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Does Gender Contribute to Heterogeneity in Criteria for Cannabis Abuse and Dependence? Results from the National Epidemiological Survey on Alcohol and Related Conditions

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Abstract

Previous research has noted that a unidimensional latent construct underlies criteria for cannabis abuse and dependence. However, no study to date has explored whether gender contributes to heterogeneity in the latent abuse and dependence construct and furthermore, whether after accounting for differences in the mean scores of abuse and dependence across genders, there is any evidence for heterogeneity in the individual abuse and dependence criteria. The present study utilizes data on criteria for cannabis abuse and dependence from a large, nationally representative sample (National Epidemiological Survey on Alcohol and Related Conditions) of 8,172 lifetime cannabis users to investigate whether gender contributes to heterogeneity in the underlying construct of cannabis abuse and dependence, and in each individual criterion as well. Analyses, all of which were conducted in MPlus, included factor analysis, as well as MIMIC and multiple-group models for an examination of dimensionality and gender heterogeneity, respectively. Results favor a uni-dimensional construct for cannabis abuse/dependence, as seen in prior research. We also identify 2 abuse (Legal and Hazard) and 2 dependence (Quit and Problems) criteria, which show significant gender heterogeneity with the abuse criteria exhibiting higher thresholds in women and the dependence criteria in men. We conclude that the criteria that serve as indicators of DSM-IV cannabis abuse and dependence do not function identically in men and women and that certain criteria (e.g. hazardous use) require further refinement.

Keywords

Cannabis; Gender; Factor Analysis; Abuse/Dependence; MIMIC

1. INTRODUCTION

Cannabis continues to be the most widely used and misused illicit drug across the world (Hall et al., 2003). Global estimates of cannabis use disorders are high (12.5% in New Zealand, (Boden et al., 2006); 7% in Australia, (Coffey et al., 2002); 2-24% in England, (Farrell et al., 1998)). In the United States, rates of cannabis use disorders have increased by an alarming 18% in the last decade (Compton et al., 2004). In the U.S. National Household Survey of Drug Use and Health, over 4.8 million drug users met criteria for past-year cannabis dependence (Substance Abuse and Mental Health Services Administration (SAMHSA), 2005). In those

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who received treatment for substance use disorders in Australia in 2004, cannabis use disorders were the second most common substance use disorder for which treatment was sought and received, a trend also observed in other countries (Swift et al., 2001). Individuals with cannabis use disorders are additionally at risk for other substance-related problems, as well as comorbid psychopathology (Coffey et al., 2003;Degenhardt et al., 2003;Hasin et al., 1988;Lynskey et al., 2004), including (controversially) psychosis (Hall et al., 2004). Despite the potent negative health consequences of cannabis abuse/dependence, research into the symptomatology of this disorder has only recently gained momentum (Dennis et al., 2002). In fact, cannabis use disorders were considered to be part of a spectrum of poly-substance problems, with significant cynicism regarding the concept of "physical" dependence on cannabis (Soellner, 2005). For example, even less than a decade ago, scientists were wary of acknowledging the existence of a cannabis withdrawal syndrome. Recently though, prior evidence from animal models that supported the occurrence of withdrawal have been validated using controlled clinical trials in humans, therefore adding credence to the existence of symptoms of cannabis withdrawal (Budney et al., 2004;Budney et al., 2006).

1.1. Criteria for Abuse and Dependence

The DSM-IV applies identical criteria for abuse and dependence of cannabis as well as other psychoactive drugs such as cocaine and opiates, with these diagnostic criteria being based on those initially developed for alcohol (Edwards et al., 1976). While some criteria, for example tolerance and withdrawal, may be considered universal indicators of substance use disorders, others, such as use in hazardous situations may be valid for some drugs but not others. Even within criteria that seem to function well across substances, drug-specific symptoms must necessarily be included to allow for better measurement (Budney et al., 2006;Rosenberg et al., 2001).

1.2. Dimensionality of Abuse and Dependence

Prior studies have investigated the dimensionality of cannabis abuse and dependence and have raised concerns regarding the measurement variance associated with certain criteria (e.g. hazardous use) using a variety of statistical techniques including factor analysis and latent class models (Fulkerson et al., 1999;Gillespie et al., 2005;Grant et al., 2006;Langenbucher et al., 2004;Nelson et al., 1999;Teesson et al., 2002). The factor analytic model, parameters from which are easily converted to item response parameters, may be used to study the relative contribution of each criterion for cannabis abuse and dependence to the underlying construct.

1.3. Gender and Cannabis Abuse and Dependence

There exists, however, an additional level of complexity in the measurement and assessment of cannabis abuse/dependence, specifically that certain criteria may function better in some sub-populations while contributing little in others. In particular, there appears to have been relatively little interest paid to possible gender heterogeneity in criterion functioning. Men are more likely than women to meet criteria for cannabis dependence (Anthony et al., 1991;Coffey et al., 2003;Compton et al., 2004;Fergusson et al., 2000;Grant et al., 1994;Kandel et al., 1997;Warner et al., 1995). For instance, in the National Longitudinal Alcohol Epidemiological Survey (NLAES), the lifetime prevalence of cannabis abuse and dependence is twice as high in men as in women with past-year diagnoses showing an even greater magnitude of difference (McCrady et al., 1999). In addition to the markedly increased prevalence of cannabis use disorders in men versus women, women may present with a diagnosis of drug dependence without a prior history of drug abuse (Hasin et al., 2005).

There are several putative contributors to gender heterogeneity in rates of cannabis abuse in general, and endorsement of certain cannabis abuse criteria in particular. First, societal roles of women have conferred a greater stigma on women with substance abuse problems than their

male counterparts (Zeese et al., 1999). Women are considered primary caregivers and supportive and stabilizing influences in the familial structure, and therefore abuse of an illegal substance by a woman, particularly if it contributes to negligence of familial responsibility, has been perceived to be socially more egregious (Kandel et al., 1985;Roberts, 1991). Second, the nosology of substance use disorders has classically been masculine, especially for abuse criteria. For instance, use of a psychoactive substance in a hazardous situation is often illustrated with exemplars such as "…used when operating machinery or driving a truck or motorcycle…" which women are less likely to identify with (American Psychiatric Association, 1994). Third, the motivations for increased substance involvement in women may differ from those in men. Women are more likely to use cannabis to cope with tension and chronic stressors while men often report mood enhancement as a motive for drug use (Chabrol et al., 2005). The co-occurrence of depressive and anxiety disorders with cannabis use disorders is also more frequently reported in women than men (Buckner et al., 2006;Copeland, 2006;Degenhardt et al., 2003;Grant et al., 2004;Harder et al., 2006;Poulin et al., 2005;Stinson et al., 2006).

Gender heterogeneity in the abuse/dependence construct, and especially in individual abuse/dependence criteria, has largely been neglected in the literature. For instance, Langenbucher and colleagues (2004) note their inability to investigate gender heterogeneity in abuse/dependence criteria as a limitation on their sample. Teesson et al (2002) did not examine the influence of gender on individual abuse/dependence criteria in their factor analysis either. However, if the same assessment is applied to men and women, the lack of measurement invariance at a criterion level may contribute to imprecision in diagnosis of cannabis use disorders. This has recently been observed for alcohol use disorders (Saha et al., 2006), where inability to quit or control drinking (Quit, in our study) discriminated better in women than in men, while hazardous use (Hazard, in our study) and recurrent alcohol use despite social/interpersonal problems (Continue, in our study) functioned better as indicators of alcohol abuse in men than in women. However, this influence of gender on individual abuse/dependence criteria, after accounting for the increased prevalence of the latent abuse/dependence construct in men versus women, remains to be studied for cannabis use disorders. Therefore, in the present study, we use data from the large nationally representative sample of the National Epidemiological Survey on Alcohol and Related Conditions (NESARC) to investigate: (i) the dimensionality of cannabis abuse and dependence in 8172 lifetime cannabis users; and (ii) the influence of gender on the latent construct of cannabis abuse/dependence as well as on individual criteria for cannabis abuse and dependence, after accounting for its effects on the latent abuse/dependence dimension.

2. METHODS

2.1. Sample

We utilized data from 43,093 individuals aged 18-99 years, who participated in the National Epidemiological Survey on Alcohol and Related Conditions (NESARC). Comprehensive details regarding the survey design and sample characteristics are available elsewhere (Grant et al., 2003b). Collected during 2001-2002 by the U.S. Bureau of Census on behalf of the National Institute on Alcohol Abuse and Alcoholism, the sample includes data from adult, non-institutionalized U.S. citizens and non-citizens (including Alaska and Hawaii). Approximately 57% of the sample is female and 19% of the sample is Hispanic (76% Caucasian), with an over-sampling for non-Hispanic Black households and for young adults aged 18-24 years. After complete description of the study to the subjects, informed consent was obtained. Statements regarding the strict confidentiality of respondent privacy are available at http://niaaa.census.gov/confidentiality.html

2.2. Measures

The Alcohol Use Disorder and Associated Disabilities Schedule (AUDADIS-IV) module was used for interviews (Grant et al., 2003a). Individual DSM-IV criteria (American Psychiatric Association, 1994) of cannabis abuse and dependence were assessed for their occurrence in the last 12 months and in the period prior to those last 12 months only in those who reported lifetime cannabis use. For each symptom, we combined across the two time frames to create a lifetime occurrence of the abuse or dependence symptom. Criteria for cannabis abuse included: (i) Legal (legal problems/getting arrested); (ii) Failure (failure to fulfill major role obligations); (iii) Hazard (use in hazardous situations); and (iv) Continue (continued use despite trouble with friends or family). Criteria for cannabis dependence included: (i) Tolerance; (ii) Withdrawal; (iii) Intend (using larger amounts/for longer than intended); (iv) Give-up (give up or cut down on important activities); (v) Problems (use of drug despite health/psychological problems); (vi) Time (spent time getting or using drug); and (vii) Quit (more than once trying to stop or cut down use of drug). Grant and colleagues detail the assessment of alcohol and illicit drug use disorders using the AUDADIS in related publications (Dawson et al., 2005;Stinson et al., 2005). Note that while cannabis withdrawal was assessed in the AUDADIS, it is currently not included in the DSM-IV diagnosis of cannabis dependence. We did include cannabis withdrawal, coded to be present when an individual reported using cannabis for relief from two or more withdrawal symptoms (see http://niaaa.census.gov/pdfs/sec3c.pdf, for list of symptoms), in our factor analyses to validate existing arguments in favor of addition of the cannabis withdrawal syndrome as a cannabis dependence criterion. To adhere to DSM-IV standards for the assessment of cannabis use disorders, we fit a sub-model where Withdrawal was dropped and model-fit was assessed.

2.3. Statistical Analyses

First, we performed exploratory factor analysis (EFA) using 4 abuse and 7 dependence criteria. Second, a confirmatory factor analysis (CFA) was performed to confirm model fit. Next, we introduced a regression path into the CFA to create a multiple-indicator multiple-causes or MIMIC (MacIntosh et al., 2003;Muthen et al., 1985;Muthen et al., 2002) model: a regression of the latent “abuse/dependence” factor on gender. To this baseline model, we individually added a regression of each symptom of abuse and dependence on gender. In other words, we fit 11 models, in each of which gender was allowed to influence an individual symptom, while still accounting for its effect on the latent score that the symptom contributed to.

After identifying the individual criteria/symptoms that were gender-variant, we fit a two-group model (Muthen et al., 2002), where means and variances were allowed to vary but factor loadings and thresholds were constrained to be equal across gender. Individually, both factor loading and threshold were freely estimated in men and women for each symptom of cannabis abuse/dependence that showed significant gender heterogeneity in the MIMIC models. The final model was one in which the factor structure was estimated separately in men and women with gender-variant criteria.

Analyses were performed in MPlus (version 3.2; (Muthen et al., 2004) using the maximum likelihood ratio (MLR) estimator. Weights were applied to generalize results to the population, and clustering was performed for primary sampling units (PSU), with stratification using the stratum variable, thus adjusting standard errors for the complex sampling design.

3. RESULTS

3.1. Prevalence of Cannabis Use Disorders

8.4% of the participants met criteria for a lifetime history of DSM-IV cannabis abuse and 1.3% for a lifetime history of DSM-IV cannabis dependence (Grant et al., 1998;Stinson et al.,

2006). Men were more likely than women to meet criteria for cannabis abuse (11.1% vs 4.9%) or cannabis dependence (1.8% vs. 0.8%). We elected to perform all analyses on the sub-sample of 8172 individuals who reported lifetime cannabis use and were therefore queried about individual symptoms of cannabis abuse and dependence. In cannabis users, rates of cannabis abuse and dependence were 39.9% and 6.5% respectively. Table 1 shows the increased prevalence of individual abuse/dependence criteria in men versus women. With the exception of Quit, which was frequently, and equally endorsed by both genders, all other criteria were endorsed more often by men than women.

3.2. Factor Analysis

The EFA showed high loadings of abuse and dependence criteria on a single underlying factor (abuse/dependence), with high loadings for all criteria except Quit, Legal and Hazard. A two-factor model, which also fit the data well, did separate an abuse factor from a dependence factor but when the 2-factor CFA was fitted using the robust maximum likelihood estimator for complex survey designs, the abuse and dependence factors were found to be very highly correlated (inter-factor correlation of 0.92), and the addition of a second factor did not significantly alter the variance explained by each variable nor the factor loadings. A CFA with 2 uncorrelated factors fit poorly. Therefore, we opted to pursue the single-factor model for further analyses (Table 2). This single factor showed high loadings of all items except Legal, Hazard and Quit, of which Hazard and Quit also had lower thresholds.

We first fit the one factor model with 4 abuse and 7 dependence criteria (i.e. including Withdrawal) and subsequently fit a sub-model where Withdrawal was dropped from the CFA. The highly significant change in model-fit ($\Delta\chi^2$=662.79) coupled with the relatively high factor loading of Withdrawal (Table 2) suggested that while the general factor structure for cannabis abuse/dependence replicates in the absence of Withdrawal, the addition of Withdrawal as a criterion of cannabis dependence appears to improve model fit.

3.3. MIMIC models

The regression of abuse/dependence on gender was significant. Males were more likely to have higher factor scores (or endorse more criteria on average) on the latent abuse and dependence construct. To this model, we individually added a regression path from each criterion to gender. As seen in Table 3, after controlling for its effect on the underlying latent construct of abuse and dependence, we found gender differences in Quit (β=0.22), Problems (β=0.41), Legal (β=−1.16) and Hazard (β=−0.66), with a trend-level significant gender difference for Give-up (β=0.42) and Intend (β=0.28). Interestingly, parameter estimates for all four dependence criteria were positive while the estimates for the abuse criteria for Legal and Hazard were negative suggesting that women were more likely than men to endorse the dependence criteria while men were more likely to endorse abuse criteria, independently of gender differences in the underlying abuse/dependence construct.

3.4. Two-group models

A model in which the factor loading and threshold of Quit ($\Delta\chi^2$ = 10.99, df=2), Problems ($\Delta\chi^2$ = 8.12, df=2), Legal ($\Delta\chi^2$ = 49.06, df=2) and Hazard ($\Delta\chi^2$ = 52.51, df=2) were freely estimated in men and women fit significantly better than the constrained model. For the two dependence criteria that showed trend-level significance in the MIMIC models, Give-up and Intend, no significant gender-variance was found in the two-group model. We noted that while women had lower thresholds for endorsement of Quit and Problems, and men had lower thresholds for Hazard and Legal, the factor loadings for these criteria did not vary considerably. Subsequently, we constrained the factor loadings to be equal across genders but allowed thresholds to differ, and this model provided a suitable fit to the data ($\Delta\chi^2$ = 4.14, df=4), results for which are presented in Table 4. Thus, results from the two-group models showed that abuse

criteria for Legal and Hazard were more likely to be endorsed by women relative to men with high scores on the latent dimension while the dependence criteria for Quit and Problems were endorsed by men relative to women with higher scores on the latent abuse/dependence dimension.

Both MIMIC and two-group analyses were repeated using 6 dependence (i.e. excluding Withdrawal) and 4 abuse criteria as currently in DSM-IV. Dropping Withdrawal did not substantively change the findings reported above.

4. DISCUSSION

4.1. Dimensionality of Cannabis Abuse and Dependence

Previous studies that assessed the manner in which cannabis abuse and dependence criteria cluster to shape the underlying latent construct showed evidence for a single unidimensional construct for abuse/dependence. Nelson et al. (1999) identified a single factor in users with evidence for a 2-factor solution in low to moderate cannabis users. Fulkerson and colleagues (1999) found evidence for a unidimensional construct for substance abuse/dependence in their sample of Minnesota high school students. Teeson and colleagues (2002) applied an item-response model to cannabis abuse and dependence symptom data from the Australian National Survey of Mental Health and Wellbeing (N=10,641) and found that both one factor (abuse/dependence) and a two correlated factor model (abuse and dependence) provided an adequate fit to the data. However, they reported a very high inter-factor correlation (r=0.99), and therefore selected the single factor model. In this model, which they selected for further elucidation, both the Hazard and Legal criteria had relatively lower factor loadings (0.53 and 0.43, respectively) than the remaining 9 criteria. Langenbucher et al. (2004) also found evidence for the unidimensionality of cannabis abuse/dependence after removal of the Tolerance and Legal criteria. Grant et al. (2006), using data from the National Longitudinal Alcohol Epidemiologic Survey (NLAES) found Hazard to be the most frequently endorsed abuse symptom while Tolerance and Withdrawal were endorsed by 18-22% of NLAES men and women. The authors performed latent class analysis to show a gradient of severity where individuals with abuse but no dependence represented a less severely affected class than those with abuse and dependence. They also could not distinguish cannabis abuse from dependence. Finally, Gillespie and colleagues (2005) also reported finding a single underlying construct that encompassed criteria for cannabis abuse and dependence in male same-sex twin pairs from Virginia. Thus, our findings are supported, in general, by this extant literature. Our CFA results closely resemble those reported by Teesson et al. (2002). Like other authors, we found little evidence for the existence of distinct abuse and dependence factors. It is also worth noting that the ordering of criteria by difficulty also did not support a clear distinction between cannabis abuse and dependence.

The single factor model can also be interpreted as a 2-parameter logistic item response model, where the threshold refers to criteria difficulty and the factor loading is reflective of criteria discrimination (Bock, 1997;MacIntosh et al., 2003;Muthen, 1985;Takane et al., 1987). In our study, difficulty, like threshold, is an index of the location along the continuum of abuse/dependence scores where a criterion functions. For example, the threshold for Quit is lower than that for Give-up. This suggests that even those at a relatively lower end of the distribution of factor scores for cannabis abuse/dependence are likely to endorse having tried to stop or cut-down cannabis use but failed to do so, while only those with higher scores of cannabis abuse/dependence are likely to endorse the symptom of giving-up important activities (like work, school, family gatherings or activities that were interesting or pleasurable) to continue use of cannabis. On the other hand, discrimination, or the factor loading, refers to the ability of a symptom to distinguish those with high scores of cannabis abuse/dependence from those with low scores of cannabis abuse/dependence at a given threshold. Viewed in conjunction,

the difficulty and discrimination (or the threshold and factor loading) indicate how criteria work to distinguish individuals at risk at the high versus low end of the factor distribution. Therefore, we expect that the abuse criterion regarding legal consequences of cannabis use, which has a high threshold (or difficulty) and low factor loading (or discrimination), is one that is endorsed more frequently in those with higher factor scores but even in these individuals, it does not distinguish those meeting criteria for abuse/dependence from those that do not receive a diagnosis. This trend is observed for withdrawal as well. On the other hand, we find that while giving-up activities is also endorsed by individuals with higher factor scores (high threshold/difficulty), in those that are at this high-end of the distribution, endorsement of this symptom contributes greatly to a diagnosis of cannabis abuse/dependence (high factor loading/discrimination). In contrast, quit/cut-back attempts and use in hazardous situations is endorsed by individuals with lower factor scores and discriminates poorly, highlighting the relatively weak contribution of these criteria to a diagnosis of cannabis abuse/dependence.

4.2. Gender Heterogeneity in Criteria for Cannabis Abuse and Dependence

Our findings suggest that there may be differences in the rates at which men and women endorse criteria for cannabis abuse/dependence and that certain criteria may be more potent markers of cannabis problems in one gender versus another. Psychometricians may refer to this effect as differential criteria/item functioning (DCF) (Birnbaum, 1968;Bolt et al., 2004), which, as the name suggests, implies that under the assumption that there is an underlying latent construct with item indicators (e.g. cannabis abuse/dependence), some criteria/items function differently in certain sub-populations (e.g. men versus women). Therefore, despite the fact that identical items are used to assess cannabis abuse and dependence in both sexes, some criteria for abuse and dependence function differently or are differentially interpreted and/or endorsed across gender. Lack of gender invariance was identified for two dependence (Quit and Problems) and two abuse (Legal and Hazard) criteria with a greater likelihood that women would endorse dependence criteria while men would endorse abuse criteria even after controlling for gender differences in the latent construct. Grant et al. (2006) noted similar gender differences in their latent class analyses with NLAES data with an elevated probability for endorsement of the Hazard criteria in NLAES men, and an increased probability for Problems and Quit in NLAES women. Furthermore, when factor analysis was performed separately in men and women, we observed that the gender heterogeneity due to these criteria was driven by threshold differences alone. In other words, the abuse criteria indicate a greater level of severity for women whereas the dependence criteria were more difficult for men.

The gender heterogeneity poses a serious problem for the validity/generalizability of cannabis abuse. While fulfilling three of seven criteria is necessary to meet diagnosis for cannabis dependence, a diagnosis of abuse requires the fulfillment of only one criterion. We find that both the Legal and Hazard criteria are only modestly discriminating and have higher thresholds (increased difficulty) in women. In fact, Legal is the only criterion which both discriminates poorly and is infrequently endorsed, thus contributing little to the construct of abuse. The remaining items, Failure and Continue, while better at discrimination, have high thresholds, indicating that in individuals with higher factor scores for cannabis abuse/dependence, these items function well to identify those that will be diagnosed from those who will not. However, none of these criteria are good at discriminating between individuals with lower factor scores (an example for such a criterion, in these data, would be Time Spent). Therefore, there may be a downward biasing in rates of cannabis abuse in general, and more so in women, especially if they present with fewer criteria. This problem is highlighted by Hasin et al's finding in NESARC where 11.2% of women with drug dependence do not meet criteria for drug abuse (Hasin et al., 2005). While the “dependence-only” construct could denote a unique, albeit rarely identified, construct, the reduced rates of cannabis abuse in women could also be reflective of the gender inequity in the abuse criteria, a proposition that warrants significant attention.

As mentioned previously, the social roles of women may preclude them from experiencing Legal and Hazard as abuse criteria. For instance Fergusson et al. (2003) reported that men were 4.2 and 19.2 times more likely to be arrested and convicted, respectively, on a cannabis-related offense, with the effect of gender on cannabis-related convictions persisting even after accounting for gender differences in prevalence of cannabis use disorders (Fergusson et al., 2003). Likewise, the hazardous activities related to cannabis misuse in women most often relate to unprotected sexual intercourse, childcare-related situations but not to driving under intoxication (after controlling for comparable levels of cannabis use across genders) and even to a lesser extent to more stereotypically masculine activities such as “riding a motorcycle” or “operating machinery” (Castillo et al., 1997;Elliott et al., 2006;Ramaekers et al., 2004;Soderstrom et al., 1995).

4.3. Implications and Conclusions

Our results suggest that certain cannabis abuse criteria function poorly, overall, and especially in women. This lack of measurement invariance poses a challenge for interview-based diagnostic assessments, as this variance may arise at two levels: in the diagnostic criteria themselves or within interview items used to determine each criterion (Neale et al., 2006). On the other hand, Withdrawal which has a very high factor loading and is not afflicted with measurement variance appears to have been excluded as a symptom of cannabis dependence. Based on these findings, we propose that:

- **i.** Abuse of and dependence on cannabis represent a unidimensional construct (Denson et al., 2006). Therefore, we have evidence that a single underlying continuum of risk contributes to both abuse and dependence. However, it is likely that an individual's liability may still place them at high versus low risk for cannabis use disorders. As proposed by Helzer et al. (2006), this component of severity could be built into the criteria themselves (e.g. not present, mild, severe) (Helzer et al., 2006).
- **ii.** Withdrawal should be incorporated into the DSM-V definition of cannabis use disorders. Our findings support the seminal work of Budney and colleagues (2006) that provide persuasive evidence for the validity of cannabis withdrawal marked by irritability, aggression and restlessness as its most notable features.
- **iii.** The utility of certain criteria may need to be reconsidered. The most obvious example here is of Legal, which appears to function poorly for cannabis as well as alcohol. In fact, several factor analytic studies have opted to exclude Legal as a criterion of cannabis use disorders in order to obtain a coherent factor structure.
- **iv.** For criteria such as Hazard, which are not gender-invariant, the inclusion of gender-appropriate alternatives are advised for interview-based assessments of cannabis use disorders. One may wish to enquire if women recurrently used cannabis when engaging in unprotected sex or providing care to infants and children, or driving their car, instead of imposing the more common and rather “masculine” examples of operating machinery or riding motorcycles or trucks.

Phenotypic refinement of cannabis use disorders continues to be informative albeit challenging. Much more psychometric and taxometric research is required to clarify the most scientifically valid and feasible diagnostic formulation of cannabis use disorders. However, the applicability of such a diagnosis in treatment settings is essential. More work is also needed to explore the impact of other covariates such as age and race/ethnicity on criteria for cannabis abuse and dependence. Such group differences will not only have substantive implications for diagnosis but will also influence genetic research which is highly sensitive to population stratification.

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Table 1

Prevalence of individual cannabis abuse/dependence criteria in men and women who report lifetime cannabis use (N=8172, in NESARC).

	Males (%)	Females (%)	p-value
Failure	9.6	6.8	<0.0001
Legal	8.2	2.3	<0.0001
Continue	18.1	13.0	<0.0001
Hazard	40.3	24.6	<0.0001
Tolerance	11.8	7.9	<0.0001
Withdrawal	3.5	2.4	0.0039
Intend	9.3	6.9	<0.0001
Give-up	6.4	4.7	0.0011
Problems	11.8	9.5	0.0008
Time Spent	23.8	17.8	<0.0001
Quit	35.3	33.6	0.104

Table 2

Factor loadings (standardized parameter estimates) and thresholds from a confirmatory factor analysis of cannabis abuse and dependence.

	Factor Loading	Threshold
Failure	0.83	4.41
Legal	0.59	3.47
Continue	0.76	2.72
Hazard	0.59	0.99
Tolerance	0.84	4.22
Withdrawal	0.85	6.42
Intend	0.82	4.43
Give-up	0.91	6.85
Problems	0.83	3.98
Time Spent	0.77	2.22
Quit	0.55	0.89

Table 3

Fit statistics and parameter estimates for MIMIC models testing whether gender explained additional variance in individual criteria for cannabis abuse and dependence even after accounting for its effect on the latent abuse/dependence construct (N=8,172 cannabis users in NESARC)

		Loglikelihood Fit	β (S.E.)	$\Delta\chi^2$ (df=1)	AIC
1	Baseline CFA	−32360.53	-	-	63767.0
2	Gender on Abuse/Dependence	−32309.60	−0.79 (0.06)	50.93	64667.2
2a	Failure	−32309.11	0.11 (0.09)	0.49	64668.2
2b	Legal	−32261.84	−1.16 (0.09)	47.76*	63573.7
2c	Continue	−32308.18	0.01 (0.05)	1.42	64669.4
2d	Hazard	−32255.97	−0.66 (0.04)	53.63*	64562.0
2e	Tolerance	−32309.60	−0.01 (0.06)	0.00	64669.2
2f	Withdrawal	−32308.97	−0.19 (0.09)	0.63	64667.9
2g	Intend	−32306.59	0.28 (0.06)	3.01	64663.4
2h	Give-up	−32306.10	0.42 (0.08)	3.50	64662.2
2i	Problems	−32301.74	0.41 (0.07)	7.86*	64653.5
2j	Time Spent	−32308.36	0.12 (0.04)	1.24	64666.7
2k	Quit	−32302.52	0.22 (0.03)	7.08*	64655.1

Notes: AIC or the Akaike's Information Criterion is a fit statistic that is an index of both parsimony and fit. Lower AIC's indicate superior fit.

The $\Delta\chi^2$ statistic is computed by subtracting the loglikelihood fit of the reduced model from the loglikelihood fit of the model where each individual symptom was regressed on gender (e.g. for Hazard: −32255.97−(−32309.60)=53.63, which is significant at α=0.05). Compare fit of Model 1 with Model 2, and of Models 2a-2k with Model 2.

* significant at p <0.05

Table 4

Factor loadings (constrained across genders) and thresholds, with some cannabis abuse/dependence criteria showing gender variance: results from a two-group gender heterogeneity model.

	Factor Loadings	Thresholds [95% Confidence Limits]	
		Men	Women
Failure	0.83	4.77 [4.33, 5.20]	4.77 [4.33, 5.20]
Legal	0.58	3.28 [3.03, 3.52]*	4.47 [4.16, 4.79]*
Continue	0.75	3.00 [2.75, 3.23]	3.00 [2.74, 3.23]
Hazard	0.67	0.94 [0.76, 1.12]*	1.60 [1.44, 1.77]*
Tolerance	0.84	4.58 [4.12-4.98]	4.58 [4.12-4.98]
Withdrawal	0.85	6.76 [6.13-7.39]	6.76 [6.13-7.39]
Intend	0.82	4.77 [4.42-5.12]	4.77 [4.42-5.12]
Give-up	0.91	7.43 [6.49, 8.37]	7.43 [6.49, 8.37]
Problems	0.83	4.45 [4.02, 4.88]*	4.21 [3.86, 4.56]*
Time Spent	0.77	2.50 [2.27, 2.72]	2.50 [2.27, 2.72]
Quit	0.56	1.10 [0.96, 1.24]*	0.98 [0.81, 0.99]*

* Thresholds freely estimated across men and women.