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Functioning of Cannabis Abuse and Dependence Criteria Across Two Different Countries: The United States and The Netherlands

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***Background*: Cross-national differences could affect the likelihood of endorsement of DSM cannabis abuse and dependence criteria. The present study examines whether cannabis abuse and dependence criteria function differently across U.S. and Dutch cannabis users. *Method*: Data on lifetime endorsement of DSM-IV cannabis abuse/dependence criteria were utilized from U.S. cannabis users who participated in the National Epidemiological Survey on Alcohol and Related Conditions (NESARC) and from Dutch cannabis users who participated in the Zuid-Holland study. In total, 1,568 cannabis users participated in the NESARC sample, and 359 cannabis users participated in the Zuid-Holland sample. The DSM-IV cannabis abuse/dependence criteria as well as cannabis withdrawal were determined using face-to-face computer-assisted personal interviews. *Results*: Using Restricted Factor Analysis with Latent Moderated Structures, the cannabis abuse/dependence criteria legal problems ($\beta = -0.43$), failed quit attempts ($\beta = -1.09$), use despite problems ($\beta = -0.32$), and withdrawal ($\beta = -0.53$) showed measurement bias, and were more likely to be endorsed by U.S. than by Dutch cannabis users. Also, men were more likely than women to endorse the criteria hazardous use ($\beta = -0.27$), legal problems ($\beta = -0.49$) and tolerance ($\beta = -0.20$). Findings on failed quit attempts and withdrawal were replicated in matched subsamples, while results on legal problems (country and gender) were partly replicated. *Conclusions*: Several CUD criteria showed measurement bias across two countries and between males and females. Therefore, differences between countries and gender in prevalence rates of CUD should be regarded with caution.**

Keywords cannabis abuse/dependence, measurement bias, US vs. the Netherlands, factor analysis, DSM-IV

Cannabis is the most widely used illicit drug in the U.S. and in Europe (NDM, 2010; SAMHSA, 2009). In the U.S., the population based estimate of lifetime cannabis use is 41% (SAMHSA, 2009), while in the Netherlands, 26% of the general population is estimated to have used cannabis at least once during their lifetime (NDM, 2010). Research shows that after first use, about 17% develop cannabis abuse and about 6% develop cannabis dependence (Wittchen et al., 2008).

According to the DSM-IV, cannabis abuse and dependence are hierarchical, and cannabis dependence is more severe than abuse. However, research consistently shows that the abuse and dependence criteria do not represent two distinct factors, but rather reflect a unidimensional construct (Gillespie, Kendler, & Neale, 2011; Hartman et al., 2008; Langenbucher et al., 2004; Piontek, Kraus, Legleye, & Bühringer, 2011; Teesson, Lynskey, Manor, & Baillie, 2002). Because of the accumulating evidence of a unidimensional construct of cannabis abuse and dependence, DSM-5 includes a single construct of cannabis use disorder (CUD).

Although the DSM-criteria are intended to function identically in diverse populations, research indicates that certain DSM-IV criteria show measurement bias in

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different subpopulations (Agrawal & Lynskey, 2007; Grant et al., 2006; Hartman et al., 2008; Mewton, Teesson, & Slade, 2010). Measurement bias occurs when differences between subpopulations in endorsing the criteria do not reflect variation in the prevalence of these criteria by subgroups, but can be attributed to differences in meaning of the CUD criteria, for example between genders, age groups, or cultural backgrounds. For instance, Hartman et al. (2008) studied the utility of DSM-IV cannabis abuse/dependence items in a substance abuse treatment sample, an adjudicated sample, and a community sample. They found that the severity estimates of the criteria hazardous use (use in hazardous situations), legal problems (legal problems/getting arrested), social problems (trouble with friends or family), tolerance and larger/longer use (using larger amounts or for longer than intended) significantly differed among the three samples, suggesting that certain items indicate greater severity of cannabis problems in some populations more than others. Agrawal and Lynskey (2007) investigated whether gender contributes to differences in DSM-IV abuse/dependence criteria, and found that some criteria do not function identically in men and women. Legal problems and hazardous use exhibited higher thresholds in women, and failed quit attempts (more than once trying to stop or cut down) and use despite problems (use despite health/psychological problems) exhibited higher thresholds in men. Measurement bias could affect the validity of a test, and it is therefore important to investigate measurement bias on various important group differences.

Thus far, little attention has been paid to cross-national differences in the endorsement of CUD criteria. Endorsement of specific CUD criteria might differ between countries because of, for instance, cultural differences in interpretation of the criteria, or differences in policies regarding possession. With the current study, we had the unique opportunity to examine the likelihood of endorsement of CUD criteria by comparing a nation-wide sample of the U.S. with a general population sample of the Netherlands. While in the Netherlands the possession of a small amount of cannabis has been de-penalized, cannabis use and possession is illegal in all U.S. states except Colorado and Washington, and will be prosecuted, albeit to varying degrees in different states. These differences in legislation may affect attitudes towards cannabis use, cannabis use behavior, and consequently endorsement of specific CUD criteria. In terms of cannabis use behavior, prevalence differences have indeed been demonstrated between citizens of San Francisco (U.S.) and Amsterdam (the Netherlands) (Reinarman, Cohen, & Kaal, 2004). U.S. cannabis users were more likely to report a pattern of many starts and stops over time when compared to Dutch cannabis users (9.5% versus 3.2%, respectively), suggesting measurement bias for the criterion failed quit attempt. With the current study, we aim (a) to provide further knowledge on the unidimensionality of CUD, and (b) to examine whether the CUD criteria function differently across the U.S. and the Netherlands.

METHOD

Samples

Data were utilized from U.S. participants in the National Epidemiological Survey on Alcohol and Related Conditions (NESARC) (Grant, Moore, Shepard, & Kaplan, 2003), and from Dutch participants in the Zuid-Holland study (Verhulst, Akkerhuis, & Althaus, 1985). NESARC is a nation-wide sample with 43,093 participants ranging in age between 18 and 99. Data from the first wave were collected in 2001–2002 by the U.S. Bureau Census, on behalf of the National Institute on Alcohol Abuse and Alcoholism. The overall survey response rate was 81%. The Zuid-Holland study is a longitudinal general population study that started in 1983 (wave 1, $n = 2{,}076$). Data on cannabis abuse and dependence were collected during the sixth data wave in 1997, when all participants were aged 18–31 years. Participation rate at the sixth measurement wave was 79% (Althoff, Verhulst, Rettew, Hudziak, & Van Der Ende, 2010). In both studies, written informed consent of the participants was obtained after complete description of the study.

For this study, the datasets were made as comparable as possible. Only participants with self-reported Caucasian background and aged 18–31 were selected. Furthermore, we included participants who had used cannabis and answered the questions pertaining to cannabis abuse and dependence. Here, a difference between samples was unavoidable. In NESARC, all participants who reported lifetime cannabis use were further interviewed about the occurrence of CUD symptoms, whereas in the Zuid-Holland study, only participants who reported using cannabis more than five times were further interviewed. We expect, however, that NESARC participants who used cannabis five times or less are not likely to report any CUD symptoms. In total, we had 359 Zuid-Holland participants (64.6% male; mean age 23.91 [SD = 3.65]) and 1,568 NESARC participants (50.0% male; mean age 24.83 [SD = 4.08]) who satisfied the inclusion criteria and were included in the analyses.

Measurements

Lifetime endorsement of DSM-IV cannabis abuse/dependence criteria was assessed using standardized interviews. In NESARC, the Alcohol Use Disorder and Associated Disabilities Schedule (AUDADIS-IV) was used (Grant, Harford, Dawson, Chou, & Pickering, 1995). This schedule includes face-to-face computer-assisted personal interviews conducted by trained lay interviewers. The AUDADIS-IV shows good reliability (kappa's between 0.71 and 0.78) in a general population (Grant et al., 1995). For the Zuid-Holland study, the Composite International Diagnostic Interview (CIDI) was used (World Health Organization, 1992), which was conducted face-to-face by well-trained interviewers. The CIDI also shows good reliability (kappa of 0.72) in a general population (Andrews & Peters, 1998; Wittchen, 1994).

We selected items that were comparable across interviews, resulting in the inclusion of 18 items from the AUDADIS-IV and 14 from the CIDI. For the criteria role impairment (failure to fulfill major role obligations), tolerance, much time spent (much time is spent getting or using cannabis) and reduced activities (give up or cut down on important activities), two questions were asked in the AUDADIS-IV to cover different aspects of these criteria, while in the CIDI these aspects were combined in a single question (see Table 1). Similar to previous studies on measurement bias in CUD criteria (e.g. Agrawal & Lynskey, 2007; Mewton et al., 2010) and because of increasing evidence for a cannabis withdrawal syndrome (Budney, Vandrey, Hughes, Moore, & Bahrenburg, 2007), we included questions corresponding to the withdrawal criterion. This resulted in the inclusion of 11 CUD criteria: role impairment, hazardous use, legal problems, social problems, tolerance, larger/longer use, failed quit attempts, much time spent, reduced activities, use despite problems and withdrawal.

Cottler et al. (1997) found that the CIDI and AUDADIS-ADR cannabis abuse/dependence criteria were more comparable to each other than to the Schedules for Clinical Assessment in Neuropsychiatry (SCAN), a clinical instrument. Agreement between the AUDADIS-ADR and the CIDI was lowest for the criteria role impairment and failed quit attempts. Because of our selection of comparable items across the AUDADIS-IV and CIDI, we are reasonably confident that differences in response tendencies between the interviews cannot be attributed to differences in criteria content.

Statistical Analyses

Statistical analyses were performed using SPSS version 20.0 for Windows (SPSS Inc. Chicago, IL) and Mplus 6.0 (Muthén & Muthén, 2007). First, percentages of endorsement of the criteria were calculated, and differences across countries and gender were tested using chi-square tests. Next, to confirm the presence of a unidimensional construct of CUD, we performed one-factor confirmatory factor analyses (CFAs) on data from the Zuid-Holland sample, the NESARC sample, and the samples combined, using the WLSMV estimator. Model fit was indicated by the chi square, Comparative Fit Index (CFI), Tucker-Lewis Index (TLI) and RMSEA. CFI and TLI values above 0.95, and RMSEA values below 0.06 reflect a good model fit. RMSEA values between 0.06–0.08 indicate an acceptable fit, and above 0.10 reflect a poor fit (Hu & Bentler, 1999).

Restricted Factor Analysis with Latent Moderated Structures (RFA/LMS) was used to detect measurement bias (Barendse, Oort, Werner, Ligtvoet, & Schermelleh-Engel, 2012). An RFA/LMS is equal to an item response theory model with differential item functioning (Mellenbergh, 1994). Terminology stems from the field of factor analysis, which is why we speak of measurement bias instead of differential item functioning. In RFA/LMS, data of different groups are taken together, and the concept of interest (CUD) is operationalized as a (latent) common factor with multiple measures (the 11 criteria) as (observed) indicators. Direct effects of group on the individual criteria, and interaction effects of group by CUD, are examined by adding group membership (e.g. country) as an exogenous variable. Direct effects indicate uniform bias, i.e. the presence of across-group differences in thresholds, which corresponds to the likelihood of endorsement of certain criteria. Interaction effects of the exogenous variable with CUD indicate non-uniform bias, i.e. the presence of across-group differences in factor loadings, reflecting how well a criterion distinguishes those with different levels of CUD. We added country to the model as an exogenous variable (NESARC = 0, Zuid-Holland = 1). Because measurement bias across gender has been established in NESARC (Agrawal & Lynskey, 2007), we also added gender as an exogenous variable (men = 0, women = 1). In the baseline model, country and gender were allowed to correlate with each other and with the latent factor CUD. All direct effects of country and gender on the criteria were fixed to zero (i.e. absence of uniform bias).

Measurement bias was evaluated by testing these fixed direct effects, using modification indices (MIs). If the largest of the MIs was significant at a Bonferroni adjusted alpha level (nominal alpha of 5% was divided by pq, where p and q are numbers of criteria [11] and exogenous variables [2]), the corresponding direct effect of country or gender on an individual criterion was set free to be estimated. In that case, the associated criterion was considered uniform biased. This procedure was repeated until no significant MI of country or gender on a criterion was found at a re-adjusted level of significance (dividing nominal alpha by $pq–r$, where r is the number of direct effects set free [Jak, Oort, & Dolan, 2010]).

After establishing the direct effects, we tested for non-uniform bias by adding interaction terms of CUD with country and gender one by one to the model. Interaction effects were only included when they improved model fit significantly. Besides the difference in chi-square, the difference in model fit was tested with Akaike's Information Criterion (AIC).

Because of differences between the samples of NESARC and Zuid-Holland with regard to sample size and (distribution of) age and gender, we repeated the analyses on uniform bias using random subsamples ($n = 359$) of the total group of NESARC cannabis users, matched with the Zuid-Holland cannabis users on age and gender. In total, we pulled 10 random subsamples from the NESARC sample to repeat the analyses.

RESULTS

CUD Criteria in Cannabis Users

In NESARC ($n = 1{,}568$), 19.6% of cannabis users met criteria for lifetime cannabis abuse and 11.8% met criteria for lifetime cannabis dependence (lifetime endorsement of three or more dependence criteria simultaneously). In the Zuid-Holland sample ($n = 359$), 16.4% of cannabis users met criteria for lifetime cannabis abuse, and 10.3%

TABLE 1. DSM IV cannabis abuse and dependence criteria used in the NESARC and the Zuid-Holland study

DSM-criteria	NESARC items	Zuid-Holland items
Role impairment	-Ever have job or school troubles because of cannabis OR -Cannabis ever interfered with taking care of home or family	-Did the use of cannabis often interfere with your activities at school, in a job, or at home?
Hazardous use	-Ever in situations that increased chances of getting hurt while under the influence of cannabis or feeling aftereffects	-Did you ever use cannabis in situations where you could get hurt, for example when cycling, driving, or sailing, operating machinery or something similar?
Legal problems	-Ever get arrested/have other legal problems because of cannabis use	-Did cannabis ever cause problems with the police?
Social problems	-Ever have arguments with family or friends because of cannabis use OR -Ever continue to use cannabis even though causing trouble with family or friends	-Did cannabis ever cause problems with your family, friends, at your job, or at school? OR -Did you continue the use of cannabis even though you knew it caused one of these problems?
Tolerance	-Ever find usual amount of cannabis had much less effect OR -Ever had to use much more cannabis to get the effect wanted	-Did you ever notice that you needed much more cannabis to have the same effect, or that the same amount of cannabis had less effect than before?
Larger/longer use	Ever use cannabis in larger amounts or longer periods than intended	-Did you often use cannabis in larger amounts or longer than you intended, or often find it difficult to quit the use of cannabis before you were 'drunk' or high?
Failed quit attempts	-More than once want to stop or cut down on cannabis	-Did you ever want to stop or cut down cannabis?
Much time spent	-Ever spent a lot of time using or getting over bad aftereffects of cannabis OR -Ever spent a lot time making sure had enough cannabis	-Did you ever spent a lot of time using, obtaining or recover from the effects of cannabis?
Reduced activities	-Ever give up or cut down on important activities to use cannabis OR -Ever give up or cut down on pleasurable activities to use cannabis	-Did you ever give up or strongly reduce important activities to get or use cannabis? (activities such as sports, work, or socializing with friends and family). Did you do that in the course of a whole month, or several times within a period of two months to be able to use cannabis?
Use despite problems	-Ever continue to use cannabis even though made depressed, uninterested in things or suspicious or distrustful to other people OR -Ever continue to use cannabis even though causing health problem	-Did you continue the use of cannabis although you knew this caused medical problems, like an accidental overdose, a persistent cough, a seizure, an infection, hepatitis, abscesses, AIDS, heart complaints or an injury? OR Did you continue the use of cannabis although you knew it caused emotional or psychological problems, like being uninterested in your normal activities, being depressed, being suspicious or distrustful to people, or having strange thoughts?
Withdrawal	One of the following: -Ever sweat or heart beat fast when effects of cannabis were wearing off -Ever have runny eyes or nose when effects of cannabis were wearing off -Ever have a fever when effects of cannabis were wearing off -Ever shake when effects of cannabis were wearing off -Ever have very bad headaches when effects of cannabis were wearing off -Ever feel anxious or nervous when effects of cannabis were wearing off -Ever have trouble falling, staying asleep when effects of cannabis were wearing off -Ever feel depressed when effects of cannabis were wearing off OR -Ever take more cannabis to avoid bad aftereffects	-Did stopping or cutting down cannabis use ever cause one of the problems that are listed on the map in front of you? Tiredness or exhaustion, sweating, diarrhea, anxious, depressive, irritable, restless, trouble with sleeping, trembling (of hands), stomach or abdominal pain, headache, feeling weak, nausea or vomiting, seizures or fits, muscle pain or cramps, watery eyes or runny nose, yawning, intense craving, seeing or hearing things that were not real, fast heartbeat, change in appetite, fever. OR -Did you ever use cannabis or something strongly similar to prevent problems that are shown on this map?

TABLE 2. Prevalence of lifetime endorsement of individual cannabis abuse and dependence criteria in men and women in the NESARC ($N = 1{,}568$) and Zuid-Holland ($N = 359$) sample who report cannabis use

	NESARC			Zuid-Holland			χ^2 *NESARC and Zuid-Holland*	
DSM criteria	Males *N* (%)	Females *N* (%)	χ^2	Males *N* (%)	Females *N* (%)	χ^2	Males	Females
Role impairment	103 (13.1%)	68 (8.7%)	8.04**	21 (9.1%)	11 (8.7%)	0.02	2.79	0.00
Hazardous use	123 (15.7%)	65 (8.3%)	20.33**	31 (13.4%)	9 (7.1%)	3.27	0.75	0.21
Legal problems	83 (10.6%)	25 (3.2%)	33.45**	5 (2.2%)	1 (0.8%)	0.93	16.09**	2.27
Social problems	160 (20.4%)	125 (15.9%)	5.25*	22 (9.5%)	13 (10.2%)	0.05	14.53	2.77
Tolerance	148 (18.9%)	83 (10.6%)	21.45**	35 (15.1%)	15 (11.8%)	0.73	1.74	0.17
Larger/Longer use	95 (12.1%)	77 (9.8%)	2.12	30 (12.9%)	14 (11.0%)	0.28	0.11	0.18
Failed quit attempts	277 (35.3%)	262 (33.4%)	0.64	11 (4.7%)	5 (3.9%)	0.13	82.48**	45.85**
Much time spent	138 (17.6%)	85 (10.8%)	14.69**	17 (7.3%)	10 (7.9%)	0.04	14.62**	1.03
Reduced activities	63 (8.0%)	41 (5.2%)	4.98*	11 (4.7%)	2 (1.6%)	2.36	2.88	3.25
Use despite problems	118 (15.1%)	93 (11.9%)	3.42	12 (5.2%)	7 (5.5%)	0.02	15.66**	4.51*
Withdrawal	234 (29.8%)	224 (28.6%)	0.31	32 (13.8%)	13 (10.2%)	0.95	23.87**	19.09**

**$p \leq .01$, *$p \leq .05$.

met criteria for lifetime cannabis dependence. There were no gender differences in the likelihood of endorsement of the individual criteria in the Zuid-Holland study, but seven criteria had a higher percentage in NESARC men compared to women (see Table 2). Compared to men from the Zuid-Holland study, NESARC men were more likely to meet the criteria legal problems, use despite problems, much time spent, failed quit attempts and withdrawal. NESARC women, when compared to Dutch women, were more likely to meet the criteria use despite problems, failed quit attempts and withdrawal.

Confirmatory Factor Analyses

CFA indicated that the one-factor model provided a good fit to the Zuid-Holland data ($\chi^2(44) = 54.49$, $p = .13$, CFI = 0.99, TLI = 0.98, RMSEA = 0.03). Likewise, the one-factor model provided a good fit to the NESARC data ($\chi^2(44) = 144.0$, $p < .01$, CFI = 0.99, TLI = 0.98, RMSEA = 0.04). Subsequently, the one-factor model was fitted on the combined data of NESARC and Zuid-Holland, resulting in a good fit ($\chi^2(43) = 134.23$, $p < .01$, CFI = 0.99, TLI = 0.98, RMSEA = 0.03) (for factor loadings per sample, see Table 3).

Measurement Bias

To test for measurement bias, we added country and gender to the one-factor model of the combined datasets. Results showed uniform bias of country, indicating that NESARC participants had a higher likelihood of endorsing the criteria legal problems ($\beta = -0.43$), failed quit attempts ($\beta = -1.09$), use despite problems ($\beta = -0.32$), and withdrawal ($\beta = -0.53$) than Zuid-Holland participants. Additionally, three criteria showed uniform bias of gender. Men were more likely to endorse the criteria hazardous use ($\beta = -0.28$), legal problems ($\beta = -0.49$) and tolerance ($\beta = -0.20$) than women. Finally, we tested for non-uniform bias in all criteria. No significant interaction effects were found. For the full model, see Figure 1.

Replication Using Subsamples

Uniform bias of country for the criteria failed quit attempts and withdrawal was replicated in all 10 matched subsamples (β's ranging from -1.47 to -0.93 and from -0.93 to -0.33 respectively), indicating that NESARC participants were more likely to endorse these criteria than Zuid-Holland participants. In seven matched subsamples it was confirmed that NESARC participants were more likely to endorse the criterion legal problems than Zuid-Holland participants (β's ranging from -0.62 to -0.50). Additionally, in two matched subsamples it was demonstrated that the criteria use despite problems and larger/longer use showed uniform bias of country (β's ranging from -0.56 to -0.40 and from 0.38 to 0.40 respectively), indicating that NESARC participants were more likely to endorse the criterion use despite problems and that Zuid-Holland participants were more likely to endorse the criterion larger/longer use.

Uniform bias of gender for the criteria legal problems and hazardous use was replicated in four and one matched

TABLE 3. Standardized factor loadings and thresholds from confirmatory factor analyses of CUD criteria in the NESARC and Zuid-Holland samples

	NESARC		Zuid-Holland	
	Factor loadings	Thresholds	Factor loadings	Thresholds
Role impairment	0.81	1.23	0.80	1.35
Hazardous use	0.56	1.18	0.47	1.22
Legal problems	0.50	1.48	0.33	2.13
Social problems	0.77	0.91	0.77	1.30
Tolerance	0.83	1.05	0.72	1.08
Larger/longer	0.81	1.23	0.89	1.16
Failed quit attempts	0.57	0.40	0.69	1.70
Much time spent	0.87	1.07	0.85	1.44
Reduced activities	0.93	1.50	0.83	1.80
Use despite problems	0.82	1.11	0.76	1.62
Withdrawal	0.69	0.55	0.70	1.15

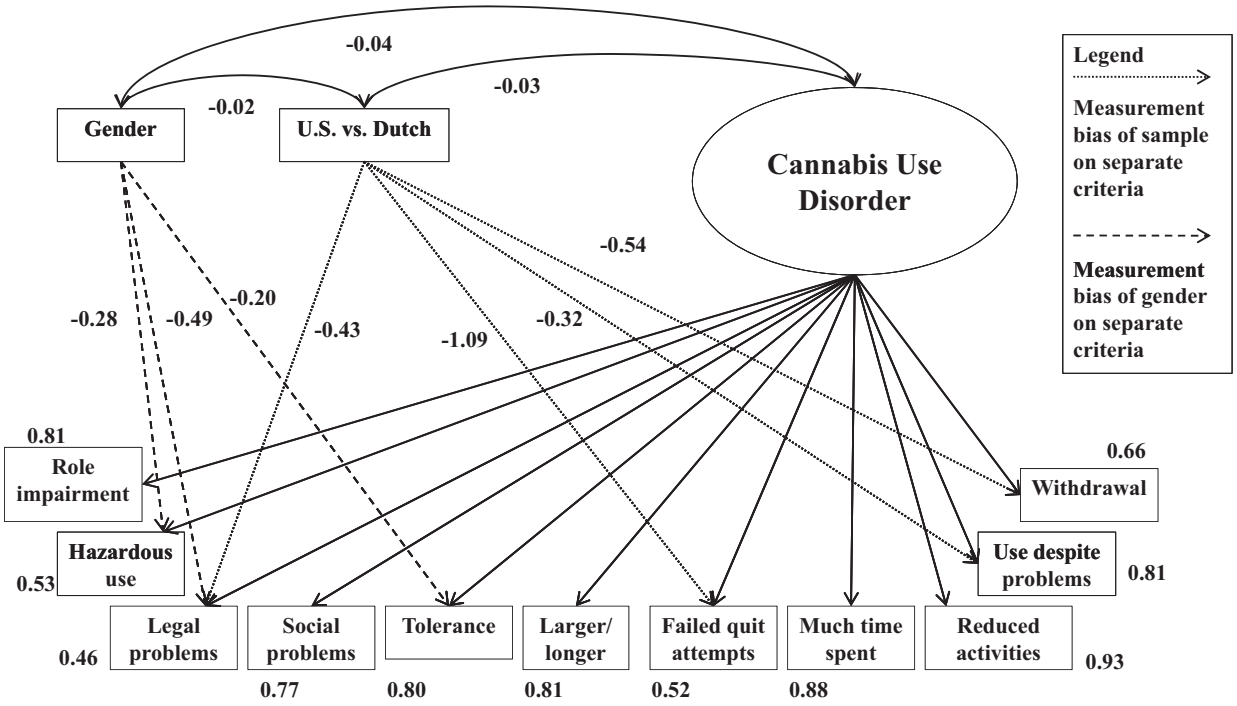

FIGURE 1. Measurement bias of cannabis use disorder (NESARC $n = 1{,}568$, Zuid-Holland $n = 359$). Note: numbers at the boxes indicate standardized factor loadings, numbers at the arrows indicate (unstandardized) correlation. Model fit: $\chi^2 = 167.94$, df $= 57$, $p < .01$, CFI $= 0.99$, TLI $= 0.98$, RMSEA $= 0.03$.

sample(s) respectively, indicating that men were more likely than women to endorse the criteria legal problems (β's ranging from -0.82 to -0.52) and hazardous use ($\beta = -0.45$).

DISCUSSION

The present study demonstrates that a one-factor (abuse/dependence) model adequately explains how cannabis abuse and dependence criteria cluster in samples from both the U.S. and the Netherlands. Thus, consistent with DSM-5 and in agreement with findings from previous studies (Gillespie et al., 2011; Hartman et al., 2008; Langenbucher et al., 2004; Piontek et al., 2011; Teesson et al., 2002), findings from this study indicate that CUD can be defined as a unidimensional construct.

Importantly, our results further demonstrate measurement bias in certain CUD criteria. For identical levels of CUD, U.S. cannabis users were found to be more likely than Dutch cannabis users to endorse the criteria failed quit attempts and withdrawal. Because age and gender were unequally distributed across the samples, we replicated the findings in matched subsamples. Measurement bias in the criteria failed quit attempts and withdrawal was found in the total sample and in all subsamples. We can only speculate about potential explanations for the established heterogeneity in the CUD criteria. Possibly, differences between countries in policy, attitudes towards cannabis use and/or social patterns of cannabis use might underlie these differences. For instance, the generally tolerant attitude towards cannabis use in the Netherlands may prevent Dutch cannabis users from considering quitting – subsequently reducing the likelihood of experiencing withdrawal symptoms – because they appraise cannabis use as less harmful or addictive than U.S. cannabis users.

Confirmed in seven out of ten matched replication samples, our results further suggest that U.S. cannabis users compared to Dutch cannabis users are more likely to endorse the criterion legal problems. In addition, this criterion also showed uniform bias of gender, with a higher likelihood of endorsement in men versus women. Overall, the criterion legal problems showed relatively low factor loadings, indicating that this criterion discriminates poorly between those with and without a CUD diagnosis. This lack of discrimination combined with signs of uniform bias of country and gender supports the decision to delete this criterion in the DSM-5.

Lastly, our primary analysis indicated that U.S. cannabis users were more likely than Dutch cannabis users to endorse the criterion use despite problems. This result was only confirmed in two out of ten replication samples, questioning the robustness of this finding. In addition, differences between the two interviews regarding item content of this criterion may have negatively affected the quality of this comparison. More specifically, in NESARC, general health problems and specific psychological problems were queried while in the Zuid-Holland study, respondents were only asked about specific health problems.

Consistent with findings from previous research (Agrawal & Lynskey, 2007; Grant et al., 2006; Piontek et al., 2011), we found that men were more likely than women to endorse the criterion hazardous use. It has been suggested that this criterion reflects aspects of risky behavior, which is generally higher in males than in females, rather than being a selective criterion for a CUD (Piontek et al., 2011). Along the same line of reasoning, it could be postulated that the gender difference in the criterion tolerance, rather than indicating a CUD, may be more indicative of amount and frequency of cannabis use. Further refinement of these criteria seems required. It should be noted that uniform biases of gender were only minimally replicated in the matched replication samples. Given the prevalence rates that are particularly low for legal problems, hazardous use and in females, power issues may explain the absence of consistent replication.

The lack of measurement invariance across countries and gender that was found in this study affects the DSM classification of a CUD. Because several criteria seem to function differently in U.S. versus Dutch cannabis users, and in male versus female cannabis users, differences in prevalence rates of CUD across countries and gender, as well as differences between these subgroups in risk factors of CUD, should be interpreted with care. In addition, the lack of measurement invariance found in other subpopulations (Agrawal & Lynskey, 2007; Grant et al., 2006; Hartman et al., 2008; Mewton et al., 2010) raises the question of which other factors influence the endorsement of CUD criteria.

Strengths of this study include the comparison of CUD criteria in cannabis users from two different countries, in comparable age groups, using interviews with equal administration procedures, in general population cohorts. However, some limitations should be considered. First, although we selected the most comparable items from the two interviews, we cannot rule out the possibility that different wording and examples have affected the endorsement of the criteria. Second, the selection of participants for the questions on cannabis abuse and dependence differed between the two studies, resulting in a U.S. sample of lifetime cannabis users and a Dutch sample of individuals who used cannabis more than five times lifetime. Because frequency of cannabis use was not assessed, we could not control for this difference. Moreover, we relied on self-reported information, which may result in over- or underrepresentation of CUD symptoms. This applies specifically to the NESARC study, as interviews were administered by a government representative (Grucza, Abbacchi, Przybeck, & Gfroerer, 2007). Last, there is a time-lag between interviews of four years. Cannabis users in the Netherlands were interviewed in 1997, while those in the U.S. were interviewed in 2001. However, prevalence studies in the Netherlands report stability of cannabis use between 1997 and 2001 (NDM, 2007), indicating comparability between countries.

CONCLUSION

To conclude, findings from this study support the DSM-5 definition of CUD as a unidimensional construct. Importantly, cannabis users from two countries differ in their likelihood of endorsing various CUD criteria, particularly failed quit attempts and withdrawal. Therefore, differences between countries and gender in prevalence rates of CUD should be regarded with caution.

Declaration of Interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

THE AUTHORS

Monique Delforterie, MSc., is studying the diagnostics of cannabis use disorders across different subpopulations, such as gender, age groups and countries, as well as risk and protective factors of cannabis use and cannabis use disorders. Her main areas of interest are substance use and substance use disorders in adolescents and young adults, and interpersonal risk and protective factors such as peers and the family.

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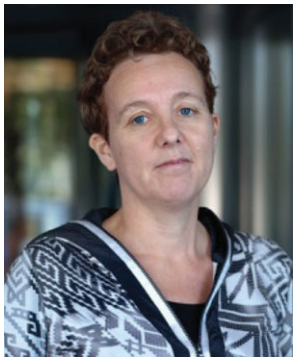

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GLOSSARY

Cannabis abuse: A mental disorder included in the DSM-IV defined by a maladaptive pattern of cannabis use manifested by recurrent negative consequences related to use which requires the presence of at least one of the four stated diagnostic criteria.

Cannabis dependence: A mental disorder included in the DSM-IV which requires a minimum of three of seven diagnostic criteria and is characterized by impaired control over cannabis use, compulsive use, desire or attempts to restrict use, continued use despite harmful consequences.

Cannabis withdrawal: as manifested by either of the following: (a) Stopping or cutting down the use of cannabis caused withdrawal symptoms, such as sweating or feeling anxious; (b) The same (or a closely related) substance is taken to relieve or avoid withdrawal symptoms.

Measurement bias: occurs when differences between subpopulations in endorsing criteria do not reflect variation in the prevalence of these criteria by subgroups, but can be attributed to differences in meaning for these subpopulations.

REFERENCES

Agrawal, A., & Lynskey, M. T. (2007). Does gender contribute to heterogeneity in criteria for cannabis abuse and dependence? Results from the national epidemiological survey on alcohol and related conditions. *Drug and Alcohol Dependence, 88*, 300–307. [doi: 10.1016/j.drugalcdep.2006.10.003]

Althoff, R. R., Verhulst, F. C., Rettew, D. C., Hudziak, J. J., & van der Ende, J. (2010). Adult outcomes of childhood dysregulation: A 14-year follow-up study. *Journal of the American Academy of Child & Adolescent Psychiatry, 49*(11), 1105–1116.

Andrews, G., & Peters, L. (1998). The psychometric properties of the Composite International Diagnostic Interview. *Social Psychiatry and Psychiatric Epidemiology, 33*, 80–88.

Barendse, M. T., Oort, F. J., Werner, C. S., Ligtvoet, R., & Schermelleh-Engel, K. (2012). Measurement bias detection through factor analysis. *Structural Equation Modeling: A Multidisciplinary Journal, 19*, 561–579. [doi: 10.1080/10705511.2012.713261]

Budney, A. J., Vandrey, R. G., Hughes, J. R., Moore, B. A., & Bahrenburg, B. (2007). Oral delta-9-tetrahydrocannabinol

suppresses cannabis withdrawal symptoms. *Drug and Alcohol Dependence, 86*, 22–29. [doi: 10.1016/j.drugalcdep.2006.04.014].

Cottler, L. B., Grant, B. F., Blaine, J., Mavreas, V., Pull, C., Hasin, D., . . ., Mager, D. (1997). Concordance of DSM-IV alcohol and drug use disorder criteria and diagnoses as measured by AUDADIS-ADR, CIDI and SCAN. *Drug and Alcohol Dependence, 47*, 195–205. [doi: 10.1016/S0376-8716(97)00090-2].

Gillespie, N. A., Kendler, K. S., & Neale, M. C. (2011). Psychometric modeling of cannabis initiation and use and the symptoms of cannabis abuse, dependence and withdrawal in a sample of male and female twins. *Drug and Alcohol Dependence, 118*, 166–172. [doi: 10.1016/j.drugalcdep.2011.03.014].

Grant, B. F., Harford, T. C., Dawson, D. A., Chou, P. S., & Pickering, R. P. (1995). The alcohol use disorder and associated disabilities interview schedule (AUDADIS): Reliability of alcohol and drug modules in a general population sample. *Drug and Alcohol Dependence, 39*, 37–44. [doi: 10.1016/0376-8716(95)01134-K].

Grant, B. F., Moore, T. C., Shepard, J., & Kaplan, K. (2003). *Source and accuracy statement: Wave 1 National Epidemiologic Survey on Alcohol and Related Conditions (NESARC)*. Bethesda, MD: National Institute on Alcohol Abuse and Alcoholism.

Grant, J. D., Scherrer, J. F., Neuman, R. J., Todorov, A. A., Price, R. K., & Bucholz, K. K. (2006). A comparison of the latent class structure of cannabis problems among adult men and women who have used cannabis repeatedly. *Addiction, 101*, 1133–1142.

Grucza, R. A., Abbacchi, A. M., Przybeck, T. R., & Gfroerer, J. C. (2007). Discrepancies in estimates of prevalence and correlates of substance use and disorders between two national surveys. *Addiction, 102*, 623–629.

Hartman, C. A., Gelhorn, H., Crowley, T. J., Sakai, J. T., Stallings, M., Young, S. E., . . . Hopfer, CJ. (2008). Item response theory analysis of DSM-IV cannabis abuse and dependence criteria in adolescents. *Journal of the American Academy of Child & Adolescent Psychiatry, 47*, 165–173. [doi: 10.1097/chi.0b013e31815cd9f2].

Hu, L. T., & Bentler, P. M. (1999). Cutoff criteria for fit indexes in covariance structure analysis: Conventional criteria versus new alternatives. *Structural Equation Modeling: A Multidisciplinary Journal, 6*, 1–55. [doi: 10.1080/10705519909540118].

Jak, S., Oort, F., & Dolan, C. (2010). Measurement bias and multidimensionality; an illustration of bias detection in multidimensional measurement models. *AStA Advances in Statistical Analysis, 94*, 129–137.

Langenbucher, J. W., Labouvie, E., Martin, C. S., Sanjuan, P. M., Bavly, L., Kirisci, L., Chung, T. (2004). An application of item response theory analysis to alcohol, cannabis, and cocaine criteria in DSM-IV. *Journal of Abnormal psychology, 113*, 72–80.

Mellenbergh, G. J. (1994). Generalized linear item response theory. *Psychological Bulletin, 115*, 300–307.

Mewton, L., Teesson, M., & Slade, T. (2010). "Youthful epidemic" or diagnostic bias? Differential item functioning of DSM-IV cannabis use criteria in an Australian general population survey. *Addictive Behaviors, 35*(5), 408–413. [doi: 10.1016/j.addbeh.2009.12.001].

Muthén, L. K., & Muthén, B. O. (2007). *Mplus user's guide*. Los Angeles, CA: Muthén & Muthén.

NDM (2007). *National Drug Monitor, 2007*. Utrecht, NL: Netherland Institute of Mental Health and Addiction.

NDM (2010). *National Drug Monitor, 2010*. Utrecht, NL: Netherland Institute of Mental Health and Addiction.

Piontek, D., Kraus, L., Legleye, S., & Bühringer, G. (2011). The validity of DSM-IV cannabis abuse and dependence criteria in adolescents and the value of additional cannabis use indicators. *Addiction, 106*, 1137–1145.

Reinarman, C., Cohen, P. D. A., & Kaal, H. L. (2004). The limited relevance of drug policy: Cannabis in amsterdam and in San Francisco. *American Journal of Public Health, 94*, 836–842. [doi: 10.2105/AJPH.94.5.836].

SAMHSA (2009). Results from the 2008 National Survey on Drug Use and Health: National Findings (Office of Applied Studies, NSDUH Series H-36, 2009; HHS Publication No. SMA 09-4434)

Teesson, M., Lynskey, M., Manor, B., & Baillie, A. (2002). The structure of cannabis dependence in the community. *Drug and Alcohol Dependence, 68*, 255–262. [doi: 10.1016/S0376-8716(02)00223-5].

Verhulst, F. C., Akkerhuis, G. W., & Althaus, M. (1985). Mental health in Dutch children: (I) a cross-cultural comparison. *Acta Psychiatrica Scandinavica, 72*, 1–108.

World Health Organization (1992). *Composite international diagnostic interview*. Version 1.1. Geneva: WHO, Division of Mental Health.

Wittchen, H. U. (1994). Reliability and validity studies of the WHO-Composite International Diagnostic Interview (CIDI): A critical review. *Journal of Psychiatric Research, 28*, 57–84. [doi: 10.1016/0022-3956(94)90036-1].

Wittchen, H. U., Behrendt, S., Höfler, M., Perkonigg, A., Lieb, R., Bühringer, G., Beesdo, K. (2008). What are the high risk periods for incident substance use and transitions to abuse and dependence? Implications for early intervention and prevention. *International Journal of Methods in Psychiatric Research, 17*, S16–S29.