The high prevalence of substance use disorders among recent MDMA users compared with other drug users: Implications for intervention

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ABSTRACT

Aim: In light of the resurgence in MDMA use and its association with polysubstance use, we investigated the 12-month prevalence of substance use disorders (SUDs) among adult MDMA users to determine whether they are at risk of other drug-related problems that would call for targeted interventions. *Methods:* Data were drawn from the 2006 National Survey on Drug Use and Health. Past-year adult drug users were grouped into three mutually exclusive categories: 1) *recent MDMA users*, who had used the drug within the past year; 2) *former MDMA users*, who had a history of using this drug but had not done so within the past year; and 3) *other drug users*, who had never used MDMA. Logistic regression procedures were used to estimate the association between respondents' SUDs and MDMA use while adjusting for their socioeconomic status, mental health, age of first use, and history of polydrug use. *Results:* Approximately 14% of adults reported drug use in the past year, and 24% of those past-year drug users reported a history of MDMA use. Recent MDMA users exhibited the highest prevalence of disorders related to alcohol (41%), marijuana (30%), cocaine (10%), pain reliever/opioid (8%), and tranquilizer (3%) use. Adjusted logistic regression analyses revealed that, relative to other drug users, those who had recently used MDMA were twice as likely to meet criteria for marijuana and pain reliever/opioid use disorders. They were also about twice as likely as former MDMA users to meet criteria for marijuana, cocaine, and tranquilizer use disorders. *Conclusions:* Seven out of ten recent MDMA users report experiencing an SUD in the past year. Adults who have recently used MDMA should be screened for possible SUDs to ensure early detection and treatment.

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1. Introduction

The use of MDMA (3,4-methylenedioxymethamphetamine; ecstasy) is a growing public health concern due to its increasing use, association with polysubstance use, various health consequences, and potential neurotoxic effects on the human brain (Johnston, O'Malley, Bachman, & Schulenberg, 2007a; Maxwell, 2005; Parrott, 2006, 2007). MDMA's reported associations with polysubstance use, as well as its likely negative effects, have important implications for prevention and treatment. It is, however, uncertain whether MDMA users should be targeted for focused interventions to reduce the adverse consequences of polysubstance use. Little is presently known about the extent to which MDMA users are characterized by a severe pattern of substance abuse and whether early case finding and interventions with this population are warranted. Given the recent increase in MDMA use among adults (Substance Abuse and Mental Health Services Administration [SAMHSA], 2007), better understanding of the prevention and treatment needs of this population is needed.

In the United States, MDMA is commonly known as one of several "club drugs" (e.g., MDMA/ecstasy, methamphetamine, d-lysergic acid diethylamide or LSD, gamma-hydroxybutyrate or GHB, and ketamine) (Wu, Schlenger, & Galvin, 2006). In the 1990s, the drug appeared to be used predominantly by whites and party or club participants (Koesters, Rogers, & Rajasingham, 2002; Maxwell, 2005), but MDMA use later spread to nonwhite groups (e.g., Hispanics and blacks) and non-club settings (Maxwell, 2005). National surveys of Americans show a significant upsurge in MDMA use during the late 1990s and early 2000s (Johnston, O'Malley, Bachman, & Schulenberg, 2007b; SAMHSA, 2007). Nationally, rates of MDMA-related mortality and admissions to emergency departments also increased substantially from 1994 to 2001 (Patel, Wright, Ratcliff, & Miller, 2004; SAMHSA, 2002). Probably due to increased reports of MDMA-related health consequences and mortality, its use had declined since then. However, the 2006 and 2007 Monitoring the Future surveys indicate that MDMA is the only illicit drug currently demonstrating evidence of an increase in use and a concomitant decline in perceptions of associated risks (Johnston et al., 2007a,b). Similarly, the 2006 National Survey on Drug Use and Health (NSDUH) reports that the number of new past-year MDMA users increased substantially from approximately 642,000 in 2003 to 860,000 in 2006 (SAMHSA, 2007).

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Epidemiological studies suggest that MDMA users are also likely to use cigarettes, alcohol, and other drugs (Carlson, Wang, Falck, & Siegal, 2005; Parrott, 2001, 2007; Strote, Lee, & Wechsler, 2002; Topp, Hando, Dillon, Roche, & Solowij, 1999; Wu et al., 2006). The 2002 NSDUH showed that the majority of past-year MDMA users reported a history of use of alcohol (99%), marijuana (98%), prescription opioids (63%), cocaine (57%), and inhalants (45%) (Wu et al., 2006). Another study of a purposive sample of 402 MDMA users recruited from Ohio (Carlson et al., 2005) also reported a high prevalence of use of other substances: alcohol (100%), marijuana (99%), cigarettes (91%), prescription opioids (80%), cocaine (63%), and inhalants (58%). In Australia, similarly high rates of history of polysubstance use have been observed among MDMA users (Topp et al., 1999).

Despite the widely reported concern over polysubstance use by MDMA users and its potential influence on functional deficits and structural changes to the brain (Parrott, 2006; Reneman, de Win, van den Brink, Booij, & den Heeten, 2006), the extent of specific current substance use disorders (SUDs) among MDMA users is unknown. Previous studies have focused mainly on substance use *per se* (e.g., Carlson et al., 2005; Parrott, 2001; Strote et al., 2002; Scholey et al., 2004; Topp et al., 1999; Wu et al., 2006)—a crude measure that provides limited information concerning the intensity and magnitude of problems related to the use of specific substances among MDMA users. As a result, there is limited information concerning whether MDMA users actually constitute a unique group of polysubstance abusers who are distinct from users of other drugs and whether MDMA users may be particularly adversely affected by the concomitant abuse of other substances (Parrott, Milani, Gouzoulis-Mayfrank, & Daumann, 2007; Gouzoulis-Mayfrank & Daumann, 2006; Parrott, 2006). Such information has important implications for designing appropriate intervention and prevention programs, as well as selecting MDMA users for clinical research.

In this study, we investigate the 12-month prevalence of specific Diagnostic and Statistical Manual of Mental Disorders (DSM)-IV SUDs (American Psychiatric Association, 2000) and their associations with MDMA use within the context of a nationally representative sample of American adults aged 18 years or older. The focus on adults is based on the findings that the vast majority (70%) of new MDMA users are aged 18 years or older (SAMHSA, 2007). We examine past-year measures of SUDs and MDMA use because they are indicators of recent or active use and because the information they provide is highly relevant to the design of early intervention and treatment programs. Additionally, while the onset of drug use prior to adulthood constitutes a risk factor for developing SUDs (Grant & Dawson, 1998), previous studies have not addressed the association between SUDs and the early onset of MDMA use. Thus, we also examine whether MDMA users who initiated use early in life are associated with increased odds of SUDs than drug users who began use later or who have never used MDMAs.

The 2006 NSDUH is the most recent year available and demonstrates the significant upsurge in MDMA use among adults (SAMHSA, 2007). These data provide an excellent means for identifying the characteristics of recent MDMA users and for determining whether MDMA use occurs among casual (e.g., experimental) or more problematic substance users. This data source also constitutes the nation's largest study of drug use, thus providing sufficient statistical power to allow us to control for the potentially confounding effects of prior MDMA use among users of drugs other than MDMA by investigating SUDs across groups stratified by MDMA and other drug use. Because it is representative of domiciled adults in the U.S., this large sample also permits the generalizability of study findings.

We address three main questions. First, what are the socio-demographic and mental health characteristics of past-year MDMA users, and are these characteristics distinct from those of former MDMA users and users of drugs other than MDMA? Second, are there higher prevalence rates of SUDs among past-year MDMA users than among former MDMA users and other drug users? Third, are past-year

and early-onset MDMA use still associated with SUDs after statistically controlling potential confounds such as socioeconomic status, mental health, age of first drug use, and history of polydrug usage.

2. Methods

2.1. Study sample

This study is based on data from adult respondents contained in the public use file of the 2006 NSDUH (SAMHSA, 2007). NSDUH is the only ongoing survey that provides population estimates of substance use, SUDs, and health in the U.S. population. The survey's sampling frame covers approximately 98% of the total U.S. population aged 12 years or older and uses multistage area probability sampling methods to select a representative sample of the civilian non-institutionalized population. Participants include household residents; residents of shelters, rooming houses, and group homes; residents of Alaska and Hawaii; and civilians residing on military bases. To increase the accuracy of drug use estimates, young adults aged 18–25 years are oversampled.

Participants were interviewed in private at their places of residence. They were assured that their names would not be recorded and that their responses would be kept strictly confidential. All field interviewers signed a confidentiality agreement, and consent forms that explained data collection procedures and protections were carefully administered. The NSDUH interview uses computer-assisted interviewing (CAI) methods to increase the validity of respondents' reports of substance use and sensitive behaviors (Turner et al., 1998). The CAI methodology includes a combination of computer-assisted personal interviewing (CAPI) and audio computer-assisted self-interviewing (ACASI) methodologies. Demographic items were administered by the field interviewer via CAPI. The interview then was conducted via ACASI, which provided respondents with a highly private and confidential setting in which to answer sensitive questions (e.g., about their use of alcohol and other drugs). In this mode, questions were displayed on a computer screen and administered orally through headphones to respondents, who then entered responses directly into a laptop computer.

A total of 67,802 respondents aged 12 years or older completed the interview. Weighted response rates for household screening and interviewing were 91% and 74%, respectively, and each independent cross-sectional NSDUH sample is considered representative of the U.S. general population aged 12 years or older. NSDUH design and data collection procedures have been reported in detail elsewhere (SAMHSA, 2007). In this report, we focused on adults aged 18 years or older ($N = 36,959$). Within the adult sample, 52% were female and 31% were non-white (Table 1).

2.2. Study variables

NSDUH assesses nine categories of *drug use*, including the use of marijuana/hashish, cocaine/crack, inhalants, heroin, and hallucinogens (including MDMA, LSD, phencyclidine or PCP, peyote, mescaline, or psilocybin), as well as non-medical use of prescription pain relievers/opioids, stimulants/amphetamines, sedatives, and tranquilizers. Assessments include a detailed verbal description of each drug group, lists of qualifying drugs, and history of use. The survey defines non-medical use as any self-reported use of prescription drugs (pain relievers/opioids, stimulants, sedatives, and tranquilizers) that were not prescribed for the respondent or that the respondent took only for the experience or feeling they caused.

History of *MDMA use* was assessed by the question "Have you ever used 'Ecstasy,' also called MDMA?" This question is almost identical to the question used by the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC) (National Institute on Alcohol Abuse and Alcoholism, 2007), but only 129 respondents reported that they were past-year MDMA users in NESARC, which precluded our

Table 1
Demographic characteristics of adults aged 18 years or older in the 2006 NSDUH ($N = 36,965$).

Selected characteristics	100%	Sample, N
Gender		
Male	48.2	17,391
Female	51.8	19,574
Age in years		
18–25	14.8	17,932
26–34	15.9	5506
35 or older	69.3	13,527
Race/ethnicity		
White	69.4	24,332
Black	11.4	4472
American Indian/Alaska native	0.5	532
Asian/Pacific Islander/native Hawaiian	4.6	1366
Multiple race	1.0	846
Hispanic	13.1	5417
Education		
Less than high school	16.6	6695
High school graduate	31.3	12,326
College or more	52.1	17,944
Current marital status		
Married	55.4	14,328
Separated/divorced/widowed	19.3	4257
Never been married	25.2	18,380
Family income		
$0–$19,999	19.3	9502
$20,000–$39,999	23.2	9170
$40,000–$74,999	28.9	10,133
$75,000+	28.5	8160
Population density		
Large metropolitan	52.5	15,573
Small metropolitan	40.4	18,077
Non-metropolitan	7.1	3315
Past-year anxiety disorder		
Yes	4.4	1753
No	95.6	35,212
Past-year major depressive episode		
Yes	7.0	3167
No	93.0	33,798
Past-year drug use status		
No use	86.2	36,965
MDMA use regardless of other drug use	0.8	660
Former MDMA use plus other drug use	2.5	1595
Other drug use without a history of MDMA use	10.5	6209

Sample size is unweighted; all other estimates are weighted figures.

analysis of the NESARC dataset for our present purposes. Respondents also reported age of first use (onset) and any MDMA use within the 12 months preceding the interview (*past-year MDMA use*). Use of MDMA prior to the past 12 months was defined as *former MDMA use.* We created four mutually exclusive groups of past-year drug users: 1) *recent (past-year) MDMA users* regardless of whether they used other drugs; 2) *former MDMA users* who reported use of drugs other than MDMA in the past year; 3) *other drug users* who reported past-year use of drugs other than MDMA; and 4) *non-drug users* who had not used any drug within the past 12 months. *Age of onset of MDMA use* was categorized into three groups: before age 18 (adolescence), 18–22 years (college years as defined by NSDUH), and 23 years or older (after-college years).

Self-reported past-year use of cigarettes and alcohol was dichotomized. Past-year SUDs (abuse or dependence as defined by the DSM-IV) (American Psychiatric Association, 2000) were dichotomized. The survey specifically assessed abuse of or dependence on alcohol, inhalants, marijuana, cocaine/crack, hallucinogens, heroin, prescription pain relievers/opioids, sedatives, tranquilizers, and stimulants (e.g., SAMHSA, 2007; Wu, Ringwalt, Mannelli, & Patkar, 2008a,b). Diagnostic assessments were based on the questions used in the National Comorbidity Survey (NCS) (Kessler et al., 1994; Wu et al., 2004), and they had been revised and standardized to meet the

DSM-IV criteria and to be used by NSDUH, which administered these structured questions to respondents through the ACASI method. Past-month *nicotine dependence* was defined as specified by the Nicotine Dependence Syndrome Scale (NDSS) (Shiffman, Hickcox, Gnys, Paty, & Kassel, 1995; Shiffman, Waters, & Hickcox, 2004) and the Fagerstrom Test of Nicotine Dependence (FTND) (Fagerstrom, 1978; Heatherton, Kozlowski, Frecker, & Fagerstrom, 1991). NDSS questions were designed to assess dependence similar to the concepts specified by the DSM-IV, while FTND focuses on its ability to discriminate between dependent smokers and non-dependent smokers by assessing how soon after waking that smokers have their first cigarette. To optimize the number of respondents who can be classified for current nicotine dependence, the NSDUH classifies respondents as having nicotine dependence in the past month if they meet criteria for dependence as specified either by the NDSS or FTND (SAMHSA, 2007). A past-year measure of nicotine dependence was not available.

Based on previous studies, age of first drug use, history of polydrug use, anxiety disorder, and major depression were examined as potential confounders in the adjusted logistic regression analysis of SUDs in relation to MDMA use status (e.g., Grant & Dawson, 1998; Parrott, 2006; Wu et al., 2008a). *Age of first drug use* referred to the age of initiation of any of the nine drug classes assessed by the survey (inhalants, marijuana, cocaine/crack, heroin, hallucinogens, and nonmedical use of prescription pain relievers/opioids, sedatives, tranquilizers, and stimulants). *History of polydrug use* was measured by summing the number of these classes ever used by respondents. *Self-reported past-year anxiety disorder* was assessed by the question "Has a doctor or other medical professional ever told you that you had an anxiety disorder in the past 12 months?" A detailed DSM-IV assessment of anxiety disorder was not available. Questions assessing *past-year major depressive episodes* were based on DSM-IV criteria (American Psychiatric Association, 2000) and were adapted from the NCS-Replication (Kessler, Chiu, Demler, Merikangas, & Walters, 2005; SAMHSA, 2007).

We examined the following *demographic variables*: gender, age (18–25, 26–34, +35 years), race/ethnicity, educational level, current marital status, total annual family income, and population density of the area in which the respondent resided (large metropolitan with a population ≥1 million, small metropolitan with population <1 million, and non-metropolitan outside a standard metropolitan statistical area).

2.3. Data analysis

We first examined the demographic distributions and the prevalence of MDMA use among all adults ($N = 36,965$). Multinomial logistic regression procedures were conducted to determine the characteristics of the three mutually exclusive groups of past-year drug users: recent (past-year) MDMA users (regardless of the use of other drugs), former MDMA users (who had used other drugs in the past year), and other drug users (who had never used MDMA). We then generated the prevalence of SUDs and age of onset of first substance use by MDMA use status. Bivariate associations were assessed with chi-square tests for categorical variables and with *F*-tests for continuous variables.

Next, we conducted logistic regression procedures to compare the odds of each SUD across the three groups and the effects of age of MDMA onset on SUD. Each discrete logistic regression model was adjusted for gender, age, race/ethnicity, education, marital status, family income, population density, major depressive episode, anxiety disorder, age of first drug use, and history of polydrug use. All analyses were conducted with SUDAAN (Research Triangle Institute, 2006) to generate accurate standard errors for estimates presented. All estimates are weighted, while sample sizes presented are unweighted.

3. Results

3.1. MDMA users vs. other drug users

Out of 36,965 adult respondents, approximately 14% reported drug use in the past year. We found that 0.8% of the sample comprised *recent MDMA users* who had used MDMA in the past year, 2.5% were *former MDMA users* who had used drugs other than MDMA in the past year, and 10.5% were *other drug users* who had never used MDMA (Table 1).

Compared with non-drug users, past-year drug users (irrespective of MDMA use) were more likely to be male, white, under age 35, single, and to report anxiety disorder and major depressive episodes (Table 2). There were also differences across groups. Compared with other drug users, recent and former MDMA users were younger and more likely to reside in large metropolitan areas. Recent MDMA users also were more likely to report anxiety disorders than were other drug users. Compared with former MDMA users, recent MDMA users were more likely to be younger, black, Asian/Pacific Islander/native Hawaiian, to reside in large metropolitan areas, and not to have attended college.

3.2. Prevalence of SUDs and onset of substance use

As shown in Table 3, both recent (72%) and former (67%) MDMA users exhibited a higher prevalence of any SUD than did other drug users (50%). Recent MDMA users had the highest prevalence of disorders related to the use of alcohol (41%), marijuana (30%), cocaine (10%), pain relievers/opioids (8%), and tranquilizers (3%). Former MDMA users (39.5%) resembled recent MDMA users (39%) in their high prevalence of nicotine dependence; they also exhibited a higher prevalence of alcohol (32% vs. 24%) and marijuana (14% vs. 9%) use disorders than other drug users.

Both groups of MDMA users reported younger mean age of first use of several substances (alcohol, marijuana, pain relievers/opioids, cocaine, tranquilizers, and stimulants) than other drug users (Table 3). Recent MDMA users also reported a younger mean age of first use of pain relievers/opioids (18.7 vs. 20.2 years) and heroin (19.2 vs. 23.1 years) than former MDMA users.

3.3. Odds ratios of SUDs

In Table 4, we summarize adjusted odds ratios of SUDs in relation to lifetime and age of first use of MDMAs among past-year drug users. To determine the independent association of MDMA use with each SUD, we adjusted for potentially confounding variables in each discrete logistic regression model, including gender, age, race/ethnicity, education, marital status, family income, population density, major depressive episode, anxiety disorder, age of first drug use, and history of polydrug use. Inhalant, stimulant, sedative, and heroin use disorders were not associated with MDMA use from previous bivariate analyses, and each of their prevalence rates was low. Thus they are not reported in Table 4.

Compared with other drug users, recent MDMA users were twice as likely to meet criteria for any drug, marijuana, and pain reliever/opioid use disorders. They also were about twice as likely as former MDMA users to meet criteria for any drug, marijuana, cocaine, and tranquilizer use disorders. The analysis of the age of onset variable showed that, relative to drug users who had never used MDMA, those who initiated MDMA use before adulthood were more likely to report nicotine dependence and pain reliever/opioid use disorder. Onset of MDMA use at age 23 years or older also was associated with marijuana

Table 2
Selected characteristics of MDMA users and other drug users aged 18 years or older in the 2006 NSDUH ($N = 36,965$).

Multinomial logistic regression model[a]	Recent MDMA use vs. no drug use	Former MDMA use vs. no drug use	Other drug use vs. no drug use	Recent MDMA use vs. other drug use	Former MDMA use vs. other drug use	Recent MDMA use vs. former MDMA use
	AOR(95% CI)	AOR(95% CI)	AOR(95% CI)	AOR(95% CI)	AOR(95% CI)	AOR(95% CI)
Gender						
Male vs. female	1.5 (1.2–2.0)[b]	2.3 (1.9–2.6)[b]	1.9 (1.7–2.0)[b]	0.9 (0.7–1.2)	1.3 (1.1–1.6)[b]	0.8 (0.6–1.0)
Age in years						
18–25 vs. 35+	24.6 (12.4–48.9)[b]	5.3 (3.9–7.2)[b]	2.8 (2.4–3.2)[b]	8.7 (4.7–16.2)[b]	1.9 (1.4–2.7)[b]	4.4 (2.3–8.4)[b]
26–34 vs. 35+	11.7 (6.1–22.4)[b]	6.2 (4.6–8.4)[b]	1.9 (1.6–2.2)[b]	6.2 (3.4–11.3)[b]	3.3 (2.3–4.6)[b]	2.0 (1.01–3.9)[b]
Race/ethnicity						
Black vs. white	0.9 (0.6–1.3)	0.3 (0.2–0.4)[b]	1.0 (0.8–1.2)	1.0 (0.7–1.5)	0.3 (0.2–0.4)[b]	3.2 (1.8–5.6)[b]
Native American vs. white	1.8 (0.5–6.6)	0.4 (0.1–1.2)	1.1 (0.7–1.7)	2.1 (0.6–7.2)	0.5 (0.2–1.2)	4.7 (1.0–23.5)
Asian/nat. Hawaiian vs. white	0.8 (0.4–1.5)	0.2 (0.1–0.3)[b]	0.4 (0.3–0.6)[b]	1.6 (1.0–2.7)	0.4 (0.2–0.7)[b]	2.8 (1.3–6.3)[b]
More than one race vs. white	1.7 (0.6–4.4)	0.6 (0.3–1.1)	1.0 (0.6–1.7)	1.5 (0.5–4.4)	0.6 (0.3–1.2)	2.4 (0.8–6.9)
Hispanic vs. white	0.3 (0.2–0.5)[b]	0.4 (0.3–0.5)[b]	0.7 (0.6–0.8)[b]	0.5 (0.4–0.7)[b]	0.5 (0.4–0.7)[b]	0.8 (0.5–1.3)
Education						
<High school vs. ≥college	1.3 (0.9–1.9)	0.8 (0.6–0.9)[b]	1.1 (1.0–1.4)	1.1 (0.8–1.5)	0.7 (0.5–0.9)[b]	1.4 (1.0–1.9)
High school vs. ≥college	1.3 (0.9–1.8)	0.7 (0.6–0.9)[b]	1.2 (1.0–1.3)[b]	1.2 (0.9–1.6)	0.6 (0.5–0.8)[b]	1.6 (1.2–2.4)[b]
Current marital status						
Married vs. single	0.3 (0.1–0.5)[b]	0.2 (0.1–0.3)[b]	0.4 (0.3–0.5)[b]	0.6 (0.3–1.1)	0.6 (0.4–0.8)[b]	0.8 (0.5–1.5)
Sep./div./wid. vs. single	0.5 (0.3–1.0)	0.6 (0.4–0.8)[b]	0.7 (0.5–0.8)[b]	0.7 (0.4–1.4)	1.0 (0.7–1.3)	0.8 (0.4–1.8)
Family income						
$0–$19,999 vs. $75 K+	1.4 (1.0–2.0)	1.0 (0.8–1.4)	1.2 (1.0–1.4)	1.2 (0.9–1.7)	0.9 (0.7–1.3)	1.3 (0.9–2.0)
$20 K–$39,999 vs. $75 K+	1.2 (0.7–1.9)	1.2 (1.0–1.6)	1.0 (0.8–1.1)	1.2 (0.8–2.0)	1.3 (1.0–1.8)	0.9 (0.5–1.6)
$40 K–$74,999 vs. $75 K+	1.1 (0.7–1.6)	1.0 (0.8–1.4)	1.0 (0.8–1.1)	1.1 (0.7–1.7)	1.1 (0.8–1.5)	1.0 (0.6–1.5)
Population density						
Small metro vs. large metro	0.7 (0.6–0.9)[b]	0.7 (0.5–0.8)[b]	1.0 (0.9–1.1)	0.7 (0.6–0.9)[b]	0.7 (0.6–0.9)[b]	0.9 (0.7–1.3)
Non-metro vs. large metro	0.3 (0.1–0.4)[b]	0.4 (0.3–0.6)[b]	0.8 (0.6–1.0)	0.3 (0.2–0.5)[b]	0.5 (0.4–0.8)[b]	0.5 (0.3–0.8)[b]
Anxiety disorder						
Yes vs. no	3.0 (1.8–5.1)[b]	2.5 (1.7–3.5)[b]	2.0 (1.6–2.5)[b]	1.6 (1.0–2.5)[b]	1.2 (0.8–1.8)	1.1 (0.6–2.0)
Major depressive episode						
Yes vs. no	2.0 (1.3–3.1)[b]	2.1 (1.7–2.5)[b]	2.1 (1.8–2.5)[b]	1.1 (0.8–1.7)	1.1 (0.8–1.4)	1.1 (0.7–1.9)

AOR = adjusted odds ratio; CI = confidence interval.
[a] The logistic regression model included all variables listed in the first column.
[b] $p<0.05$.

Table 3
Twelve-month prevalence of substance use disorders and age of first substance use among past-year MDMA users and other drug users aged 18 years or older in the 2006 NSDUH ($N = 8464$).

Past-year MDMA use status	Recent MDMA users	Former MDMA users	Other drug users	χ^2 (df) or
	$n = 660$	$n = 1595$	$n = 6209$	F test p value
Substance use disorders	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Any of the 11 disorders	72.9 (66.50–78.54)	67.0 (62.77–71.02)	50.1 (47.97–52.27)	78.3 (2)<0.001
Alcohol	40.9 (33.83–48.33)	31.8 (27.80–36.06)	24.1 (22.47–25.82)	28.0 (2)<0.001
Nicotine[a]	39.1 (33.64–44.92)	39.5 (35.67–43.50)	29.9 (28.11–31.79)	31.9 (2)<0.001
Marijuana	29.8 (24.06–36.15)	13.7 (11.61–16.18)	8.7 (7.72–9.68)	54.1 (2)<0.001
Cocaine/crack	10.4 (7.51–14.34)	7.2 (5.24–9.93)	4.4 (3.67–5.38)	13.9 (2)<0.001
Pain relievers/opioids	7.9 (5.20–11.94)	6.3 (4.81–8.29)	3.7 (3.05–4.47)	12.5 (2)<0.001
Hallucinogens[b]	6.6 (4.57–9.38)	0.6 (0.66–2.14)	0.4 (0.39–1.15)	34.4 (2)<0.001
Tranquilizers	3.3 (2.06–5.21)	1.3 (0.75–2.19)	0.8 (0.50–1.29)	10.9 (2) 0.01
Stimulants	2.2 (1.13–4.34)	1.2 (0.66–2.14)	0.7 (0.39–1.15)	NS
Heroin	2.2 (1.09–4.19)	1.2 (0.67–2.25)	0.8 (0.38–1.61)	NS
Inhalants	0.2 (0.05–0.70)	0.2 (0.14–2.11)	0.08 (0.03–0.22)	NS
Sedatives	0.2 (0.04–0.75)	0.5 (0.16–1.38)	0.1 (0.05–0.27)	NS
Age of onset in years[c]	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)	Mean (95% CI)
Alcohol	14.4 (13.96–14.89)	14.1 (13.85–14.28)	15.3 (15.17–15.46)	<0.001
Cigarettes	15.2 (14.36–16.07)	14.8 (14.44–15.12)	14.7 (14.48–14.88)	NS
Marijuana	15.6 (14.95–16.25)	15.2 (14.98–15.47)	16.9 (16.55–17.19)	<0.001
Inhalants	17.9 (17.00–18.86)	18.0 (17.38–18.60)	17.9 (17.23–18.45)	NS
Pain relievers/opioids	18.7 (17.83–19.49)	20.2 (19.56–20.78)	23.2 (22.64–23.78)	<0.001
Sedatives	19.1 (16.78–21.41)	19.9 (18.35–21.36)	22.3 (21.04–23.60)	NS
Heroin	19.2 (17.89–20.49)	23.1 (20.53–25.67)	23.9 (21.89–25.85)	<0.001
Cocaine/crack	19.3 (18.46–20.05)	19.5 (19.12–19.84)	22.0 (21.25–22.83)	<0.001
Tranquilizers	19.5 (18.56–20.43)	21.0 (20.02–22.04)	23.4 (22.73–24.11)	<0.001
Hallucinogens[b]	19.5 (18.28–20.76)	18.7 (18.25–19.04)	19.2 (18.75–19.72)	NS
Stimulants	20.0 (17.58–22.35)	19.0 (18.49–19.56)	21.3 (20.27–22.40)	<0.001
MDMA	21.2 (20.03–22.37)	21.9 (21.27–22.46)	....	NS

CI = confidence intervals; NS: p>0.01.

[a] Past-month nicotine dependence; all other disorders were past-year abuse of or dependence on the substance.

[b] Any hallucinogens included MDMA, LSD, PCP, peyote, mescaline, or psilocybin.

[c] Age of first use among respondents who had used the substance.

use disorders as compared with drug users who had never used MDMA.

4. Discussion

This study reports new findings on specific DSM-IV SUDs in a large nationally representative sample of adult MDMA users. In 2006, approximately one in seven adults reported drug use in the past year. Of these drug users, close to 6% had used MDMA in the past year, and 18% had used it prior to the past year. Both groups of MDMA users reported a higher prevalence of several SUDs than did other drug users. Even after controlling for potentially important confounders, recent MDMA users not only were more likely than other drug users to

meet criteria for marijuana and pain reliever/opioid use disorders, but they were also more likely than former MDMA users to meet criteria for marijuana, cocaine, and tranquilizer use disorders. These findings provide evidence that recent adult MDMA users constitute a uniquely vulnerable subgroup of polysubstance abusers who are likely to benefit from regular screening and referrals for problems related to substance abuse.

4.1. MDMA users are distinct from other drug users

MDMA users differ from drug users who had never used MDMA in a variety of demographic and mental health characteristics. Overall, MDMA users were more likely than other drug users to be young

Table 4
Logistic regression analysis of substance use disorders among past-year drug users aged 18 years or older in the 2006 NSDUH ($N = 8464$).

AOR (95% CI)	Past-year drug use status			Age of first MDMA use		
Substance use disorders[a]	Recent MDMA use vs. other drug use	Former MDMA use vs. other drug use	Recent MDMA use vs. former MDMA use	Before 18 years vs. never used	18–22 years vs. never used	23+ years vs. never used
Nicotine[b]	1.2 (0.9–1.5)	1.2 (1.0–1.5)	1.0 (0.7–1.4)	1.3 (1.0–1.7)[d]	1.1 (0.9–1.4)	1.2 (0.9–1.5)
Alcohol	1.2 (0.8–1.6)	0.8 (0.7–1.0)	1.4 (1.0–2.0)	1.0 (0.8–1.4)	1.0 (0.8–1.3)	0.8 (0.5–1.1)
Any drug[c]	2.2 (1.6–3.1)[d]	1.0 (0.7–1.3)	2.1 (1.5–3.0)[d]	1.2 (0.9–1.6)	1.4 (1.0–1.8)	1.2 (0.9–1.7)
Marijuana	2.4 (1.7–3.5)[d]	1.1 (0.8–1.4)	2.2 (1.5–3.2)[d]	1.2 (0.9–1.7)	1.4 (1.0–1.9)	1.7 (1.1–2.6)[d]
Cocaine/crack	1.6 (1.0–2.7)	0.9 (0.5–1.6)	1.8 (1.1–3.0)[d]	1.1 (0.7–1.7)	1.3 (0.7–2.4)	0.7 (0.4–1.5)
Hallucinogens	5.8 (2.7–12.7)[d]	0.5 (0.2–1.4)	12.0 (4.8–29.8)[d]	1.4 (0.5–3.9)	1.8 (0.8–4.1)	1.6 (0.4–6.7)
Pain relievers/opioids	2.0 (1.2–3.2)[d]	1.2 (0.8–1.9)	1.3 (0.8–2.3)	1.7 (1.2–2.4)[d]	1.2 (0.7–2.1)	0.7 (0.3–1.5)
Tranquilizers	2.1 (0.9–4.7)	0.8 (0.4–1.7)	2.7 (1.2–5.8)[d]	1.9 (0.7–5.1)	0.6 (0.3–1.4)	1.0 (0.3–3.5)

Note: The prevalence of stimulant, heroin, inhalant, and sedative use disorders was low; and each was not associated with MDMA use status.

AOR = adjusted odds ratios; CI = confidence interval.

[a] Each separate logistic regression model adjusted for gender, age, race/ethnicity, education, marital status, family income, population density, past-year major depressive episode, past-year anxiety disorder, age of first drug use, and history of polydrug use.

[b] Past-month nicotine dependence; all others were past-year abuse of or dependence on that substance.

[c] Any drug use disorder included abuse of or dependence on marijuana, cocaine, inhalants, hallucinogens, heroin, stimulants, pain relievers/opioids, sedatives, and tranquilizers.

[d] p<0.05.

adults (<35 years), whites, and residents of large metropolitan areas. Recent MDMA users also exhibit higher odds of anxiety disorder than other drug users, which might be associated with their higher rates of SUDs and other pre-existing differences in psychopathology (Medina & Shear, 2007; Soar, Turner, & Parrott, 2006). The comparison between recent and former MDMA users further reveals that blacks, Asians/ Pacific Islanders/native Hawaiians, and those who did not attend college might be at risk for using MDMA in the past year. Other reports also have found that MDMA use has spread from predominantly white users to non-white groups, including black adults (National Institute on Drug Abuse, 2006; Boeri, Sterk, & Elifson, 2004).

4.2. Recent MDMA users have a particularly high rate of SUDs

This study's most salient finding concerns the disturbingly high prevalence of SUDs among drug users in general and recent MDMA users in particular. More than seven in ten recent MDMA users and close to seven in ten former users of MDMA also reported an SUD. The high rates of SUDs among MDMA users are also consistent with our descriptive findings showing that MDMA users on average start consuming several substances earlier than other drug users. These findings not only are in line with the previously reported pervasiveness of substance use among MDMA users (Carlson et al., 2005; Parrott, 2001; Strote et al., 2002; Topp et al., 1999; Wu et al., 2006) but also help elucidate specific SUDs that disproportionally affect MDMA users. By employing logistic regression procedures to hold constant the potentially confounding influences of a variety of respondents' characteristics and drug use patterns, recent MDMA users were found to be twice as likely as other drug users to manifest any drug, marijuana, and pain reliever/opioid use disorders, and they also exhibited higher odds of any drug, marijuana, cocaine, and tranquilizer use disorders than former MDMA users. These results, hence, suggest that recent MDMA users are at risk for SUDs. The cross-sectional nature of the data cannot address the reasons accounting for this finding. Study results, nonetheless, suggest that recent MDMA users on average use opioids and heroin at a younger age than drug users who do not use MDMA in the past year. Because heroin is typically the drug used at the later stage of drug involvement (Chen & Kandel, 1995) and opioids/ heroin may be used to self-medicate psychological distress, pain, and discomfort related to mental/medical conditions or post-use of other drugs (Brands, Blake, Sproule, Gourlay, & Busto, 2004; Khantzian, 1985; Leri, Bruneau, & Stewart, 2003), it could be that a subset of early-onset, problematic drug users are at risk for using MDMA actively.

4.3. SUDs are not limited to early-onset MDMA users

This study also extends previously unaddressed questions by clarifying the association with SUDs by age of onset of MDMA use. Previous research indicates that adolescent onset of drug use confers a risk for SUDs (Grant & Dawson, 1998). In this study, early MDMA use (before adulthood) was associated moderately with only two SUDs (nicotine and pain reliever/opioid), which is likely to be explained by the finding that MDMA users on average initiate MDMA use at a later age (i.e., 21–22 years) than the average ages of initial use of most other substances. In addition, we found that onset of MDMA use at age 23 years or older was associated with marijuana use disorders. This finding may be explained by the possibility that MDMA often is used within the context of other substance use (Parrott, 2001). Adult-onset MDMA use therefore may reflect a serious pattern of substance use exhibited primarily by a subset of problematic drug users (i.e., marijuana abusers).

4.4. Pharmacodynamic reasons for polydrug use

There are several possible reasons for our finding concerning extensive polydrug use among drug users in general and MDMA users

in particular. Research suggests that once individuals are exposed to drug use, they are likely to have additional opportunities to use other substances (Wilcox, Wagner, & Anthony, 2002); the use of multiple drugs can then become problematic or develop into a formal disorder. For example, the use of MDMA in dance clubs provides another social gateway into polydrug use, as the use of one drug at clubs leads to others—often through the same dealer (Parrott, 2004a). There may also be common risk factors (e.g., early behavior problems, delinquency, and personality traits) that co-occur early and influence each other to increase the risk of substance use and subsequent polysubstance abuse (Jessor, 1998; Newcomb & Felix-Ortiz, 1992; Alati et al., 2008). A recent longitudinal analysis shows that the association between early delinquency and later MDMA use appears to be explained, in part, by early alcohol or tobacco use (Alati et al., 2008).

Pharmacodynamic reasons may also account for the co-usage of multiple drugs. Chronic tolerance often develops with MDMA, and this can lead to the use of other stimulants such as amphetamines or cocaine (Parrott, 2005; Scholey et al., 2004). Cross-tolerance may then become an issue, with dosage escalation likely across different stimulants. In such circumstances, the mono-stimulant user may escalate to a poly-stimulant user or even a problematic polydrug user (Parrott, Morinan, Moss, & Scholey, 2004). Another problem with MDMA is the recovery period afterwards, which is accompanied by feelings of lethargy and depression that can last for several days (Parrott, Lock, Conner, Kissling, & Thome, 2008). MDMA users often take marijuana or alcohol to relieve later discomfort associated with post-MDMA comedown (Winstock, Griffiths, & Stewart, 2001).

Drug users also may co-use multiple substances (i.e., alcohol, marijuana, stimulants, or opioids/heroin) with or without MDMA to either improve or modulate their subjective effects (Boys, Marsden, & Strang, 2001; Leri et al., 2003). Together, the present data confirm challenges related to the role played by polydrug use in studies of the adverse effects of MDMA use in humans. Clearly, longitudinal studies of large cohorts of young participants before their initiation of drug use are needed to better understand the neurotoxic consequences of MDMA use (Gouzoulis-Mayfrank & Daumann, 2006).

4.5. Study limitations and strengths

These findings are subject to several limitations. The cross-sectional design of the NSDUH precludes making inferences of causal relationships from our findings. In addition, the survey relies on respondents' self-reports, which may be influenced by under-reporting and memory errors. Individuals who suffered severe consequences from MDMA use might not have been included in the sampling frame of this household survey or may otherwise have been unable to participate. Further, as with any other U.S. national survey, the NSDUH does not collect information concerning either the dosage or purity of MDMA tablets consumed, both of which may affect substance use patterns. Nonetheless, Parrott (2004b) reviewed the literature and concluded that MDMA impurity was predominantly a phenomenon of the 1990s. By the early 2000s, non-MDMA tablets had become rare, and high-dose MDMA tablets have been seen more frequently. Last, the assessment of anxiety disorder was assessed only in terms of overt medical diagnosis, which may be under-estimated.

The NSDUH data also have noteworthy strengths. The very large sample represents the domiciled U.S. population aged 18 years and older, and the sample thus has a high degree of generalizability. Perhaps the most important characteristic of potentially productive MDMA research is a sample of sufficient size to support the comparison of specific SUDs between distinct groups of MDMA users and other drug users, which is precluded in smaller-scale studies. Additionally, the survey employs the most advanced technology available (i.e., computer-assisted self-interviewing) to increase

respondents' reporting of socially stigmatized, illegal, or otherwise sensitive drug use behaviors (Turner et al., 1998).

4.6. Implications and conclusions

The disturbingly high prevalence SUDs among drug users in general and recent MDMA users in particular has important implications for intervention. Regular polysubstance users may suffer from the adverse and potentially multiplicative effects of multiple drugs. For instance, cognitive skills are impaired by either MDMA or marijuana use, but are impaired to a greater extent among marijuana-using MDMA users (Rodgers et al., 2003; Gouzoulis-Mayfrank et al., 2000). Similar interactive processes may underlie the use of MDMA in conjunction with nicotine or alcohol, in which case long-term psychobiological distress can be further increased (Parrott, 2006). Substance abuse can also cause long-term adverse effects on health, including cardiovascular disease, stroke, kidney and liver damage, cancer, HIV/AIDS, hepatitis, lung disease, mental disorders, and mortality (Brick, 2004). These results thus emphasize the need to screen recent drug users in health care settings for medical and psychiatric problems related to the use of a variety of substances and then to intervene as appropriate. Given the pervasiveness of their substance abuse, recent MDMA users may particularly benefit from targeted interventions or additional medical monitoring.

There are currently no specific behavioral or pharmacological treatments for MDMA abuse or dependence (National Institute on Drug Abuse, 2006), although research suggests that the rate of MDMA abuse or dependence among regular MDMA users is prevalent (Cottler, Womack, Compton, & Ben-Abdallah, 2001). The resurgence in MDMA use and concomitant decline in the perceived risk of the drug, as reported by recent national surveys (Johnston et al., 2007a,b; SAMHSA, 2007), underscore the need for monitoring the trend in MDMA use and problems associated with its use, as well as for identifying effective treatments for MDMA abuse.

Acknowledgments

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