

2005

## Limitations of DSM-IV operationalizations of alcohol abuse and dependence in a sample of Australian twins

Michael T. Lynskey  
*Washington University School of Medicine in St. Louis*

Elliot C. Nelson  
*Washington University School of Medicine in St. Louis*

Rosalind J. Neuman  
*Washington University School of Medicine in St. Louis*

Kathleen K. Bucholz  
*Washington University School of Medicine in St. Louis*

Pamela A.F. Madden  
*Washington University School of Medicine in St. Louis*

*See next page for additional authors*

Follow this and additional works at: [https://digitalcommons.wustl.edu/open\\_access\\_pubs](https://digitalcommons.wustl.edu/open_access_pubs)

**Please let us know how this document benefits you.**

---

### Recommended Citation

Lynskey, Michael T.; Nelson, Elliot C.; Neuman, Rosalind J.; Bucholz, Kathleen K.; Madden, Pamela A.F.; Knopik, Valerie S.; Slutske, Wendy; Whitfield, John B.; Martin, Nicholas G.; and Heath, Andrew C., "Limitations of DSM-IV operationalizations of alcohol abuse and dependence in a sample of Australian twins." *Twin Research and Human Genetics*. 8, 6. 574-584. (2005).  
[https://digitalcommons.wustl.edu/open\\_access\\_pubs/3228](https://digitalcommons.wustl.edu/open_access_pubs/3228)

This Open Access Publication is brought to you for free and open access by Digital Commons@Becker. It has been accepted for inclusion in Open Access Publications by an authorized administrator of Digital Commons@Becker. For more information, please contact [vanam@wustl.edu](mailto:vanam@wustl.edu).

---

**Authors**

Michael T. Lynskey, Elliot C. Nelson, Rosalind J. Neuman, Kathleen K. Bucholz, Pamela A.F. Madden, Valerie S. Knopik, Wendy Slutske, John B. Whitfield, Nicholas G. Martin, and Andrew C. Heath

---

# Limitations of DSM-IV Operationalizations of Alcohol Abuse and Dependence in a Sample of Australian Twins

Michael T. Lynskey,<sup>1,2</sup> Elliot C. Nelson,<sup>2</sup> Rosalind J. Neuman,<sup>2</sup> Kathleen K. Bucholz,<sup>2</sup> Pamela A. F. Madden,<sup>2</sup> Valerie S. Knopik,<sup>2</sup> Wendy Slutske,<sup>3</sup> John B. Whitfield,<sup>1,4</sup> Nicholas G. Martin,<sup>1</sup> and Andrew C. Heath<sup>2</sup>

<sup>1</sup> Queensland Institute of Medical Research, Brisbane, Queensland, Australia

<sup>2</sup> Missouri Alcoholism Research Center and Department of Psychiatry, Washington University School of Medicine, St Louis, Missouri, United States of America

<sup>3</sup> Missouri Alcoholism Research Center and Department of Psychology, University of Missouri, Columbia, Missouri, United States of America

<sup>4</sup> Royal Prince Alfred Hospital, Sydney, Australia

Alcohol abuse and dependence are among the most common psychiatric conditions identified in epidemiological surveys of the general population. The aim of this article is to examine the psychometric properties of *Diagnostic and Statistical Manual of Mental Disorders*, (4th ed.; DSM-IV; American Psychiatric Association, 1994) criteria for alcohol abuse and dependence using latent class analysis (LCA). Six thousand two hundred and sixty-five young Australian twins (median age 30 years) were interviewed by telephone between 1996 and 2000 using a modified version of the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA). DSM-IV symptoms of alcohol abuse and dependence were collected by structured diagnostic interview and analyzed using methods of LCA. LCA revealed a 4-class solution for women that classified individuals according to the severity of their alcohol-related problems: no/few problems (66.5%), heavy drinking (23.9%), moderate dependence (7.6%) and severe dependence (2.0%). Among men the preferred solution included 5 classes corresponding to no/few problems (46.4%), heavy drinking (34.3%), moderate dependence (12.2%), severe dependence (3.0%) and abuse (4.0%). Evidence of a male-specific class of alcohol-related problems corresponding to abuse partially supports the DSM conceptualization of alcohol use disorders but suggests that this conceptualization — and measurement — may need to be refined for women. Identification of a male-specific abuse class also has important implications for interventions and treatment as these individuals experienced significant alcohol-related problems and comprised approximately 21% of all men classified with an alcohol use disorder.

lation (Andrews et al., 2001; Bijl et al., 1998; Helzer et al., 1991; Kessler et al., 1994). For example, the Epidemiologic Catchment Area (ECA) studies reported that just under 14% of the United States adult population met lifetime *Diagnostic and Statistical Manual of Mental Disorders*, (3rd ed.; DSM-III; American Psychiatric Association, 1980) criteria for an alcohol use disorder (abuse or dependence; Helzer et al., 1991). Higher rates were reported in the National Comorbidity Survey (NCS), which reported a lifetime prevalence of DSM-III-R (3rd ed., rev.; American Psychiatric Association, 1987) abuse and dependence of 9.4% and 14.1% respectively (Kessler et al., 1994). There is also consistent evidence of gender differences in the prevalence of alcohol use disorders with estimates from the NCS suggesting that 14.6% of women compared with 32.6% of men meet lifetime criteria for alcohol abuse or dependence (Kessler et al., 1994).

Despite the widespread application of the DSM system of nomenclature, there has been continued controversy about the distinction between dependence and abuse (Rounsaville et al., 1986; Schuckit, 1996). The results of a factor analysis suggested that these criteria were best represented by a one-factor model with abuse and dependence criteria loading on a single factor (Hasin et al., 1994). In contrast, other analyses have supported a two-factor solution, consistent with the DSM-IV conceptualization (Harford & Muthen, 2001; Muthen et al., 1993). Nonetheless, there were significant departures between these models and DSM-IV with a number of the putative

---

Alcohol use disorders, separated in *Diagnostic and Statistical Manual of Mental Disorders* (4th ed.; DSM-IV; American Psychiatric Association, 1994) into abuse and dependence, are among the most prevalent psychiatric conditions in the general popu-

---

Received 1 September, 2005; accepted 15 September, 2005.

Address for correspondence: Michael T. Lynskey, PhD, Mid-West Alcoholism Research Center, Department of Psychiatry, Washington University School of Medicine, 660 S Euclid, Box 8134, St Louis, MO 63110, USA. E-mail: Mlynkskey@matlock.wustl.edu

'abuse' criteria loading on the 'dependence' factor and vice versa.

Additionally, Schuckit and Simon (2001) noted that abuse and dependence share similar predictors leading them to suggest that the two categories should be combined. Several studies have also reported that there is only moderate to poor agreement between diagnoses of alcohol abuse (or, for *International Classification of Diseases*, misuse) between different systems of nomenclature, again leading to some doubt over the validity of this diagnosis (Hasin et al., 1996, 1997; Pull et al., 1997). Nonetheless, a number of prospective studies have now reported that the majority of individuals meeting criteria for abuse do not progress to dependence, a finding that has been used to support the diagnostic utility of abuse (Hasin et al., 1997; Schuckit et al., 2000, 2001).

One further approach to studying the distinction between abuse and dependence involves the use of latent class analysis (LCA; McCutcheon, 1987). These analyses rest on the assumption that correlations between individual symptoms can be explained by the existence of a number of mutually exclusive classes and that the endorsement probabilities for each symptom are class-specific. A major advantage of LCA is that it allows assignment of individuals to specific classes on a probabilistic basis. The results of previous LCA analyses of alcohol-related symptom data have *not* supported the existence of a qualitatively distinct symptom class representing abuse, but have concluded that alcohol-related symptomatology can best be represented by a model in which different classes fall along a continuum of severity, with each successive class characterized by higher endorsement probabilities for all criteria (Bucholz et al., 1996; Heath et al., 1994; Nelson et al., 1998). There have been differences between the preferred models reported by these studies and, in particular, the number of separate classes identified has varied: Heath et al. (1994) reported a five-class solution while Bucholz et al. (1996) and Nelson et al. (1998) both reported four-class solutions ranging from the asymptomatic to the severely dependent.

In contrast to these analyses, an analysis of male Swedish temperance board registrations suggested the presence of five qualitatively distinct subtypes of alcoholism (Kendler et al., 1998): multiple cause registrants with early onset, multiple cause registrants with late onset, and three classes of single cause registrants corresponding to those registered for driving under the influence, those registered for public drunkenness and those registered for alcohol related crime. Nonetheless, this typology, which was supported by external validation indicating unique correlates of class membership, does not map directly to the abuse and dependence distinction in DSM-IV.

Thus, the results of previous LCA of alcohol abuse and dependence symptoms have produced mixed results. However, relatively few studies have examined

this issue and, as yet, there has been no study examining the issue within a general population sample of both males and females: the existing studies have been based either on the analysis of temperance board registrations (Kendler et al., 1998), high-risk family members of people clinically ascertained (Bucholz et al., 1996) and/or on samples of males only (Heath et al., 1994; Kendler et al., 1998). While the analyses of Nelson et al. (1998) included both males and females from the general population, they focused on transitions across time in symptomatology. This article presents a LCA of symptoms of alcohol use disorders using data from a general population of male and female Australian twin pairs.

## Methods

### Sample

Participants were young adult twins born between 1964 and 1971 from a volunteer adult twin panel maintained by the Australian National Health and Medical Research Council. As described elsewhere (Heath et al., 2001; Knopik et al., 2004; Nelson et al., 2002), they were originally recruited as children during the period 1980 to 1982, through systematic appeals to parents through Australian school systems and mass media appeals, and were drawn from all socioeconomic strata. Respondents ( $N = 2774$  men,  $N = 3430$  women) completed a telephone diagnostic interview during the period 1996 to 2000, at a median age of 30 years. The original volunteer twin panel comprised a total of 4262 pairs believed to be born between 1964 and 1971. A total of 235 pairs were never successfully retraced as adults and an additional 17 pairs where at least one twin pair had participated in the 1989 questionnaire survey could not be retraced. Four pairs were found to have a year of birth that made them ineligible for the study. After excluding these pairs, the final response rate was 77.4%.

### Assessment

Twins completed a telephone diagnostic interview that was adapted for telephone administration from the Semi-Structured Assessment for the Genetics of Alcoholism (SSAGA; Bucholz et al., 1994; Hesselbrock et al., 1999), and updated for DSM-IV diagnostic criteria (American Psychiatric Association, 1994). The diagnostic interview included lifetime assessments of DSM-IV alcohol dependence and abuse, major depressive disorder, and childhood conduct disorder, as well as nondiagnostic assessments of drinking history (quantity, frequency and frequency of drinking to intoxication during the respondent's heaviest drinking period, which was required to be of at least 12 months' duration). Twins also reported on whether they believed that their co-twin had ever been an excessive drinker or had alcohol-related problems (Slutske et al., 1998). The interview proceeded only after verbal consent had been obtained from the interviewees. Consent procedures were reviewed and approved by the Human Studies

Committee at Washington University School of Medicine, and the Ethics Committee at Queensland Institute of Medical Research.

#### **Alcohol Dependence**

Alcohol dependence was determined based on DSM-IV criteria, using a computer algorithm that took into account respondents' reporting of clustering of three or more alcohol dependence symptoms in the same 12-month period. We report lifetime prevalence of alcohol dependence according to both broad and narrow criteria. For broad dependence, we (a) coded tolerance as positive if a respondent either reported the subjective experience of being able to drink much more before getting drunk or feeling the effects of alcohol, compared to when he or she started drinking regularly, or if the respondent reported at least a 50% increase in the number of drinks needed to get drunk or feel an effect, compared to when he or she started drinking regularly, and (b) interpreted literally the criterion 'substance often taken in larger amounts or over a longer period that was intended'. For narrow dependence, we used only (a) subjective reports of tolerance, and (b) coded respondents positive for 'use more than intended' only if they specifically indicated that this involved often getting drunk when they didn't want to. The latter narrow operationalizations of tolerance and 'use more than intended' were used in the LCA described below.

DSM-IV cites continued use of alcohol despite recurrent blackouts as an example of the 'continued use' dependence criterion. Therefore, in both broad and narrow operationalizations, we coded respondents as positive for continued use if they reported recurrent blackouts in the same 12-month period. However, we cannot exclude the possibility of false positive responses to this item where respondents did not view the occurrence of multiple blackouts as an undesirable outcome, as we did not explicitly query this possibility.

#### **Alcohol Abuse**

In the assessment of alcohol abuse we did not impose the requirement of recurrent problems within the same 12-month period. In the case of recurrent alcohol-related arrests, previous work had shown that endorsement of this item for a single 12-month period would be too rare to be useful for analysis (Heath & Martin, 1994). For other abuse items, recurrence was implied by the wording of questions (e.g., 'often drove etc. when you had had a lot to drink or too much to drink'; 'drinking caused serious or repeated problems in any marriage or romantic relationship').

#### **Analyses**

In preliminary descriptive analyses, endorsement frequencies for alcohol dependence and abuse symptom criterion items ('symptom groups' such as tolerance, withdrawal) were calculated using SAS (SAS Institute Inc., 1996). To investigate further the

clustering of criterion items, latent class models were fitted to observed symptom profiles separately by gender, using the Latent Class Analysis Program (LCAP; Neuman et al., 1999; Statistical Genetics Group, 2002). In fitting LCA models to twin data, we ignored the correlation between observations on twin pairs. Ignoring statistical clustering in this way will not bias estimates of model parameters, but invalidates traditional goodness-of-fit criteria, in particular the Bayes Information Criteria (BIC) measure, as it involves a correction factor which is in part a function of total sample size would be ultraconservative (i.e., because twin pairs are correlated, the effective sample size should be less than the total number of twins), while Akaike's Information Criterion (AIC) and likelihood ratio criteria would tend to overestimate the required number of classes. As our primary interest was in our ability to identify meaningful 'abuse' and 'dependence' classes, we used a heuristic approach to determine the number of classes that could usefully be estimated for each gender, comparing the most likely class assignment for every respondent in successive solutions as the number of estimated classes was increased, with data summarized in the form of a probability tree showing the reassignment of subjects assigned to a given class in the  $n$ -class solution to different classes in the  $(n + 1)$ -class solution. This allowed us to determine whether meaningful subdivision of classes was occurring as additional classes were estimated.

To investigate the discriminant validity of our preferred LCA solutions in males and females, we tested for associations between class membership and (a) DSM-IV-based alcohol dependence and abuse diagnoses, (b) respondents' reported drinking histories, (c) respondents' self-reports (and, for respondents from complete pairs, ratings by co-twin) of excessive drinking and alcohol-related problems, as well as self-reports of treatment-seeking. Each individual was assigned the most probable class membership associated with their self-report symptom profile under the preferred latent class model. Dummy predictor variables were created for membership in classes 2 ...  $n$ , using the first (no/minimal problem) class as the reference group, and regression models were fitted using STATA (StataCorp, 1999). For alcohol diagnoses and symptom group data, where age-of-onset information was available, Kaplan-Meier product-limit survival curves were estimated, and differences as a function of class membership were tested under a Cox regression model by Wald chi-square test, using the Huber-White robust variance estimator to correct for nonindependence of observations on twin pairs. For other variables, logistic regression models were fitted, with the Huber-White adjusted Wald chi-square again used for comparisons across classes.

Diagnostic questions and quantitative alcohol consumption questions in the interview were skipped for those who reported only minimal alcohol use, who

**Table 1**

Endorsement Probabilities for DSM-IV Alcohol Dependence and Abuse Criteria for Regular Drinkers

	Endorsement probabilities (%)	
	Women	Men
Tolerance	38	55
Withdrawal	5	9
Use in larger amounts/over longer period than intended	23	29
Persistent desire/unsuccessful efforts to cut down or quit	16	27
Great deal of time using/recovering	8	17
Important activities given up	4	8
Continued use despite emotional/physical problems	14	26
Interference with major role obligations	6	14
Hazardous use	13	27
Recurrent alcohol-related arrests	1	9
Recurrent social/interpersonal problems	6	18

we shall characterize as nonregular drinkers. These were individuals who had never been drunk and had never used alcohol as often as once a month for 6 months or longer ( $N = 210$  women,  $N = 65$  men). LCA analyses excluded these individuals, as well as those who were lifetime abstainers (32 women, 34 men) and those with only partial diagnostic data (8 women, 4 men). Individuals who had used alcohol regularly but had never had as many as 5 standard drinks in a 24-hour period ( $N = 327$  women,  $N = 47$  men) were asked quantitative consumption items, but were not asked diagnostic items. These individuals were imputed as having no abuse or dependence symptoms for inclusion in the LCA analyses.

## Results

This young Australian cohort was a heavy drinking cohort: approximately 89% of men, and 69% of women reported having consumed respectively nine or more standard drinks, or seven or more standard drinks on a single occasion. Using narrow criteria for DSM-IV dependence, 7.4% of women and 15.1% of men (8.0% of female regular drinkers, 15.7% of male regular drinkers), reported a history of alcohol dependence, with these proportions increasing to 16.1% and 31.0% (16.8% and 31.8% for regular drinkers) if broad criteria were used. Endorsement frequencies for DSM-IV dependence and abuse symptom groups in regular drinkers ( $N = 2700$  men,  $N = 3204$  women) are summarized by gender in Table 1.

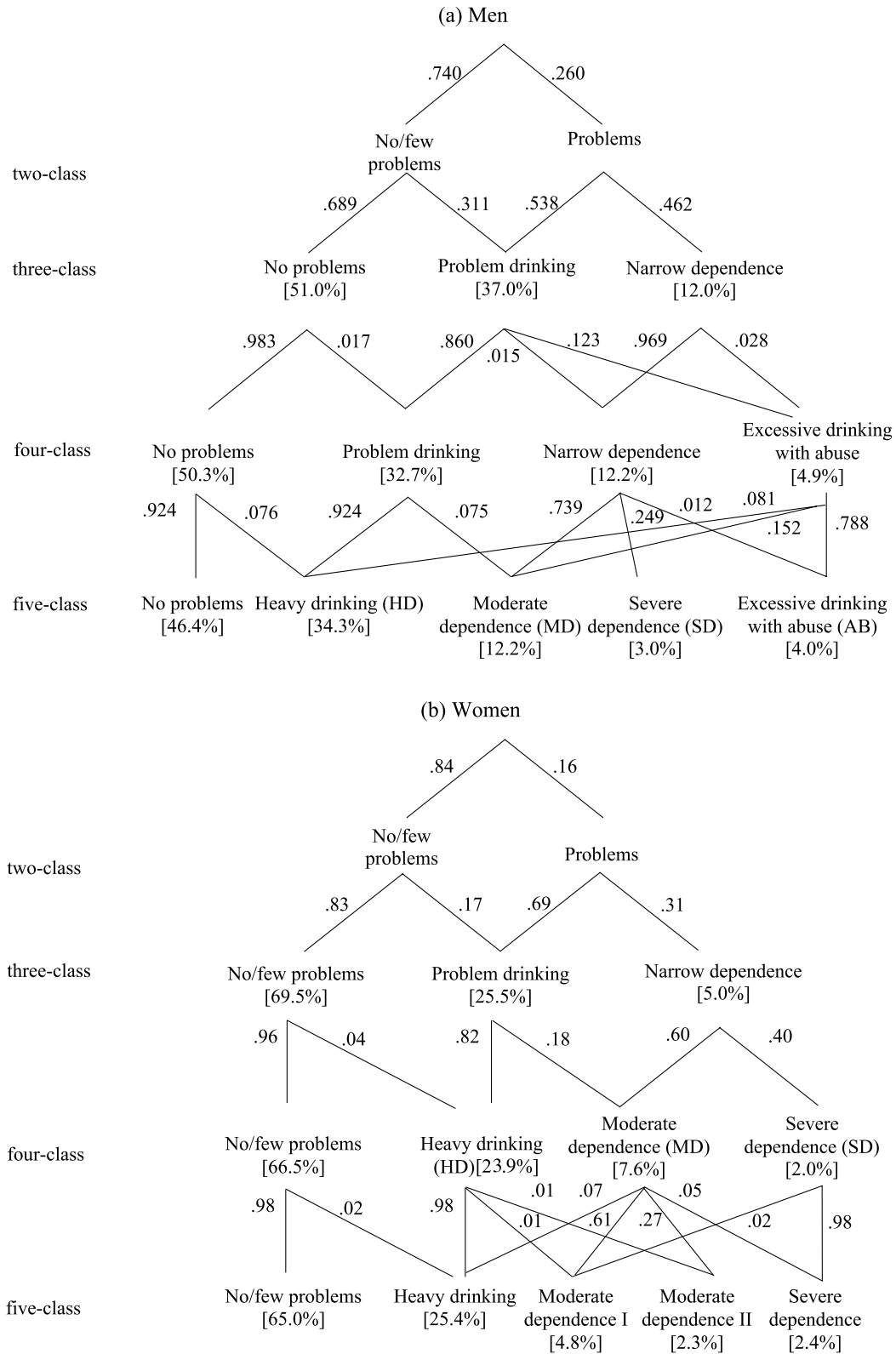
### Alcohol Problem Latent Classes

The conservative BIC criterion suggested that three latent classes were needed to account for the observed symptom clustering in both women and men, while AIC and likelihood ratio chi-square criteria continued to show significant improvements in fit beyond the six-class solution. In men, 'Dependence' and 'Abuse' (AB)

classes emerged by the four-class solution, and by the five-class solution separate 'Moderate Dependence' (MD), 'Severe Dependence' (SD) and AB classes were identified (Figure 1a). In the six-class solution (not shown), the 'No Problem', 'Heavy Drinking' (HD), AB and SD classes were retained and the five-class MD class had split into two moderate dependence groups, suggesting there was little further insight to be gained from estimating more than five classes. In women, MD and SD classes emerged by the four-class solution, and in the five-class solution the MD class split into two MD classes, but with symptom endorsement profiles that did not replicate the male six-class MD classes (Figure 1b). Estimating additional classes in women led to further subdivision of the MD and SD classes, but did not identify a separate AB class.

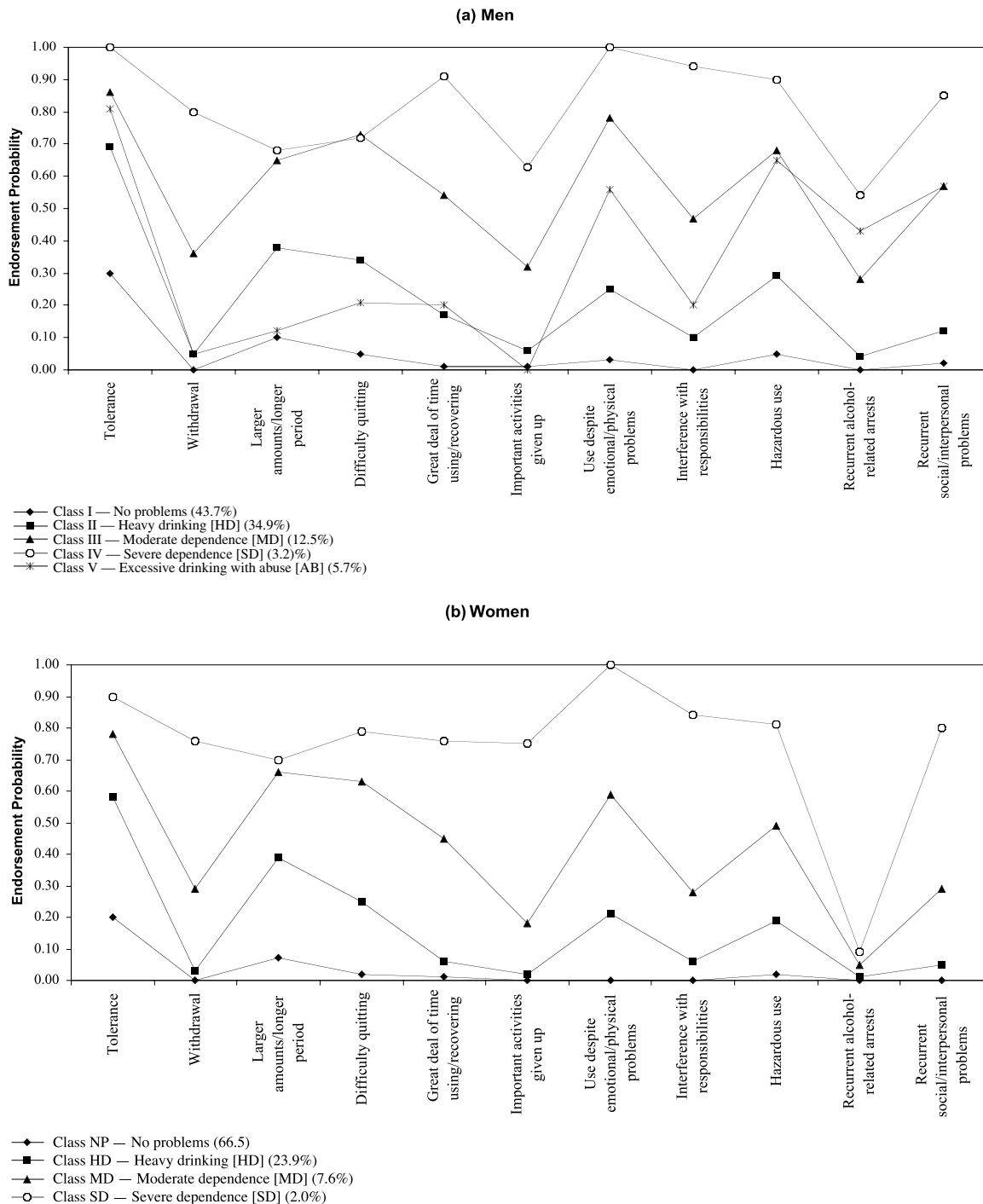
When the male five-class solution was used to assign most probable class membership to the female symptom data, only 11 women (with 11 distinct symptom profiles) were unambiguously assigned to the male-type AB class, with an additional 5 women (with 4 associated symptom profiles) having roughly equal probabilities of assignment to the male-type AB and male-type HD classes. Using the male five-class solution, estimated prevalence of the AB class in women was 1.2%. Thus, even in this large sample of heavy-drinking women, clustering of abuse symptoms in those reporting few or no dependence symptoms was too rare to support further investigation of this group of women. In what follows, therefore, we focus on the male five-class and female four-class solutions.

Figures 2a and 2b summarize symptom endorsement probability profiles for the five male and four female classes. For the SD classes (3.2% lifetime prevalence in men, 2.0% in women), broadly comparable symptom endorsement probabilities were observed for men and women, with men more likely than women to acknowledge tolerance and spending a great deal of time using or recovering from the effects of alcohol, and women more likely than men to report giving up important activities because of their drinking. SD men were more likely than women to endorse the abuse symptoms of interference with major role obligations, hazardous use, and especially recurrent arrests. For the MD classes (12.2% lifetime prevalence in men, 7.6% in women), while tolerance, withdrawal, and 'use more than intended' were endorsed equally by both sexes, other endorsement probabilities were higher for men than women, thus males assigned to the MD class on average had more severe problems than the women. 'Use more than intended' did not discriminate between MD and SD classes in either gender; difficulty quitting also did not discriminate between MD and SD classes in men. For all dependence and abuse symptoms, endorsement probabilities were lower for the HD class (34.9% lifetime prevalence in men, 23.9% in women) than for the MD class, though somewhat elevated for tolerance, use



**Figure 1a and 1b**

Changes in most probable class assignment in LCA one- to five-class solutions in (a) men, (b) women. Shown are conditional probabilities that an individual assigned to class *i* in the *n*-th class solution will be assigned to class *j* in the (*n* + 1)-th class solution; for example, 74% of men are assigned to the 'no/few problem' class in the two-class solution, of whom 31.1% are assigned to the problem-drinking class in the three-class solution. Probabilities less than .01 are omitted. Also shown (in square brackets) are the proportions assigned to each class, based on the most probable class membership.



**Figure 2a and 2b**

Symptom endorsement probabilities as a function of class membership in (a) men (five-class solution) and (b) women (four-class solution).

more than intended, difficult quitting, and use despite physical/emotional problems dependence items, and for hazardous use and interference with responsibilities.

The male-specific AB class was characterized by relatively high endorsement probabilities for tolerance and for continued drinking despite physical or emotional problems caused by alcohol, and also moderately high

endorsement probabilities for the abuse symptoms. However, for all dependence symptoms except tolerance, endorsement probabilities were significantly lower for those assigned to the AB class compared to the MD class ( $p < .05$  in all cases by Wald chi-square test). Furthermore, with the exception of tolerance and continued use criteria, endorsement rates for other dependence



**Table 2**  
Self-Report Alcohol Consumption History as a Function of Latent Class

	Women			Men			
	Heavy drinkers (HD) (N = 768)	Moderate dependence (MD) (N = 243)	Severe dependence (SD) (N = 65)	Heavy drinkers (HD) (N = 926)	Abuse (AB) (N = 109)	Moderate dependence (MD) (N = 329)	Severe dependence (SD) (N = 82)
Drinking during heaviest 12-month period							
5 or more drinks in a day, at least 3–4 days per week (%)	19	47 <sup>c</sup>	71 <sup>a</sup>	40	63 <sup>d</sup>	68 <sup>c</sup>	87 <sup>a</sup>
Drunk — at least weekly (%)	47	75 <sup>c</sup>	95 <sup>a</sup>	63	79 <sup>d</sup>	85 <sup>c</sup>	95 <sup>a</sup>
— at least 3–4 days per week (%)	6	24 <sup>c</sup>	57 <sup>a</sup>	13	25 <sup>d</sup>	33 <sup>c</sup>	59 <sup>a</sup>
Drinks per typical drinking occasion							
— 5 or more (%)	52	67 <sup>c</sup>	68	65	82 <sup>d</sup>	75 <sup>c</sup>	90 <sup>a</sup>
— 7 or more (%)	25	40 <sup>c</sup>	48	40	57 <sup>d</sup>	54 <sup>c</sup>	67 <sup>a</sup>
— 9 or more (%)	12	21 <sup>c</sup>	38 <sup>a</sup>	23	41 <sup>d</sup>	33 <sup>c</sup>	51 <sup>a</sup>
Maximum one-day consumption							
Median (# of standard drinks)	13	16 <sup>c</sup>	23	25	35	30	38
75th percentile (# of standard drinks)	19	25	30	33	45	38	50
— 15 or more (female)/30 or more (male) (%)	41	64	80 <sup>a</sup>	40	64 <sup>d</sup>	59 <sup>c</sup>	78 <sup>a</sup>
— 20 or more (female)/40 or more (male) (%)	23	39 <sup>c</sup>	55 <sup>a</sup>	14	39 <sup>d</sup>	25 <sup>c,e</sup>	49 <sup>a</sup>
Quantitative tolerance measures							
> 6 drinks before getting drunk (%)	52	64 <sup>c</sup>	70	81	89	88 <sup>c</sup>	94
> 9 drinks before getting drunk (%)	24	37 <sup>c</sup>	45	54	65 <sup>d</sup>	65 <sup>c</sup>	74
> 12 drinks before getting drunk (%)	6	10 <sup>c</sup>	20 <sup>a</sup>	25	38 <sup>d</sup>	32 <sup>c</sup>	44 <sup>a</sup>
> 6 drinks, at least 50% increase (%)	39	49 <sup>c</sup>	58	68	76	74 <sup>c</sup>	87 <sup>a</sup>
> 9 drinks, at least 50% increase (%)	19	31 <sup>c</sup>	42	48	60 <sup>d</sup>	57 <sup>c</sup>	70 <sup>a</sup>

Note: All comparisons are by Wald chi-square test, and are adjusted for the nonindependence of observations on twin pairs.

a = SD > MD,  $p < .05$ ; b = MD > AB,  $p < .05$ ; c = MD > HD,  $p < .05$ ; d = AB > HD,  $p < .05$ ; e = MD > HD,  $p < .05$ .

criteria were either no higher in the AB than in the male HD class, or were actually significantly lower in the AB class than in the male HD class, while endorsement probabilities for abuse symptoms were significantly higher in the AB class than in the male HD class ( $p < .05$  in all cases).

#### Latent Class Assignment and DSM-IV Diagnoses of Abuse and Dependence

Using the narrow operationalization of DSM-IV dependence criteria, 96.8% of SD men were classified by DSM-IV as dependent, 3.2% as abusers (99.1% and 0.9% using broad dependence criteria); 72.6% of MD men as dependent, 26.9% as abusers and 0.5% as unaffected (91.8%, 7.6% and 0.6% using broad criteria); and 7.1% of the AB class as dependent, 88.3% as abusers and 4.6% as unaffected (49.5%, 45.9% and 4.7% using broad criteria). In women, 95.6% of the SD class were classified as dependent using the narrow operationalization, 4.4% as abusers (99.5% and 0.5% by broad criteria); and 55.0% of the MD class was classified as dependent, 39.7% as abusers, and 5.3% as unaffected (80.8%, 13.9% and 5.3% using broad criteria). Some 8.9% of HD men and 4.1% of HD women were classified as dependent by DSM-IV narrow criteria (but 43.3% and 33.0% by broad criteria), and an additional 56.0% and 40.4% as abusers (31.5% and 27.3% using broad dependence criteria).

#### Associated Drinking Histories

In both sexes, SD and MD individuals were significantly differentiated by their drinking histories (Table 2). Predictably, men reported higher levels of consumption than women from a comparable severity class, although frequency of drinking to intoxication was almost identical for the SD women and men. The same measures also differentiated MD individuals from HD individuals, and also differentiated male AB individuals from HD individuals. What was most striking, however, was the absence of differences in consumption indices for men from the AB and MD classes. These two groups did not differ on measures of frequency of heavy drinking or drinking to intoxication or typical consumption during their heaviest drinking period. The AB group was, however, significantly more likely to report high consumption levels for maximum number of drinks in a single day.

#### Treatment Seeking and Perception of Problems

In both men and women, SD cases were more likely than MD cases, and MD cases more likely than those in the HD class to perceive themselves, and to be perceived by their co-twin, as being an excessive drinker or having problems with alcohol; to discuss drinking problems with a professional, or want to discuss problems even if they didn't; and to be treated for a drinking problem (Table 3). AB men were significantly less likely than MD men to report that they had been an excessive

**Table 3**

History of Excessive Drinking or Alcohol Problems as Rated by Self or Co-Twin and Treatment Seeking as a Function of Latent Class

Drinking during heaviest 12-month period	Women			Men			
	Heavy drinkers (HD) (N = 768) (%)	Moderate dependence (MD) (N = 243) (%)	Severe dependence (SD) (N = 65) (%)	Heavy drinkers (HD) (N = 926) (%)	Abuse (AB) (N = 109) (%)	Moderate dependence (MD) (N = 329) (%)	Severe dependence (SD) (N = 82) (%)
Excessive drinker (self-report)	25	58 <sup>c</sup>	94 <sup>a</sup>	27	35	67 <sup>b,c</sup>	82 <sup>a</sup>
Excessive drinker (rated by co-twin)	13	33 <sup>c</sup>	63 <sup>a</sup>	21	33 <sup>d</sup>	34 <sup>c</sup>	52 <sup>a</sup>
Felt s/he had drinking problem (self-report)	9	41 <sup>c</sup>	83 <sup>a</sup>	11	20 <sup>d</sup>	45 <sup>b,c</sup>	73 <sup>a</sup>
Problems with alcohol (rated by co-twin)	11	24 <sup>c</sup>	62 <sup>a</sup>	18	43 <sup>d</sup>	38 <sup>c</sup>	55 <sup>a</sup>
Discussed drinking problem with professional	4	19 <sup>c</sup>	57 <sup>a</sup>	5	16 <sup>d</sup>	21 <sup>c</sup>	60 <sup>a</sup>
Wanted to discuss but didn't	2	12 <sup>c</sup>	40 <sup>a</sup>	2	5 <sup>d</sup>	13 <sup>b,c</sup>	43 <sup>a</sup>
Treated for a drinking problem	0	2 <sup>c</sup>	31 <sup>a</sup>	0	2	5 <sup>c</sup>	24 <sup>a</sup>

Note: All comparisons are by Wald chi-square test, and are adjusted for the nonindependence of observations on twin pairs.

a = SD > MD,  $p < .05$ ; b = MD > AB,  $p < .05$ ; c = MD > HD,  $p < .05$ ; d = AB > HD,  $p < .05$ ; e = MD > HD,  $p < .05$ .

drinker or that they had had problems with alcohol, but were equally likely to be described by their co-twin as an excessive drinker, and more likely (though not significantly so) to be described by their co-twin as having a history of alcohol problems.

### Psychiatric Comorbidity

In both men and women, histories of depression and childhood conduct disorder were reported most commonly by the SD class, and least commonly by the 'No Problem' class, with the MD and HD classes being intermediate (Table 4). In contrast to the MD class, a history of depression was reported no more often by the male AB class than by the 'No Problem' class. Childhood conduct disorder was reported significantly less often by the male AB class than by the MD class ( $\chi^2 = 6.67$ ,  $df = 1$ ,  $p = .01$ ).

### Discussion

In this heavy-drinking sample a significant proportion of people reported experiencing lifetime alcohol related problems: 82.7% of men and 65.3% of women reported experiencing at least one alcohol-related problem while 16.1% of women and 31.0% of men met (broad) DSM-IV criteria for a lifetime diagnosis of alcohol dependence.

The findings of LCA indicated that symptoms of alcohol abuse and dependence could best be represented by a four-class solution in women and a five-class solution in men. In women these classes varied along a continuum of severity with 2.0% of the sample being classified as severely dependent, 7.6% as moderately dependent, 23.9% as heavy drinkers, and 66.5% as no or low problem drinkers. The preferred five-class solution among men identified four analogous classes, albeit with higher prevalences among the dependent classes: 3.2% were classified as severely dependent; 12.2% as moderately dependent; 34.3% as heavy drinkers and 46.4% as low/no problem

drinkers. In addition the analysis identified a fifth class — corresponding to abuse — in men only. This class comprised 4.0% of men in the sample who reported comparable drinking patterns for their heaviest drinking period to those reported by males assigned to the MD class, and were no less likely to report tolerance to alcohol, yet had very low probability of meeting narrow criteria for alcohol dependence. As the period of heaviest drinking was required to be of at least 12 months' duration, and as an even higher proportion of the AB than MD individuals reported very high levels of 1-day consumption (ever had 40 or more standard drinks in a single day), these differences are unlikely to result from a much briefer period of heavy drinking on the part of the AB class.

Examination of rates of DSM-IV diagnoses of alcohol abuse and dependence across these solutions provided support for the DSM conceptualization of abuse among men: specifically, using the narrow operationalization of DSM-IV dependence criteria, 88.3% of the abuse class were classified as meeting DSM-IV criteria for abuse while 7.1% were classified as dependent and only 4.6% were classified as unaffected. Comparison of rates of major depression and conduct disorder across the latent classes provided further validation of the above classification: among women there was a strong and consistent increase in risks of both these disorders with increasing severity of alcohol-related problems. Similarly, in men there were increasing rates of these disorders from no/few problems, heavy drinking, moderate and severe dependence. However, the pattern of comorbidity for the alcohol abuse group in men was unique: these individuals had a rate of depression equivalent to that among the no/few problem group and a rate of childhood conduct disorder that was significantly lower than that among the MD class.

Two explanations that are not mutually exclusive need to be considered for the male-only AB class. One explanation is that it is comprised of individuals who

**Table 4**

Associations Between Latent Class and History of Childhood Conduct Disorder and Major Depression in Women and Men

Class	Women						Men					
	Depression			Conduct disorder			Depression			Conduct disorder		
	%	OR	95% CI	%	OR	95% CI	%	OR	95% CI	%	OR	95% CI
No problems	27.0	1.00	—	0.7	1.00	—	16.7	1.00	—	2.2	1.00	—
Heavy drinking	39.4	1.75	1.46–2.08	2.0	3.02	1.45–6.31	22.0	1.41	1.14–1.75	5.2	2.39	1.49–3.84
Moderate dependence (MD)	49.4	2.68	2.04–3.52	5.4	8.57	3.88–18.95	33.7	2.58	1.96–3.38	17.0	9.06	5.63–14.56
Severe dependence (SD)	69.2	6.02	3.54–10.24	26.2	54.38	24.22–122.07	58.5	7.91	4.84–12.93	35.4	25.74	14.11–46.98
Abuse (AB)	—	—	—	—	—	—	17.4	1.06 <sup>NS</sup>	0.63–1.76	9.2	4.48	2.11–9.55

Note: NS = nonsignificant.

Odds ratios (OR) and 95% confidence intervals (95% CI) are reported, together with lifetime prevalence (%) of these disorders as a function of class membership.

may be dependent but lack insight into their problems with alcohol. Alternatively, these individuals, despite a comparable period of heavy drinking, were much less likely to experience dependence symptoms. Their lower risk may potentially be a function of lower genetic or other risk factors for dependence. Consistent with this interpretation are the facts that the two dependence symptoms that were most likely to be endorsed were tolerance, which discriminated poorly between severe and moderate dependence and heavy drinking classes, and recurrent alcohol-related blackouts, an item whose appropriateness as an indicator of continued use despite physical problems may be questioned, and that alcohol withdrawal, and time spent using or recovering from the effects of alcohol had very low probability of endorsement by the AB class.

The findings of this study have important implications for the validity of DSM-IV and future nosologies. Specifically, they provide empirical support for the validity of 'abuse' as a qualitatively distinct component of alcohol use disorders in men. The existence of such a class has remained controversial with a number of authors arguing that abuse is not qualitatively distinct, but rather represents a mild or prodromal form of dependence. Some of the apparent discrepancy between our and previous findings may be related to the gender composition of the different samples studied. Specifically, the majority of previous studies have combined data from males and females and, given our finding that the AB class is male-specific, this practice may have obscured the existence of an AB class. Our findings of the unique nature of alcohol abuse are paralleled by recent findings that alcohol abuse is not simply a prodromal form of dependence, with relatively few subjects progressing to dependence over a 5-year period — although approximately half of those with a diagnosis of abuse continued to experience alcohol-related problems over that period (Schuckit et al., 2001).

Given the male-specific nature of the AB class, future work should explore whether there is a similar, qualitatively distinct abuse group in women, but with such a group being distinguished by symptoms other

than those studied here. For example, prior research has pointed to problems surrounding arrests as a criterion (Heath & Martin, 1994) and, given the low rates of recurrent arrests among women (which may, in part, be due to gender-related biases in policing practices), the utility of this criterion for women is questionable. Similarly, our analyses suggested the need for further refinement of several criteria for dependence: both tolerance and using more than intended were frequently endorsed by members of the no/low problem and HD classes indicating that these criteria, as currently defined, have low specificity. Similar problems have been highlighted previously with several authors pointing to the need to refine these criteria (Caetano, 1999; Chung & Martin, 2002; Dawson, 1998; Langenbucher et al., 1996, 1997).

The identification of the AB class has important clinical and public health implications. First, they comprise a significant proportion of individuals classified with an alcohol use disorder: approximately 22% of men identified as such were classified in the abuse group. Second, the high rate of alcohol-related problems in this group attests to the importance of interventions to reduce and ameliorate the adverse consequences of alcohol consumption in this group.

### Acknowledgments

This work was supported by grants AA07728, AA10248, AA13321, AA11998 from the US National Institute on Alcohol Abuse and Alcoholism.

### References

- American Psychiatric Association. (1980). *Diagnostic and statistical manual of mental disorders* (3rd ed.). Washington, DC: Author.
- American Psychiatric Association. (1987). *Diagnostic and statistical manual of mental disorders* (3rd ed., rev.). Washington, DC: Author.
- American Psychiatric Association. (1994). *Diagnostic and statistical manual of mental disorders* (4th ed.). Washington, DC: Author.

- Andrews, G., Henderson, S., & Hall, W. (2001). Prevalence, comorbidity, disability and service utilization. Overview of the Australian national mental health survey. *British Journal of Psychiatry*, *178*, 145–153.
- Bijl, R. V., Ravelli, A., & van Zessen, G. (1998). Prevalence of psychiatric disorder in the general population: Results of The Netherlands Mental Health Survey and Incidence Study (NEMESIS). *Social Psychiatry and Psychiatric Epidemiology*, *33*, 587–595.
- Bucholz, K. K., Cloninger, C. R., Dinwiddie, S. H., Hesselbrock, V. M., Nurnberger, J. I., Reich, T., Schmidt, I., & Schuckit, M. A. (1994). A new, semi-structured psychiatric interview for use in genetic linkage studies: A report of the reliability of the SSAGA. *Journal of Studies on Alcohol*, *55*, 149–158.
- Bucholz, K., Heath, A., Reich, T., Hesselbrock, V., Kramer, J., Nurnberger, J., & Schuckit, M. (1996). Can we subtype alcoholism? A latent class analysis of data from relatives of alcoholics in a multicenter family study of alcoholism. *Alcoholism: Clinical and Experimental Research*, *20*, 1462–1471.
- Caetano, R. (1999). The identification of alcohol dependence criteria in the general population. *Addiction*, *94*, 255–267.
- Chung, T., & Martin, C. S. (2002). Concurrent and discriminant validity of DSM-IV symptoms of impaired control over alcohol consumption in adolescents. *Alcoholism: Clinical and Experimental Research*, *26*, 485–492.
- Dawson, D. A. (1998). Symptoms and characteristics of individuals with different types of recovery from DSM-IV alcohol dependence. *Journal of Substance Abuse*, *10*, 127–142.
- Harford, T. C., & Muthen, B. O. (2001). The dimensionality of alcohol abuse and dependence: A multivariate analysis of DSM-IV symptom items in the national longitudinal survey of youth. *Journal of Studies on Alcohol*, *62*, 150–157.
- Hasin, D., Grant, B. F., Cottler, L., Blaine, J., Towle, L., Ustun, B., & Sartorius, N. (1997). Nosological comparisons of alcohol and drug diagnoses: A multisite, multi-instrument international study. *Drug and Alcohol Dependence*, *25*, 217–226.
- Hasin, D., Li, Q., McCloud, S., & Endicott, J. (1996). Agreement between DSM-III, DSM-III-R, DSM-IV and ICD-10 alcohol diagnoses in US community-sample heavy drinkers. *Addiction*, *91*, 1517–1527.
- Hasin, D. S., Muthen, B., Wisnicki, K. S., & Grant, B. (1994). Validity of the bi-axial dependence concept: A test in the US general population. *Addiction*, *89*, 573–579.
- Hasin, D. S., Van Rossem, R., McCloud, S., & Endicott, J. (1997). Differentiating DSM-IV alcohol dependence and abuse by course: Community heavy drinkers. *Journal of Substance Abuse*, *9*, 127–135.
- Heath, A. C., Bucholz, K. K., Slutske, W. S., Madden, P. A. F., Dinwiddie, S. H., Dunne, M. P., Statham, D. J., Whitfield, J. B., Martin, N. G., & Eaves, L. J. (1994). The assessment of alcoholism in surveys of the general community: What are we measuring? Some insights from the Australian Twin Panel Interview Survey. *International Review of Psychiatry*, *6*, 295–307.
- Heath, A. C., Howells, W., Kirk, K. M., Madden, P. A., Bucholz, K. K., Nelson, E. C., Slutske, W. S., Statham, D. J., & Martin, N. G. (2001). Predictors of non-response to a questionnaire survey of a volunteer twin panel: Findings from the Australian 1989 twin cohort. *Twin Research*, *4*, 73–80.
- Heath, A. C., & Martin, N. G. (1994). Genetic influences on alcohol consumption patterns and problem drinking: Results from the Australian NH&MRC twin panel follow-up survey. *Annals of the New York Academy of Science*, *708*, 72–85.
- Helzer, J. E., Burnam, A., & McEvoy, T. (1991). Alcohol abuse and dependence. In L. N. Robins & D. A. Regier (Eds.), *Psychiatric disorders in America: The Epidemiologic Catchment Area study* (pp. 81–115). New York, NY: The Free Press.
- Hesselbrock, M., Easton, C., Bucholz, K. K., Schuckit, M., & Hesselbrock, V. (1999). A validity study of the SSAGA: A comparison with the SCAN. *Addiction*, *94*, 1361–1370.
- Kendler, K. S., Karkowski, L. M., Prescott, C. A., & Pedersen, N. L. (1998). Latent class analysis of Temperance Board registrations in Swedish male-male twin pairs born 1902–1949: Searching for subtypes of alcoholism. *Psychological Medicine*, *28*, 803–813.
- Kessler, R., McGonagle, K., Zhao, S., Nelson, C., Hughes, M., Eshleman, S., Wittchen, H., & Kendler, K. (1994). Lifetime and 12-month prevalence of DSM-III-R psychiatric disorders in the United States: Results from the National Comorbidity Survey. *Archives of General Psychiatry*, *51*, 8–19.
- Knopik, V. S., Heath, A. C., Madden, P. A. F., Bucholz, K. K., Slutske, W. S., Nelson, E. C., Statham, D., Whitfield, J. B., & Martin, N. G. (2004). Genetic effects on alcohol dependence risk: Re-evaluating the importance of psychiatric and other heritable risk factors. *Psychological Medicine*, *34*, 1519–1530.
- Langenbucher, J., Chung, T., Morgenstern, J., Labouvie, E., Nathan, P. E., & Bavly, L. (1997). Physiological alcohol dependence as a ‘specifier’ of risk for medical problems and relapse liability in DSM-IV. *Journal of Studies on Alcohol*, *58*, 341–350.
- Langenbucher, J., Labouvie, E., & Morgenstern, J. (1996). Measuring diagnostic agreement. *Journal of Consulting and Clinical Psychology*, *64*, 1258–1289.
- McCutcheon, A. L. (1987). *Latent class analysis*. Newbury Park, CA: Sage.
- Muthen, B. O., Grant, B., & Hasin, D. (1993). The dimensionality of alcohol abuse and dependence: Factor analysis of DSM-III-R and proposed DSM-IV

- criteria in the 1988 National Health Interview Survey. *Addiction*, 88, 1079–1090.
- Nelson, C. B., Heath, A. C., & Kessler, R. C. (1998). Temporal progression of alcohol dependence symptoms in the U. S. household population: Results from the National Comorbidity Survey. *Journal of Consulting and Clinical Psychology*, 66, 474–483.
- Nelson, E. C., Heath, A. C., Madden, P. A. F., Cooper, M. L., Dinwiddie, S. H., Bucholz, K. K., Glowinski, A., McLaughlin, T., Dunne, M. P., Bierut, L. J., Statham, D. J., & Martin, N. G. (2002). The consequences and correlates of childhood sexual abuse: A retrospective examination using the twin study design. *Archives of General Psychiatry*, 59, 139–145.
- Neuman, R. J., Todd, R. D., Heath, A. C., Reich, W., Hudziak, J., Bucholz, K. K., Madden, P. A. F., Begleiter, H., Porjesz, B., Kuperman, S., Hesselbrock, V., & Reich, R. (1999). Evaluation of ADHD typology in three contrasting samples: A latent class approach. *Journal of the American Academy of Child and Adolescent Psychiatry*, 38, 25–33.
- Pull, C. B., Saunders, J. B., Mavreas, V., Cottler, L. B., Grant, B. F., Hasin, D. S., Blaine, J., Mager, D., & Ustun, B. T. (1997). Concordance between ICD-10 alcohol and drug use disorder criteria and diagnoses as measured by the AUDAIS-AIR, CIDI and SCAN: Results of a cross-national study. *Drug and Alcohol Dependence*, 47, 207–216.
- Rounsaville, B., Spitzer, R., & Williams, J. (1986). Proposed changes in DSM-III substance use disorders: Description and rationale. *American Journal of Psychiatry*, 143, 463–468.
- SAS Institute Inc. (1996). *SAS/STAT software: Changes and enhancements for release 6.12*. Cary, NC: Author.
- Schuckit, M. (1996). Editor's corner. DSM-V: There's work to be done. *Journal of Studies on Alcohol*, 57, 469–470.
- Schuckit, M., & Simon, T. (2001). A comparison of correlates of DSM-IV alcohol abuse or dependence among more than 400 sons of alcoholics and controls. *Alcohol: Clinical and Experimental Research*, 25, 1–8.
- Schuckit, M. A., Smith, T. L., Danko, G. P., Bucholz, K. K., Reich, T., & Bierut, L. (2001). Five-year clinical course associated with DSM-IV alcohol abuse or dependence in a large group of men and women. *American Journal of Psychiatry*, 158, 1084–1090.
- Schuckit, M. A., Smith, T. L., & Landi, N. (2000). The five-year clinical course of high functioning men with DSM-IV alcohol abuse or dependence. *American Journal of Psychiatry*, 157, 2028–2035.
- Slutske, W., True, W., Scherrer, J., Goldberg, J., Bucholz, K. K., Heath, A. C., Henderson, W. G., Eisen, S. A., Lyons, M. J., & Tsuang, M. T. (1998). Long-term reliability and validity of alcoholism diagnoses and symptoms in a large national telephone interview survey. *Alcohol: Clinical and Experimental Research*, 22, 553–558.
- StataCorp. (1999). *Stata statistical software (Release 6.0) [Computer software]*. College Station, TX: Stata Corporation.
- Statistical Genetics group, Washington University in St Louis. (2002). Retrieved September, 2005, from <http://hardy.wustl.edu>
-