

DSM-IV alcohol dependence and abuse: Further evidence of validity in the general population[☆]

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Abstract

Background: In order to understand the validity of the Diagnostic and Statistical Manual of Mental Disorders, 4th ed. (DSM-IV) alcohol abuse and dependence diagnoses, studies are needed in both clinical and general population samples. The purpose of this study was to examine the construct and criterion-oriented validity of DSM-IV alcohol dependence and abuse in the general population with respect to factor structure and their relationship to family history of alcoholism, treatment utilization, and psychiatric comorbidity.

Methods: This analysis is based on data from the 2001–2002 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), in which nationally representative data were collected in personal interviews conducted with one randomly selected adult in each sample household or group quarters. A subset ($n=26,946$) of the NESARC sample (total $n=43,093$) who reported drinking one or more drinks during the year preceding the interview formed the basis of analyses. Latent variable modeling was used to assess the concurrent validity of DSM-IV alcohol abuse and dependence symptom items.

Results: The latent variable modeling yielded one major factor related to alcohol dependence, a second factor related to alcohol abuse and a third smaller factor defined by tolerance. The validity of alcohol dependence in general population samples was further supported by statistically significant associations with family history of alcoholism, treatment utilization, and psychiatric and medical comorbidities.

Conclusions: The factor structure and relationship to external criterion variables observed in the study provide support for the further validity of DSM-IV alcohol dependence in the general population, whereas support for the validity of DSM-IV abuse was equivocal.

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1. Introduction

The DSM-IV (American Psychiatric Association, 1994) criteria for alcohol abuse and dependence serve as the basis for

diagnosis in clinical work, prevalence estimation in epidemiology, and on much of the etiologic research conducted in the United States. Thus, understanding the validity of the DSM-IV criteria for alcohol abuse and dependence and their relationship to one another is highly important. The origin of the criteria in the DSM was the alcohol dependence syndrome (ADS) of Edwards and Gross (Edwards and Gross, 1976), later generalized to all drug disorders as classified in the World Health Organization's International Classification of Diseases (ICD) (Room, 1998). The essential elements of ADS continue to be reflected in contemporary definitions of alcohol abuse and dependence as classified in the DSM-IV and ICD-10.

The ADS was conceptualized as a combination of physiological and psychological processes reflecting impaired control over

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use, constituting what is now recognized as a “complex” disorder. Consistent with this, DSM-IV dependence criteria reflect both physiological and psychological symptoms, a syndrome that is now known to be highly heritable (Prescott and Kendler, 1999a; Prescott et al., 1997). The dependence syndrome was considered one “axis” of problems, differentiated from another axis consisting of problems resulting from substance use such as substance-related injuries, social, or legal problems (Edwards and Gross, 1976). This second axis corresponds to DSM-IV substance abuse. Importantly, the two axes in the “bi-axial” dependence syndrome distinction were not considered “orthogonal”. Instead, they were defined as different types of substance-related problems expected to co-occur in some but not all cases. Since alcohol dependence is described as increasing loss of control over drinking despite the occurrence of negative consequences, while abuse consists of those consequences, the two concepts differ theoretically in their etiology but are likely to be correlated in practice. The fundamental difference between the DSM-IV and its underlying ADS conceptualization is that the DSM-IV is categorical whereas the ADS is definitively dimensional in nature. More validation research is needed in order to understand the underlying dimensional construct underlying both the DSM-IV and ICD-10 categorizations of alcohol use disorders.

However, few such studies have been conducted. Partial support for construct validity is found in studies that explore the factor structure of criteria and the individual symptom items included within the criteria. In one such study, Muthén et al. (1993a,b,c) examined the dimensionality of the relevant criteria in both the DSM-IV and its precursor, the Diagnostic and Statistical Manual of Mental Disorders, 3rd ed. Revised (DSM-III-R; American Psychiatric Association, 1987) across three population subgroups defined by progressively greater risk for alcohol dependence: current drinkers, heavy drinkers, and high-risk drinkers. Data were derived from the National Institute on Alcohol Abuse and Alcoholism’s (NIAAA) Alcohol Supplement to the 1988 National Health Interview Survey (NHIS; Grant et al., 1991) and individuals were assigned to subgroups based on background characteristics predictive of alcohol problems (e.g., family history of alcoholism). Analysis yielded a two-factor model that applied consistently to all three subgroups and performed identically in each validation sample. Similar analysis at the symptom level (Muthén, 1995) produced a two-factor solution that best described the item correlations and bore a strong resemblance to the criterion-level solution reported by Muthén et al. (1993a). One factor was represented by “persistent efforts to cut down or control drinking,” “giving up important activities in favor of drinking,” and “continuing to drink despite physical, psychological or social problems,” “neglect of roles in favor of drinking” together with symptom items related to “tolerance” and “withdrawal”; this factor may be interpreted as corresponding to alcohol dependence. The second factor was represented by two criteria: “drinking larger amounts over a longer period of time” and “recurrent drinking in situations where alcohol use is physically hazardous”; this factor appeared to correspond to alcohol abuse. These studies provide some support for the validity of DSM-IV alcohol dependence criteria in general populations, although the distribution of criteria between the two

factors did not exactly match that defined in DSM-IV. For example, the factor suggestive of dependence included items related to the DSM-IV criteria for alcohol abuse (e.g., continued drinking despite social problems and recurrent drinking resulting in failure to fulfill role obligations). Similarly, the factor suggestive of abuse included some DSM-IV criteria for dependence (i.e., “drinking larger amounts or over longer periods of time”).

Another approach for establishing the validity of DSM-IV alcohol dependence criteria, other than construct validation, in the general population involves criterion-oriented validation that relates the category of dependence to a set of external criterion correlates (i.e., variables that potentially indicate an alcohol use disorder but which are not included in the diagnostic criteria themselves). Hasin et al. (1997a,b) identified heavy drinkers from among a general population sample and divided them into three groups: those with a DSM-IV diagnosis of alcohol dependence, those with a DSM-IV diagnosis of alcohol abuse, and those with no current alcohol use disorder diagnosis. A DSM-IV diagnosis of alcohol dependence, when compared with no diagnosis, was significantly associated with external criterion variables such as alcohol consumption, treatment seeking, family history of alcoholism, and suicidal ideation. DSM-IV alcohol abuse, compared with the no diagnosis group, was not associated with these variables. Drawing upon the 1992 NIAAA National Longitudinal Alcohol Epidemiologic Survey (NLAES; Grant et al., 1994), Hasin and Paykin (1999a) reported that a DSM-IV diagnosis of alcohol dependence, when compared with a diagnosis of alcohol abuse and no positive diagnosis, was significantly associated with each of the following external criteria: average daily ethanol consumption, suicidal ideation/attempts, treatment/help-seeking, blackouts, and family history of alcoholism. Comparisons between a diagnosis of alcohol abuse and no positive diagnosis yielded significantly greater odds of alcohol abuse for average consumption and blackouts, a marginal relationship for treatment/help-seeking, and no significant differences for suicidal ideation and family history of alcoholism.

Given that the two-factor solutions depart somewhat from DSM-IV conceptualizations of alcohol abuse and dependence, further studies of the construct validity of alcohol abuse and dependence in the general population are warranted. Harford and Muthén (2001) adopted a latent variable modeling approach in a secondary analysis of the National Longitudinal Survey of Youth (NLSY; Frankel et al., 1983), a representative sample of young adults at an age when the prevalence of alcohol use disorders is highest. Because alcohol use disorders cannot be observed directly with observations containing measurement error, the “true” value of these disorders is said to be latent, or hidden (see Muthén, 1992). In structural equation modeling, one or more continuous latent variables (e.g., alcohol dependence and abuse) are estimated from a number of indicators (i.e., symptom items) and regressed on other background or external validating variables. To avoid misclassification errors and the problem of choosing cut-points, researchers use a dimensional representation in which increasing factor values correspond to increased risk when compared with a dichotomous diagnosis. Findings from this study replicated earlier studies of the factor structure of alcohol symptoms. Background covariates, which were simi-

larly related in the samples of current and heavier drinkers, provide further support for the criterion-oriented validity of DSM-IV alcohol dependence in general population studies. The findings indicated that alcohol dependence was significantly associated with positive family history of alcoholism, early age at onset of alcohol use, and patterns of current alcohol consumption — outcomes consistent with criterion outcomes used in other general population studies (Grant and Dawson, 1997; Hasin et al., 1997a,b; Hasin and Paykin, 1999a; Muthén, 1995; Prescott and Kendler, 1999a,b). Demographic variables were also differentially related to alcohol dependence and abuse. Alcohol dependence was not related to age, and alcohol-dependent individuals were more likely to be black or Hispanic and to be school dropouts. Alcohol abusers were younger, more likely to be white, and less likely to be school dropouts.

This study is based on data from NIAAA's National Epidemiologic Survey on Alcohol and Related Conditions (NESARC: Grant et al., 2004a,b,c,d). The major goal of this study is to examine the construct and criterion-oriented validity of DSM-IV alcohol abuse and dependence. The main objectives of the present study were to examine the factor structure of symptom items used to configure DSM-IV diagnoses of alcohol use disorders, to assess associations between symptom items and demographic covariates, and to examine associations between the obtained factors (i.e., latent variables) and the covariates. It extends previous work by Hasin and Paykin (1999a) by including a structural equation-modeling framework and by expanding the set of criterion variables to include type of treatment, psychiatric and medical conditions, in addition to demographic variables, parental history of alcoholism, and family history of antisocial personality disorder among biological fathers.

2. Methods

2.1. Study sample

The NESARC is a nationally representative face-to-face survey of 43,093 respondents conducted in 2001–2002 that has been described in detail elsewhere (Grant et al., 2004b,c). The sampling frame response rate was 99%, the household response rate was 89%, and the person response rate was 93%, yielding an overall response rate of 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% ($n=8245$) and the percentage of Hispanic households from 12.5% to 19.3% ($n=8308$). One person from each household or group quarters' unit was randomly selected for interview, and young adults, aged 18–24 years, were oversampled at a rate of 2.25 that of other members in the household. The study draws upon a subsample of 26,946 respondents who reported drinking one or more drinks in the past year.

2.2. Measures

A set of 32 symptom item questions designed to operationalize the DSM-IV were used as indicators of alcohol abuse and dependence in the past year (Table 2). These items were drawn from the Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS — Grant et al., 2001). The reliability and validity of the AUDADIS alcohol abuse and dependence criteria and diagnoses have been shown to be good to excellent in general population studies in the U.S. and elsewhere (Canino et al., 1999; Chatterji et al., 1997; Cottler et al., 2006; Grant et al., 1995a,b, 2003; Pull et al., 1997; Vrásti et al., 1997). Variables used as indicators of concurrent validity included: (1) parental alcoholism; (2) father's history of antisocial personality disorder; (3) seeking

treatment related to drinking in the past year, including Alcoholics Anonymous, detoxification, emergency room admission, and inpatient and outpatient hospitalizations; (3) past year diagnoses for major depression, panic disorder with and without agoraphobia, and lifetime diagnosis for antisocial personality disorder, and medical conditions in the past year (i.e., liver problems, stomach ulcers, gastritis, angina, tachycardia, myocardial infarction).

Other background variables included sex, race-ethnicity, age, education, family income, marital status, geographic region, and urbanicity.

2.3. Analytic plan

The DSM-IV symptom items were related to criterion outcomes using the statistical technique of structural equation modeling (see, e.g., Joreskog and Sorbom, 1979) generalized to dichotomous outcomes (see, e.g., Muthén, 1979, 1989). The model used in this study is a special case of structural equation modeling, a multiple causes and multiple indicators (MIMIC) model (example shown in Fig. 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 symptom items). In this model, item correlations are not dependent on item prevalences. As a preliminary step, the 32 alcohol symptom items were analyzed 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.

The MIMIC model includes three sets of relationships: those between the symptom items and the factors (the measurement model); those between the factors and the covariates (the structural regression equations); those between the symptom items 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 non-invariance of the measurement of criteria across subgroups of individuals in the population, thereby avoiding distortion of the risk factor assessment. The analyses were implemented in the computer program Mplus (Muthén and Muthén, 1998, 2005). The default estimator for analysis was a robust, weighted, least-squares estimator. Fit indices for measurement models included χ^2 , comparative fit index (CFI), root mean square residuals (RMSR), and root mean square error approximation (RMSEA). Muthén and Muthén (2005) suggested the following cutoff values as indicators of good fit: CFI > 0.95; RMSR < 0.05; RMSEA < 0.06. 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.

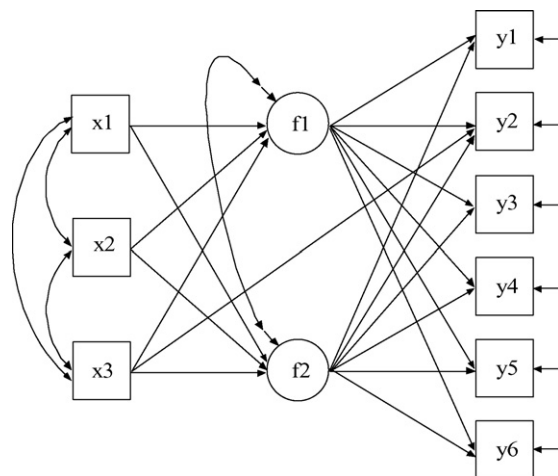


Fig. 1. The MIMIC model with categorical factor indicators (y1–y6). For each of the two factors (f1 and f2), one path has a factor loading fixed at 1 and another path has a factor loading fixed at 0, for a total of four model restrictions. Background characteristics are defined by x1, x2, and x3. The path between x3 and y2 represents a direct effect.

Table 1
Demographic characteristics of current drinkers

Characteristic	%	N
Sex		
Male	52.6	13067
Female	47.4	13879
Race-ethnicity		
White	75.3	16732
Black	9.0	4185
Native American	1.9	416
Asian/Pacific Islander	3.2	664
Hispanic	10.6	4949
Age		
18–29	24.35	6144
30–44	33.95	9455
45–64	30.51	7959
65 and older	11.19	3388
Education		
8 years or less	3.46	1118
9–11 years	7.63	2263
12 or GED	27.29	7359
Some college or 2-year degree	32.65	8711
Bachelor's degree or higher	28.97	7495
Family income		
US\$ 1–19999	18.89	6015
US\$ 20000–34999	18.80	5682
US\$ 35000–69999	33.44	8885
US\$ 70000 or more	28.91	6364
Marital status		
Married	62.43	14262
Previously married	15.16	5992
Never married	22.41	6692
Region		
Northeast	21.33	5492
Midwest	24.27	6093
South	31.74	9007
West	22.20	6354
Urbanicity		
Central city in MSA	29.15	9191
Not a central city in MSA	53.26	13455
Not in MSA	17.59	4300

MSA, metropolitan statistical area; %, weighted; N, unweighted.

3. Results

3.1. Exploratory factor analysis

The demographic and background characteristics of the sample are presented in Table 1. The factor loadings and fit statistics for the EFAs are presented in Table 2 for the two-, three- and four-factor solutions. Since the fit statistics decline smoothly when adding factors without a distinct drop anywhere, they are of less help in the choice between alternative models. Model selection was based on its “interpretability” and “replicability”. While the two-factor solution is similar to prior studies (Muthén et al., 1993a,b; Muthén, 1995), the items for “tolerance” loaded on the alcohol abuse and not dependence factor and the RMSR (0.057) exceeded suggested level for good fit. The three-factor solution retained the structure of the two-factor solution with

the tolerance items as a third factor with cross-loadings on items related to the dependence criterion “drinking larger amounts or for longer periods than intended”. The four-factor solution also retained the structure of the two-factor solution with two additional factors based on “tolerance” and “drinking larger amounts or for longer periods than intended”. The three-factor solution provides the best agreement with an EFA for an earlier national survey (Grant et al., 1994). In addition, the first two factors are comparable to studies cited above. This “replicability” is a strong point given the similarity in samples and items sets. For these reasons, and satisfactory fit indices, the three-factor solution was retained for subsequent direct effect and MIMIC analyses. The inclusion of residual correlations (see below) provided an intermediate model between the three- and four-factor models.

Factor 1 (interpreted as dependence) is well defined by items from five of the DSM-IV dependence criteria (“withdrawal symptoms and withdrawal relief/avoidance”, “persistent desire and repeated attempts to cut down/stop drinking”, “time spent recovering from withdrawal symptoms”, “giving up important activities in favor of drinking”, and “continued drinking despite physical/psychological problems”), and two DSM-IV abuse criteria related to “failure to fulfill role obligations” and “continued drinking despite social or interpersonal problems”. Factor 2 (interpreted as alcohol abuse) was well measured by the DSM-IV abuse criterion “drinking in hazardous situations” and the DSM-IV dependence criterion related to “drinking larger amounts or for longer periods than intended”. Factor 3 (tolerance) was well measured by the three tolerance items. Three items with cross-loadings on factors were retained: two associated with abuse criteria (“legal problems” and “physical fights”) loading on the dependence and abuse factors and one associated with a dependence criterion, “spent a lot of time drinking”, loading on all three factors. There were moderately high correlations between the three factors (dependence/abuse, 0.70; dependence/tolerance, 0.67; abuse/tolerance, 0.60). The EFA model fit was improved by adjusting for correlated residuals using an extended EFA within a confirmatory factor analysis (CFA). This is the measurement model used in the MIMIC analysis. The addition of correlated residuals does not affect the estimates of the key parameters of the model (structural regression coefficients and R^2), but merely is a polishing of model fit, taking into account a variety of minor factors that are not included in this three-factor solution. The residuals included minor factors based on the two items for relief of withdrawal, the two items for drinking larger amounts than intended, the two items related to unsuccessful efforts to control drinking, the two items related to giving up activities in favor of drinking, and a few withdrawal symptoms.

3.2. MIMIC analysis

In the MIMIC model, the exploratory factor analysis of the symptom items was specified in a CFA framework based on the three-factor solution described above and related to the background variables. The inclusion of several direct effects further improved the model fit ($\chi^2 = 401.6$, d.f. = 41, CFI = 0.98, RMSEA = 0.01).

Table 2
Factor loadings for exploratory factor analysis of DSM-IV alcohol abuse and dependence symptom items among current drinkers

Criteria/items	Two-factor		Three-factor		Four-factor				Item percent (weighted)	
Alcohol abuse										
Recurrent drinking resulting in failure to fulfill major role obligations at work, school, or home										
Drinking interfered with taking care of home or family	0.81	0.10	0.76	0.18	−0.01	0.70	0.18	−0.01	0.09	0.85
Have job or school problems because of drinking	0.67	0.24	0.60	0.30	0.03	0.57	0.31	0.05	0.05	0.55
Recurrent drinking in situations where alcohol use is physically hazardous										
Drove car or other vehicle while drinking	0.01	0.75	−0.05	0.91	−0.10	−0.01	0.86	−0.06	0.05	6.92
Drove car or other vehicle after having too much to drink	0.02	0.82	−0.07	1.00	−0.14	−0.07	0.99	−0.12	0.12	4.39
Got into risky situation during or after drinking	0.32	0.52	0.19	0.63	0.05	0.16	0.58	0.04	0.15	2.82
Recurrent alcohol-related legal problems										
Getting arrested or other legal problems because of drinking	0.36	0.37	0.30	0.48	−0.03	0.37	0.49	0.03	−0.10	0.96
Continued drinking despite persistent or recurrent social or interpersonal problems caused or exacerbated by drinking										
Continued to drink despite causing problems with family	0.78	0.16	0.74	0.23	−0.02	0.73	0.26	0.02	−0.02	1.43
Got into physical fights during or after drinking	0.46	0.36	0.36	0.32	0.18	0.37	0.32	0.19	0.01	1.58
Alcohol dependence										
Tolerance										
Usual amount had less effect than before	−0.07	0.90	0.01	−0.04	0.91	0.01	−0.06	0.87	0.09	5.04
Had to drink more than before to get the same effect	−0.07	0.99	0.06	−0.05	0.96	0.08	−0.06	0.91	0.07	3.10
Increased drinking because former amount had no effect	0.02	0.92	0.13	0.03	0.85	0.14	0.01	0.82	0.06	2.12
Withdrawal symptoms or withdrawal relief/avoidance										
Had trouble sleeping	0.71	0.03	0.66	0.09	0.01	0.44	−0.01	−0.10	0.47	4.26
Shaking	0.83	0.02	0.82	0.01	0.03	0.64	−0.05	−0.03	0.36	1.65
Anxious or nervous	0.92	−0.05	0.91	−0.02	−0.03	0.72	−0.08	−0.10	0.39	1.97
Felt sick or vomited	0.52	0.31	0.37	0.30	0.21	0.17	0.15	0.09	0.51	9.02
More restless than usual	0.84	0.01	0.82	0.02	0.02	0.59	−0.09	−0.07	0.47	3.42
Sweating or fast heart beating	0.77	0.05	0.73	0.04	0.06	0.51	−0.06	−0.02	0.46	3.11
Hallucinated	0.71	0.10	0.73	−0.07	0.16	0.61	−0.12	0.13	0.24	0.56
Had fits or seizures	0.83	−0.16	0.83	−0.11	−0.11	0.83	−0.08	−0.10	0.04	0.11
Took a drink to get over the bad aftereffects	0.57	0.24	0.47	0.31	0.05	0.41	0.29	0.01	0.17	2.37
Took a drink to keep from having had aftereffects	0.61	0.21	0.53	0.29	0.01	0.53	0.28	−0.01	0.14	1.38
Drinking larger amounts or for longer period of time than intended										
Ended up drinking more than intended	0.39	0.58	0.07	0.56	0.41	−0.09	0.28	0.22	0.68	9.59
Kept drinking for longer period of time than intended	0.36	0.62	0.01	0.61	0.43	−0.14	0.35	0.24	0.66	7.84
Persistent desire or unsuccessful efforts to cut down or control drinking										
More than once wanted to stop or cut down drinking	0.56	0.24	0.51	0.05	0.27	0.49	0.03	0.27	0.08	9.50
More than once tried to stop or cut down but could not	0.76	0.06	0.74	−0.05	0.16	0.73	−0.04	0.19	−0.04	1.90
Great deal of time spent in activities to obtain alcohol, to drink, or to recover from its effects										
Had a period when spent a lot of time drinking	0.51	0.43	0.39	0.30	0.29	0.35	0.29	0.28	0.12	2.33
Spent a lot of time being sick or getting over aftereffects	0.71	0.18	0.64	0.14	0.14	0.55	0.09	0.11	0.22	0.96
Important social, occupational, or recreational activities given up or reduced in favor of drinking										
Gave up important activities in order to drink	0.93	0.04	0.93	0.02	0.02	0.93	0.12	0.09	−0.11	0.77
Cut down on activities in order to drink	0.93	0.03	0.96	−0.03	0.03	0.93	0.09	0.12	−0.16	0.63
Continued to drink despite knowledge of having a persistent or recurrent physical or psychological problem caused or exacerbated by drinking										
Continued to drink despite feeling depressed	0.82	0.12	0.79	0.10	0.06	0.77	0.14	0.09	−0.01	1.52
Continued to drink despite health problems	0.79	0.07	0.76	0.10	0.01	0.74	0.12	0.03	0.02	2.32
Continued to drink after blackouts	0.59	0.31	0.48	0.31	0.15	0.42	0.27	0.13	0.18	2.19
Fit statistics										
Factor χ^2	4631.82(220)				2841.52(214)				1982.74(216)	
RMSEA	0.027				0.021				0.017	
RMSR	0.057				0.043				0.034	

Note: Numbers in boldface indicate items that load highly on a factor.

The structural regression estimates for each of the three factors with each of the background variables are presented in Table 3. The relationships between the factors and the covariates are described statistically by means of linear regression and are

interpreted as partial regression coefficients just as in ordinary linear multiple regression. The structural regression coefficients for the demographic characteristics indicate that males (compared with females) and Native Americans, Blacks and

Table 3
Estimated effects of background variables on symptom factors

Characteristic	Dependence		Abuse		Tolerance	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Sociodemographic factors						
Sex						
Male	0.31*	0.02	0.32*	0.02	0.24*	0.02
Female (referent)						
Race-ethnicity						
White (referent)						
Black	0.06*	0.02	−0.29*	0.02	0.03	0.03
Native American	0.26*	0.07	0.05	0.04	0.13	0.09
Asian/Pacific Islander	0.02	0.03	−0.39*	0.02	0.03	0.03
Hispanic	0.09*	0.02	−0.21*	0.02	0.12*	0.02
Age						
18–29 (referent)						
30–44	−0.13*	0.03	−0.43*	0.02	−0.42*	0.02
45–64	−0.34*	0.03	−0.78*	0.02	−0.59*	0.03
65 and older	−0.78*	0.04	−1.30*	0.03	−0.88*	0.04
Education						
8 years or less	0.34*	0.04	−0.32*	0.05	0.25*	0.05
9–11 years	0.17*	0.03	−0.12	0.03	0.33*	0.04
12 or GED	0.04**	0.02	−0.01	0.02	0.25*	0.02
Some college or 2-year degree	0.04**	0.02	0.11*	0.02	0.22*	0.02
Bachelor's degree or higher (referent)						
Family income						
US\$ 1–19999	0.14*	0.03	−0.10*	0.02	0.10*	0.02
US\$ 20000–34999	−0.01	0.02	−0.07*	0.02	−0.09*	0.02
US\$ 35000–69999	−0.02	0.02	−0.10*	0.01	−0.08*	0.02
US\$ 70000 or more (referent)						
Marital status						
Married (referent)						
Previously married	0.26*	0.03	0.35*	0.02	0.27*	0.03
Never married	0.30*	0.02	0.31*	0.01	0.44*	0.02
Region						
Northeast	−0.12*	0.01	−0.06*	0.02	0.02	0.02
Midwest	−0.11*	0.02	0.12*	0.02	0.03	0.02
South	−0.09*	0.01	−0.03	0.02	−0.08*	0.02
West (referent)						
Urbanicity						
Central city in MSA (referent)						
Not a central city in MSA	−0.01	0.01	−0.04*	0.01	−0.02	0.01
Not in MSA	0.01	0.03	−0.01	0.03	0.10*	0.03
Family history variables						
Parental alcoholism						
No (referent)						
Yes	0.27*	0.02	0.19*	0.02	0.16*	0.02
Father antisocial personality disorder						
No (referent)						
Yes	0.06*	0.02	0.07*	0.02	0.04**	0.02
Past year psychiatric disorders						
Major depression						
No (referent)						
Yes	0.43*	0.03	0.10*	0.03	0.39*	0.03
Panic disorder without agoraphobia						
No (referent)						
Yes	0.19*	0.02	0.15*	0.02	−0.06	0.04
Panic disorder with agoraphobia						
No (referent)						
Yes	0.29*	0.07	0.28*	0.04	0.07	0.05

Table 3 (Continued)

Characteristic	Dependence		Abuse		Tolerance	
	Coefficient	S.E.	Coefficient	S.E.	Coefficient	S.E.
Antisocial personality disorder						
No (referent)						
Yes	0.30*	0.02	0.28*	0.02	0.25*	0.03
Treatment setting past 12 months						
Alcoholics anonymous						
No (referent)						
Yes	0.58*	0.03	0.48*	0.03	0.36*	0.04
Alcoholic detoxification						
No (referent)						
Yes	0.68*	0.05	0.47*	0.04	0.34*	0.05
Inpatient hospital ward						
No (referent)						
Yes	−0.09	0.05	−0.12*	0.04	−0.13**	0.06
Emergency room						
No (referent)						
Yes	0.59*	0.05	0.27*	0.05	0.26*	0.07
Medical conditions past 12 months						
Liver condition						
No (referent)						
Yes	0.39*	0.11	−0.01	0.06	0.24**	0.11
Stomach ulcer						
No (referent)						
Yes	0.01	0.04	−0.03	0.03	0.01	0.05
Gastritis						
No (referent)						
Yes	0.05	0.03	0.03	0.03	0.04	0.03
Angina						
No (referent)						
Yes	0.16*	0.03	−0.04	0.03	0.13*	0.04
Tachycardia						
No (referent)						
Yes	0.28*	0.03	0.01	0.03	0.08**	0.04
Myocardial infarction						
No (referent)						
Yes	0.21**	0.09	0.01	0.08	−0.10**	0.05
R^2	0.27		0.34		0.23	

$\chi^2 = 401.6$, d.f. = 41; CFI = 0.98; RMSEA = 0.01.

* $p < 0.01$.

** $p < 0.05$.

Hispanics (compared to Whites) were more likely to have higher estimates for alcohol dependence. Compared with respondents with at least a 4-year degree, those with lower educational levels were more likely to have higher estimates of dependence, as were respondents in the lowest income bracket relative to those in the highest income bracket. Further, never married and previously married respondents had higher estimates of dependence. In contrast, older respondents (ages 30 years and older) had lower estimates for alcohol dependence compared with the youngest respondents, a result that was also true for respondents living in the non-Western regions of the country.

Males, those with some college or a 2-year degree and those who were never or previously married or residing in the Midwest region of the country were more likely to have higher

estimates for alcohol abuse. However, Blacks, Asian/Pacific Islanders, Hispanics, respondents 30 years and older, and those with less than 9 years of education, with less than US\$ 70,000 family income, or residing in the Northeast region of the country had lower estimates for alcohol abuse. Further, males, Hispanics and respondents with less than a 4-year degree, in the lowest income bracket, never married or previously married or not residing in an MSA were more likely to have higher estimates for tolerance. In contrast, older respondents (30 years and older), those with moderate family incomes, and respondents residing in the South and not in central cities but in an MSA had lower estimates for tolerance.

Among the variables selected for concurrent validation, parental history of alcoholism and father's history of antisocial

personality disorder were positively related to alcohol dependence, alcohol abuse and tolerance. Respondents with past year major depression, panic disorder with and without agoraphobia, and lifetime antisocial personality disorder had higher estimates for alcohol dependence. Similar associations were present for alcohol abuse. Respondents with major depression and antisocial personality disorder had higher estimates for tolerance. Respondents reporting seeking treatment in the last 12 months had higher estimates for alcohol dependence, alcohol abuse and tolerance. Inpatient treatment was negatively associated with alcohol abuse and tolerance. Respondents who reported 12-month medical problems related to liver conditions, angina, and tachycardia had higher estimates of dependence and tolerance, whereas those reporting myocardial infarctions had lower estimates of tolerance and higher estimates of dependence.

3.3. Direct effects

The presence of direct effects indicates that not all of the effects of background variables are fully mediated by the latent variables and that there is therefore evidence of measurement non-invariance. The direct effects shown in Table 4 are probit regression coefficients for the binary symptoms (only significant coefficients are presented). Interpretations of direct effects should be viewed in conjunction with the structural estimates of the factors. The negative direct effects of male gender for the withdrawal item related to having trouble with sleeping (-0.19) implies that for respondents with the same value on this (dependence) factor, respondents who are male had a lower probability of reporting this symptom. As shown in Table 3, there are several direct effects associated with gender, race-ethnicity, age, and years of education. Factor values being the same, males were less likely to report specific withdrawal symptoms, time spent getting over withdrawal symptoms, drinking more than intended, and more likely to report physical fights, drinking in hazardous situations, and driving while drinking or after having too much to drink.

Factor values being the same, Blacks were less likely to report trouble sleeping and continuing to drink after blackouts and more likely to report a persistent desire or unsuccessful efforts to control drinking. Hispanics were less likely to report trouble sleeping and drinking more than intended and more likely to report unsuccessful efforts to control drinking.

Factor values being the same, older respondents (over 29 years old) were less likely to report specific withdrawal symptoms, continuing to drink after blackouts, and physical fights and more likely to report drinking more or longer than intended and driving after drinking. Older respondents were more likely to report drinking more than intended and drinking in hazardous situations.

Factor values being the same, respondents with some college or less education were less likely to report trouble sleeping and more likely to report fighting. Those with less than 9 years of education were less likely to report drinking interfered with taking care of home or family and more likely to get into fights during or after drinking and to have drinking-related legal problems. High school graduates and those with some college education were

more likely to report alcohol-related legal problems, physical fights, and continuing to drink despite family problems, and less likely to report drinking more to get the same effect (a tolerance item) and trouble sleeping.

4. Discussion

The three-factor solution adopted in this study retained the structure of the two-factor solution (alcohol dependence and abuse) reported in other general population samples (Muthén et al., 1993a,b,c; Muthén, 1995) in addition to a third minor factor defined by three items related to tolerance. These similarities remain despite the fact that the earlier studies were conducted on data collected a decade earlier using somewhat different criteria items. Factor 1, interpreted as alcohol dependence, is well defined by symptom items related to five of the DSM-IV dependence criteria including “withdrawal”, “unsuccessful efforts to control drinking”, “giving up activities in favor of drinking”, “time spent recovering from withdrawal symptoms”, and “drinking despite physical and/or psychological problems”. Factor 1 also draws upon two DSM-IV abuse criteria: “recurrent drinking resulting in failure to fulfill major role obligations” and “continuing to drink despite social problems”. Factor 2, interpreted as alcohol abuse, is defined by items related to the DSM-IV abuse criterion “recurrent drinking in hazardous situations” and the DSM-IV dependence criterion, “drinking larger amounts or over a longer period than intended”. The third factor (tolerance) represented the tolerance items and was correlated with both dependence (0.67) and abuse (0.60) factors. The factor correlation between dependence and abuse (0.70) is consistent with DSM-IV conceptualization of alcohol dependence with and without abuse.

Less clear are reasons why tolerance items loaded separately from the dependence factor in this survey and in a prior, similar survey (Muthén et al., 1993a,b,c). The tolerance items also were cross-loaded with the “drinking more or longer than intended” criterion; items which defined the alcohol abuse factor. The high prevalence of tolerance reported in adolescent samples may indicate that the onset of tolerance during adolescence is a normal development phenomenon (Martin and Winters, 1998). The higher prevalence of tolerance items in the present study (Table 2) may indicate that this phenomenon extends to younger adult populations as well. Chung et al. (2001) concluded that current assessments of tolerance among adolescent and young adult samples reflect low or moderate levels of tolerance rather than a pathological process indicative of alcohol dependence. Alternatively, the factor associated with tolerance in this study may relate more to innate tolerance or more appropriately innate sensitivity rather than acquired tolerance, especially in view of the finding that the tolerance items cross-loaded on the drinking more or longer than intended symptom items.

Although these results provide some support for the construct validity of DSM-IV conceptions of alcohol dependence and abuse, there are some important variations in the measurement of the symptom items with respect to dependence in the present study. Two abuse criteria (“neglect of role obligations” and “continuing to drink despite social problems”) defined the

Table 4
Estimated direct effects of background variables on symptom factors

Background variables	Estimate	S.E.	Item	Factor
Male	−0.19	0.02	Withdrawal: had trouble sleeping	Dependence
Male	−0.19	0.02	Withdrawal: shaking	Dependence
Male	−0.21	0.01	Withdrawal: felt sick or vomit	Dependence/abuse
Male	−0.10	0.01	Ended up drinking more than intended	Abuse/tolerance
Male	0.07	0.02	More than once, wanted to stop or cut down drinking	Dependence
Male	−0.18	0.04	Spent a lot of time being sick or getting over aftereffects	Dependence
Male	0.25	0.02	Drove car or other vehicle while drinking	Abuse
Male	0.16	0.02	Drove car or other vehicle after having too much to drink	Abuse
Male	0.21	0.03	Drank in hazardous situations	Abuse
Male	0.20	0.02	Got into physical fights during or after drinking	Dependence/abuse
Black	−0.26	0.03	Withdrawal: had trouble sleeping	Dependence
Black	0.22	0.02	More than once, wanted to stop or cut down drinking	Dependence
Black	0.30	0.03	More than once, tried to stop or cut down drinking but could not	Dependence
Black	−0.24	0.04	Continued to drink after blackouts	Dependence
Hispanic	−0.24	0.02	Withdrawal: had trouble sleeping	Dependence
Hispanic	−0.16	0.02	Drinking more than intended	Abuse/tolerance
Hispanic	0.26	0.03	More than once, wanted to stop or cut down drinking	Dependence
Age: 30–44	−0.26	0.02	Withdrawal: felt sick or vomit	Dependence/abuse
Age: 45–64	−0.44	0.03	Withdrawal: felt sick or vomit	Dependence/abuse
Age: 65+	−0.83	0.04	Withdrawal: felt sick or vomit	Dependence/abuse
Age: 30–44	−0.15	0.02	Withdrawal: more restless than usual	Dependence
Age: 45–64	−0.15	0.03	Withdrawal: more restless than usual	Dependence
Age: 65+	−0.27	0.04	Withdrawal: more restless than usual	Dependence
Age: 30–44	0.05	0.02	Ended up drinking more than intended	Abuse/tolerance
Age: 30–44	0.14	0.02	Kept drinking for longer period of time than intended	Abuse/tolerance
Age: 30–44	−0.16	0.03	Continued to drink after blackouts	Dependence
Age: 45–64	−0.20	0.04	Continued to drink after blackouts	Dependence
Age: 30–44	0.30	0.02	Drove car or other vehicle while drinking	Abuse
Age: 45–64	0.40	0.03	Drove car or other vehicle while drinking	Abuse
Age: 65+	0.55	0.04	Drove car or other vehicle while drinking	Abuse
Age: 30–44	0.31	0.03	Drove car or other vehicle after having too much to drink	Abuse
Age: 45–64	0.43	0.03	Drove car or other vehicle after having too much to drink	Abuse
Age: 30–44	−0.27	0.03	Got into physical fights during or after drinking	Dependence/abuse
Age: 45–64	−0.55	0.04	Got into physical fights during or after drinking	Dependence/abuse
Education				
12 years or GED	0.09	0.03	Had to drink more than before to get effects	Tolerance
Some college	0.08	0.02	Had to drink more than before to get effects	Tolerance
8 years or less	−0.47	0.05	Withdrawal: had trouble sleeping	Dependence
9–11 years	−0.47	0.03	Withdrawal: had trouble sleeping	Dependence
12 years or GED	−0.37	0.02	Withdrawal: had trouble sleeping	Dependence
Some college	−0.28	0.02	Withdrawal: had trouble sleeping	Dependence
8 years or less	−0.63	0.12	Drinking interfered with taking care of home or family	Dependence
12 years or GED	0.15	0.02	Drove car or other vehicle while drinking	Abuse
8 years or less	0.78	0.13	Getting arrested or other legal problems because of drinking	Dependence/abuse
9–11 years	0.61	0.06	Getting arrested or other legal problems because of drinking	Dependence/abuse
12 years or GED	0.29	0.04	Getting arrested or other legal problems because of drinking	Dependence/abuse
9–11 years	0.49	0.05	Continued to drink despite causing problems with family	Dependence
12 years or GED	0.43	0.04	Continued to drink despite causing problems with family	Dependence
Some college	0.21	0.04	Continued to drink despite causing problems with family	Dependence
8 years or less	0.61	0.08	Got into physical fights during or after drinking	Dependence/abuse
9–11 years	0.45	0.04	Got into physical fights during or after drinking	Dependence/abuse
12 years or GED	0.39	0.03	Got into physical fights during or after drinking	Dependence/abuse
Some college	0.27	0.03	Got into physical fights during or after drinking	Dependence/abuse
Sought treatment				
AA	−0.11	0.02	Withdrawal: trouble sleeping	Dependence/abuse
AA	0.23	0.03	More than once, wanted to stop or cut down drinking but could not	Dependence
AA	0.52	0.06	Getting arrested or other legal problems because of drinking	Dependence/abuse
Lifetime major depression				
	−0.19	0.04	More than once, wanted to stop or cut down drinking but could not	Dependence
	0.10	0.04	Got into risky situation during or after drinking	Abuse
	0.19	0.05	Getting arrested or other legal problems because of drinking	Dependence/abuse

Table 4 (Continued)

Background variables	Estimate	S.E.	Item	Factor
Antisocial personality disorder	−0.15	0.04	Withdrawal: shaking	Dependence
	−0.16	0.04	Withdrawal: more restless than usual	Dependence
	0.31	0.04	Got into physical fights during or after drinking	Dependence/abuse

dependence factor. Consistent with other studies (Hasin et al., 1990, 1997a,b; Hasin and Paykin, 1999b), alcohol abuse was associated with excessive and hazardous drinking experiences and items related to the dependence criterion, “drinking more or longer than intended”. These two items reflect excessive and hazardous drinking experiences and not explicit negative consequences associated with drinking. Thus, drinking more or longer than intended without a link to negative consequences may reflect otherwise healthy individuals who recognize they are drinking too much, perhaps in a hazardous way, who are in the intermediate stages on the way to changing their drinking patterns. Inspection of the proportions of respondents endorsing the symptom items in the present study (Table 2) indicates relatively higher prevalence of the abuse items when compared with the dependence items, and may indicate a less severe problem. Longitudinal study of individuals with this particular symptom configuration would clarify if they are most likely to show no alcohol problems at follow-up, which would support an interpretation of these symptoms as reflecting a stage of change towards non-problem drinking or no drinking.

One of the strengths of the structural equation-modeling approach used here is the ability to detect and compensate for non-invariance of the measurement of criteria across subgroups of individuals in the population, thereby avoiding distortion of the risk factor assessment. 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). Several direct effects were related to gender, race-ethnicity, and age, indicating that not all of the effects of the background variables were fully mediated by the latent variables. Males were less likely to report withdrawal symptoms, suggesting that females may be more susceptible to adverse effects of drinking or that males are less likely to admit negative effects of drinking. Similarly, younger respondents were less likely to report feeling sick or restless after drinking. Other gender and age effects may reflect actual behaviors (males were more likely to report drinking in hazardous situations whereas older respondents reported more driving after drinking experiences). Blacks and Hispanics were more likely to report attempts to control drinking which may reflect concerns with social status. Social control theories (Makela, 1987; Park, 1983) posit that drinking behaviors in subordinate groups in society are more heavily restricted and sanctioned. There were few direct effects related to educational level, controlling for other variables in the model, which might reflect consequences of drinking behavior (e.g., reports of legal problems and physical fights decreased with level of education).

With respect to background variables, the probability of alcohol dependence in this study increased with male gender, among

Blacks, Native Americans and Hispanics, and among younger respondents, those with lower socioeconomic status or never or previously married. When compared to western geographic areas, other areas were associated with lower probabilities of alcohol dependence. The majority of these independent risk factors were similarly related to alcohol abuse and tolerance. However, there were some notable differences in the demographic profiles related to dependence and abuse. Alcohol abusers were less likely to be Black, Asian/Pacific Islander or Hispanic and were better educated. The probability of alcohol abuse was higher in the Midwest and lower among those residing in central cities. Further, the probability of tolerance was increased among Hispanics but not the other racial-ethnic groups. The probability of tolerance was significantly increased among those residing in the South and significantly decreased among those not residing in an MSA.

Interpretations of the relationships between demographic variables and the latent variables for dependence and abuse, as well as comparisons with other studies, are constrained because the measurement of the factors in this study, especially alcohol abuse, were shown to depart somewhat from DSM-IV definitions. The methodology used in this study also differs from conventional risk factor analysis in which a dichotomous diagnostic variable is regressed on a set of covariates or hypothesized antecedents. Instead, three continuous latent variables, alcohol dependence, abuse and tolerance, factors that explain the covariation among a set of criteria (i.e., symptom items), are regressed on the covariates. Despite these measurement differences, the associations between the demographic variables and alcohol dependence and abuse found in this study are consistent with other general population studies (Caetano and Clark, 1998; Grant and Dawson, 1997; Hasin et al., 1997a,b; Hasin and Paykin, 1999a; Muthén, 1995; Prescott and Kendler, 1999b) which have used traditional risk factor analysis to examine DSM-IV alcohol abuse and dependence.

Further support for the criterion-oriented validity of alcohol dependence was reflected in the statistically significant associations with family history, treatment seeking, medical conditions, and other psychiatric comorbidity. Family history of alcoholism and antisocial personality disorder among biological fathers were associated with alcohol dependence, alcohol abuse and tolerance. Similar associations were present for treatment seeking via Alcoholics Anonymous, alcohol detoxification, and emergency room visits but not for inpatient hospitalization. The absence of an association between alcohol dependence and inpatient care in the general population contrasts with findings reported for treatment settings. The negative association with alcohol abuse is consistent with the measurement of alcohol abuse in this study (i.e., recurrent drinking in hazardous sit-

uations and drinking larger amounts over a longer period of time). Treatment seeking related to hazardous use in the general population would be expected to relate to acute compared to longer-stay settings, a finding consistent with the significant association of abuse and emergency room treatment. Medical conditions in the past year for liver and cardiac conditions (e.g., angina, tachycardia, myocardial infarction) were significantly associated with alcohol dependence but not abuse, reflecting the more chronic nature of dependence.

Associations between alcohol use disorders and mood and anxiety disorders have been reported in the general population (Grant and Harford, 1995; Hasin and Grant, 2002; Kessler et al., 1996; Regier et al., 1990). More recently, Grant et al. (2004c) reported the comorbidity of DSM-IV alcohol use disorders and independent mood and anxiety disorders (excluding those that are substance induced and due to general medical conditions). Major depression was strongly associated with alcohol dependence (OR = 3.7, 95% CI = 3.1–4.4) but not alcohol abuse (OR = 1.2, 95% CI = 1.0–1.5). Similarly, in the present study, the probability of alcohol dependence and tolerance, but not alcohol abuse, was related to major depression. Consistent with Grant et al. (2004c), the probabilities of alcohol dependence were also associated with panic disorder. However, in contrast to Grant et al. (2004b), the probability of alcohol abuse was associated with panic disorder with and without agoraphobia. Consistent with literature (Verheul et al., 1995; Grant et al., 2004d), the probability of alcohol dependence and abuse is related to antisocial personality disorder. Differences in these associations may be due to restricting analyses in this study to current drinkers and differences due to the analytic approaches taken.

This study is not without limitations. First, only DSM-IV diagnostic criteria for abuse and dependence were assessed, making our inquiry incomplete. The need to expand this current research to tap alternative clinical features of alcohol use disorders appears warranted. Second, we examined diagnostic criteria as opposed to individual symptom items. Further research should also examine the dimensional properties of criterion symptom items as these and other levels of aggregation may uncover different features related to the dimensions. Third, there were several withdrawal symptoms relative to fewer symptom items tapping other abuse and dependence diagnostic criteria. Although this will have some impact on EFA rotations, we decided to retain the number of withdrawal symptoms to accurately represent the complexity of the criterion, rather than lose information by combining withdrawal in an attempt to be more consistent with the number of symptoms associated with other criteria. Fourth, we did not conduct multiple group analyses to investigate factor loading invariance because it was impractical when so many grouping variables are involved. However, future multiple group analytical approaches could extend and complement the results of this study, providing important information on convergence between results derived from multiple methods. Lastly, split-half replication was not conducted in this study. Given the number of critical covariates examined, using the entire sample would give more robust results. These important issues of replication can best be addressed in other large contemporaneously collected datasets to determine the

invariance of our findings across important subgroups of the population.

In summary, findings from this study provide further support for the validity of DSM-IV alcohol dependence in general population samples, although the results for abuse are equivocal. The conceptual basis of alcohol abuse has not received comparable attention (Helzer, 1994; Langenbucher and Martin, 1996). A general population psychometric study of alcohol use disorders using variables external to the diagnosis as validators also produced equivocal results for alcohol abuse (Hasin et al., 1997a,b). It is not clear whether abuse in this study reflects a residual category based on symptoms with high prevalence or some abuse-like condition as described by Saunders and Lee (2000). The measure of alcohol abuse in the present study, however, did yield some demographic distinctions with alcohol dependence. The probability of alcohol abuse was lower among Blacks, Asian/Pacific Islanders and Hispanics and among those with the lowest income or education. When compared to alcohol dependence, alcohol abuse is not related to current medical complications. Whether these differences provide sufficient support for a separate alcohol abuse disorder warrants further study.

In view of the high factor correlations and the absence of a substantive theory for alcohol abuse, a more parsimonious interpretation of the EFA analysis in the present study suggests that the symptom items may be viewed as a single dimension of alcohol dependence rather than two independent categories. External support for this interpretation is based on studies of age at symptom onset. Among adult samples, Langenbucher and Chung (1995) report that the initial symptoms included drinking larger amounts, drinking longer than intended, or abuse symptoms. In a study of the sequencing in age of symptom onset in adolescents (Martin et al., 1996), the initial symptom stage included three dependence criteria (“tolerance”; “drinking larger amounts or longer than intended”; “time spent obtaining alcohol, drinking, or recovering from its effects”) and two abuse criteria (“neglect of roles” and “drinking despite social problems”). Prospective studies also have indicated that respondents classified with DSM-IV alcohol abuse do not necessarily progress to alcohol dependence (Hasin et al., 1990; Hasin and Paykin, 1999b). In a short-term (1-year) prospective follow-up of their community study of heavy drinkers, Hasin et al. (1997a,b) found chronicity to be the most common outcome for dependence but not abuse. Further studies using other continuous and categorical latent trait analyses promise to provide convergent validation of the classes or dimensions underlying the DSM-IV alcohol dependence and abuse categories.

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