Available online at www.sciencedirect.com
ScienceDirect
Drug and Alcohol Dependence 88 (2007) 146–155
DRUG and ALCOHOL DEPENDENCE
www.elsevier.com/locate/drugalcdep

Psychiatric disorders in inhalant users: Results from The National Epidemiologic Survey on Alcohol and Related Conditions

Li-Tzy Wu [a,*], Matthew Owen Howard [b]

[a] *Department of Psychiatry and Behavioral Sciences, Duke University School of Medicine, Duke University Medical Center, Duke Clinical Research Institute (DCRI), P.O. Box 17969, Durham, NC 27715, USA*
[b] *Department of Psychiatry, University of Michigan School of Medicine, 1080 South University Avenue, Ann Arbor, MI 48109, USA*

Received 20 May 2006; received in revised form 10 October 2006; accepted 12 October 2006

Abstract

Objective: To examine the prevalence and correlates of mood, anxiety, and personality disorders among lifetime inhalant users.
Methods: Statistical analyses were based on data from the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), a nationally representative survey of adults in the United States.
Results: Inhalant users ($N = 664$) had high lifetime prevalences of DSM-IV mood (48%), anxiety (36%), and personality (45%) disorders. Of all inhalant users, 70% met criteria for at least one lifetime mood, anxiety, or personality disorder and 38% experienced a mood or anxiety disorder in the past year. Prevalences of comorbid psychiatric disorders varied by gender. Compared with male inhalant users, female inhalant users had higher prevalences of lifetime dysthymia (24% versus 16%), any anxiety disorder (53% versus 30%), panic disorder without agoraphobia (25% versus 11%), and specific phobia (28% versus 14%), but a lower prevalence of antisocial personality disorder (22% versus 36%). Female inhalant users also were more likely than male inhalant users to meet criteria for three or more mood or anxiety disorders (15% versus 8%) in the past year. Among inhalant users with comorbid disorders, those who developed social or specific phobia typically experienced onset of these disorders prior to initiation of inhalant use; all other mood and anxiety disorders usually developed following the onset of inhalant use. Inhalant users who were women, poor, less educated, with early onset of inhalant use, family histories of psychopathology, and personal histories of substance abuse treatment had increased odds of psychiatric disorders.
Conclusions: Psychiatric disorders are highly prevalent among inhalant users nationally and female inhalant users are more likely than male inhalant users to experience multiple psychiatric disorders. Inhalant use and its consequences among females warrant greater research attention.

Keywords: Anxiety disorder; Comorbidity; Gender differences; Inhalant use; Major depression; Personality disorder

1. Introduction

Inhalant use is among the most prevalent, pernicious, and poorly studied forms of substance use (Brouette and Anton, 2001; Dinwiddie, 1998; Sharp and Rosenberg, 1997). Findings from the 2004 National Survey on Drug Use and Health indicated that nearly 23 million US residents aged 12 or older had used inhalants, with approximately 2,255,000 respondents reporting use in the past year (Substance Abuse and Mental Health Services Administration, 2005). In 2004, the lifetime prevalence of inhalant use among 8th graders (17.3%) nationally exceeded the prevalences for marijuana (16.3%), amphetamines (7.5%), hallucinogens (3.5%), cocaine (3.4%), and heroin (1.6%) (Johnston et al., 2005). Recurrent inhalant use is associated with serious health problems including cerebellar ataxia, Parkinsonism, encephalopathy, trigeminal neuropathy, hepatorenal syndrome, hepatotoxicity, and "sudden sniffing death" (Brett, 1997; Meadows and Verghese, 1996; Utti et al., 1994).

Despite the substantial prevalence and deleterious consequences of inhalant use, little is known about the natural history of inhalant use in the general population (Balster, 1996, 1998; Mikkelsen, 1997). In particular, studies of psychiatric disorders among inhalant users from large, population-based samples are generally absent from the literature. Available mental health findings are based principally on case reports, clinical investigations, local or regional surveys of high-risk populations, and

* Corresponding author. Tel.: +1 919 668 8576; fax: +1 919 668 7107.
E-mail addresses: litzywu@yahoo.com (L.-T. Wu), matthowa@umich.edu (M.O. Howard).

0376-8716/$ – see front matter © 2006 Elsevier Ireland Ltd. All rights reserved.
doi:10.1016/j.drugalcdep.2006.10.012

criminological studies of inhalant users. For example, recent investigations have examined inhalant use among urban American Indian adolescents in the Pacific Northwest (Howard et al., 1999), youth probationers in Utah (Howard and Jenson, 1999), adolescent patients in substance abuse treatment (Sakai et al., 2004), and incarcerated youth in long-term correctional settings in Missouri (Howard et al., under preparation). Results of these investigations suggest that serious antisocial behavior and psychopathology may commonly attend adolescent inhalant use. Studies of adult inhalant users in treatment and criminal justice settings have also identified a high prevalence of depression, anxiety, and other mental health disorders, although important concerns have been raised regarding the generalizability, methodological adequacy, and public health utility of the limited available literature (e.g., Compton et al., 2005; Dinwiddie, 1994; Evren et al., 2006; Howard et al., 2001).

To date, characteristics associated with comorbid psychiatric disorders among inhalant users in general, and gender differences in the prevalence of these disorders in particular, have been understudied. Findings from such analyses are needed to guide the design and implementation of gender-sensitive prevention and treatment interventions. The aims of this investigation were to examine the prevalence, patterns, and correlates of comorbid DSM-IV psychiatric disorders (American Psychiatric Association, 1994) among a national sample of lifetime inhalant users. Specifically, we (1) described inhalant users' sociodemographic characteristics, (2) estimated the prevalence of mood, anxiety, and personality disorders, (3) assessed the influences of gender, age of onset of inhalant use, and prior substance abuse treatment on psychiatric disorders, (4) examined the age at onset of inhalant use, inhalant use disorders, and co-occurring psychiatric disorders, and (5) identified factors associated with the development of mood, anxiety, and personality disorders among lifetime inhalant users.

In addition to the gender variable, we focused on the influence of early onset of inhalant use and a history of substance abuse treatment on the prevalence of comorbid psychiatric disorders because both have been found to be significant correlates of drug abuse or dependence (Anglin et al., 1997; Claus et al., 1999; Grant and Dawson, 1998; Howard and Jenson, 1999; Hser et al., 1997) which, in turn, is highly correlated with the development of psychiatric disorders (Compton et al., 2000; Kessler et al., 1996). We hypothesized that the prevalence and patterns of psychiatric disorders among lifetime inhalant users would vary by gender: women would be more likely than men to meet criteria for mood and anxiety disorders (Breslau et al., 2000), whereas men would be more likely than women to have antisocial personality disorders (Grant et al., 2004a). We also hypothesized that early inhalant use and prior use of substance abuse treatment would predict increased odds of psychiatric disorders.

2. Methods

2.1. NESARC survey methodology

The National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) is a longitudinal investigation of a nationally representative sample of 43,093 U.S. residents aged 18 or older (Dawson et al., 2004; Grant et al., 2004a). The survey was designed and funded by the National Institute on Alcohol Abuse and Alcoholism and conducted by the U.S. Census Bureau using computer assisted personal interviewing. NESARC provides past-year and lifetime prevalences for DSM-IV Axis I (substance use, mood, and anxiety disorders) and Axis II (personality) disorders and is the largest comorbidity study and the first national study to assess DSM-IV personality disorders (Grant et al., 2004a, 2005). Wave 1 data were collected between August 2001 and May 2002.

NESARCs target population was the civilian, non-institutionalized adult household population of all 50 states and the District of Columbia, including adults living in non-institutional group quarters such as group homes, shelters, and college quarters. Privacy rights of NESARC respondents were carefully protected. All NESARC respondents provided written informed consent and were assured that their participation was voluntary and their responses would be kept confidential.

Respondents were selected to participate in NESARC using a multistage cluster sampling design (Dawson et al., 2004). To increase the accuracy of national estimates of psychiatric disorders for population subgroups, Hispanics ($N = 8308$), non-Hispanic Blacks ($N = 8245$), and respondents aged 18–24 ($N = 5199$) were oversampled. Of all respondents, 18,518 were male and 24,575 were female. The overall household response rate was 89%; the person response rate was 93%; and the sample frame response rate was 99%. Thus, the overall survey response rate was 82%. Other details of the NESARC survey design and methods are reported elsewhere (Grant et al., 2004a, 2005).

2.2. Assessment and definition of study variables

2.2.1. Psychiatric disorders. Psychiatric disorders were assessed with the Alcohol Use Disorders and Associated Disabilities Interview Schedule – Diagnostic and Statistical Manual of Mental Disorders – Fourth Revision (AUDADIS – DSM-IV), an instrument of demonstrated reliability and validity (Grant et al., 2003). Several diagnostic modules were included to assess mood disorders (major depression, dysthymia, mania, and hypomania), anxiety disorders (panic disorder, agoraphobia, social phobia, specific phobia, and generalized anxiety disorder), personality disorders (avoidant, dependent, obsessive-compulsive, paranoid, schizoid, histrionic, and antisocial), and substance use disorders (tobacco, alcohol, solvents/inhalants, marijuana, cocaine, sedatives, tranquilizers, painkillers, heroin, amphetamines, and hallucinogens).

In this paper, we examined mood, anxiety, and personality disorders among inhalant users. We report NESARC-defined non-hierarchical diagnoses of mood and anxiety disorders (i.e., without using exclusionary criteria of the DSM-IV) because our aim is to understand the overall extent of these disorders afflicting inhalant users. Elucidating different possible causes of these disorders (e.g., substance use, medical conditions, or independence of former conditions) is not the focus of our study. In a future paper, we will describe the prevalence and correlates of comorbid substance use disorders in this national sample of inhalant users.

2.2.2. Inhalant use-related variables. In the Drug Use Module, respondents were read the following statement: "Now I'd like to ask you about your experiences with medicines and other kinds of drugs that you may have used on your own—that is, either WITHOUT a doctor's prescription (PAUSE); in GREATER amounts, MORE OFTEN, or LONGER than prescribed (PAUSE); or for a reason other than a doctor said you should use them. People use those medicines and drugs ON THEIR OWN to feel more alert, to relax or quiet their nerves, to feel better, to enjoy themselves, or to get high or just to see how they would work." Respondents were given a flashcard and were asked to indicate whether they have ever used each of nine separate categories of drugs listed on the card. If "yes," the interviewer asked "which ones?" and then recorded the specific agent(s) used. The inhalant question asked, "Have you EVER used: Inhalants or solvents, for example amyl nitrate, nitrous oxide, glue, toluene, or gasoline?" The survey instrument was computerized. Interviewers were allowed to answer respondents' questions and were trained to administer the survey in a standardized way. Respondents who reported any lifetime inhalant use then completed additional inhalant specific items assessing use in the prior 12 months, lifetime use, frequency and recency of use, symptoms of inhalant abuse and dependence, and age at onset of inhalant use, abuse, and dependence.

2.2.3. Substance abuse treatment and family history of psychopathology. A history of personal substance abuse treatment was defined as having ever received any treatment or services for problems related to alcohol or drug use at any location (e.g., an inpatient ward, outpatient clinic, emergency room, addiction treatment program, mental health treatment program, self-help group, jail, or church) (Grant et al., 2004b). A history of family psychopathology included any self-reported, positive family history of alcohol or drug use problems, depression, or antisocial behavior among any of the respondent's biological family members (i.e., natural parents, sons, daughters, grandparents, full brothers, and full sisters). Respondents were considered to have a positive family history of antisocial behavior if they reported that one or more of their biological relatives had ever evidenced behavior problems including being cruel to people or animals, fighting or destroying property, having trouble keeping a job or paying bills, acting impulsively or not planning ahead, lying to or conning people, or getting arrested and who also did not seem to care if they hurt others and who had problems at an early age such as truancy or running away.

2.2.4. Sociodemographics. We examined the following social and demographic characteristics of all lifetime inhalant users: age, gender, race and ethnicity, educational level, current marital status, and total annual family income.

2.3. Statistical analysis

We conducted a secondary data analysis of the public-use data file of the 2001–2002 NESARC. Because NESARC used a complex survey design, data were weighted and analyzed with SUDAAN software (Research Triangle Institute, 2002), which applies a Taylor series linearization method to account for complex design effects.

We first examined sociodemographic characteristics of all respondents and the subset of lifetime inhalant users. We then determined lifetime inhalant users' prevalences of past-year inhalant use and inhalant use disorders. Then, we generated prevalences of lifetime and past-year psychiatric disorders and determined whether these prevalences of psychiatric disorders varied by gender, age at onset of inhalant use, and respondent's prior use of substance abuse treatment services. Next, we examined the mean age at onset of inhalant use and each psychiatric disorder among inhalant users, as well as among respondents who met criteria for that specific disorder regardless of their inhalant use, in order to understand the comparative temporal sequencing of their occurrences. Using multiple logistic regression procedures (Hosmer and Lemeshow, 2000), we identified correlates of mood, anxiety, personality, and multiple (three or more disorders) psychiatric disorders among all inhalant users.

Finally, to better understand whether inhalant users were more likely than non-inhalant users to meet criteria for a psychiatric disorder, we stratified all respondents by gender, matched inhalant users to non-inhalant users on age, and conducted gender-specific conditional logistic regression analyses to specify associations between inhalant use and psychiatric disorders while adjusting for demographics and a family history of psychopathology. Conditional logistic regression analysis was conducted with STATA 7.0 (STATA Corp, 2001) because SUDAAN does not have procedures for the matched analysis. We report odds ratios (ORs) from the logistic regression analysis. ORs reflect the estimated strength of identified associations.

3. Results

3.1. Characteristics of the NESARC total sample

A total of 43,093 adults aged 18–98 participated in 2001–2002 NESARC. Weighted proportions for the total sample indicated that respondents were approximately evenly divided with respect to gender (males: 48%; females: 52%) and four levels of annual family income ($0–$19,999: 24%; $20,000–$39,999: 26%; $40,000–$74,999: 29%; $75,000+: 21%). Nearly three-quarters of respondents were non-Hispanic White (71%) compared with lesser proportions who were non-Hispanic Black (11%); American Indian, Alaska Native, or Asian (6%); or Hispanic (12%).

3.2. Characteristics of inhalant users

A total of 664 respondents (1.7% of all respondents) reported lifetime inhalant use, 19% of whom met criteria for a lifetime inhalant use disorder. Most (88%) respondents with a lifetime inhalant use disorder met criteria for inhalant abuse but not inhalant dependence, whereas 12% met criteria for inhalant dependence irrespective of whether or not they had ever met criteria for inhalant abuse. Nearly 60% of inhalant users reported initiation of inhalant use prior to age 18. Prevalences of past-year inhalant use and inhalant use disorders (6.4% and 1.4%, respectively) among lifetime inhalant users were relatively low.

Overall, 82% of inhalant users were White, 41% had a high school or less education, 65% were not currently married, 53% reported a total annual family income of less than $40,000, 64% were from non-central city or non-metropolitan areas, and 31% were from the western region of the US. There were gender differences in age group ($\chi^2 = 7.42$, d.f. = 2, $P = 0.029$) and marital status ($\chi^2 = 9.00$, d.f. = 2, $P = 0.015$). Female inhalant users were younger and more likely to be widowed, divorced, or separated than male users, whereas male users were more likely to have never been married.

3.3. Prevalence of lifetime psychiatric disorders in inhalant users

We report in Table 1 lifetime prevalences of psychiatric disorders among all inhalant users and by gender, age at onset of inhalant use, and history of substance abuse treatment. Inhalant users had high prevalences of lifetime mood (48%), anxiety (36%), and personality (45%) disorders. Particularly elevated lifetime prevalences were observed for major depression (41%), dysthymia (18%), manic episode (15%), specific phobia (18%), obsessive-compulsive personality disorder (17%), and antisocial personality disorder (32%). Prevalences of comorbid psychiatric disorders were high, with approximately one-in-seven (13%) inhalant users meeting criteria for six or more lifetime psychiatric disorders, and more than one-in-five (21%) meeting criteria for three to five such disorders.

Women who had used inhalants reported significantly higher prevalences of dysthymia (24% versus 16%), any anxiety disorder (53% versus 30%), panic disorder without agoraphobia (25% versus 11%), and specific phobia (28% versus 14%) than their male counterparts. Men who had used inhalants were significantly more likely than women to meet criteria for antisocial personality disorder (36% versus 22%).

Early onset of inhalant use was strongly associated with increased prevalences of having multiple psychiatric disorders, particularly mood and personality disorders. Respondents with early-onset inhalant use (before age 18) were more likely than late-onset inhalant users (18 or older) to report a prior hypomanic episode (10% versus 4%), to meet criteria for avoidant (10% versus 5%), paranoid (16% versus 9%), and antisocial (41% versus 19%) personality disorders, and to meet criteria for

Table 1
Prevalence of lifetime mood, anxiety, and personality disorders among lifetime inhalant users participating in the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (unweighted $N = 664$)

Prevalence of lifetime psychiatric disorders column %	Overall	Men	Women	Onset of inhalant use before age 18 years	Onset of inhalant use 18 or older	Ever used substance abuse treatment	Never used substance abuse treatment
Unweighted sample size	664	470	194	368[a]	288[a]	50	614
Mood disorders							
Any mood disorder	48.4	46.7	53.2	**53.6**	**40.4****	**72.5**	**46.6****
Major depression	40.8	38.3	48.0†	**44.4**	**35.0***	56.0	39.7†
Dysthymia	17.7	**15.6**	**23.6***	**20.9**	**13.2***	**34.0**	**16.5***
Mania	15.4	15.2	16.0	17.9	12.1	23.9	14.8
Hypomania	7.7	8.6	5.0†	**10.1**	**4.3***	22.7	6.6†
Anxiety disorders							
Any anxiety disorder	36.3	**30.3**	**53.4*****	38.7	32.7	39.1	36.1
Panic disorder with agoraphobia	3.7	4.1	2.7	4.9	2.0	11.3	3.1
Panic disorder without agoraphobia	14.3	**10.5**	**25.3****	16.4	11.4	13.8	14.4
Social phobia	12.1	10.8	15.7	13.5	10.4	13.4	12.0
Specific phobia	17.7	**14.1**	**28.0****	16.6	19.2	15.6	17.8
Generalized anxiety disorder	10.7	9.1	15.4†	**12.7**	**7.6***	11.1	10.7
Personality disorders							
Any personality disorder	45.1	46.7	40.6	**51.7**	**35.4****	**63.4**	**43.8***
Avoidant	7.8	7.5	8.7	**9.9**	**4.9***	10.6	7.6
Dependent	2.1	2.1	2.0	3.0	0.8	2.7	2.0
Obsessive-compulsive	17.2	17.9	15.2	19.9	13.9†	13.4	17.5
Paranoid	13.1	13.4	12.1	**16.3**	**8.8***	13.3	13.1
Schizoid	7.5	7.5	7.7	7.9	6.9	9.9	7.3
Histrionic	7.6	7.9	6.9	8.7	6.1	11.0	7.4
Antisocial	32.1	**35.5**	**22.3****	**40.7**	**18.9*****	**55.9**	**30.3***
Number of psychiatric disorders							
0 diagnoses	30.1	31.4	26.4	**24.7**	**38.3***	12.6	31.4†
1–2	35.5	35.5	35.4	**36.4**	**33.6**	37.8	35.3
3–5	21.3	20.1	24.7	**22.2**	**20.1**	31.4	20.6
6 or more	13.1	12.9	13.4	**16.7**	**8.0**	18.2	12.7

χ^2-test: $^{\dagger}P < 0.10$; $^{*}P \leq 0.05$; $^{**}P \leq 0.01$; $^{***}P \leq 0.001$. Numbers in bold indicate statistically significant effects.
[a] A total of eight inhalant users did not report age of first inhalant use; these eight cases were not included in the analysis.

six or more lifetime psychiatric disorders (17% versus 8%). In absolute terms, more than half of all early-onset inhalant users met criteria for one or more mood disorders (54%) and one or more personality disorders (52%), and 39% met criteria for one or more anxiety disorders.

Lifetime inhalant users with a history of alcohol or drug abuse treatment were significantly more likely than inhalant users without such a history to meet criteria for any mood disorder (73% versus 47%), dysthymia (34% versus 17%), any personality disorder (63% versus 44%), and antisocial personality disorder (56% versus 30%).

3.4. Prevalence of past-year psychiatric disorders in inhalant users

We then examined the prevalence of past-year (recent or active) psychiatric disorders among all inhalant users and by gender, age at onset of inhalant use, and history of substance abuse treatment (data not shown in a table). Approximately one-quarter (26%) of lifetime inhalant users met criteria for a mood disorder and a similar proportion (25%) met criteria for an anxiety disorder in the prior year. Overall, 38% of lifetime inhalant users experienced a mood or anxiety disorder in the past year. There also were gender differences in recent anxiety disorders. Female inhalant users were more likely than male inhalant users to meet criteria for any anxiety disorder (37% versus 20%), panic disorder without agoraphobia (11% versus 4%), specific phobia (22% versus 11%), and to experience three or more mood or anxiety disorders (15% versus 8%) in the past year.

Although the prevalences of past-year mood and anxiety disorders were higher for early-onset inhalant users than for later-onset inhalant users, none of these differences was statistically significant. Elevated prevalences of past-year mood disorders were reported by lifetime inhalant users with a history of substance abuse treatment compared with untreated inhalant users (47% versus 24%). The pattern of the finding suggested a higher prevalence of past-year psychiatric disorders among inhalant users who reported a history of substance abuse treatment. Yet the small sample of treated inhalant users appeared to limit the power to detect such differences.

3.5. Temporal ordering of inhalant use, inhalant use disorders, and comorbid psychiatric disorders

To understand the temporal ordering of inhalant use and comorbid psychiatric disorders, we examined the mean age at

onset of inhalant use and inhalant use disorders, as well as the mean age at onset of each psychiatric disorder. For each condition, the mean age at onset was calculated in two subsamples: (1) among respondents who met criteria for that specific disorder and who also had ever used inhalants and (2) among respondents who met criteria for that specific disorder regardless of their lifetime inhalant use (Table 2).

The mean ages at onset of inhalant use for inhalant users who progressed to inhalant abuse (16.1 years) or dependence (14.9 years) were younger than the mean age at onset of inhalant use among all inhalant users (17.5 years). There was no difference in the mean age at onset of inhalant abuse (17.0 years) and dependence (16.9 years). Gender was not associated with the mean age at onset of inhalant use status.

For inhalant users who developed specific mood or anxiety disorders, onset of social phobia (mean = 13.7 years) and specific phobia (mean = 13.8 years) typically preceded the onset of inhalant use, whereas other mood and anxiety disorders typically developed subsequent to inhalant use initiation. Among inhalant users, mania, hypomania, and major depression typically had onsets in the early 20s, whereas dysthymia, generalized anxiety disorder, and panic disorder generally developed in the mid-20s. Gender differences in the onset of psychiatric disorders among inhalant users were observed for major depression only: female inhalant users had a significantly earlier average age at onset of major depression than male inhalant users (19.7 years versus 23.2 years).

Our analysis of the mean age at onset of each disorder among respondents who met criteria for that specific disorder regardless of their inhalant use found a similar pattern of temporal ordering of onsets indicating that inhalant use tended to occur before the onset of most mood and anxiety disorders. This analysis also suggested that onset of mood and anxiety disorder (i.e., major depression, dysthymia, mania, panic disorder without agoraphobia, and generalized anxiety disorder) tended to occur earlier among inhalant users than among non-inhalant users.

3.6. Correlates of psychiatric disorders among inhalant users

To control for the potentially confounding influences of sociodemographic variations on the prevalence of psychiatric disorders, we conducted multiple logistic regression analyses to specify the correlates of lifetime psychiatric disorders separately for any mood, anxiety, personality, and multiple disorders (Table 3). Here, lifetime multiple disorders referred to as having three or more mood, anxiety, and personality disorders.

3.6.1. Mood disorder. We found that onset of inhalant use prior to age 13, lifetime substance abuse treatment, and a positive family history of psychopathology were each associated with increased odds of a lifetime mood disorder. Lifetime inhalant users who reported each of these characteristics were about three

Table 2
Mean age at onset of inhalant use, inhalant use disorders, mood disorders, and anxiety disorders: Data from the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions

Mean age in years (S.E.)	Mean age of onset of first inhalant use and mean age of first episode of the disorders among respondents who developed that disorder and who also had ever used inhalants[a]				Mean age of onset of inhalant use disorder and mean age of first episode of the disorders among respondents who developed that disorder regardless of inhalant use[b]			
	Overall	Men	Women	*t*-Test for gender differences *P*-values	Overall	Men	Women	*t*-Test for gender differences *P*-values
Inhalant use and disorder								
Any inhalant use[c]	17.5 (0.22)	17.5 (0.26)	17.6 (0.45)	0.778				
Inhalant abuse[d]	16.1 (0.40)	16.2 (0.44)	15.9 (0.86)	0.745	17.0 (0.56)	17.2 (0.62)	16.3 (1.01)	0.453
Inhalant dependence[e]	14.9 (0.90)	14.0 (0.72)	17.1 (0.86)	0.122	16.9 (1.04)	16.6 (1.20)	17.5 (2.16)	0.728
Mood disorders								
Major depression	22.1 (0.66)	**23.2 (0.85)**	**19.7 (0.90)**	**0.007**	29.7 (0.22)	29.7 (0.38)	29.7 (0.23)	0.989
Dysthymia	24.0 (1.30)	23.9 (1.58)	24.2 (2.25)	0.922	31.2 (0.40)	30.4 (0.72)	31.6 (0.46)	0.158
Mania	20.2 (1.21)	19.1 (1.14)	23.3 (2.74)	0.147	25.4 (0.40)	**23.5 (0.57)**	**27.0 (0.53)**	**<0.001**
Hypomania	22.4 (1.73)	22.9 (1.66)	19.8 (4.75)	0.524	23.2 (0.43)	**22.2 (0.57)**	**24.1 (0.61)**	**0.021**
Anxiety disorders								
Panic disorder with agoraphobia	27.4 (3.49)	28.1 (4.15)	24.5 (3.99)	0.543	28.5 (0.66)	**26.0 (1.23)**	**29.6 (0.74)**	**0.014**
Panic disorder without agoraphobia	26.4 (1.06)	27.8 (1.66)	24.9 (1.65)	0.255	32.3 (0.39)	32.3 (0.73)	32.3 (0.49)	0.985
Social phobia	13.7 (0.92)	14.1 (1.11)	12.9 (1.40)	0.516	15.2 (0.32)	14.9 (0.48)	15.4 (0.39)	0.393
Specific phobia	13.8 (1.16)	13.6 (1.45)	14.1 (1.86)	0.816	14.6 (0.24)	14.3 (0.39)	14.7 (0.28)	0.355
Generalized anxiety disorder	24.9 (1.75)	25.2 (1.88)	24.4 (3.09)	0.803	33.3 (0.46)	32.8 (0.79)	33.5 (0.50)	0.444

Numbers in bold indicate statistically significant effects.

[a] The analysis sample for each condition was restricted to respondents who met criteria for that condition and who also had ever used inhalants.

[b] The analysis sample for each condition was restricted to respondents who met criteria for that disorder regardless of their inhalant use.

[c] A total of eight inhalant users did not report age of first inhalant use and were not included in analyses.

[d] The analysis sample included respondents who met criteria for inhalant abuse and who did not met criteria for inhalant dependence.

[e] The analysis sample included respondents who met criteria for inhalant dependence regardless of whether or not they had ever met criteria for inhalant abuse.

Table 3
Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for lifetime mood, anxiety, and personality disorders among lifetime inhalant users participating in the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (unweighted $N = 664$)

Adjusted logistic regression analysis	AOR (95% CI)			
	Any lifetime mood disorder[a]	Any lifetime anxiety disorder[a]	Any lifetime personality disorder[a]	Any three or more lifetime disorders[a]
Age group				
18–29 vs. 45 or older	0.76 (0.43–1.33)	**0.51 (0.26–0.99)***	0.94 (0.55–1.58)	0.81 (0.38–1.76)
30–44 vs. 45 or older	1.00 (0.60–1.68)	0.66 (0.37–1.16)	0.84 (0.51–1.41)	0.97 (0.49–1.89)
Gender				
Male vs. female	0.75 (0.50–1.12)	**0.33 (0.20–0.52)*****	1.32 (0.86–2.03)	**0.56 (0.33–0.95)***
Race/ethnicity				
Black, Non-Hispanic vs. White	0.50 (0.23–1.09)	**0.24 (0.09–0.64)****	1.15 (0.51–2.59)	0.47 (0.16–1.38)
Hispanic vs. White	1.73 (0.82–3.65)	0.70 (0.30–1.63)	0.83 (0.47–1.44)	**0.52 (0.28–0.96)***
Other[b] vs. White	1.02 (0.49–2.13)	1.41 (0.68–2.92)	1.13 (0.52–2.47)	1.20 (0.47–3.05)
Educational level				
Less than high school vs. college or more	1.48 (0.76–2.88)	1.06 (0.56–2.01)	1.25 (0.68–2.32)	1.69 (0.81–3.53)
High school vs. college or more	1.02 (0.64–1.62)	0.95 (0.60–1.51)	1.29 (0.78 –2.12)	1.21 (0.59–2.46)
Marital status				
Widowed/divorced/separated vs. married	1.52 (0.88–2.61)	0.92 (0.56–1.52)	1.61 (0.94–2.75)	1.46 (0.78–2.73)
Single vs. married	1.18 (0.68–2.04)	0.80 (0.46–1.40)	1.08 (0.62–1.89)	0.97 (0.48–1.98)
Total family income				
$0–$19,999 vs. $75,000 or more	1.86 (0.91–3.79)	**3.52 (1.70–7.28)****	**2.71 (1.31–5.63)****	**4.73 (1.62–13.80)****
$20,000–$39,999 vs. $75,000 or more	1.13 (0.58–2.20)	**2.33 (1.13–4.80)***	1.38 (0.73–2.58)	2.40 (0.93–6.24)
$40,000–$74,999 vs. $75,000 or more	1.58 (0.85–2.94)	1.85 (0.98–3.49)	1.66 (0.86–3.20)	1.93 (0.74–5.04)
Age of onset of inhalant use				
Before 13 years vs. 18 or older	**2.97 (1.44–6.10)****	1.70 (0.73–3.97)	**3.12 (1.56–6.25)****	**2.83 (1.26–6.32)***
13–17 vs. 18 or older	1.34 (0.88–2.06)	1.21 (0.76–1.92)	**1.60 (1.02–2.52)***	1.38 (0.77–2.47)
History of substance abuse treatment				
Yes vs. no	**2.61 (1.18–5.79)***	1.09 (0.50–2.39)	1.73 (0.86–3.50)	**2.22 (1.01–4.85)***
Family history of psychopathology				
Yes vs. no	**3.12 (1.85–5.25)*****	**1.94 (1.20–3.13)****	**2.33 (1.43–3.79)*****	**2.63 (1.53–4.54)*****

$^{*}P \leq 0.05$; $^{**}P \leq 0.01$; $^{***}P \leq 0.001$. Numbers in bold indicate statistically significant effects.
[a] Each separate logistic regression model included all variables listed in that column.
[b] Other included American Indian, Alaska Native, Asian, Native Hawaiian, and Pacific Islander.

times as likely as those without such characteristics to develop a lifetime mood disorder.

3.6.2. Anxiety disorder. Inhalant users who were 45 and older, female, White, in the two lowest categories of family income, or with a family history of psychopathology had an increased likelihood of meeting criteria for a lifetime anxiety disorder. For example, lifetime inhalant users who reported a family history of psychopathology were 1.9 times as likely as those who did not report such a history to meet criteria for an anxiety disorder.

3.6.3. Personality disorder. Among inhalant users, being in the lowest category of family income, initiating inhalant use in adolescence, and reporting a family history of psychopathology were significantly associated with increased odds of having a personality disorder. In particular, inhalant users who initiated inhalant use before age 13 were 3.1 times as likely as those who initiated inhalant use in adulthood to have a personality disorder.

3.6.4. Multiple psychiatric disorders. Relative to male and Hispanic inhalant users, female and white inhalant users were significantly more likely to meet criteria for three or more psychiatric disorders in their lifetime. Multiple lifetime diagnoses was associated with being in the lowest category of family income, onset of inhalant use prior to age 13, a lifetime history of substance abuse treatment, and a family history of psychopathology.

3.6.5. Past-year psychiatric disorders. We report the findings of past-year psychiatric disorders in Table 4. Here, we focus on recent or active mood and anxiety disorders that are highly burdensome to respondents and society and that are likely to warrant immediate attention for interventions or treatment. Diagnoses of past-year personality disorders were not available. Among inhalant users, less education, prior use of substance abuse treatment services, and a family history of psychopathology predicted increased odds of experiencing a recent mood disorder. Female gender, low income, and a family history of psychopathology were each associated with increased odds of having a recent anxiety disorder as well as experiencing three or more mood and/or anxiety disorders in the prior year.

Table 4
Adjusted odds ratios (AORs) and 95% confidence intervals (CIs) for past-year mood and anxiety disorders among lifetime inhalant users participating in the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (unweighted $N = 664$)

Adjusted logistic regression analysis	AOR (95% CI)		
	Any past-year mood disorder[a]	Any past-year anxiety disorder[a]	Three or more past-year mood or anxiety disorders[a]
Age group			
18–29 vs. 45 or older	1.12 (0.57–2.20)	0.73 (0.37–1.44)	1.13 (0.30–4.28)
30–44 vs. 45 or older	1.52 (0.81–2.83)	0.72 (0.40–1.29)	1.23 (0.35–4.29)
Gender			
Male vs. female	0.79 (0.49–1.28)	**0.36 (0.23–0.56)*****	**0.25 (0.10–0.64)****
Race/ethnicity			
Hispanic vs. White	1.33 (0.64–2.77)	0.49 (0.20–1.20)	0.64 (0.16–2.55)
Other[b] vs. White	0.82 (0.42–1.59)	0.49 (0.21–1.13)	0.29 (0.06–1.53)
Educational level			
Less than high school vs. college or more	**2.53 (1.37–4.66)****	1.55 (0.93–2.56)	1.17 (0.34–4.08)
High school vs. college or more	**1.89 (1.11–3.24)***	1.25 (0.75–2.11)	1.09 (0.39–3.03)
Marital status			
Widowed/divorced/separated vs. married	1.64 (0.90–3.00)	0.83 (0.44–1.56)	0.70 (0.19–2.62)
Single vs. married	1.75 (0.96–3.19)	0.65 (0.34–1.23)	0.72 (0.18–2.86)
Total family income			
$0–$19,999 vs. $40,000 or more	1.67 (0.92–3.04)	**2.25 (1.24–4.09)****	**7.98 (2.11–30.14)****
$20,000–$39,999 vs. $40,000 or more	0.93 (0.52–1.68)	1.66 (0.88–3.14)	**6.04 (1.48–24.54)***
Age of onset of inhalant use			
Before 13 years vs. 18 or older	1.56 (0.71–3.44)	1.88 (0.82–4.30)	0.41 (0.07–2.37)
13–17 vs. 18 or older	0.99 (0.60–1.61)	1.03 (0.62–1.71)	0.67 (0.26–1.70)
History of substance abuse treatment			
Yes vs. no	**2.28 (1.04–4.99)***	1.50 (0.69–3.26)	1.71 (0.36–8.19)
Family history of psychopathology			
Yes vs. no	**2.70 (1.67–4.37)*****	**1.72 (1.08–2.76)***	**4.32 (1.61–11.59)****

$^{*}P \leq 0.05$; $^{**}P \leq 0.01$; $^{***}P \leq 0.001$. Numbers in bold indicate statistically significant effects.
[a] Each separate logistic regression model included all variables listed in that column.
[b] Other included Black, American Indian, Alaska Native, Asian, Native Hawaiian, and Pacific Islander.

3.7. Inhalant use and risk for psychiatric disorder

Finally, we determined whether lifetime inhalant users were significantly more likely than non-inhalant users to develop a psychiatric disorder in their lifetime. To control for age and gender effects on the risk for developing a psychiatric disorder, we stratified the whole NESARC sample by gender, matched all inhalant users with non-inhalant users on age, and conducted conditional logistic regression analyses to determine the influence of a history of inhalant use on the likelihood of having a lifetime psychiatric disorder (i.e., any mood, anxiety, and personality disorders).

Age-matched conditional logistic regression procedures (data not shown in a table) found that lifetime inhalant use was significantly associated with increased odds of meeting criteria for having one or more psychiatric disorders for both males (crude OR = 4.9; 95% confidence interval [CI] = 4.0–6.0) and females (crude OR = 3.6; 95% CI = 2.6–4.9). Even after controlling for race/ethnicity, educational level, marital status, annual family income, and a family history of psychopathology, male inhalant users were 4.1 times (95% CI = 3.4–5.0) and female inhalant users were 2.9 times (95% CI = 2.1–4.0) as likely as their same-gender, age-matched non-inhalant-using peers to meet criteria for one or more lifetime psychiatric disorder.

4. Discussion

In this national sample of American adults, approximately one in five lifetime inhalant users had ever progressed to an inhalant use disorder. Other psychiatric disorders are highly prevalent among lifetime inhalant users nationally. Of all inhalant users, we found that 41% met criteria for lifetime major depression and 32% met criteria for antisocial personality disorder. The prevalence of any personality disorder were substantially higher among inhalant users (45%) compared with the prevalence among the overall sample of NESARC respondents (15%) (Grant et al., 2004a,c). Overall, 70% of all inhalant users in this study had at least one lifetime personality, mood, or anxiety disorder and 38% experienced a mood or anxiety disorder in the past year. About one-half (49%) of those with at least one lifetime diagnosis met criteria for three or more psychiatric disorders.

Our findings suggest that inhalant users are a particularly disadvantaged subgroup of substance users afflicted with a very

high prevalence of psychiatric disorders (Dinwiddie, 1994; Wu et al., 2005). Inhalant users also confront significant social challenges. About two-thirds are widowed, divorced or separated or have never married; a majority report an annual family income of less than $40,000; and a sizable minority have a high school or less education. In conjunction with such a socioeconomic disadvantage, a high prevalence of psychiatric disorders is likely to result in significantly curtailed occupational, interpersonal, and other life opportunities for inhalant users.

Consistent with findings of other studies that did not focus specifically on inhalant users, we found that women were more likely than men to meet criteria for depression and anxiety disorders (Breslau et al., 2000), but were less likely than men to meet criteria for antisocial personality disorder (Grant et al., 2004a). Although Grant et al. (2004a) reported a significantly higher prevalence of avoidant, dependent, and paranoid personality disorders in women relative to men in the overall NESARC sample, significant gender differences were not observed across these disorders in this study of lifetime inhalant users.

Adjusted logistic regression analyses underscored the importance of low income, early age at onset of inhalant use, female gender, and a history of family psychopathology in influencing the risk for lifetime psychiatric disorders in inhalant users. It is clear that a family history of psychopathology conveys a high risk for both internalizing and externalizing disorders among inhalant users. Its influences on inhalant use and psychopathology may be directly and indirectly linked with biological and environmental factors (e.g., dysfunctional family, poverty, poor parenting, school difficulties, and affiliating with deviant peers) (Brennan et al., 2002; Moss et al., 2002; Wilens et al., 2002). Our findings suggest that adolescent inhalant users with family histories of psychopathology may benefit from early prevention interventions that enhance their psychosocial health, academic performance, self-esteem, and coping skills.

High prevalences of comorbid psychiatric disorders among females were identified. Our findings suggest that female inhalant users may have a worse course of psychopathology in their adult lives than males'. They are more likely than male inhalant users to experience three or more lifetime and past-year psychiatric disorders and are particularly susceptible to the development of anxiety disorders. Female adolescents appear to have increased their inhalant use to match the rate of male adolescents (Wu et al., 2004). Recent national surveys also reveal an increased prevalence of inhalant use among youths in school (Johnston et al., 2006). Hence, inhalant use and its consequences among females warrant greater research attention. Research on gender variations in psychiatric consequences of inhalant use among adolescents and young adults is recommended and collaborative efforts identifying effective interventions to delay or prevent the onset of inhalant use are needed.

There are limitations to the NESARC design. Our findings are derived from a cross-sectional survey of respondents; no causal inferences can be drawn from them. It is possible that inhalant use *per se* plays no role whatsoever in the high prevalence of psychiatric disorders observed among inhalant users nationally. Nonetheless, it may well be useful for clinical and prevention purposes to identify a marker, such as inhalant use, that is reliably associated with a range of treatable mental disorders. Retrospective studies of drug use requiring respondents to recall prior behaviors over lengthy periods of time also are subject to potential biases including reluctance to report stigmatized behaviors and forgetting. Given that some survey participants may have commenced inhalant use early in life or have very brief histories of inhalant use, problems in recall may be particularly relevant to investigations of inhalant use among adults. It is also important to note that the NESARC inhalant assessment was limited to a small (though important) set of agents, which may have accounted for the relatively low prevalence of inhalant use.

Nonetheless, the NESARC has important advantages over the other national surveys. Although the National Survey on Drug Use and Health (Wu et al., 2004, 2005; Wu and Ringwalt, 2006) includes a detailed assessment of specific types of inhalant use, it includes no formal diagnostic assessments for lifetime psychiatric disorders. The Monitoring the Future survey of students does not collect information pertaining to inhalant use disorders or other psychiatric disorders (Johnston et al., 2006). Thus, NESARC data provide a unique opportunity to examine comorbid psychiatric disorders among inhalant users nationally.

The very high prevalence of both lifetime and past-year psychiatric disorders among adult lifetime inhalant users has important implications for mental health treatment and future research. Screening for psychiatric disorders among adults who report a history of inhalant use may help identify individuals who are in need of psychiatric counseling or treatment. Early identification and referrals to effective treatment services could reduce the cost and consequences of psychiatric disorders. Relatively little is known about the natural history or long-term consequences of inhalant use. This investigation indicates that most mood and anxiety disorders, except for social and specific phobias, generally developed after the onset of both inhalant use and inhalant use disorders. Previous studies also found that phobias, except for agoraphobia, tended to have an early onset age and predicted later onsets of psychiatric disorders (Compton et al., 2000; Magee et al., 1996). Our findings suggest several lines of research for future investigations, including the roles that social and specific phobias, temperament, negative affect, and early life experiences (e.g., living in a family with parental psychopathology) may play in the initiation of inhalant use and transition to a psychiatric disorder. The possible independent and interactive effects of phobias and inhalant use on the risk for later occurrences of psychiatric disorders also deserve further inquiry. A great deal more needs to be learned about the natural history of inhalant use both with regard to comorbid psychiatric disorders and possible methods by which such disorders can be identified, treated, and prevented.

Acknowledgments

The NESARC is funded by the U.S. National Institute on Alcohol Abuse and Alcoholism, with supplemental support from the U.S. National Institute on Drug Abuse. Data analysis and preparation of this article were supported by a grant award from the National Institute on Drug Abuse (R21DA015938)

to Dr. Wu. Some of the descriptive findings were presented at a meeting, "Inhalant abuse among children and adolescents: Consultation on building an international research agenda", National Institute on Drug Abuse and Fogarty International Center, Rockville, Maryland, November 7–9, 2005. The opinions expressed in this paper are solely those of the authors. Readers are encouraged to read the NESARC reports for more details on the survey design, data collection, and its limitations.

References

American Psychiatric Association, 1994. Diagnostic and Statistical Manual of Mental Disorders (DSM-IV), 4th ed. American Psychiatric Association, Washington, DC.

Anglin, M.D., Hser, Y.I., Grella, C.E., 1997. Drug addiction and treatment careers among clients in the Drug Abuse Treatment Outcome Study (DATOS). Psychol. Addict. Behav. 11, 308–323.

Balster, R.L., 1996. Inhalant abuse, a forgotten drug problem. In: Presidential Address, 1996 Conference Proceedings, College on Problems of Drug Dependence.

Balster, R.L., 1998. Neural basis of inhalant use. Drug Alcohol Depend. 51, 207–214.

Brennan, P.A., Hammen, C., Katz, A.R., Le Brocque, R.M., 2002. Maternal depression, paternal psychopathology, and adolescent diagnostic outcomes. J. Consult. Clin. Psychol. 70 (5), 1075–1085.

Breslau, N., Chilcoat, H.D., Peterson, E.L., Schultz, L.R., 2000. Gender differences in major depression: the role of anxiety. In: Frank, E. (Ed.), Gender and Its Effects on Psychopathology. American Psychiatric Press Inc., Washington, DC.

Brett, A., 1997. Myeloneuropathy from whipped cream bulbs presenting as conversion disorder. Aust. N.Z. J. Psychiat. 31, 131–132.

Brouette, T., Anton, R., 2001. Clinical review of inhalants. Am. J. Addict. 10, 79–94.

Claus, R.E., Mannen, R.K., Schicht, W.W., 1999. Treatment career snapshots: profiles of first treatment and previous treatment clients. Addict. Behav. 24 (4), 471–479.

Compton, W.M., Conway, K.P., Stinson, F.S., Colliver, J.D., Grant, B.F., 2005. Prevalence, correlates, and comorbidity of DSM-IV antisocial personality disorder syndromes and alcohol and specific drug use disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. J. Clin. Psychiat. 66, 677–685.

Compton, W.M., Cottler, L.B., Phelps, D.L., Abdallah, A.B., Spitznagel, E.L., 2000. Psychiatric disorders among drug dependent subjects: are they primary or secondary? Am. J. Addict. 9, 126–134.

Dawson, D.A., Grant, B.F., Stinson, F.S., Chou, P.S., 2004. Psychopathology associated with drinking and alcohol use disorder in the college and general adult populations. Drug Alcohol Depend. 77, 139–150.

Dinwiddie, S.H., 1994. Abuse of inhalants: a review. Addiction 89, 925–939.

Dinwiddie, S.H., 1998. Psychological and psychiatric consequences of inhalants. In: Tarter, R. (Ed.), Handbook of Substance Abuse: Neurobehavioral Pharmacology. Plenum, New York.

Evren, C., Barut, T., Saatcioglu, O., Cakmak, D., 2006. Axis I psychiatric comorbidity among adult inhalant dependents seeking treatment. J. Psychoactive Drugs 38 (1), 57–64.

Grant, B.F., Dawson, D.A., 1998. Age of onset of drug use and its association with DSM-IV drug abuse and dependence: results from the National Longitudinal Alcohol Epidemiologic Survey. J. Subst. Abuse 10, 163–173.

Grant, B.F., Dawson, D.A., Stinson, F.S., Chou, P.S., Kay, W., Pickering, R., 2003. The Alcohol Use Disorders and Associated Disabilities Interview Schedule-IV (AUDADIS IV): reliability of alcohol consumption, tobacco use, family history of depression and psychiatric diagnostic modules in a general population sample. Drug Alcohol Depend. 71, 7–16.

Grant, B.F., Hasin, D.S., Stinson, F.S., Dawson, D.A., Chou, S.P., Ruan, W.J., Pickering, M.S., 2004a. Prevalence, correlates, and disability of personality disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. J. Clin. Psychiat. 65, 948–958.

Grant, B.F., Stinson, F.S., Dawson, D.A., Chou, S.P., Dufour, M.C., 2004b. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch. Gen. Psychiat. 61, 807–816.

Grant, B.F., Stinson, R.S., Dawson, D.A., Chou, S.P., Ruan, W.J., Pickering, R.P., 2004c. Co-occurrence of 12-month alcohol and drug use disorders and personality disorders in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch. Gen. Psychiat. 61, 361–368.

Grant, B.F., Hasin, D.S., Stinson, F.S., Dawson, D.A., Patricia, Chou, S., June, R.W., Huang, B., 2005. Co-occurrence of 12-month mood and anxiety disorders and personality disorders in the US: results from the National Epidemiologic Survey on Alcohol and Related Conditions. J. Psychiat. Res. 39 (1), 1–9.

Hosmer, D.W., Lemeshow, S., 2000. Applied Logistic Regression. John Wiley and Sons Inc., New York, NY.

Howard, M.O., Balster, R.L., Cottler, L.B., Wu, L.T., under preparation. Inhalant use among incarcerated youth: prevalence, predictors, and characteristics of use.

Howard, M.O., Cottler, L.B., Compton, W.M., Abdallah, A., 2001. Diagnostic concordance of DSM-III-R, DSM-IV, and ICD-10 inhalant use disorders. Drug Alcohol Depend. 61, 223–228.

Howard, M.O., Jenson, J.M., 1999. Inhalant use among antisocial youth: prevalence and correlates. Addict. Behav. 41, 59–74.

Howard, M.O., Walker, R.D., Walker, P.S., Cottler, L.B., Compton, W.M., 1999. Inhalant use among urban American Indian youth. Addiction 94, 83–95.

Hser, Y.I., Anglin, M.D., Grella, C., Longshore, D., Prendergast, M.L., 1997. Drug treatment careers: a conceptual framework and existing research findings. J. Subst. Abuse Treat. 14 (6), 543–558.

Johnston, L.D., O'Malley, P.M., Bachman, J.G., Schulenberg, J.E., 2005. Monitoring the Future National Results on Adolescent Drug Use: Overview of Key Findings, 2004. National Institute on Drug Abuse, Rockville, MD.

Johnston, L.D., O'Malley, P.M., Bachman, J.G., Schulenberg, J.E., 2006. Monitoring the Future National Results on Adolescent Drug Use: Overview of Key Findings, 2005. National Institute on Drug Abuse, Rockville, MD.

Kessler, R.C., Nelson, C.B., McGonagle, K.A., Edlund, M.J., Frank, R.G., Leaf, P.J., 1996. The epidemiology of co-occurring addictive and mental disorders: implications for prevention and service utilization. Am. J. Orthopsychiat. 66, 17–31.

Magee, W.J., Eaton, W.W., Wittchen, H.U., McGonagle, K.A., Kessler, R.C., 1996. Agoraphobia, simple phobia, and social phobia in the National Comorbidity Survey. Arch. Gen. Psychiat. 53 (2), 159–168.

Meadows, R., Verghese, A., 1996. Medical complications of glue sniffing. South Med. J. 89, 455–462.

Mikkelsen, S., 1997. Epidemiological update on solvent neurotoxicity. Environ. Res. 73, 101–112.

Moss, H.B., Lynch, K.G., Hardie, T.L., Baron, D.A., 2002. Family functioning and peer affiliation in children of fathers with antisocial personality disorder and substance dependence: associations with problem behaviors. Am. J. Psychiat. 159 (4), 607–614.

Research Triangle Institute, 2002. SUDAAN User's Manual: Release 8.0. Research Triangle Institute, Research Triangle Park, NC.

Sakai, J.T., Hall, S.K., Mikulich-Gilbertson, S.K., Crowley, T.J., 2004. Inhalant use, abuse, and dependence among adolescent patients: Commonly comorbid problems. J. Am. Acad. Child. Adolesc. Psychiat. 43, 1080–1088.

Sharp, C.W., Rosenberg, N., 1997. Inhalant-related disorders. In: Tasman, A., Kay, J., Lieberman, J.A. (Eds.), Psychiatry, vol. 1. W.B. Saunders Company, Philadelphia, PA.

STATA Corp, 2001. STATA 7.0. STATA Corp, College Station, Texas, USA.

Substance Abuse and Mental Health Services Administration, 2005. Results from the 2004 National Survey on Drug Use and Health: National Findings. Office of Applied Studies, Substance Abuse and Mental Health Services Administration, Rockville, MD.

Utti, R.J., Snow, B.J., Shinotoh, H., Vingerhoets, J.G., Hayward, M., Hashimoto, S., Richmond, J., Markey, S.P., Markey, C.J., Calne, D.B., 1994. Parkinsonism induced by solvent abuse. Ann. Neurol. 35, 616–619.

Wilens, T.E., Biederman, J., Bredin, E., Hahesy, A.L., Abrantes, A., Neft, D., Millstein, R., Spencer, T.J., 2002. A family study of the high-risk children of opioid- and alcohol-dependent parents. Am. J. Addict. 11 (1), 41–51.

Wu, L.T., Pilowsky, D.J., Schlenger, W.E., 2004. Inhalant abuse and dependence among adolescents in the United States. J. Am. Acad. Child. Adolesc. Psychiat. 43, 1206–1214.

Wu, L.T., Pilowsky, D.J., Schlenger, W.E., 2005. High prevalence of substance use disorders among adolescents who use marijuana and inhalants. Drug Alcohol Depend. 78, 32–33.

Wu, L.T., Ringwalt, C.L., 2006. Inhalant use and disorders among adults in the United States. Drug Alcohol Depend. 85, 1–11.