Relationship of Substance Abuse to Dependence in the U.S. General Population

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ABSTRACT. Objective: The diagnostic categories of the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition*, for substance abuse and dependence are commonly used in clinical work and research studies, but whether abuse and dependence represent two different syndromes has been debated. The purpose of this article is to investigate the relationship of substance abuse and dependence for cannabis, cocaine, stimulants and sedatives among lifetime users of these substances in the National Epidemiologic Survey on Alcohol and Related Conditions, a nationally representative survey conducted in 2001–2002. **Method:** The multiple indicators multiple causes (MIMIC) model addresses three sets of relationships: those between (1) diagnostic criteria and latent factors, (2) latent factors and covariates, and (3) criteria and covariates. This approach allows for the detection of and compensation for noninvariance of the measurement of criteria across subgroups. **Results:** Compared with one-factor models, two-factor models (factors

roughly corresponding to abuse and dependence) fit significantly better across all substances, with abuse and dependence factors highly correlated. The MIMIC model indicated that race/ethnicity, age, income, and marital status showed some differential relationships across substance groups, although most covariates showed similar associations to dependence and abuse factors. Noninvariance of criteria measurement by demographic covariates was most pronounced for cannabis abuse and dependence criteria. **Conclusions:** The general relationship of abuse to dependence was consistent across substances. Results were equivocal on the value of retaining separate factors; therefore, investigating the relationships of specific genetic variants and treatment outcomes to dimensional indicators of abuse, dependence, and measures combining these criteria is warranted. Measurement of cannabis abuse and dependence criteria appears most affected by demographic characteristics. (*J. Stud. Alcohol Drugs*, 73, 368–378, 2012)

THE SUBSTANCE DEPENDENCE CRITERIA in the *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* (DSM-IV; American Psychiatric Association, 1994), are based on the concept of the alcohol dependence syndrome (Edwards, 1986; Edwards and Gross, 1976), generalized to drugs in 1981 (Edwards et al., 1981). Dependence was considered to be a combination of physiological and psychological processes leading to increasingly impaired control over substance use even in the face of negative consequences. This syndrome was viewed as one “axis” of substance problems, with the consequences of heavy use (social, legal, and medical problems; hazardous use) considered a separate axis. This bi-axial characterization

(Edwards, 1986) led to the DSM-IV distinction (American Psychiatric Association, 1994) between abuse (mainly social, role functioning, or legal problems or hazardous use, most commonly driving while intoxicated) and dependence criteria (tolerance, withdrawal, and numerous indicators of impaired control over use).

The concepts of DSM-IV substance abuse and dependence are commonly used in clinical work and research; however, there is debate about whether abuse and dependence represent two different but related syndromes or represent a continuum of severity of a common syndrome (Hasin and Grant, 2004). This is important because if currently used categories do not appropriately characterize the underlying structure of substance use disorders, research may target imprecisely defined entities or processes and, thus, be less likely to advance the understanding of etiology and effective treatment.

One way to examine the validity of substance use disorders’ categories is to investigate the factor structure of the diagnostic criteria. Several studies have investigated the factor structure of alcohol use disorders in clinical epidemiologic samples (Grant et al., 2007; Harford and Muthén, 2001; Hasin et al., 1997; Muthén, 1995; Muthén et al., 1993a, 1993b). Regardless of whether DSM-III-R (American Psychiatric

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Association, 1987) or DSM-IV criteria were used, those studies consistently indicated the presence of two correlated but distinct factors.

Previous studies have identified considerable overlap between DSM-IV criteria for abuse and dependence (Langenbucher and Chung, 1995; Langenbucher et al., 1995). Even factor analytic studies that report two-factor models do not yield complete differentiation between abuse and dependence criteria (Grant et al., 2007; Harford and Muthén, 2001; Muthén, 1995). Multiple-factor models consistently yield one large factor and one or two minor factors that are highly correlated with the first factor. Although not replicating the DSM-IV division between dependence and abuse criteria exactly, the first factor is generally characterized by DSM-IV dependence criteria, whereas the second generally reflects abuse criteria. Studies in clinical samples also report evidence for both one- and two-factor models generally corresponding to dependence and abuse. However, in view of the high correlation between abuse and dependence in the two-factor models, many clinical investigators favor a single factor as more appropriate in treatment samples. More recent applications of item response theory in adult samples (Kahler and Strong, 2006; Krueger et al., 2004; Langenbucher et al., 2004; Saha et al., 2006, 2007) and treated adolescents (Martin et al., 2006) suggest that abuse and dependence criteria are intermixed along the spectrum between mild and severe aspects of symptom pathology.

Several investigators (Budney, 2006; Hughes, 2006) emphasize the need for further studies of the validity and utility of generic versus drug-specific criteria for substance use disorders. Clinical studies need to be supplemented with general population samples. Because previous studies on the relationship between dependence and abuse symptoms show both important similarities and important differences when alcohol is compared with illicit drugs (Hasin and Grant, 2004; Hasin et al., 2005), expansion of the research on latent variable analysis from alcohol to illicit drugs is needed. Although the bulk of this literature has focused on alcohol use disorders, fewer studies have examined cannabis, cocaine, and other psychoactive substances (Blanco et al., 2007; Feingold and Rounsaville, 1995a, 1995b; Langenbucher et al., 2004; Morgenstern et al., 1994; Nelson et al., 1999; Swift et al., 2001; Teesson et al., 2002). A recent analysis of criteria for cannabis and cocaine in a large, nationally representative U.S. sample (National Longitudinal Alcohol Epidemiologic Survey [NLAES]) yielded two-factor solutions for both substances that resemble DSM-IV concepts of substance abuse and dependence (Blanco et al., 2007). In an analysis of eight illicit drug classes from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), Lynskey and Agrawal (2007) noted that a two-factor model provided a better fit to the data for each drug class. However, in view of the high factor correlations, the authors selected

the one-factor model as more parsimonious and retained all symptom criteria in the item response analyses for each substance. This study used item response theory to explore the dimensionality of illicit drug use disorders and did not examine the effects of important covariates such as age, race/ethnicity, education, income, and treatment on those disorders.

In the current study, the comparability of DSM-IV criteria across a range of illicit drugs in the general population is examined. The major objectives were to examine the factor structure of the criteria for lifetime DSM-IV diagnoses of substance use disorders involving cannabis, cocaine, stimulants, and sedatives and to examine associations of the obtained factors (i.e., the latent variables) with background variables: sociodemographic characteristics, family history of drug problems, and drug treatment. Given the epidemiological evidence for comorbidity among illicit drug use disorders (Stinson et al., 2005), we analyzed each of these substances simultaneously in a structural equation model, an advance over previous work. Further, in addition to a simultaneous analysis of substances, the present study sought to replicate the two-factor model reported earlier for cannabis and cocaine in the NLAES (Blanco et al., 2007) and to extend the work of Lynskey and Agrawal (2007) by examining associations between latent variables for each substance and background variables. The main questions addressed in this study are as follows: Is there evidence supporting retention of abuse and dependence as separate diagnostic categories in DSM-V, and are the patterns of relationships between the criteria themselves—and between the criteria and the background factors—the same or different across the substances?

Method

Study sample

The NESARC is a nationally representative face-to-face survey of 43,093 respondents conducted in 2001–2002, as described in detail elsewhere (Grant et al., 2004a, 2004b). The overall response rate for the survey was 81%. Black and Hispanic households were oversampled. The oversampling procedure increased the percentage of non-Hispanic Black households in the sample from 12.3% to 19.1% ($n = 8,245$) and the percentage of Hispanic households from 12.5% to 19.3% ($n = 8,308$). One person from each household or group quarters unit was randomly selected for interview, and young adults, ages 18–24 years, were oversampled at a rate of 2.25 times greater than the rate of other household members. The study draws on a subsample of respondents who reported lifetime use of drugs other than alcohol (cannabis users: $n = 8,172$; cocaine users: $n = 2,528$; amphetamine users: $n = 1,750$; sedative users: $n = 1,609$; tranquilizer users: $n = 1,301$; opioid users: $n = 1,815$).

Measures

The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS; Grant et al., 2003) is a structured diagnostic interview designed for trained nonclinician interviewers. The AUDADIS showed excellent psychometric properties in U.S. and international reliability and validity studies of DSM-IV substance dependence (Chatterji et al., 1997; Grant et al., 1995; Hasin et al., 1997). To operationalize DSM-IV substance use disorders criteria, the AUDADIS includes detailed questions covering repeated instances of the seven dependence and four abuse criteria. For each criterion, we used the lifetime timeframe for cannabis, cocaine (including crack), stimulants, sedatives, tranquilizers, and opiates.

Background variables included dummy variables for gender (male as referent), race/ethnicity (non-Hispanic Black, Native American, Asian/Pacific Islander, and Hispanic with White as the reference group), age (30–44 years, 45–64 years, 65 and older, with 18–29 years as referent), years of education (<9 years, 9–11 years, 12 years or General Educational Development [GED] credential, some college or 2-year degree, with bachelor's degree or higher as the reference group), family income (\$1–\$19,999; \$20,000–\$34,999; \$35,000–\$69,999; with \$70,000 as the reference group [all in U.S. dollars]), and marital status (previously married, never married, with married as the reference group). Additional variables, used as external criterion variables, included a family history of drug problems and history of treatment related to substance use. The family history variable defined those who reported no relatives with drug problems as the reference group, with additional categories of drug problems among first-degree relatives only, among second-degree relatives only, and among both first- and second-degree relatives. Treatment related to substance use was a binary variable, coded positive if the respondent reported seeking help from any of 13 potential sources, including 12-step groups (e.g., Narcotics Anonymous), counseling, detoxification, emergency room, and inpatient or outpatient hospitalization.

Analytic plan

The model used in this study is a special case of structural equation modeling, a multiple indicators multiple causes (MIMIC) model (a general model is shown in Figure 1) in which one or more latent variables intervene between a set of observed background variables predicting a set of observed response variables (i.e., DSM-IV criteria). The MIMIC model includes three sets of relationships: (a) those between the observed criteria and the factors (the measurement model), (b) those between the factors and the covariates (the structural regression equations), and (c) those between the criteria and the covariates (the direct effects). The presence of direct effects implies that there are differences in the measurement

parameters of the factor model based on the covariates (e.g., the factor models may differ for different subgroups in the population). One of the strengths of the structural equation modeling approach used here is the ability to detect and compensate for noninvariance of the measurement of criteria across subgroups of individuals in the population, thereby avoiding distortion of the risk factor assessment.

As a preliminary step, the criteria for each drug category were analyzed separately using exploratory factor analysis (EFA). The results of the EFA were used to specify the factor structure in the MIMIC model using confirmatory factor analysis for each drug class. To assess the inclusion of direct effects, MIMIC models were run separately with and without direct effects. For each model, modification indices were used to identify pairs of items within a factor for which model fit would improve if error estimates were freed to correlate.

To increase sample sizes for some drug categories, we grouped sedatives, tranquilizers, and opiates into a separate category ($n = 2,874$). Justification for this combined category is provided by the latent class analysis for lifetime drug use with the NESARC (Agrawal et al., 2007); this analysis yielded a separate class for these drugs, which the researchers labeled *prescription use*. Further, preliminary EFA and MIMIC analyses for each of these drug categories yielded essentially comparable results. The analyses were implemented in the computer program Mplus (Muthén and Muthén, 1998–2010). The default estimator for analysis was a robust, weighted, least-squares estimator, and complex survey design was included. Fit indices for measurement models included chi-square difference test (DIFFTEST was analyzed using exploratory structural equation model in Mplus to compare the two- versus one-factor models and MIMIC model to compare models with and without correlated residuals), comparative fit index (CFI), Tucker–Lewis index (TLI), and root mean square error of approximation (RMSEA). Hu and Bentler (1999) provided a test of the “rules of thumb” cutoffs for the most commonly used fit indices, advocating a two-index strategy to assess the adequacy of fit of structural models. Hu and Bentler (1999) suggest that a cutoff of .95 or above on either the TLI (Tucker and Lewis, 1973) or the CFI (Bentler, 1990) combined with the RMSEA “close to .06” indicates a good fit of a factor model. Sampling weights and controls for design effects of the NESARC were used in the structural equation model. These two sampling features are taken into account for parameter estimation as well as standard error and model fit calculations.

Results

Among the lifetime drug users ($n = 9,140$), 90.1% ($n = 8,172$) reported use of cannabis, 27.0% ($n = 2,528$) reported use of cocaine, 20.4% ($n = 1,750$) reported use of stimulants, and 32.5% ($n = 2,874$) reported use of sedatives/tranquiliz-

FIGURE 1. Substance abuse and dependence: multiple indicators multiple causes (MIMIC) model

ers/opiates. The characteristics of users of each drug type are shown in Table 1. In general, lifetime use of each substance was greater among men, Whites, and persons who were married, with high school or greater education, between the ages 30 and 44 years, and with family incomes greater than \$35,000 per year. The majority of substance users had not had treatment and had no family history of drug problems.

Exploratory factor analysis

The factor loadings and fit statistics for the EFAs of the DSM-IV criteria for each drug are shown in Table 2. Model selection (number of factors) is based on fit statistics, interpretability and replicability. The EFAs for each drug yielded one large factor (eigenvalues 6.34 for cannabis, 8.10 for cocaine, 7.60 for stimulants, and 7.58 for sedatives/tranquilizers/opiates) with declining eigenvalues less than 1.0 with each additional factor. Ratios were high between the first and second eigenvalues (7.8 for cannabis, 11.13 for cocaine, 8.27 for stimulants, and 8.57 for sedatives/tranquilizers/opiates), which can be interpreted as favoring

a one-factor model. However, for each drug, a two-factor model significantly improved the fit (information for each substance provided below), and the majority of the abuse criteria loaded on a separate factor. The chi-square for difference test showed that the two-factor model fit significantly better than the one-factor model. Prior studies also reported two-factor solutions in national populations for alcohol (Muthén, 1995; Muthén et al., 1993a, 1993b) and cannabis and cocaine (Blanco et al., 2007). For these reasons, despite the high between-factor correlations, we chose to retain both factors in the MIMIC analysis.

Cannabis. Although the fit statistics for the one-factor solution for cannabis (CFI = .987, TLI = .984, RMSEA = .03) were adequate, the two-factor solution fit significantly better (CFI = .992, TLI = .986, RMSEA = .03). Factor 1 (interpreted as abuse) was well defined by all of the DSM-IV abuse criteria and two dependence criteria ("gave up activities" and "continued use"). Factor 2 was defined by four of the six DSM-IV dependence criteria. There was a moderately high correlation between the two factors (.83). Two-factor solutions were examined by using four abuse and

TABLE 1. Distribution of background variables by drug-specific lifetime use^a

Background variables	Cannabis users (<i>n</i> = 8,172)		Cocaine users (<i>n</i> = 2,528)		Stimulant users (<i>n</i> = 1,750)		Prescription users ^b (<i>n</i> = 2,874)	
	%	[95% CI]	%	[95% CI]	%	[95% CI]	%	[95% CI]
Sex								
Female	42.1	[40.7, 43.4]	35.7	[33.3, 38.2]	37.5	[34.6, 40.3]	41.7	[39.6, 43.9]
Male	57.9	[56.6, 59.3]	64.3	[61.8, 66.7]	62.5	[59.7, 65.4]	58.3	[56.1, 60.4]
Race/ethnicity								
White	77.5	[75.2, 79.9]	77.8	[74.9, 80.6]	84.1	[81.8, 86.5]	79.9	[77.0, 82.8]
Black	9.6	[8.2, 10.9]	7.7	[6.5, 9.0]	3.6	[2.8, 4.4]	6.3	[5.1, 7.5]
Native American	3.2	[2.6, 3.8]	3.7	[2.5, 4.8]	4.8	[3.4, 6.2]	3.1	[2.2, 3.9]
Asian/Pacific Islander	2.1	[1.4, 2.7]	1.7	[1.0, 2.3]	1.2	[0.5, 1.9]	3.1	[2.0, 4.1]
Hispanic	7.6	[6.0, 9.3]	9.2	[7.0, 11.3]	6.2	[4.5, 8.0]	7.7	[5.7, 9.6]
Age, in years								
18–29	28.4	[27.0, 29.7]	19.2	[17.2, 21.3]	20.6	[18.1, 23.1]	29.9	[27.7, 32.1]
30–44	42.5	[41.0, 43.9]	51.9	[49.5, 54.3]	45.0	[42.2, 47.7]	37.4	[35.4, 39.3]
45–64	28.1	[26.9, 29.3]	28.3	[26.1, 30.5]	33.0	[30.5, 35.5]	27.9	[25.8, 30.1]
≥65	1.1	[0.9, 1.3]	0.5	[0.2, 0.8]	1.4	[0.8, 2.1]	4.8	[3.8, 5.8]
Education								
≤8 years	1.5	[1.2, 1.9]	1.8	[1.1, 2.4]	1.3	[0.6, 1.9]	2.5	[1.7, 3.2]
9–11 years	9.1	[8.3, 10.0]	10.4	[8.8, 12.0]	11.2	[9.3, 13.2]	12.4	[10.8, 13.9]
12 years or GED	25.5	[23.9, 27.2]	27.6	[25.2, 29.9]	27.7	[24.9, 30.5]	28.7	[26.5, 31.0]
Some college or 2-year degree	35.7	[34.3, 37.2]	36.1	[33.4, 38.7]	39.0	[36.2, 41.9]	36.3	[33.9, 38.7]
Bachelor's degree or higher	28.0	[25.9, 30.1]	24.2	[21.4, 26.9]	20.8	[18.1, 23.5]	20.2	[17.9, 22.4]
Family income								
\$1–19,999	19.8	[18.4, 21.1]	19.5	[17.3, 21.7]	20.9	[18.5, 23.3]	25.6	[23.6, 27.7]
\$20,000–34,999	18.0	[16.8, 19.2]	19.2	[17.1, 21.3]	19.3	[17.2, 21.4]	20.2	[18.6, 21.8]
\$35,000–69,999	32.2	[30.9, 33.5]	32.4	[29.9, 34.8]	34.3	[31.5, 37.1]	31.6	[29.4, 33.9]
≥\$70,000	30.1	[27.8, 32.4]	28.9	[25.6, 32.1]	25.5	[22.4, 28.6]	22.5	[20.0, 25.0]
Marital status								
Married	57.6	[55.9, 59.3]	57.4	[54.9, 60.0]	58.5	[55.7, 61.3]	53.9	[51.5, 56.2]
Previously married	15.3	[14.3, 16.2]	19.4	[17.6, 21.2]	19.9	[17.9, 21.9]	18.2	[16.6, 19.7]
Never married	27.1	[25.6, 28.7]	23.3	[21.1, 25.5]	21.6	[19.2, 24.1]	27.0	[25.9, 30.0]
Family history of drug abuse								
Second degree only	8.6	[7.9, 9.3]	8.1	[6.8, 9.4]	8.8	[7.3, 10.3]	9.3	[8.0, 10.7]
First degree only	19.5	[18.5, 20.6]	23.3	[21.4, 25.3]	24.9	[22.5, 27.2]	21.2	[19.3, 23.1]
Intergenerational	9.9	[9.1, 10.7]	12.6	[11.1, 14.2]	14.0	[12.0, 16.0]	11.7	[10.2, 13.3]
None	62.0	[60.6, 63.4]	56.0	[53.3, 58.6]	52.3	[49.5, 55.2]	57.7	[55.2, 60.2]
Drug abuse treatment								
No	92.4	[91.6, 93.2]	81.7	[80.0, 83.7]	81.2	[79.2, 83.4]	84.8	[83.2, 86.5]
Yes	7.6	[6.8, 8.3]	18.3	[16.3, 20.1]	18.8	[16.6, 20.8]	15.2	[13.5, 16.8]

Notes: CI = confidence interval; GED = General Educational Development credential. ^aPercentages are weighted and *ns* are unweighted; ^bincludes sedative, tranquilizer, and opiate users.

six dependence cannabis criteria compared with one factor. Because the two-factor solution representing cannabis abuse and dependence criteria produced better fit, the two-factor solution reflecting abuse and dependence was used.

Cocaine. Although the fit statistics for the one-factor solution for cocaine (CFI = .995, TLI = .993, RMSEA = .04) were adequate, the two-factor solution significantly improved model fit (CFI = .998, TLI = .996, RMSEA = .03). Factor 1 (interpreted as abuse) was well defined by all of the DSM-IV abuse criteria. Factor 2 was well defined by all seven DSM-IV dependence criteria. There was a moderately high correlation between the two factors (.83).

Stimulants. Similar to the results for cannabis and cocaine, the fit statistics for the one-factor solution for stimulants (CFI = .989, TLI = .987, RMSEA = .04) were adequate. Again, however, we found that the two-factor

solution significantly improved model fit (CFI = .996, TLI = .993, RMSEA = .03). Factor 1 (interpreted as abuse) was well defined by all of the DSM-IV abuse criteria. Factor 2 was well defined by all of the seven DSM-IV dependence criteria. The correlation between the two factors was .79.

Sedatives/tranquilizers/opioids. Similar to what we found for the other substances, although the fit statistics for the one-factor solution for sedatives/tranquilizers/opioids were adequate (CFI = .989, TLI = .987, RMSEA = .04), the two-factor solution significantly improved model fit (CFI = .994, TLI = .990, RMSEA = .02). Factor 1 (interpreted as abuse) was well defined by all of the four DSM-IV abuse criteria. Factor 2 was well defined by all of the seven DSM-IV criteria. The correlation between the two factors was also similar to that found for the other substances (.77).

TABLE 2. Factor loadings for DSM-IV criteria for lifetime cannabis, cocaine, stimulants and prescription drugs (sedatives/tranquilizers/opiates)

DSM-IV criteria	Cannabis (n = 8,172)		Cocaine (n = 2,528)		Stimulants (n = 1,750)		Prescription drug (n = 2,874)	
	Factor 1 Abuse	Factor 2 Dependence	Factor 1 Abuse	Factor 2 Dependence	Factor 1 Abuse	Factor 2 Dependence	Factor 1 Abuse	Factor 2 Dependence
Abuse								
Role	.94	-.09	.82	.13	.83	.10	.78	.14
Hazard	.48	.24	.47	.32	.60	.15	.50	.30
Legal	.39	.20	.78	-.12	.70	-.04	.90	-.15
Social	.76	.03	.91	.00	.91	.00	.92	.01
Dependence								
Tolerance	.40	.48	.16	.74	.06	.80	-.10	.97
Withdrawal	—	—	.28	.68	.15	.77	.18	.75
More/longer	-.01	.90	-.02	.95	.00	.91	.09	.79
Impaired control	.07	.56	.22	.48	-.03	.72	.16	.53
Spent time	.24	.67	.00	.96	-.01	.96	-.01	.94
Give up activities	.93	-.01	.44	.53	.36	.57	.40	.49
Continued use	.72	.12	.33	.64	.24	.69	.21	.72
Fit statistics								
CFI		.992		.998		.996		.994
TLI		.986		.996		.993		.990
RMSEA [90% CI]		.028 [.024, .032]		.028 [.021, .034]		.030 [.022, .038]		.023 [.017, .029]

Notes: **Bold** indicates the highest factor loadings and also shows the factor group (abuse or dependence). DSM-IV = Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval.

Multiple indicators multiple causes analysis

MIMIC modeling was used to assess the effects of covariates on illicit drug use disorders. The MIMIC technique, a specification of structural equation modeling, consists of two parts: (a) a measurement model that defines the relations between the latent variables “dependence” and “abuse” and their criteria (as discussed in the previous section) and (b) a structural model that specifies the causal relationships among latent variables and explains the causal effects (Jöreskog and Sorbom, 1996). This technique was chosen because MIMIC models can estimate the effect of indicators on latent variables and at the same time estimate the direct effects of covariates on the latent variables. Thus, MIMIC modeling is an excellent approach to investigate the validity of a factor model in the presence of covariates.

The inclusion of significant direct effects improved the fit of the MIMIC model for each drug, which was estimated using the chi-square difference test in Mplus. The model fit in the measurement model of MIMIC analysis was improved by adjusting for correlated residuals. The addition of correlated residuals did not affect the estimates of the key parameters.

The three residual correlations included for cannabis were minor factors based on dependence criteria (more/longer and impaired control; gave up activities and continued drinking despite physical problems; gave up activities and more/longer). Further, two other residual correlations based on abuse and dependence criteria such as neglected roles and gave up activities, and legal problems and continued use, were included. For cocaine, the single residual

correlation included was a minor factor based on two dependence criteria (more/longer and time spent). Model fit for stimulants was improved by adjusting for a single correlated residual based on two dependence criteria (more/longer and time spent).

The inclusion of direct effects for all drugs produced only slight changes in estimates. The structural regression estimates for background variables for abuse and dependence associated with each substance are shown in Table 3. The relationships between the factors and the categorical covariates are presented as standardized coefficients, which represent the change from one category to the other, such as male to female, for example. There were statistically significant associations for each of the background variables. Men were more likely to endorse both abuse and dependence criteria for cannabis and abuse criteria for prescription drugs. Compared with White respondents, Blacks were less likely to endorse cannabis and prescription drug abuse criteria, and criteria for both abuse and dependence of stimulants. However, Blacks were more likely to endorse criteria for cocaine abuse and dependence. Native Americans were more likely to endorse sedative/tranquilizer/opiate abuse criteria, whereas Hispanics were less likely to report cannabis abuse criteria than were Whites. Older age was a significant predictor of cannabis abuse and dependence, and negative coefficients indicate protective factors so that the probability of cannabis abuse, as well as dependence, is decreased. There were consistent associations for educational status across all substances. Compared with respondents who had at least a 4-year degree, those with lower educational levels were more likely to endorse abuse

TABLE 3. Estimated effects of background variables on drug-specific abuse and dependence (figures are standardized coefficient)

Background variables (referent category)	Cannabis		Cocaine		Stimulant		Prescription drug	
	Abuse	Dependence	Abuse	Dependence	Abuse	Dependence	Abuse	Dependence
Sex (ref. = female)								
Male	0.22**	0.16**	0.09	-0.04	-0.03	-0.12	0.30**	0.11
Race/ethnicity (ref. = White)								
Black	-0.14**	-0.00	0.24**	0.31**	-0.28*	-0.26*	-0.28**	-0.13
Native American	0.07	0.06	0.15	0.30	-0.06	-0.10	0.42**	0.29
Asian/Pacific Islander	-0.12	0.15	-0.05	0.02	0.52	0.32	-0.12	0.27
Hispanic	-0.15**	-0.02	0.01	0.08	0.06	0.26*	-0.05	-0.01
Age, in years (ref. = 18–29)								
30–44	-0.06	-0.11*	0.12	0.06	0.08	-0.17	0.11	0.06
45–64	-0.19**	-0.29**	0.00	-0.02	0.01	-0.17	0.18	0.18
65 and older	-1.11**	-0.92**	-0.89	-0.77*	-0.31	-0.40	-0.22	-0.11
Education (ref. = 4-year degree)								
≤8 years	-0.03	0.04	0.23	0.26	0.31	-0.05	0.06	0.28
9–11 years	0.52**	0.42**	0.58**	0.52**	0.53**	0.39**	0.44**	0.34**
12 years or GED	0.35**	0.26**	0.56**	0.46**	0.42**	0.31**	0.23**	0.12
Some college	0.28**	0.27**	0.46**	0.42**	0.36**	0.29**	0.32**	0.23**
Family income (ref. = ≥\$70,000)								
\$1–19,999	0.11	0.14*	0.11	-0.06	0.20	0.23	0.10	0.16
\$20,000–34,999	0.05	0.08	0.12	0.01	0.18	0.17	0.07	0.11
\$35,000–69,999	0.04	0.07	0.11	-0.04	0.10	0.11	-0.01	0.02
Marital status (ref. = married)								
Previously married	0.07	0.10	0.05	0.08	0.08	0.07	0.18*	0.11
Never married	0.05	0.08	-0.06	0.01	0.02	0.02	-0.07	-0.05
Family history of drug problem (ref. = none)								
Second degree only	0.17**	0.21**	0.16	0.03	0.06	-0.01	0.11	0.09
First degree only	0.25**	0.27**	0.32**	0.31**	0.19*	0.23**	0.17*	0.21**
Intergenerational	0.45**	0.51**	0.20**	0.37**	0.23**	0.29**	0.12	0.18*
Drug treatment (ref. = no)								
Yes	1.14	0.99**	1.00**	0.92**	0.95**	0.67**	1.09**	0.934**
Fit statistics								
CFI	.989		.994		.993		.990	
TLI	.986		.992		.991		.987	
RMSEA [90% CI]	.009 [.007, .010]		.012 [.009, .015]		.012 [.006, .016]		.010 [.007, .013]	

Notes: Coefficient = standardized coefficient; ref. = reference; GED = General Educational Development credential; CFI = comparative fit index; TLI = Tucker–Lewis index; RMSEA = root mean square error of approximation; CI = confidence interval.

* $p < .05$; ** $p < .01$.

and dependence criteria for each substance. Respondents with family incomes less than \$20,000 were more likely to endorse criteria reflecting cannabis dependence. Compared with married respondents, previously married respondents were more likely to endorse sedative/tranquilizer/opiate abuse criteria. With few exceptions, both a positive family history of drug problems and treatment for drug problems were significantly related to both abuse and dependence for each substance.

For the most part, associations between background variables and abuse were similar to those for dependence. Blacks were less likely to endorse criteria for cannabis abuse but not dependence. Previously married respondents were more likely to report symptoms meeting criteria for prescription drug abuse but not dependence.

The presence of direct effects (Table 4) indicates that not all associations with background variables were fully mediated by the latent variables and, therefore, that there was evidence of measurement noninvariance. There were six

direct effects related to lifetime cannabis use, four of which were related to abuse. There were two direct effects related to cocaine abuse and one direct effect each of stimulant and sedative/tranquilizer/opiate abuse.

As shown in Table 4, the majority of direct effects related to gender, Black race, and drug treatment. These are standardized coefficients, and interpretations of direct effects should be viewed in conjunction with the structural estimates of the factors. For example, the positive direct effect of male gender for the cannabis abuse criterion of hazardous use (.29) implies that for respondents with the same value on this (abuse) factor, respondents who are male had a higher probability of reporting symptoms meeting this criterion.

Given the same factor scores, men were more likely to report cannabis abuse criteria, such as use in hazardous situations and legal problems, and the cannabis dependence criterion of time spent. Blacks were more likely to report cannabis symptom criteria for impaired control. Respondents who reported drug treatment were less likely to report the

TABLE 4. Significant direct effects of background variables on drug disorder criteria

Drug	Background variables	Coefficient	Criterion
Cannabis	Male	.29**	Abuse: Hazard
	Male	.53**	Abuse: Legal
	Male	.20**	Dependence: Spent time
	Black	.20**	Dependence: Impaired control
	Drug treatment	-.43**	Abuse: Hazard
	Drug treatment	.34**	Abuse: Legal
Cocaine	Drug treatment	-.34**	Abuse: Hazard
	Drug treatment	.38**	Abuse: Legal
Stimulants	Drug treatment	-.49**	Abuse: Hazard
Sedative/tranquilizer/opiates	Drug treatment	-.41**	Abuse: Hazard

Note: Coefficient = standardized coefficient.

** $p < .01$.

abuse criterion of hazardous use for all illicit drug use but more likely to report the abuse criterion of legal problems for cannabis and cocaine.

Discussion

The factor analytic findings from this study of a national population of lifetime illicit drug users yielded two factors across all four illicit substance categories. For the most part, the factors were consistent with the DSM-IV concept of abuse and dependence. The present findings are also consistent with results of a similar analysis of data from the NLAES, conducted 10 years earlier (Blanco et al., 2007). One important finding of this study is the validation of the two-dimensional model of illicit drug abuse and dependence found by Blanco et al. (2007) using a general population sample.

Among model covariates, educational status, family history of drug problems, and drug treatment had consistent effects across all drugs. Men had significantly higher probabilities of endorsing criteria for prescription drug abuse and cannabis dependence and abuse. Those with lower educational achievement were generally more likely to report symptoms meeting criteria for drug abuse and dependence. Epidemiological studies have indicated that dropping out of high school results in an elevated long-term risk for substance abuse (Crum et al., 1993; Harford et al., 2006). Findings from the present study replicate this association but only among those dropping out in upper grades (9–11). The absence of a significant association between illicit drug use and early school dropouts (8 years or less) may indicate the presence of other contributory factors, including health problems and severe poverty. Earlier dropouts (less than 8 years of schooling) may differ from later dropouts (9–11 years of schooling) in exposure to drug cultures.

Although there were no significant differences between married and never married respondents in any illicit drug group, marital disruption (previously married) is significantly

associated with dependence on sedatives. Age and racial/ethnic identification differed by illicit substance category. Among cannabis users the probability of endorsing abuse and dependence criteria is lower among respondents ages 45 years and older. This finding of peak use of cannabis occurring earlier than age 45 years is consistent with the findings in numerous longitudinal studies of drug use. However, an Australian study (Mewton et al., 2010) that focused on the differential functioning of DSM-IV cannabis use criteria did not find any age-based differences in cannabis use disorders. The use of stimulants and sedatives/tranquilizers/opiates, however, was not related to age in the present study. In a few instances, race/ethnicity was related to endorsement of drug abuse/dependence criteria. For example, compared with White respondents, Blacks were less likely to endorse criteria for cannabis abuse, sedatives abuse, and stimulant abuse and dependence but more likely to endorse criteria for cocaine abuse and dependence. In general, family income was not related to illicit drug use disorders. A family history of drug problems, especially an inter-generational history, and drug treatment were related to illicit drug abuse and dependence across all illicit drug categories, consistent with studies reporting heritability to substance use disorders generally rather than a specific drug (Tsuang et al., 1996, 1998). In addition to dependence, drug abuse was consistently related to drug treatment.

Note that the DSM-IV abuse criteria formed a minor factor relative to dependence, with high correlations between the two factors. Of further relevance is the finding that the examined background covariates did not differentiate dependence from abuse. The presence of consequences, included in the definition of DSM-IV abuse for illicit substances, especially substances other than cannabis, requires further study, particularly of the distinctions between abuse with and without dependence. Among the drug users in this national sample, however, the prevalence of drug dependence without abuse is less than 2%.

Despite the commonalities across drugs in this study, the abuse and dependence criteria load on the respective factors in a manner more consistent with their DSM-IV diagnostic definitions for cocaine, stimulants, and prescription drugs (sedatives/tranquilizer/opioids) than for cannabis. The cannabis abuse factor is defined by dependence criteria related to giving up activities and continued use. Similar to cannabis, two-factor models for alcohol use disorders do not yield complete differentiation between DSM-IV abuse and dependence criteria (Grant et al., 2007; Harford and Muthén, 2001), especially in studies of treatment populations (Langenbucher et al., 2004). Possible explanations related to abuse/dependence distinctions between cannabis and other drug categories include differences between substances related to prevalence, measurement bias in symptom criteria, social sanctions, and other exogenous characteristics not included in the present analysis (i.e., concurrent drug use patterns).

Departures from the DSM-IV distinctions between abuse and dependence for alcohol and cannabis may reflect, in part, the higher prevalence for these substances. Approximately 90% of lifetime drug users reported cannabis use, whereas less than one third used other substances. We considered whether this might be explained by the higher number of cannabis users, potentially a large subset of respondents with less exposure to manifestations of dependence among whom interpretation problems related to the clinical significance of some criteria might have occurred. To address this, we further analyzed a subset of cannabis users who reported the use of cannabis at least one to two times a week during the period of their highest lifetime use ($n = 3,701$). The MIMIC estimates were similar to those in the total sample, suggesting that this explanation could not account for the findings, which remain to be explained. Regarding measurement bias, significant direct effects were included in the structural equation model to adjust the estimated effects of background factor with the latent illicit drug variables. The presence of direct effects implies that there are differences in the measurement parameters of the factor model based on the covariates. Larger numbers of direct effects were identified for cannabis criteria than for criteria related to stimulants and sedatives. The analysis of criteria with these same data, however, indicated little variation in symptom discrimination and severity across the different substances (Lynskey and Agrawal, 2007). The sharper distinction between abuse and dependence for substances other than cannabis may reflect the fact that these substances confer higher risk than cannabis for societal sanctions. In particular, disorders associated with substances other than alcohol and tobacco reflect illegal behavior. Finally, preexisting characteristics of individuals prone to incurring societal sanction (i.e., conduct and antisocial personality disorder) may also contribute to phenomena underlying the abuse factor.

Some investigators prefer a focus on the current (or past-year) rather than the lifetime timeframe because recent events are more likely to be recalled and reported than more remote events. We agree with these concerns about reporting and recall. However, the properties of the diagnostic criteria need to be understood well in both the current and lifetime timeframes, as the latter is used in most genetic studies and for many epidemiologic purposes. In addition, assessing a lifetime history of disorders is also commonly part of a clinical evaluation. Therefore, we conducted these analyses using data reflecting respondents' lifetimes.

In conclusion, the latent structure of substance use disorders appears to be best described by substance dependence and a minor abuse factor highly correlated with dependence. In view of the high correlations between the factors and similar associations between most covariates and the dependence and abuse factors, the findings appear equivocal on the value of retaining separate factors, although for some specialized purposes, this separation may remain of value. Investigation of the relationships of additional validators such as specific genetic variants to dimensional indicators of abuse, dependence, and measures combining these criteria is warranted. A greater understanding of these criteria will be gained when their biological and social determinants can be examined conjointly.

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