, correction fluid, butane, and Freon were used by significant numbers of youth. Inhalants differed considerably in their perceived capacity to produce intoxication. Between 80 and 90% of gasoline, computer duster spray, paint thinner, Freon, ether, and carburetor cleaner users reported that they became intoxicated when they used these products. There were no significant gender differences in the lifetime prevalence of use for any of

Table 2
Lifetime prevalence of inhalant use in the total sample (N = 723), proportion of users who reported getting high while using each inhalant product and predominant modality of use

Inhalant product	Lifetime prevalence N (%)	Got high ^a N (%)	Predominant modality ^b (%)
Any inhalant	267 (36.9%)		
Gasoline	159 (22.0)	130 (81.8)	4 (72.3)
Permanent markers	106 (14.7)	45 (42.5)	4 (54.7)
Computer duster spray	106 (14.7)	96 (90.6)	1 (58.5)
Spray paint	83 (11.5)	65 (78.3)	2 (59.0)
Nail polish remover	63 (8.7)	30 (47.6)	4 (55.6)
Nail polish	61 (8.4)	25 (41.0)	4 (82.0)
Paint thinner	60 (8.3)	54 (90.0)	3 (38.3)
Air freshener	58 (8.0)	41 (70.7)	3 (53.4)
Correction fluid	52 (7.2)	18 (34.6)	4 (84.6)
Butane	50 (6.9)	29 (58.0)	1 (48.0)
Freon	44 (6.1)	41 (93.2)	2 (40.9)
Airplane/model glue	39 (5.4)	22 (56.4)	4 (51.3)
Rubber cement	35 (4.8)	17 (48.6)	4 (65.7)
Hairspray	29 (4.0)	15 (51.7)	3 (55.2)
Other glues/cements	29 (4.0)	17 (58.6)	4 (51.7)
Paint remover/stripper	25 (3.5)	19 (76.0)	3 (44.0)
Propane	21 (2.9)	15 (71.4)	4 (61.9)
Deodorant spray	21 (2.9)	14 (66.7)	3 (50.0)
Ether	20 (2.8)	18 (90.0)	3 (50.0)
Any other cleaning agent	18 (2.5)	9 (50.0)	3 (50.0)
Carburetor cleaner	17 (2.4)	14 (82.4)	3 (41.2)
Car/exhaust fumes	17 (2.4)	8 (47.1)	5 (82.4)
Aerosol glass cleaner	16 (2.2)	9 (56.3)	4 (43.8)
Kerosene	14 (1.9)	9 (64.3)	4 (64.3)
Lighter fluid	14 (1.9)	9 (64.3)	4 (42.9)
Shoe shine/polish	13 (1.8)	2 (15.4)	4 (46.2)
Dry erase markers	13 (1.8)	3 (23.1)	4 (53.8)
Liquid paint	9 (1.2)	5 (55.6)	4 (55.6)
Insecticide spray	7 (1.0)	5 (71.4)	4/5 (28.6)
Paint pens	7 (1.0)	3 (42.9)	4 (85.7)
PAM	7 (1.0)	3 (42.9)	^c 2/4/5 (28.6)
Other inhalants ^d			

^a Number and percentage of users of each inhalant who reported having “gotten high” while using that inhalant.

^b This column reports the most prevalent modality of use for each inhalant (1 = spray the substance directly into your nose/mouth; 2 = sniff/inhale from a plastic bag placed over your nose, mouth, or head; 3 = sniff/inhale from a cloth or clothing saturated with the substance and placed over your nose, mouth, or head; 4 = sniff/inhale from a container [such as a jar or bottle] or balloon filled with gas; 5 = other). The percentage that follows the number reflects the proportion of users of each inhalant product who reported that they most often used the inhalant in that manner. For example, 72.3% of gasoline users reported that they most often used gasoline by sniffing/inhaling from a container (such as a jar or bottle) or balloon filled with gas.

^c All three modalities of use (2, 4, and 5 defined above) were equally prevalent for this product at 28.6% each.

^d The following inhalant products were used by <1.0% of the total sample: gun cleaning solvents, waxes, hair mousse, cooking gas, antifreeze, degreasing agents, fire extinguisher gases, Scotch guard, spot remover, stainless steel cleaner, “any other aerosol use,” Brakeleen, Octane Booster, toluene, balsa wood cement, dry cleaning fluid/products, floor polisher, acetone, plaster & gum remover, “any other anesthetic gas,” “other refrigerant gases,” mothballs, “other paint-related products,” and analgesic spray.

the products listed in Table 2, except for lifetime nail polish use, which was more prevalent among girls than boys [M: 7.2% vs. F: 17.0%, $\chi^2(1) = 10.3$, $p < .001$].

3.2.3. *Modes of use.* More than half of all inhalants were usually sniffed from a container such as a jar or bottle. Sniffing from a container was particularly common among nail polish,

correction fluid, gasoline, and paint pen users. Spraying the inhalant directly into the nose or mouth was uncommon and associated with use of computer duster spray and butane. Inhaling from a plastic bag placed over the nose, mouth, or head was uncommon and associated with inhalation of spray paint and Freon. Inhaling from a cloth saturated with a substance was prevalent among users of paint thinner, air freshener, hair spray, paint remover/stripper, deodorant spray, ether, and carburetor cleaner. Mixed modes of administration were common across inhalants.

3.2.4. Addiction liability. Comparatively large proportions of butane (14.0%), computer duster spray (13.2%), gasoline (11.9%), liquid paint (11.1%), air freshener (10.3%), paint thinner (10.0%), and spray paint (8.4%) users reported 100 or more lifetime days of use of those substances. Conversely, most users of gun cleaning solvents (83.3%), waxes (83.3%), mothballs (100.0%), cooking gases (80.0%), “any other cleaning agent” (77.8%), plaster and gum remover (100.0%), insecticide spray (100.0%), shoe shine/polish (92.3%), other glues/cements (75.8%), and balsa wood cement (100.0%) had <5 lifetime days of use of these inhalants, respectively.

3.2.5. Recency of use. Overall, 233 (87.3%) lifetime inhalant users reported use of an inhalant in the year prior to incarceration. For the most commonly used inhalants listed in Table 2, the proportion of lifetime users of specific inhalants reporting use of those products in the year prior to incarceration were: gasoline (69.2%), computer duster spray (87.6%), permanent markers (76.4%), spray paint (74.7%), nail polish (72.1%), paint thinner (86.7%), nail polish remover (73.0%), air freshener (72.4%), correction fluid (63.5%), hairspray (78.6%), Freon (79.5%), butane (80.0%), and airplane/model glue (59.0%).

3.3. Reasons for starting and stopping inhalant use

3.3.1. Reasons for starting. Users were most likely to agree/strongly agree that they began using inhalants because they were curious about their effects (77.2%), thought they would be fun and exciting to use (70.4%), felt bored (63.3%), they were easier to get than other drugs (61.8%), and were fun to use (51.0%).

3.3.2. Reasons for stopping. Inhalant users were most likely to agree/strongly agree that they stopped using inhalants because they got tired of them (56.6%), felt they needed to change (56.2%), or did not like them (48.4%).

3.4. Spatial, temporal, and contextual patterns of use

3.4.1. Preferred locations and temporal patterns of use. Users most often used inhalants at home (35.2%) or at a friend's home (28.5%). Less prevalent locations of use were at parties (15.4%), “on the street” (12.0%), “other” places (4.9%), or on school grounds (4.1%). Five respondents used primarily in cars. Inhalant users most frequently used on weekends (39.7%) or

evenings (35.2%) smaller percentages used immediately after school (10.9%), during school hours (10.1%), or on mornings before school (4.1%).

3.4.2. Contexts of use. Many inhalant users reported that they frequently/almost always used inhalants when they began to think about how good a rush or high had felt (51.3%), met some friends and wanted to have a good time (43.4%), were with a group of people who were using inhalants (43.0%), were with friends and wanted to increase their enjoyment (42.7%), were happy (37.4%), were with other people and felt they were expected to join in (35.7%), unexpectedly found an inhalant or saw something that reminded them of inhalants (35.2%), or when they felt overwhelmed and wanted to escape (34.1%).

3.5. Perceived risks, problems, availability, and likelihood of future use

3.5.1. Perceived risks. More than one-third (38.6%) of inhalant users saw great risk in inhalant use on even 1 or 2 occasions, followed by 23.6%, 27.0%, and 10.9% who viewed such use as of moderate, slight, or no risk. Regular inhalant use was viewed as of great, moderate, slight, or no risk by 70.4%, 18.0%, 6.7%, and 4.9% of lifetime inhalant users, respectively.

3.5.2. Perceived problems with inhalants. A majority (56.9%) of inhalant users reported that they never had experienced a problem with their inhalant use, compared to 21.0% who reported a small problem with inhalants, 14.6% who reported a moderate problem, and 7.5% who reported a big problem with inhalants.

3.5.3. Perceived availability of inhalants. Inhalants were perceived as widely available; 81.3% and 12.0% of lifetime users reported that it would be very or fairly easy for them to get inhalants if they were not in custody, respectively.

3.5.4. Perceived likelihood of future inhalant use. Nearly three-quarters of lifetime inhalant users (72.3%) felt there was “no chance” they would use inhalants after they were released, whereas 16.9%, 7.5%, 2.6%, and 0.7%, reported that there was little chance, an even chance, a good chance, or a certainty they would use inhalants after they were released.

3.6. Peer and sibling inhalant use

3.6.1. Peer use. Peer inhalant use was commonly reported by inhalant users, with 3.4%, 14.6%, 18.0%, and 36.3% of users reporting that all, most, some, or a few of their friends used inhalants.

3.6.2. Sibling use. Of the 254 lifetime inhalant users who had siblings and who provided complete data, 51 (20%) had a sibling who used inhalants. In one-quarter of the families of inhalant users, three or more offspring in the family were inhalant users.

3.7. Differences between lifetime inhalant users and nonusers

3.7.1. Univariate contrasts. Lifetime inhalant users (*U*) and nonusers (*N*) did not differ significantly with regard to mean age, grade level, or proportion reporting family receipt of public assistance. Significant differences across racial categories were observed for rates of lifetime inhalant use [$\chi^2(3) = 129.1, p < .001$]. Nearly three-quarters (71.4%) of Latino/Latina youth reported lifetime use, compared to 50.0% of Caucasian youth, 46.4% of Bi/Multi-racial youth, and 8.4% of African American youth. Rates of polyinhalant use were high, with 55.0%, 57.7%, 47.0%, and 35.0% of Latino/Latina, Bi/Multi-racial, Caucasian, and African American inhalant users, respectively, reporting lifetime use of 4 or more inhalant products. Youth residing in small town (49.7%) or rural (38.9%) environs were more likely to report lifetime inhalant use, compared to youth living in suburban (34.0%) or urban (24.7%) locations [$\chi^2(3) = 38.4, p < .001$].

Lifetime inhalant users did not differ significantly from nonusers with regard to scores on the SRD Violent Crimes Index, Victimization Index, or average age at first referral to juvenile court. However, inhalant users had significantly higher rates of total delinquency and property crime and were younger at the time of their first offense, than nonusers.

Inhalant users were significantly more likely to report histories of head injury with loss of consciousness, diagnosis with a mental illness and having “heard voices” than noninhalant users. Lifetime inhalant users had higher rates of kidney disease (*U*: 1.9% vs. *N*: 0.2%) and hormonal disorders (*U*: 2.2% vs. *N*: 0.4%), and an earlier age at first contact with police (*U*: 10.8, S.D. = 2.6 vs. *N*: 11.2, S.D. = 2.6), but these differences were significant at $p < .05$ level. Inhalant users with a history of diagnosed mental illness reported an average of 5.3 (S.D. = 4.4) inhalant products used, compared to 3.7 (S.D. = 3.2) for non-mentally ill inhalant users [$t(233.5) = -3.1, p < .01$]. Lifetime inhalant users evidenced significant elevations in current psychiatric symptomatology compared to nonusers across all BSI scales.

Measures of antisocial traits revealed notable differences between inhalant users and nonusers. Effect sizes were largest for the Total PPI, Fearlessness, and Impulsive Nonconformity scales. With respect to the APSD, effect sizes were substantial for the Impulsivity and total score scales.

Inhalant users had significantly higher scores than nonusers on the Traumatic Experiences and Suicide Ideation scales. A larger percentage of lifetime users (40.8%) than nonusers (16.5%) reported a prior suicide attempt [$\chi^2(1) = 52.5, p < .001$]. Inhalant users also evidenced more extensive and problematic substance use histories than nonusers.

3.7.2. Adjusted models. Adjusted logistic regression models were used to identify correlates of lifetime inhalant use while controlling for potentially confounding factors. Variables were selected for inclusion in analyses on the basis of several considerations. First, the findings of bivariate analyses guided our selection of variables included in the adjusted model. Sec-

ond, a 40×40 zero-order correlation matrix of all continuous variables was constructed so that potential multicollinearity problems could be assessed and avoided. Third, given that logistic regression is a large sample estimation procedure, we limited our variable set to <20 variables. Finally, we selected variables with little missing data to enhance power and reduce bias.

An adjusted analysis with simultaneous entry of 19 covariates using simple contrasts was conducted using the following variables: race, geographic area of residence, gender, SRD-Property Crime Index, age at onset of offending, history of head injury, history of kidney disease, history of hormonal problems, history of mental illness, BSI-Global Severity Index, PPI-Fearlessness, PPI-Carefree Nonplanfulness, PPI-Impulsive Nonconformity, APSD-Callous/Unemotional Traits, APSD-Impulsivity, MAYSI-2 Traumatic Experiences Scale, MAYSI-2 Suicide Ideation Scale, MAYSI-2 Alcohol/Drug Use Scales, and lifetime number of different drug types used (Table 3).

Model coefficients, statistical tests, odds ratios, and 95% confidence intervals for odds ratios are presented in Table 4. Findings indicated that Caucasian, Latino/Latina, and Bi/Multiracial youth were significantly more likely than African American youth to use inhalants. Youth residing in small towns were twice as likely as urban youth to have used inhalants. Although statistical tests for history of medical disorders did not achieve statistical significance, odds ratios for history of kidney and hormonal disease were large. Inhalant users were significantly more likely than nonusers to display fearless temperaments, greater suicidality and more varied substance use histories.

3.8. Predictors of lifetime frequency of inhalant use

3.8.1. Lifetime frequency of use. Lifetime inhalant users were asked to report, for each of the 55 individual inhalants assessed, their lifetime frequency of use of each inhalant (1 = <5 times, 2 = 5–10 times, 3 = 11–99 times, and 4 = ≥ 100 times). Total lifetime inhalant use frequency scores were then computed by summing individual inhalant lifetime frequency of use scores. For example, an individual who had used one inhalant between 5 and 10 times and a second inhalant more than 100 times would get a score of $2 + 4 = 6$, whereas a respondent who had used 7 different inhalants each 11–99 times would receive a score of 21. Scores on the frequency of lifetime inhalant use measure for the 267 inhalant users averaged 8.7 (S.D. = 9.5, range = 1–62, median: 5.0). Due to the non-normality of the distribution (skewness: 2.4, S.E. = .15; kurtosis = 7.2, S.E. = .30), the inhalant frequency measure was recoded into an ordinal variable with 6 categories ranging from low (1) to high (6) frequency use. The new lifetime frequency measure had a mean of 3.4 (S.D. = 1.7) and approximated a normal distribution (skewness: .07, S.E. = .15; kurtosis = -1.2, S.E. = .30). The six groups differing in frequency of lifetime inhalant use were similar in size and consisted of youth who obtained a value of 1 ($N = 45$), 2–3 ($N = 50$), 4–5 ($N = 44$), 6–9 ($N = 47$), 10–17 ($N = 45$), or 18–62 ($N = 36$) on the original frequency measure. Roughly speaking, the first two groups were experimental/low frequency users, the

Table 3
Unadjusted univariate contrasts of lifetime inhalant users ($N=267$) and nonusers ($N=456$) across criminological, health, mental health, attitudinal, and substance use measures

Variables	Lifetime inhalant users	Nonusers	Results
Criminological M^a (S.D.)			
SRD (Total Delinquency)	27.8 (19.1)	22.4 (17.8)	$t(721) = -3.9, p < .001, d = -.29^b$
SRD (Property Crime Index)	16.9 (12.2)	12.3 (11.3)	$t(721) = -5.1, p < .001, d = -.38$
Age at onset of offending (years)	10.1 (2.8)	10.8 (2.9)	$t(719) = 3.2, p < .01, d = .24$
Physical and mental health N (%)			
History of head injury	64 (24.0%)	68 (15.0%)	$\chi^2(1) = 9.0, p < .01, OR^c = 1.8 (1.2-2.6)$
Diagnosis W/mental illness	176 (66.2%)	194 (42.7%)	$\chi^2(1) = 36.9, p < .001, OR = 2.6, (1.9-3.6)$
Hearing voices	58 (21.7%)	48 (10.5%)	$\chi^2(1) = 16.9, p < .001, OR = 2.4 (1.6-3.6)$
Brief Symptom Inventory M (S.D.)			
Global Severity Index	54.6 (37.5)	37.4 (31.5)	$t(482.9)^d = -6.3, p < .001, d = -.57$
Somatization	4.5 (4.7)	3.1 (4.0)	$t(490.6) = -4.3, p < .001, d = -.39$
Obsessive-Compulsive	8.4 (5.8)	5.5 (4.8)	$t(480.5) = -6.9, p < .001, d = -.63$
Interpersonal Sensitivity	3.6 (3.7)	2.5 (3.1)	$t(485.6) = -4.0, p < .001, d = -.36$
Depression	6.2 (5.6)	3.9 (4.5)	$t(460.4) = -5.7, p < .001, d = -.53$
Anxiety	5.9 (5.3)	3.5 (4.1)	$t(459.8) = -6.4, p < .001, d = -.60$
Hostility	7.0 (5.1)	5.5 (4.8)	$t(721) = -4.0, p < .001, d = -.30$
Phobic Anxiety	2.5 (3.4)	1.7 (3.0)	$t(508.3) = -3.1, p < .01, d = -.27$
Paranoid Ideation	7.2 (4.7)	5.7 (4.6)	$t(721) = -4.2, p < .001, d = -.31$
Psychoticism	4.7 (4.4)	3.0 (3.3)	$t(445.3) = -5.5, p < .001, d = -.52$
Psychopathic Personality Inventory M (S.D.)			
Total	141.5 (15.1)	133.4 (12.5)	$t(478.7) = -7.4, p < .001, d = -.68$
Machiavellian Egocentricity	7.9 (4.4)	16.9 (4.5)	$t(721) = -3.0, p < .01, d = -.22$
Carefree Nonplanfulness	15.4 (3.8)	13.5 (3.8)	$t(721) = -6.6, p < .001, d = -.49$
Fearlessness	19.4 (4.9)	15.7 (5.0)	$t(721) = -9.7, p < .01, d = -.72$
Blame Externalization	18.9 (4.7)	17.9 (4.8)	$t(721) = -2.8, p < .01, d = -.21$
Impulsive Nonconformity	16.1 (4.5)	14.0 (3.7)	$t(472.6) = -6.3, p < .001, d = -.58$
Stress Immunity	18.3 (4.4)	19.4 (4.3)	$t(721) = 3.3, p = .001, d = .25$
Antisocial Process Screening Device M (S.D.)			
Total	17.7 (5.4)	15.4 (5.4)	$t(720) = -5.5, p < .001, d = -.41$
C/U Traits	8.3 (3.3)	7.3 (3.0)	$t(720) = -3.9, p < .001, d = -.29$
Impulsivity	7.2 (2.0)	6.1 (2.1)	$t(720) = -7.3, p < .001, d = -.54$
Massachusetts Youth Screening Inventory M (S.D.)			
Traumatic Experiences	2.6 (1.4)	2.3 (1.4)	$t(715) = -3.34, p < .001, d = -.25$
MAYSI-Suicide Ideation	2.9 (2.1)	1.4 (1.8)	$t(508.9) = -9.9, p < .001, d = -.88$
Substance use and related problems			
MAYSI-Alcohol/Drug Problems Scale M (S.D.)	5.1 (2.9)	3.2 (2.3)	$t(626.1) = -11.6, p < .001, d = -.93$
Lifetime # of drug types used M (S.D.)	5.9 (2.9)	2.9 (2.1)	$t(432.4) = -15.0, p < .001, d = -1.44$
Lifetime alcohol use N (%)	254 (95.1%)	359 (78.7%)	$\chi^2(1) = 35.1, p < .001, OR = 5.3 (2.9-9.6)$
Age at onset of alcohol use (years) M (S.D.)	11.1 (2.8)	12.0 (2.6)	$t(611.1) = 3.8, p < .001, d = .31$
Lifetime marijuana use N (%)	255 (95.5%)	371 (81.4%)	$\chi^2(1) = 29.0, p < .001, OR = 4.9 (2.6-9.1)$
Age at onset of marijuana use (years) M (S.D.) ^e	11.0 (2.4)	11.5 (2.1)	$t(623.2) = 3.1, p < .01, d = .25$

^a M = mean; S.D. = standard deviation.

^b d = Cohen's effect size for two independent groups computed using t -test values and associated degrees of freedom (cf., web.uccs.edu/lbecker/Psy590/es.htm for effect size calculator).

^c OR = unadjusted odds ratio with 95% confidence interval.

^d Statistical contrasts associated with fractional degrees of freedom represent cases where violations of homogeneity of variance assumptions necessitated more stringent tests for statistical significance.

^e Lifetime inhalant users had significantly higher rates of kidney disease ($U: 1.9\%$ vs. $N: 0.2\%$, $OR = 8.7$, $CI = 1.0-74.7$) and hormonal disorders ($U: 2.2\%$ vs. $N: 0.4\%$, $OR = 5.2$, $CI = 1.0-26.0$), and an earlier mean age at onset of contact with police ($U: 10.8$, $S.D. = 2.6$ vs. $N: 11.2$, $S.D. = 2.6$), but these differences were significant at only $p < .05$.

fifth and sixth groups were high frequency users, with the two middle groups representing moderate frequency use groups.

3.8.2. Univariate contrasts. Detailed findings pertaining to the groupwise unadjusted univariate contrasts are available in the DOI file of [Supplementary materials](#) that will be posted to the

WWW when this article is published. In general, omnibus one-way ANOVAs were conducted with continuous variables with post hoc mean contrasts controlling for Type 1 error. For categorical variables, 6-group χ^2 analyses were conducted with follow-up 2×2 χ^2 tests. Frequency of inhalant use did not differ significantly by gender, age, race/ethnicity, grade, family receipt

Table 4

Multiple logistic regression analysis (with simultaneous entry of covariates) examining correlates of lifetime inhalant use in total sample of inhalant users ($N=264$)^a and nonusers ($N=433$)^b

Variable	b	S.E.	Wald	<i>p</i>	Odds Ratio	95.0% CI (OR)
Race						
African American ^c	22.2	1.0				
Caucasian	1.2	.35	12.6	<.001	3.4	(1.7–6.7)
Latino/Latina	2.4	.57	18.0	<.001	11.2	(3.7–34.1)
Bi/Multiracial	.94	.46	4.2	<.05	2.6	(1.0–6.3)
Geographic area of residence						
Urban ^c		15.9	1.0			
Suburban	-.46	.36	1.7	.20	.63	(.31–1.3)
Small town	.70	.27	6.8	<.01	2.0	(1.2–3.4)
Rural	-.01	.42	.00	.99	.99	(.43–2.3)
Gender	-.43	.33	1.7	.19	.65	(.34–1.2)
SRD-Property Crime Index	.01	.01	1.1	.29	1.0	(.99–1.0) ^d
Age at onset of offending	.01	.04	.08	.78	1.0	(.94–1.1) ^d
History						
Head injury	-.11	.29	.15	.70	.90	(.51–1.6)
Kidney disease	1.9	1.9	.95	.33	6.4	(.15–262.9)
Hormonal disorders	1.4	1.0	2.0	.16	4.2	(.56–30.6)
Mental illness	.19	.23	.70	.40	1.2	(.77–1.9)
BSI-Global Severity Index	.00	.00	.56	.45	1.0	(.99–1.0) ^d
PPI^e						
Fearlessness	.09	.02	14.0	<.001	1.1	(1.0–1.1) ^d
Carefree Nonpainfulness	.05	.03	2.4	.12	1.1	(.99–1.1) ^d
Impulsive Nonconformity	.03	.03	1.2	.28	1.0	(.97–1.1) ^d
APSD^f						
Callous/Unemotional	.00	.04	.00	.99	1.0	(.92–1.1) ^d
Impulsivity	-.08	.07	1.4	.24	.92	(.81–1.1) ^d
MAYSI ^g -2 Suicide Ideation Index-2	.18	.05	11.8	=.001	1.2	(1.1–1.3) ^d
MAYSI ^g -2 Traumatic Experiences Index	-.10	.08	1.5	.23	.91	(.78–1.1) ^d
MAYSI ^g -2 Alcohol/Drug Use Index	.03	.02	1.8	.18	1.0	(.99–1.1) ^d
Total number of drug types used	.37	.05	57.3	<.001	1.4	(1.3–1.6) ^d

^a 3 missing cases.

^b 23 missing cases.

^c Reference category.

^d Continuous variable.

^e Psychopathic Personality Inventory.

^f Antisocial Process Screening Device.

^g Massachusetts Youth Screening Instrument.

of welfare, geographical area of residence, total months in custody, mean age at onset of offending, first contact with police or first referral to juvenile court.

Significant group differences were observed on the SRD Property, Violent, and Total Crime Indexes and Victimization Index with the highest frequency groups evidencing significantly higher rates of criminality and victimization than lower frequency groups. Chi-square analyses examining rates of medical disorders across inhalant use frequency groups indicated that only rates of diagnosis with mental illness and having “heard voices” were significantly associated with frequency of lifetime inhalant use. Moderate effect sizes were observed for a history of mental illness [$F(1, 264) = 8.3, p < .01$] and of having heard voices [$F(1, 265) = 14.8, p < .001$], with higher frequency groups reporting more extensive histories of these problems.

Frequency of lifetime inhalant use was significantly positively related to all BSI measures of current psychiatric symptoms, with particularly strong associations observed for

the Obsessive–Compulsive, Psychoticism, and Global Severity Index scales. Significant differences were observed between inhalant use frequency groups across 6 of the 9 PPI scales, with heavy lifetime inhalant users demonstrating greater Fearlessness, Machiavellian Egocentricity, Blame Externalization, Coldheartedness and lower Stress Immunity and Social Potency than lighter users. High frequency inhalant users also had significantly higher scores than lower frequency users on the Impulsivity, Narcissism, and Total score scales of the APSD. Frequency of lifetime inhalant use was significantly positively associated with extent of exposure to traumatic events, greater suicidality, and more varied and adversely consequential substance use.

3.8.3. Adjusted models of lifetime frequency of inhalant use. Variables were considered for inclusion in adjusted models if they were significantly associated with lifetime frequency of inhalant use in correlational or comparative analyses. Efforts

were made to avoid multicollinearity; thus, not all variables significant in univariate analyses were included in the final model. Given the subsample size, analyses focused on main effects to ensure adequate power.

Two adjusted multiple linear regression models predicting lifetime frequency of inhalant use were assessed. In each analysis, the set of dummy-coded race variables was entered in the first step and the dummy-coded set of geographic area of residence variables was entered in the second step. Race or geographic area of family residence did not enter any prediction equation. The remaining variables were entered in the third step.

In addition to race and geographic area of residence, the following variables were included in the analyses: SRD-Violent and Property Crime Indexes; Victimization Index; history of birth complications, diagnosis with mental illness and having heard voices health measures; BSI-Psychoticism and Obsessive–Compulsive scales; PPI-Blame Externalization, Social Potency, Machiavellianism, Stress Immunity, Fearlessness, and Coldheartedness scales; APSD-Narcissism, Impulsivity, and Callous/Unemotional Traits scales; MAYSI-2 Suicide Ideations and Traumatic Experiences scales; and age at onset of offending. A second model also included the MAYSI-2 Alcohol/Drug Use Scale and a measure of total number of lifetime drug types used.

The simultaneous entry model with all covariates was statistically significant [$F(28, 235) = 4.4, p < .001$] and explained 35.0% of the variance in lifetime frequency of inhalant use. Variables entering the final equation were having heard voices ($B = .47, S.E. = .24, t = 1.9, p < .05$, BSI-Obsessive–Compulsive scale ($B = .07, S.E. = .02, t = 3.0, p < .01$), and the MAYSI-2 Alcohol/Drug Use Problems scale ($B = .17, S.E. = .06, t = 3.1, p < .01$). Total number of drug types used ($B = .08, S.E. = .04, t = 1.8, p < .07$) and PPI-Fearlessness ($B = .04, S.E. = .02, t = 1.7, p < .08$) approached significance but did not enter the model.

The reduced simultaneous entry model was also significant [$F(26, 238) = 3.9, p < .001$] and explained 30% of the variance in lifetime frequency of inhalant use. The only significant predictors were the BSI-OC scale ($B = .08, S.E. = .02, t = 3.4, p < .01$) and having heard voices ($B = .51, S.E. = .25, t = 2.1, p < .05$).

4. Discussion

4.1. Characteristics of inhalant use

Inhalant use was widespread in this state population of incarcerated juvenile offenders. Nearly 4 in 10 youth (36.9%) reported lifetime use, a finding similar to the 34.3% rate identified by Howard and Jenson (1999) in a large sample of juvenile probationers. The prevalence of lifetime inhalant use among study participants exceeded the general population estimate of 9.0% for 12–17 year-olds reported by Wu et al. (2004) by 4-fold and was twice the rate identified by Sakai et al. (2004) in their sample of 847 clinic-referred youth with serious substance use and behavior problems.

Polyinhalant use was the norm among inhalant users in this population. Four in five users had used two or more inhalants and nearly half had tried four or more inhalant products. Once the

threshold for inhalant use is breached, use of multiple inhalants is highly likely, at least in this sample of antisocial youth. Given that many individual products, themselves, contain an array of chemicals, it is probable that most inhalant users were exposed to numerous potentially toxic chemicals.

The 12 inhalants most widely abused were gasoline, permanent markers, computer duster spray, spray paint, nail polish remover, nail polish, paint thinner, air freshener, correction fluid, butane, Freon, and glue. Of the 55 inhalants assessed, 43 were used by less than 5.0% of respondents. Thus, while popular inhalant prevention and educational materials often refer to the myriad products that can be abused, prevention and screening efforts should pay particular attention to the most commonly abused products. In this vein, it may prove feasible to promote policy efforts to reformulate some products or to otherwise limit their availability to youth. If our screening assessment had been limited to the 12 most commonly abused inhalants, we would have identified 97% of the inhalant users we detected with the extensive inhalant screen.

Inhalants differed significantly in their perceived capacity to produce intoxication. Agents used by more than 1% of study participants and perceived as intoxicating by 75.0% or more of users included gasoline, computer duster spray, spray paint, paint thinner, Freon, paint remover, ether, and carburetor cleaner. Inhalants most likely to be used on 100 or more days were butane, computer duster spray, gasoline, liquid paint, air freshener, paint thinner, and spray paint. In general, many of the most commonly and extensively abused inhalants were those most widely regarded as intoxicating. For example, 22% of our sample had abused gasoline, 82% of gasoline abusers reported that they had gotten high when they inhaled the product, and 12% of gasoline users had inhaled gasoline on 100 or more days. Further, nearly 9 in 10 lifetime inhalant users had used inhalant products within the year prior to incarceration; rates of recent use were also comparatively high for inhalant products generally perceived as intoxicating. These findings suggest that many of the youth we studied consciously selected inhalants they knew to be reliably intoxicating and became intoxicated repeatedly using these substances.

Significant heterogeneity was observed with regard to modes of inhalant use. No prior research we are aware of has examined this issue. Future studies might profitably be conducted in this area, with particular attention to possible adverse consequences of inhalant use specific to different modalities of use and more nuanced evaluations of the drug administration process. For example, several youth reported that they heated or combusted the inhalant product prior to use to enhance intoxication.

Initiation of inhalant use appeared to be related to the ready availability of the agents and to youths' curiosity about their effects, feelings of boredom, and expectation that they would be fun to use. The key role of sensation seeking orientation in initiation of substance abuse is well established and apparent in the etiology of inhalant use (Howard et al., 1996). Approximately two-thirds of youth who used inhalants used them at home or at a friend's home, suggesting that widespread parent training in the signs of inhalant use is needed.

More than a third of inhalant users saw little/no risk in experimental inhalant use, but only 12.0% saw little/no risk in regular inhalant use. These findings suggest that many youth have used inhalants, despite perceiving a moderate or greater level of risk in association with their use. Although it is possible that perceptions of risk followed actual use of inhalants, inhalant prevention and treatment strategies may need to rely on more than simple educational strategies designed to increase awareness of potential dangers of inhalant use. Although post hoc analyses indicated that there was a positive relationship between lifetime frequency of inhalant use and respondents' estimates of the likelihood they would use inhalants in the year following discharge ($r = .29, p < .001$), lifetime frequency of inhalant use was not significantly related to estimates of perceived risks of experimental or regular inhalant use. Greater experience with inhalants does not appear to influence risk perceptions associated with use, but is associated with significantly greater positive expectancies for future use.

A relatively large proportion of inhalant users (43.1%) regarded their use as problematic, with 22.1% of the total study sample reporting a moderate or big problem with inhalants. One-in-nine users thought there was an even or better chance they would use inhalants again after they were released. Nearly three-fourths of users reported that at least a few of their friends used inhalants and one-fifth had one or more siblings who used inhalants. Clearly, many incarcerated adolescent inhalant users are returning to life contexts in which they are at continued risk for inhalant use. Prevention interventions targeted to individual youths might serve to reduce peer inhalant use; conversely, such interventions may achieve optimal effectiveness only if they target the larger family and peer networks of adolescent inhalant users.

4.2. *Correlates of lifetime inhalant use*

Similar proportions of girls and boys had used inhalants and girls had similar levels of polyinhalant use and preferred the same inhalants as boys. The only exception was nail polish, which was used significantly more frequently by girls, probably due to more ready access. These findings raise important concerns about the potential toxicity of inhalants to the developing fetuses of pregnant adolescent girls (Jones and Balster, 1998). Little is currently known about gender differences in adverse consequences of inhalant use and additional research in this area is clearly needed. Wu et al. (2004) also found similar inhalant use rates for boys and girls in their nationally representative sample.

Inhalant use was highly prevalent among Latino/Latina youth, roughly three-fourths of whom had used inhalants. Nearly half of the Caucasian and Bi/Multiracial youth were inhalant users, whereas rates of use were low among African-Americans consistent with other reported findings (Wu et al., 2004). These findings are also similar to those reported by Neumark et al. (1998), who identified low rates of inhalant use among African American youth participating in the National Household Survey on Drug Abuse between 1990 and 1995, with substantially higher rates observed among Caucasian and Hispanic respondents. Analyses conducted by Neumark et al. (1998) indicated

that community-level factors (e.g., social disadvantage) did not account for these racial differences. At present, it is not clear why rates of inhalant use are consistently found to be low among African American youth. Youth from small town environments were at comparatively high risk for inhalant use compared to youth from urban locales.

Inhalant users evidenced worrisome psychological and behavioral profiles. In unadjusted analyses, users had significantly higher rates of total and property crime, an earlier onset of offending and younger average age at first contact with police, significantly higher scores on most subscales of the Psychopathic Personality Inventory and Antisocial Process Screening Device (particularly those assessing impulsive, fearless, and egocentric traits), significantly elevated rates of symptomatology across all measures of current psychiatric distress, and reported more lifetime trauma, suicidality, polysubstance use, substance-related problems, and physical and mental health problems (head injury, kidney disease, hormonal disorders, mental illness, having "heard voices) than nonusers. In adjusted logistic regression analyses, race, geographic area of residence, trait fearlessness, suicidality, and polysubstance use were significant correlates of inhalant use.

These findings are consistent with reports documenting associations between inhalant use and antisocial behavior, delinquency, and mental health problems in juvenile justice, clinical, high risk, and general population samples of adolescents (Howard and Jenson, 1999; Howard et al., 1999; Wu et al., 2004). Although case reports have suggested possible associations of inhalant use with health disorders such as renal disease (e.g., O'Brien et al., 1971), relatively few studies have examined inhalant-related health problems in adolescent inhalant users. The relatively high odds ratios we observed for kidney and endocrine disorders in inhalant users compared to nonusers should be followed-up using large, nationally representative samples. The common occurrence of head injury with loss of consciousness among inhalant users is a special concern and indicates that this group is at very high risk for serious neurological impairments (which may, in turn, cause further affective and behavioral dysregulation).

Few overtly psychotic youth were identified, although self-reported receipt of antipsychotic medication was reported by 10% of youth. Thus, the curious finding that inhalant use and having "heard voices" were associated may be explained by recent findings indicating that auditory hallucinations are not rare among adolescents and are often associated with concurrent and future non-psychotic psychiatric problems as well as psychotic disorders (Dhossche et al., 2002). Particularly large differences between inhalant users and nonusers and more frequent vs. less frequent users were observed for the BSI Obsessive–Compulsive and Psychoticism scales. Item-level analyses suggest possible reasons for these differences. The largest item-level differences between inhalant users and nonusers were for current distress in relation to "trouble remembering things," "your mind going blank," "trouble concentrating," and "the idea that something is wrong with your mind." The first three of these symptoms are included in the 6-item BSI Obsessive–Compulsive scale, but could well

reflect incipient inhalant-related neurological impairment. The last item listed above is included in the Psychoticism scale. It is interesting to note, in this vein, that of the 53 BSI items, the symptoms, “mind going blank” ($r = .37$), “difficulty making decisions” ($r = .35$), “the idea that something is wrong with your mind” ($r = .34$), “trouble concentrating” ($r = .31$), and “trouble remembering things” ($r = .29$) had the highest zero-order correlations with frequency of lifetime inhalant use. Adolescents who used inhalants more frequently also reported substantially higher levels of current distress in relation to the symptom of “numbness or tingling in parts of your body” than less frequent users ($r = .26$), an item in the BSI Somatization scale but also potentially reflective of inhalant-related peripheral neuropathy.

The findings above make it painfully evident that inhalant users will require comprehensive psychosocial and psychiatric interventions; however, little is currently known about potentially effective cognitive, pharmacologic, or social interventions for adolescent inhalant use.

4.3. Frequency of lifetime inhalant use

Univariate contrasts of low vs. moderate vs. high frequency inhalant users revealed that high frequency inhalant users committed more property, violent, and total crimes, were significantly more likely to have been diagnosed with a mental illness and to have heard voices, reported higher levels of all types of current psychiatric symptomatology, evidenced significantly higher levels of most antisocial traits, and had histories of significantly more trauma, suicidality, and substance-related problems than lower frequency users. In adjusted analyses, having heard voices, the BSI-OC scale, and extent of substance abuse problems were the only significant predictors of lifetime inhalant use. As discussed above, it is possible that the O-C scale captures cognitive impairments secondary to inhalant use. Conversely, cognitive impairments may contribute to risk for inhalant use, which, in turn, leads to further neurological impairment. Similarly, youth who report having heard voices may have greater experience with substance-induced intoxication and/or be at elevated risk for psychiatric disorders. At present, it is unclear whether the BSI O-C scale and having heard voices measures assess neurological consequences of inhalant use and/or co-occurring other substance use, possible neurological precursors of inhalant use, or some combination thereof. Additional research examining the natural history of inhalant use, particularly factors that contribute to escalation and eventual cessation of use is needed.

4.4. Conclusions

The clinical picture of inhalant users derived from our study is substantially more comprehensive and nuanced than prior studies of antisocial youth, but disturbingly consistent in its results. Inhalant use is highly prevalent among youth in the juvenile justice system, associated with substantial and varied psychiatric and health-related comorbidities, and found most commonly in youth who report current distress in relation to impaired cognitive functioning and histories of suicidality, trauma, and

extensive other drug involvement. That so many significant differences were detected in a sample of restricted range for measures of antisocial involvement, substance use, and psychopathology may attest to the magnitude and breadth of these inhalant-related effects. It is also possible, however, that these factors antedate and possibly predispose to inhalant use.

Strengths of this study included the high participation rate, large sample size, and detailed inhalant use assessment. This study is perhaps the first to examine inhalant-specific perceptions of intoxication in adolescent inhalant users and to examine a full range of inhalant products and the modalities by which they are used. Limitations of the research include reliance on several self-report measures of unknown reliability and validity – the VSSI and CSAI – and problems inherent in efforts to generalize more broadly from a criminological sample. That said, many of our results were concordant with findings obtained in general population surveys and it is clear that antisocial youth, themselves, are greatly in need of better inhalant prevention and treatment approaches.

Conflict of interest

The authors have no real or perceived conflicts of interest in relation to this report.

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Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at [doi:10.1016/j.drugalcdep.2007.08.023](https://doi.org/10.1016/j.drugalcdep.2007.08.023).

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