Marijuana use subtypes in a community sample of young adult females

Marcel A. de Dios[a,b,*], **Bradley J. Anderson**[b], **Debra S. Herman**[a,b], **Claire E. Hagerty**[b], **Celeste M. Caviness**[b], **Alan J. Budney**[c], and **Michael Stein**[b,d]

[a]Department of Psychiatry & Human Behavior, Warren Alpert Medical School of Brown University, Providence, RI 02912

[b]Butler Hospital, 345 Blackstone Blvd., Providence, RI 02906

[c]Center for Addiction Research, Department of Psychiatry, University of Arkansas for Medical Sciences, Little Rock, AR 72205

[d]Department of Medicine and Community Health, Warren Alpert Medical School of Brown University, Providence, RI 02912

Abstract

Objective—This study sought to empirically derive marijuana user subtypes based on DSM abuse and dependence criteria and examine demographic and substance abuse distinctions of derived classes.

Method—A community sample of 308 female marijuana users between the ages of 18-24 were recruited in the Southern New England region. Latent class analysis was used to derive subgroups based on DSM criteria. The use and demographic characteristics of classes were further analyzed using ANOVA and chi-square tests.

Results—Based on fit criteria, a three class solution was selected. Class I (37%), an "unaffected/ mild" group was characterized by very low endorsement rates of abuse and dependence criteria. This class was also found to have significantly lower rates of other substance use problems. Class II (41.6%) "moderate problem users" showed moderate endorsement rates of abuse and dependence criteria. Class III (21.4%) - "severe problem users" showed the greatest levels of abuse and dependence with 90% meeting DSM criteria for abuse and 100% meeting diagnostic criteria for marijuana dependence. Class III also showed the greatest levels of other substance use problems.

Conclusion—Three distinct marijuana abuse and dependence subtypes were derived using LCA. Findings may have implications for the development of more targeted treatment and prevention interventions for young women struggling with varying degrees of marijuana abuse and dependence.

*Corresponding Author: Marcel A. de Dios, Ph.D., Butler Hospital, 345 Blackstone Boulevard, Weld Building, Room 211, Providence, RI 02906. TEL: 401.455.6645 FAX: 401.455-6618, mdedios@butler.org.

Keywords

Marijuana; Cannabis; Latent Class Analysis; Females; Young Adults; Substance Use

Introduction and Background

Marijuana is the most widely used illicit substance in the United States. In 2007, approximately 6% of Americans over the age of 12 reported using marijuana at least once in the past month (Substance Abuse and Mental Health Services Administration, 2008). Regular marijuana use is associated with respiratory illnesses such as bronchitis, emphysema, and lung infections (Brook et al., 2008; Tashkin, 2005; Moore et al., 2004) as well as neuro-cognitive deficits (Solowij et al., 2002; Brook et al., 2008). The use of marijuana has also been linked with psychosocial problems including occupational absenteeism, work-related accidents (Zwerling et al., 1990), poor educational achievement (Brook et al., 2008; Fergusson et al., 2003; Lynskey et al., 2000), and increased likelihood of mental health conditions, including anxiety, depression and suicidal behavior (Fergusson et al., 2002; Brook et al., 2001; King et al., 2001). Given these associations and the high prevalence of use, marijuana represents a significant public health problem in the United States.

Young adults between the ages of 18 and 25 have the highest rate of marijuana use (Substance Abuse and Mental Health Services Administration, [SAMHSA] 2008). Approximately 16.4% of adults in this age group report using marijuana at least once in the past month (SAMHSA, 2008). The ages of 18 through 25 are marked by several important life transitions and milestones, e.g. leaving home, attaining higher education, career and marital initiation, that lay the foundation for future decades (Arnett, 2000; Chrisholm & Hurrelman, 1995). Substance use during early adulthood in the United States is often considered a cultural norm tied to establishing independence, exploring one's identity, and transitioning to limited supervision (Arnett, 2000). Substance use during this period occurs within the context of significant life transitions that can be particularly susceptible to the negative consequences of use. Substance-related legal, health, interpersonal, and achievement problems can have an enduring impact. Therefore young adults have been the focus of research and clinical efforts aimed at understanding, reducing, and treating substance use.

Historically, studies focusing on young adult marijuana users have struggled to recruit women (Fattore et al., 2008). Knowledge regarding marijuana use in this group is important since marijuana use is highest among women between the ages of 18 and 25 and may pose unique risks to women this age. In 2006, approximately 12.5% of women between the ages of 18 and 25 reported marijuana use in the past year (Substance Abuse and Mental Health Services Administration, 2007). Furthermore, rates of marijuana related disorders (cannabis abuse & dependence) among female marijuana users between the ages of 18–29 have increased from 25% in the early 1990's to 32% in 2002 (Compton, et al., 2004). Additionally, marijuana use has also been linked to increased sexual activity and inconsistent condom use (De Genna et al., 2007 & Poulin & Graham 2001). These types of sexually risky behaviors increase a woman's risk for unplanned pregnancies and the contraction of sexually transmitted diseases. Taken together, the risks associated with marijuana use represent a significant threat to the health and well-being of women in the early stages of adulthood.

Marijuana abuse and dependence subtypes

The *Diagnostic and Statistical Manual of Mental Disorders (DSM-IV*; American Psychiatric Association, 2000) distinguishes between marijuana (cannabis) abuse and dependence. Recently, investigators have proposed a unidimensional approach for DSM substance dependence diagnoses (Compton, et al., 2009; Lynskey & Agrawal, 2007; Budney, 2006; Martin et al., 2006). This approach combines abuse and dependence and conceptualizes dependence on a severity continuum (Lynskey & Agrawal, 2007). Studies utilizing Item Response Theory (IRT) have identified a single latent dimension to DSM marijuana abuse/ dependence and have consequently advocated for incorporating a single dimensional diagnostic approach to future versions of the DSM (Compton, et al., 2009; Lynskey & Agrawal, 2007; Martin et al., 2006; Langenbucher et al., 2004; Teeson et al., 2002;). Nevertheless the adoption of a DSM dimensional approach to the psychiatric diagnosis of cannabis disorders will continue to require severity thresholds to direct level of care. Therefore investigators have also attempted to identify unique subtypes of marijuana users based on endorsed abuse and dependence criteria using latent class analysis (LCA). This approach complements IRT studies and can further our understanding of potential subclasses of users on the severity continuum of DSM abuse and dependence criteria. LCA has been utilized in studies of alcohol users and cigarette smokers (Moss et al., 2007; Rose et al., 2007; Auerbach & Collins, 2006; Bucholz et al., 1996) but has yet to be widely applied to marijuana users.

In the only identified study using LCA to identify marijuana user subtypes, Grant and colleagues (2006) applied this approach to a large sample (n=5821) of lifetime marijuana users and derived groupings based on DSM marijuana abuse and dependence criteria. Grant and colleagues (2006) found four classes illustrating a severity spectrum in terms of DSM abuse and dependence criteria. Females were more likely to be unaffected/mild hazardous users, and a three-class solution fit the female sub-sample more precisely.

The Grant et al. (2006) study not only offers the first and only attempt at elucidating marijuana user subtypes using LCA, but also highlights the gender distinctions with respect to marijuana user problems. One limitation noted by Grant and colleagues (2006) was their measure of "lifetime" marijuana used to derive the latent classes. This approach potentially grouped individuals based on marijuana use that occurred many years ago and possibly during a transient period of atypical use. Deriving latent classes based on more "current" use may offer a clearer understanding of the patterns of use among marijuana users. Furthermore, the Grant and colleagues' study (2006) did not examine levels of other substance use among latent classes. This is particularly important when one considers the high rate of poly-substance use and its impact (Ives & Ghelani, 2006). Further research is needed in order to fully appreciate the poly-substance use patterns of marijuana users.

Despite considerable clinical and research efforts focused on substance use among young adults, there is still much to be learned about young adult <u>female</u> marijuana users. Namely, studies have yet to fully explore the substance use characteristics of this group and investigate whether unique subgroups of users exist. Applying LCA to identify unique subtypes and exploring the various demographic and substance use-related distinctions of subgroups can provide a greater understanding of this relatively understudied group. In the current study, we seek to replicate the work of Grant et al., (2006) in a community sample of female <u>current</u> marijuana users between the ages of 18 and 24. We also investigate demographic and comorbid substance use distinctions among marijuana use subtypes.

Methods

Sample

The current study used baseline data from a randomized clinical trial testing the effectiveness of a brief, motivationally-focused intervention for reducing marijuana use and sexual risk behaviors among females between the ages of 18 and 24. The primary aims of this study are to test whether this intervention decreases 1) marijuana use, and 2) sexual risk behaviors, as well as 3) exploring the mediating role of marijuana use on the relationship between the treatment effect and sexual risk behavior. The sample included 308 females aged 18 to 24. Participants were recruited from the community using advertisements aimed at women who have used marijuana at least 3 times in the past three months. Advertisement flyers were posted on several college campuses and community agencies. In addition, we conducted radio advertisement and purchased an advertisement that was posted on a public bus. Our advertisement used the following wording: *"Women between 18 and 24, have you used Marijuana during the past 3 Months? You may be eligible to participate in a research study about the health behaviors of young adults. Participation is completely confidential. Eligible participants receive: Compensation for interviews, and free STD testing."* Study inclusion criteria included: 1) live within 20 miles of Providence RI and planning to remain in the geographic area for the next 6 months, 2) speak English, 3) heterosexual intercourse on at least one occasion in the past 90 days, 4) not be pregnant and 5) not meet criteria for substance dependence (other than marijuana, alcohol, or nicotine) within the past year. The study inclusion/exclusion criteria did <u>not</u> include a desire to quit using marijuana or a desire to change sexual practices.

Procedures

Of the 1,690 individuals that were screened, 1,177 did not meet eligibility criteria. Of the 513 women eligible for participation, 170 refused or were unable to enroll. In total, 343 women provided informed consent approved by the institutional review board of Butler Hospital. Of these, 35 were determined to be ineligible during the baseline assessment. A total of 308 women completed the baseline assessment.

Measures

Substance use

Past 90-day marijuana, alcohol, and other substance use was assessed using the *Timeline Follow Back (TLFB;* Sobell & Sobell, 1992). The TLFB is a calendar-based questionnaire that prompts participants to recall the frequency of substance use in the past 90 days (Sobell & Sobell, 1992). Additional questions included the number of marijuana quit attempts, the number of times smoked marijuana per day, and whether or not participants were tobacco smokers.

DSM symptoms and substance related problems

Substance abuse and dependence symptoms (for marijuana, alcohol, and other drugs) in the past 90 days were assessed by trained research assistants using the *Structured Clinical Interview for DSM-IV*, (SCID-I; First, et al., 2002). Problems associated with marijuana use were assessed using the *Marijuana Problems Scale (MPS;* Stevens et al., 1993, 1994, 2000). This 19-item scale asks participants to rate a list of marijuana problems on a 3-point scale ranging from 0 (no problem) to 2 (serious problem). The 19-item problem scale has been shown to have strong internal consistency (Stevens, et al., 2000).

Analyses

We used LCA (McCutcheon 1987; Lazarsfeld & Henry, 1968) to identify homogenous subgroups of young female marijuana users based on their observed endorsement of 10 marijuana abuse and dependence criteria. Legal problems resulting from marijuana use (11th criteria item) was excluded because it was endorsed by only 4 (1.3%) participants. LCA assumes the observed indicator variables are statistically independent within categories of the latent class variable and standardized bivariate residuals are examined to evaluate this assumption (Vermunt & Magdison, 2000). Large standardized residuals indicate the latent classes do not adequately account for the covariance among observed indicators. Several statistical indices of model fit are also used to determine the number of latent classes to retain; however, no single criterion is universally accepted. These include information criterion such as BIC (Schwartz, 1978), which has generally been shown to perform better than the AIC (Akaike, 1987) in the context of LCA (Tofighi & Enders, 2007; Nyland et al., 2007). Alternatives to traditional LR tests have been proposed, these include the Lo-Mendell-Rubin (LMR-LRT) (Lo et al., 2001), the Vuong-Lo-Mendell-Rubin (VLMLR-LRT) (Golden, 2000), and the parametric bootstrap likelihood ratio test (BLRT) (McLachlan & Peel, 2000). In the current study, latent class models were fit using Mplus Version 5.1 (Muthén & Muthén, 1998–2009). The above noted indices of fit were used to compare models with 1 to 5 latent classes. The final number of latent classes retained was determined by the fit indices as well as the degree to which classes were conceptually distinct and theoretically or clinically meaningful.

Input variables for the LCA were 10 dichotomous (absent/present) indicators of marijuana abuse and dependence symptoms derived from the SCID. LCA estimates the probability of class membership for each participant and participants were assigned to the class in which their posterior probability of membership was highest. The average posterior probabilities within classes reflect the extent to which subgroups are distinct. Estimated probabilities of item endorsement on the input variables are reported to describe the latent classes. ANOVA and chi-square tests were used to compare the identified latent classes on a range of external variables; these included demographic characteristics, marijuana use behaviors, and use of other substances. In cases where the assumptions underlying use of ANOVA were not reasonably well approximated the nonparametric Kruskall-Wallis test was evaluated; in all cases the p-values obtained for the Kruskal-Wallis test were of similar magnitude to those we report from the ANOVA. When significant between class differences on external variables were observed, pairwise comparisons of means and percentages were used to identify which latent classes were different. Using the Bonferroni correction, pairwise comparisons were considered statistically significant if the observed p-value < .05/3. Since the Bonferonni adjustment is conservative and we considered these comparisons exploratory, we also identify pairwise comparisons with marginally significant p-values (.017 < p < .05) in Table 4 footnotes.

Results

Sample Characteristics

Participants averaged 20.9 (± 1.7) years of age (Table 1). About 67% (n = 206) were Caucasian, 11% (n = 35) were African American, 11% (n=34) were Hispanic, and 11% (n=33) were of other racial or ethnic origins. On average, participants reported using marijuana on 51.2 (± 30.4, Median = 50.5) of the 90 days. Most participants 96% (n = 295) had never married. A total of 23% (n=71) were living with a sex partner at baseline, 14% (n=43) reported having 1 or more children and 61% (n=187) had attended some college. In total, 52% (n=159) of participants met diagnostic criteria for marijuana abuse and 41% (n=129) met dependence criteria (Table 1).

As compared to study participants, those refusing were not found to be significant different in terms of race/ethnicity (χ^2 = 1.43 df = 1, p = .231), age (t = 1.82, p = .070), and frequency of marijuana use (t = 0.05, p = .963).

Latent Class Analysis

Fit statistics for models with 1 to 5 latent classes are reported in Table 2. These consistently indicate that models with 1- and 5-latent classes provide a poor statistical fit with the observed data. The fit indices are less consistent regarding the fit of models with 2 to 4 latent classes. While BIC slightly favors a 2-class model, all 3 alternative LR-tests indicate that a 3-class model fits the observed data better than a 2-class model. An examination of standardized residuals also favored the 3-class model. In a 2-class model 12 of 180 standardized bivariate residuals exceeded | 1.96 |; none of the standardized residuals in the 3-class model exceeded this threshold. The BLRT favors a 4-class model (p < .05), while the p-values for both the LMR-LRT and the VLMR-LRT support a 3-class model (.05 < p < .10). The standardized bivariate residuals from the 3-class model did not exceeded | 1.96 | indicating that the observed indicators are statistically independent within classes (e.g., locally or conditionally independent) and that additional classes are not required to account for the covariation between observed indicators. Based on model fit statistics and an evaluation of substantive differences between 3- and 4-class solutions the more parsimonious 3-class solution was selected for additional analysis.

The average within-class posterior probabilities for the 3-class model were .887, .870, and .870 for classes I, II, and III, respectively; this reflects strong between-class separation and within-class homogeneity. This is consistent with Grant et al. (2006) who reported that among females a model with 3 latent classes provided the best fit.

Endorsement patterns for the DSM-IV marijuana abuse and dependence criteria and the estimated within class probability of meeting each criterion are given in Table 3. Overall, the abuse criteria most frequently met were failing to fulfill obligations (34.1%) and use in hazardous situations (30.8%); the dependence criteria most often endorsed were using larger amounts than intended (52.9%), time spent using marijuana (43.5%) and tolerance (43.5%). Based on estimated posterior probabilities of class membership, 114 (37.0%), 128 (41.6%), and 66 (21.4%) women were assigned to Classes I, II, III, respectively. The estimated probability of meeting individual abuse and dependence criteria in Class I were, with one exception, < .10. The criterion with the highest probability of endorsement in Class I was using larger amounts of marijuana than intended. Class III had the highest estimated probabilities of meeting all 10 abuse/dependence criteria (Table 3). Class II had relatively high estimated probabilities of endorsing failing to fulfill obligations (.43), use in hazardous situations (.38), using larger amounts than intended (.65), using a great deal of the time (.51) and tolerance (.55). Relative to Class II, the estimated probability of endorsing interpersonal problems, unsuccessful efforts to cut down, giving up activities, and experiencing withdrawal are especially high in Class III. We use the labels "Unaffected/Mild," "Abuse/Moderate Dependence," and "Severe Abuse/Dependence" to describe Classes I, II, and III, respectively.

Nine (7.9%) of those assigned to Class I, 88 (68.8%) of those assigned to Class II, and 62 (93.9%) of those assigned to Class III met clinical criteria for a diagnosis of marijuana abuse in the past 90 days. None of the participants assigned to Class I met diagnostic criteria for marijuana dependence compared with 59 (46.1%) of those in Class II and 66 (100.0%) of those assigned to Class III.

Socio-demographic comparisons of latent classes

Participants were assigned to classes based on their highest estimated probability of membership. Significant between-class differences were observed with respect to ethnicity ($\chi^2 = 13.49$, df = 6, $p < .05$) and educational attainment ($\chi^2 = 6.88$, df = 2, $p < .05$) (Table 4). African-Americans (25.7%) and Hispanics (29.4%) were less likely to be classified in the unaffected/mild class than non-Hispanic Whites (39.8%) or those with other ethnic background (39.4%). African-Americans (45.7%) had the highest rate of being assigned to the moderate problem user class while Hispanics (41.2%) had the highest rate of being classified in the severe problem user group (See Table 4). Participants assigned to the unaffected/mild class (76.3%) were more likely to have had some college or completed a college degree than those in the moderate problem user (62.5%) or severe problem user (60.6%) classes. The identified classes did not differ with respect to mean age (F [2,305] = 1.40, $p > .10$), marital/partner status ($\chi^2 = 1.77$, df = 2, $p > .10$), or having children ($\chi^2 = 1.82$, df = 2, $p > .10$).

Marijuana use, problems, and quit attempts

Significant between-class differences were observed for mean age of first marijuana use (F [2,305] = 7.31, $p < .01$), mean days of marijuana use during the 90 days prior to baseline (F [2,305] = 48.34, $p < .01$), mean number of times marijuana was used on use days (F [2,305] = 26.80, $p < .01$), mean marijuana problem severity index scores (F [2,305] = 106.17, $p < .01$), and mean number of previous quit attempts (F [2,305] = 14.31, $p < .01$) (Table 4). The association between-class membership and these external indicators of marijuana involvement suggested a monotonic pattern. Participants assigned to the severe problem user class had the youngest mean age of initiating marijuana use, the highest mean daily frequency of marijuana use, highest quantity of marijuana use, highest marijuana problem severity, and the highest mean number of quit attempts (Table 4).

Other substance use

The three latent classes did not differ significantly with respect to the percentage of current cigarette smokers ($\chi^2 = 2.51$, df = 2, $p > .10$) (Table 4). However, the classes differed significantly with respect to the likelihood of meeting criteria for alcohol abuse ($\chi^2 = 22.87$, df = 2, $p < .01$) and alcohol dependence ($\chi^2 = 20.06$, df = 2, $p < .01$); participants assigned to the severe problem user class had the highest rates of alcohol abuse (45.5%) and dependence (25.8%). The mean frequency of daily alcohol consumption did not differ significantly across classes (F [2,305] = 0.67, $p > .10$).

Mean frequency of cocaine use in the 90 days prior to baseline did not differ significantly across the three identified classes (F [2,305] = 1.11, $p > .10$), but significant between-class differences were observed for mean number of days of opioid use (F [2,305] = 6.42, $p < .01$ - Table 4). Participants assigned to the severe problem class used opioids on approximately 2.1 days compared to .5 days and about .2 days for those in the moderate problem user and unaffected/mild classes, respectively.

Discussion

In the current study, we sought to replicate and extend the work of Grant et al. (2006) by attempting to identify subgroups of young adult female marijuana users based on DSM abuse and dependence criteria. Results from the LCA indicated a three class model that reflects a severity continuum of mild, moderate and severe. The three latent classes parallel those found by Grant et al. (2006) and in both studies a mild unaffected user class and a severe problem user class emerged. In the current study, Class III consisted entirely of individuals meeting diagnostic criteria for marijuana dependence with the highest number of

days of marijuana use, greatest frequency of marijuana use, highest levels of alcohol abuse and dependence, and the highest rates of other drug use. Class III includes marijuana users whose level of severity has caused marked impairments and problems likely to necessitate treatment. Accordingly, Class III had the highest rates of marijuana quit attempts.

In contrast, Class I reported relatively infrequent marijuana use and very few marijuana-related problems. Less frequent marijuana users have received little empirical attention. These users rarely present for substance use treatment, including marijuana treatment. Nevertheless, mild users constitute a significant proportion of female marijuana users. For example, in the Grant et al. (2006) study, approximately 67% of females in the sample were classified in the mild unaffected class. In the current investigation, the only distinguishing demographic characteristic of the "mild/unaffected" class was a higher level of education. A higher level of education or current college enrollment was associated with lower severity marijuana use in this sample. In large scale epidemiological surveys of both users and non-users, college students have been shown to have similar rates of marijuana use as their non-college peers (Johnston et al., 2007). Educational distinctions may be more likely to emerge when the relationship between education level and use are examined exclusively (as in our study) among female marijuana users. We speculate that higher levels of educational attainment or current college enrollment may serve a protective function due to a greater level of commitment to academic success and career, endeavors where more frequent marijuana use may interfere .

Alcohol abuse and dependence was found to be highest among participants in Class III - the severe problem user group. This finding is consistent with Ives & Gelani's (2006) review of the literature relating to poly-substance use which noted an association between alcohol and marijuana use. Studies have also consistently found that the use of alcohol among young people increases the risk for using any illicit substance including marijuana (Pape et al., 2009; Ives & Gelani, 2006, Bailey et al., 1999; Merill et al., 1999). It is thought that marijuana is often used in the context of alcohol use and one substance can cue the use of the other (Pape et al., 2009). Furthermore, studies have revealed additive negative effects of combined alcohol and marijuana use (Kelly et al., 2004; Ramaekers et al., 2000; Robbe, 1998). In our sample, this is illustrated by higher endorsement rates of DSM alcohol abuse and dependence criteria among our most severe marijuana problem users.

Interestingly, the derived latent classes did not differ significantly in the proportion endorsing current tobacco use. Nevertheless, Class III members reported a higher rate (56.1%) of tobacco use than the rates reported by Classes I or II (43.9, 49.2, respectively). Agrawal and colleagues (2009) found young adult female tobacco smokers to be up to 9.5 times more likely to have co-occurring marijuana use. Our findings suggest that when the relationship between tobacco use and marijuana use severity are examined among marijuana users exclusively, significant tobacco use distinctions disappear. The role of socio-economic status (SES) may have played a role in our findings. In a recent general population study, Tehranifar and colleagues (2009) found lower SES to increase the risk of tobacco use by up to 2.7 times. Similarity in SES characteristics across our sample may have resulted in the similar rates of tobacco use irrespective of marijuana use severity reported here.

Also noteworthy, the three derived latent classes were found to significantly differ in their age of marijuana initiation. Class III was found to have the earliest mean age of onset (13.8) while Class I (the mild unaffected group) had the oldest age of onset (15.1). This finding is consistent with the body evidence that suggests that an earlier age of onset of any substance is associated with greater levels of substance use and substance use problems later in life (Wittchen, et al., 2008). Even among our cohort of young females with a mean age of twenty-one, the consequences of very early adolescent marijuana can be seen. The

differences in age of initiation among latent classes may represent the progressive nature of marijuana use, with longer periods of use leading to greater DSM marijuana problems in the next few years that include life transitions and milestone crucial to development. The relationship between age of marijuana initiation and later marijuana problems has implications for prevention efforts targeting young adult females. Primary and secondary prevention efforts during earlier periods of adolescence may thwart the progression of use and decrease the risk for marijuana abuse and escalating consequences.

Implications

The findings of the current study have implications for informing the development of prevention, assessment, and treatments for young women with varying degrees of marijuana use and comorbid substance use problems. A number of treatment modalities for marijuana dependence have been developed and tested (Budney et al., 2007). However, as noted earlier, individuals seeking or being mandated to treatment are likely to be more severe users similar to Class III in this study. Interventions for moderate and infrequent marijuana users have yet to be fully developed and tested. The current study begins to characterize such users in the hopes that such information can lead to treatment approaches that address the unique needs of young women with varying levels of use. Our findings also highlight the need for interventions to target the use of alcohol and other substances in the context of marijuana treatment.

Findings from the current study may also contribute to the growing debate surrounding the DSM approach (i.e., categorical versus dimensional) to the classification of substance use disorders. Recent studies that have sought to examine this issue using Item Response Theory (IRT) have repeatedly demonstrated that the DSM cannabis abuse and dependence distinctions are not empirically supported (Compton et al., 2009; Lynskey & Agrawal, 2007; Martin et al., 2006; Gillespie et al., 2007). Instead, a single dimensional scale of severity has been shown to be a more valid approach. The latent classes in our study correspond to a severity spectrum and suggest subtypes along the severity spectrum. Furthermore, the adoption of a DSM dimensional approach to the psychiatric diagnosis of cannabis disorders will continue to require severity thresholds to direct level of care. Therefore, LCA sub-typing based on DSM cannabis disorder criteria offers an empirical approach for obtaining information on cannabis severity groupings.

Limitations

The use of self-reports for gathering substance use data is a limitation of this study. Despite the potential for self-report biases, studies have found a high concordance rate between self-report and biomarkers of use (Rose, et al., 2007; Solbergsdottir et al., 2004; Neale & Robertson, 2003). The cross-sectional nature of the current study limits our ability to make conclusions regarding the stability of class associations.

Third, despite the fact that participants were asked about DSM criteria for each substance individually, the incidence of poly-substance could potentially make it difficult for participants to fully distinguish between specific marijuana related problems and problems associated with other substance use (Compton, et al., 2009). Future studies can address this issue through the use of more stringent inclusion/exclusion criteria that results in samples of "purer" marijuana users.

A related limitation is the use of DSM categorical variables in the LCA models. Considering the dimensional nature of DSM marijuana problem severity, utilizing continuous variables of DSM marijuana problems in the LCA may potentially enhance the derived subgroupings. However, our approach was intentionally selected in order to replicate Grant et al's (2006)

methodology. Furthermore, the LCA may have also been enhanced by including potential covariates. Once again, our intent to replicate the work of Grant et al. (2006) as well as our aim of deriving subgroups based purely on DSM problems guided our methodological approach.

Finally, we specifically sought to investigate the subpopulation of females between the ages of 18 and 24. Thus, our findings may not generalize to older women, non-current users of marijuana, women who are not sexually active, non-community samples, or males. However, we specifically focused on this highly vulnerable subgroup due to the high levels of both substance use and risk for sexually transmitted diseases. The current study remains the only investigation examining LCA-derived marijuana user subgroups in a female sample of young adults and our findings begin to shed light on the user profiles of this relatively understudied subpopulation.

Acknowledgments

References

Agrawal A, Lynskey MT, Madden PA, Pergadia ML, Bucholz KK, Heath AC. Simultaneous cannabis and tobacco use and cannabis-related outcomes in young women. Drug and Alcohol Dependence 2009;101(1–2):8–12. [PubMed: 19081202]

Akaike H. Factor analysis and AIC. Psychometrika 1987;52:317–332.

American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-IV-TR. Washington, DC: Author; 2000.

Arnett JJ. Emerging adulthood: A theory of development from late teens through twenties. American Psychologist 2000;55(5):469–480. [PubMed: 10842426]

Auerbach KJ, Collins LM. A multidimensional developmental model of alcohol use during emerging adulthood. Journal of Studies on Alcohol 2006;67(6):917–925. [PubMed: 17061010]

Bailey SL. The measurement of problem drinking in young adulthood. Journal of Studies on Alcohol 1999;60:234–244. [PubMed: 10091962]

Brook JS, Rosen Z, Brook DW. The effect of early marijuana use on later anxiety and depressive symptoms. NYS Psychologist 2001 January;:35–39.

Brook JS, Stimmel MA, Zhang C, Brook DW. The association between earlier marijuana use and subsequent academic achievement and health problems: A longitudinal study. American Journal on Addictions 2008;17(2):155–160. [PubMed: 18393060]

Buchholz KK, Heath AC, Reich T, Hesselbrock VM, Kramer JR, Nurnberger JI, et al. 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 1996;20(8):1462–1471.

Budney AJ. Are specific dependence criteria necessary for different substances: How can research on cannabis inform this issue? Addiction 2006;101 Suppl.1:125–133. [PubMed: 16930169]

Budney AJ, Roffman R, Stephens RS, Walker D. Marijuana dependence and its treatment. Addiction Science and Clinical Practice 2007;4(1):16–18. [PubMed: 18292705]

Chisholm L, Hurrelmann K. Adolescence in modern Europe: Pluralized transition patterns and their implications for personal and social risks. Journal of Adolescence 1995;18:129–158.

Compton WM, Saha TD, Conway KP, Grant BF. The role of cannabis use within a dimensional approach to cannabis use disorders. Drug and Alcohol Dependence 2009;100(3):221–227. [PubMed: 19062204]

Compton WM, Grant BF, Colliver JD, Glantz MD, Stinson FS. Prevalence of marijuana use disorders in the United States. JAMA 2004;291(17):2114–2121. [PubMed: 15126440]

De Genna NM, Cornelius MD, Cook RL. Marijuana use and sexually transmitted infections in young women who were teenage mothers. Women's Health Issues 2007;17(5):300–309.

Fattore, L.; Altea, S.; Fratta, W. Women's Health. Vol. 4. London. England: 2008. Sex differences in drug addiction: A review of animal and human studies; p. 51-65.

Fergusson DM, Horwood LJ, Beautrais AL. Cannabis and educational achievement. Addiction 2003;98(12):1681–1692. [PubMed: 14651500]

Fergusson DM, Horwood LJ, Swain-Campbell N. Cannabis use and psychosocial adjustment in adolescence and young adulthood. Addiction 2002;97(9):1123–1135. [PubMed: 12199828]

First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JB. Structured Clinical Interview for DSM-IV-TR Axis I Disorders Research Version, Patient Edition (SCID-I/P). New York, NY: Biometrics Research New York State Psychiatric Institute; 2002.

Gillespie NA, Neale MC, Prescott CA, Aggen SH, Kendler KS. Factor and item-response analysis DSM-IV criteria for abuse of an dependence on cannabis, cocaine, hallucinogens, sedatives, stimulants and opioids. Addiction 2007;102(6):920–930. [PubMed: 17523987]

Golden RM. Statistical Tests for comparing possibly misspecified and nonnested models. Journal of Mathematical Psychology 2000;44:153–170. [PubMed: 10733862]

Grant JD, Scherrer JF, Neuman RJ, Todorov AA, Price RK, Bucholz KK. A comparison of the latent class structure of cannabis problems among adult men and women who have used cannabis repeatedly. Addiction 2006;101(8):1133–1142. [PubMed: 16869843]

Ives R, Ghelani P. Polydrug use (the use of drugs in combination). A brief review. Drugs: Education, Prevention & Policy 2006;12:225–232.

Johnston, LD.; O'Malley, PM.; Bachman, JG.; Schulenberg, JE. Monitoring the future national survey results on drug use, 1975–2006: Volume II, college students and adults ages. Bethesda, MD: National Institute on Drug Abuse; 2007. p. 19-45.(NIH Publication No. 07-6206)

Kelly E, Drake S, Ross J. A review of drug use and driving: epidemiology, impairment and risk perceptions. Drug and Alcohol Review 2004;23:319–344. [PubMed: 15370012]

King RA, Schwab-Stone M, Flisher AJ, Greenwald S, Kramer RA, Goodman, et al. Psychosocial and risk behavior correlates of youth suicide attempts and suicidal ideation. Journal of the American Academy of Child & Adolescent Psychiatry 2001;40(7):837–846. [PubMed: 11437023]

Langenbucher JW, Labouvie E, Martin CS, Sanjuan PM, Bavly L, Kirisci L. An application of item response theory analysis to alcohol, cannabis, and cocaine criteria in DSM-IV. Journal of Abnormal Psychology 2004;113:72–80. [PubMed: 14992659]

Lazarsfel, P.; Henry, N. Latent Structure Analysis. New York: Houghton-Miffin; 1968.

Lo Y, Mendell N, Rubin D. Testing the number of components in a normal mixture. Biometrika 2001;88:767–778.

Lynskey MT, Agrawal A. Psychometric properties of DSM assessments of illicit drug abuse and dependence: Results from the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). Psychological Medicine 2007;37(9):1345–1355. [PubMed: 17407621]

Lynskey M, Hall W. The effects of adolescent cannabis use on educational attainment. Addiction 2000;95(11):1621–1630. [PubMed: 11219366]

Magidson, J.; Vermunt, JK. Latent Class Models. In: Kaplan, D., editor. The Sage Handbook of Quantitative Methodology for the Social Sciences, Chapter 10. Thousand Oaks: Sage Publications; 2000.

Martin CS, Chung T, Kirisci L, Langenbucher JW. Item response theory analysis of diagnostic criteria for alcohol and cannabis use disorders in adolescents: Implications for DSM-V. Journal of Abnormal Psychology 2006;115(4):807–814. [PubMed: 17100538]

McCutcheon, AC. Latent Class Analysis. Beverly Hills, CA: Sage; 1987.

McLachlan, G.; Peel, D. Finite mixture models. Beverly Hills, CA: Sage; 2000.

Merrill JC, Kleber HD, Schwartz M, Lui H, Lewis SR. Cigarettes, alcohol, marijuana, and other risk behaviors, and American youth. Drug and Alcohol Dependence 1999;56:205–212. [PubMed: 10529022]

Moore BA, Auguston EA, Moser RP, Budney AJ. Respiratory effects of marijuana tobacco use in a U.S. sample. Journal of General Internal Medicine 2004;20:33–37. [PubMed: 15693925]

Moss HB, Chen CM, Yi HY. Subtypes of alcohol dependence in a nationally representative sample. Drug and Alcohol Dependence 2007;91(2):149–158. [PubMed: 17597309]

Muthén, LK.; Muthén, BO. Mplus User's Guide: Fifth Edition. Los Angeles, CA: Authors; 1998–2009.

Neale J, Robertson M. Comparisons of self-report data and oral fluid testing in detecting drug use amongst new treatment clients. Drug and Alcohol Dependence 2003;71(1):57–64. [PubMed: 12821206]

Nyland KL, Asparouhov T, Muthén BO. Deciding on the Number of Classes in Latent Class Analysis and Growth Mixture Modeling: A Monte Carlo Simulation Study. Structural Equation Modeling 2007;4:535–569.

Pape H, Rossow I, Storvoll EE. Under double influence: Assessment of simultaneous alcohol and cannabis use in general youth populations. Drug and Alcohol Dependence 2009;101(1–2):69–73. [PubMed: 19095380]

Poulin C, Graham L. The association between substance use, unplanned sexual intercourse and other sexual behaviors among adolescent students. Addiction 2001;96(4):607–621. [PubMed: 11300964]

Ramaekers JG, Robbe HWJ, O'Hanlon JF. Marijuana, alcohol and actual driving performance. Human Psychopharmacology: Clinical and Experimental 2000;15:551–558. [PubMed: 12404625]

Robbe HWJ. Marijuana's impairing effects on driving are moderate when taken alone but severe when combined with alcohol. Human Psychopharmacology: Clinical and Experimental 1998;13:S71–S78.

Rose JS, Herman DS, Hagerty C, Phipps MG, Pelpert JF, Stein MD. Marijuana use among young women in a primary care setting. Journal of General Internal Medicine 2007;22(6):826–829. [PubMed: 17372785]

Schwartz G. Estimating the dimension of a model. Annals of Statistics 1978;6:461–464.

Sobell, L.; Sobell, M. Timeline follow-back: A technique for assessing self-reported alcohol consumption. In: Allen, LA., editor. Measuring Alcohol Consumption. New York, NY: The Humana Press; 1992.

Solbergsdottir E, Bjornsson G, Gudmundsson LS, Tyrfingsson T, Kristinsson J. Validity of self-reports and drug use among young people seeking treatment for substance abuse or dependence. Journal of Addictive Diseases 2004;23(1):29–38. [PubMed: 15077838]

Solowij N, Stephens RS, Roffman RA, Babor T, Kadden R, Miller M, et al. Cognitive functioning of long-term heavy cannabis users seeking treatment. JAMA 2002;287(9):1123–1131. [PubMed: 11879109]

Stephens RS, Roffman RA, Curtin L. Comparison of extended versus brief treatments for marijuana use. Journal of Consulting and Clinical Psychology 2000;68(5):898–908. [PubMed: 11068976]

Stephens RS, Roffman RA, Simpson EE. Adult marijuana users seeking treatment. Journal of Consulting and Clinical Psychology 1993;61:1100–1104. [PubMed: 8113490]

Stephens RS, Roffman RA, Leghorn F, Simpson EE. Treating adult marijuana dependence: A test of the relapse prevention model. Journal of Consulting and Clinical Psychology 1994;62:92–99. [PubMed: 8034835]

Substance Abuse and Mental Health Services Administration. Results from the 2006 National Survey on Drug Use and Health: National Findings. Rockville, MD: Office of Applied Studies; 2007. NSDUH Series H-32, DHHS Publication No. SMA 07-4293

Substance Abuse and Mental Health Services Administration. Results from the 2007 National Survey on Drug Use and Health: National Findings. Rockville, MD: Office of Applied Studies; 2008. NSDUH Series H-34, DHHS Publication No. SMA 08-4343

Tashkin DP. Smoked marijuana as a cause of lung injury. Monaldi Archives for Chest Disease 2005;63:93–100. [PubMed: 16128224]

Teeson M, Lynskey M, Manor B, Baillie A. The structure of cannabis dependence in the community. Drug and Alcohol Dependence 2002;68:255–262. [PubMed: 12393220]

Tehrani P, Liao Y, Ferris JS, Terry MB. Life course socioeconomic conditions, passive tobacco exposures and cigarette smoking in a multiethnic birth cohort of U.S. women. Cancer Causes and Control 2009;20(6):867–876. [PubMed: 19238563]

Tofighi, D.; Enders, CK. Identifying the correct number of classes in a growth mixture model. In: Hancock, GR., editor. Mixture models in latent variable research. Greenwich, CT: Information Age; 2007. p. 317-341.

Wittchen HU, Behrendt S, Hofler M, Perkonigg A, Lieb R, Buhriners G, et al. 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 2008;17 Suppl:16–29.

Zwerling C, Ryan J, Orav EJ. The efficacy of preemployment drug screening for marijuana and cocaine in predicting employment outcome. JAMA 1990;264(20):2639–2643. [PubMed: 2232039]

Table 1

Background Characteristics (n = 308).

	Mean (± SD)	Median	Range
Age (Years)	20.88 (1.76)	20.0	18 – 24
Age First Used Marijuana	14.75 (2.18)	15.0	8 – 21
Days (Past 90) Used Marijuana	51.23 (30.37)	50.5	3 – 90
Marijuana Problem Severity Index	5.04 (3.80)	4.0	0 – 18
Marijuana Quit Attempts	1.55 (3.99)	0.0	0 – 50
Days (Past 90) Used Alcohol	18.68 (16.32)	14.0	0 – 80
Days (Past 90) Used Cocaine	0.36 (1.49)	0.0	0 – 10
Days (Past 90) Used Opioids	0.75 (3.60)	0.0	0 – 49
Race/Ethnicity	% (n)		
Caucasian (non-Hispanic)	66.9 (206)		
African – American	11.4 (35)		
Hispanic	11.0 (34)		
Other Minority	10.7 (33)		
Some College or Degree (Yes)	67.2 (207)		
Married or Lives w Partner (Yes)	23.1 (71)		
Marijuana Abuse (Yes)	51.6 (159)		
Marijuana Dependence (Yes)	40.6 (129)		
Met Alcohol Abuse Criteria (Yes)	26.3 (81)		
Met Alcohol Dependence Criteria (Yes)	11 (34)		
Current Cigarette Smoker (Yes)	48.7 (150)		
Recent (90 Days) Opioid Use (Yes)	15.9 (49)		
Recent (90 Days) Cocaine Use (Yes)	14.9 (46)		

Table 2

Fit Indices for Models with 1 to 5 Latent Classes (n = 308).

Criterion	Number of Latent Classes				
	1	2	3	4	5
BIC	3495.1	3167.2	3170.8	3199.6	3243.8
VLMR[a] p =	NA	.000	.015	.074	.318
LMR[b] p =	NA	.000	.016	.078	.324
Bootstrapped LR Test[c] p =	NA	.000	.000	.000	.667

[a]Vuong-Lo-Mendell-Rubin Likelihood Ratio Test comparing a model with k latent classes to a model with k-1 latent classes, not applicable for 1-class models.

[b]Lo-Mendell-Rubin Adjusted Likelihood Ratio Test comparing a model with k latent classes to a model with k-1 latent classes, not applicable for 1-class models.

[c]Parametric bootstrapped likelihood ratio test comparing a model with k latent classes to a model with k-1 latent classes, not applicable for 1-class models.

Table 3

Observed Distribution and Estimated Probability of Marijuana Abuse/Dependence Criteria by Latent Class (n= 308)

		Latent Class		
		I (n = 114)	II (n = 128)	III (n = 66)
		Unaffected/	*Abuser/Moderate*	*Severe Abuse/*
Abuse Criterion	**Total (n = 308)**[a]	*/Mild*	*Dependence*	*Dependence*
Failed to Fulfill Obligations	105 (34.1%)	.01	.43	.69
Used in Hazardous Situations	95 (30.8%)	.07	.38	.54
Interpersonal Problems	36 (11.7%)	.02	.06	.38
Dependence Criterion				
Larger Amounts Than Intended	163 (52.9%)	.14	.65	.90
Unsuccessful Efforts to Cut Down	81 (26.3%)	.03	.25	.66
Great Deal Time Spent Using	134 (43.5%)	.08	.51	.85
Gave Up Activities	61 (19.8%)	.01	.12	.64
Continued Use Despite Problems	63 (20.5%)	.03	.20	.49
Tolerance	134 (43.5%)	.07	.55	.78
Withdrawal	30 (9.7%)	.02	.02	.38

[a]Observed number and percentage meeting each criterion.

Table 4

Comparison of Latent Classes on Background Characteristics, Substance Use Behaviors, and Other Problems (n = 308).

	Latent Class			
	I	II	III	
	(n = 114)	(n = 128)	(n = 66)	
Demographic Characteristics	Unaffected/ /Mild	Abuser/Moderate Dependence	Severe Abuse/Depen	p = [a]
Mean (SD) Age	21.1 (1.7)	20.8 (1.8)	20.7 (1.7)	.247
Race/Ethnicity				**.036**
% (n) White (Non-Hispanic)[bc]	39.8 (82)	43.7(90)	16.5 (34)	
% (n) African-American[b]	25.7 (9)	45.7 (16)	28.6 (10)	
% (n) Hispanic [bcd]	29.4 (10)	29.4 (10)	41.2 (14)	
% (n) Other Minority [b]	39.4 (13)	36.4 (12)	24.2 (8)	
% (n) Some College or Degree [e]	76.3 (87)	62.5 (80)	60.6 (40)	**.032**
% (n) Married or Lives with Partner	27.2 (31)	20.3 (26)	21.25 (14)	.413
% (n) Any Children	10.5 (12)	15.6 (20)	16.7 (11)	.403
Substance Use				
Mean (SD) Age 1st Used MRJ [c]	15.1 (2.4)	14.9 (1.9)	13.8(2.1)	**.027**
Mean (SD) Days of MRJ (Past 90)[f]	32.8 (27.9)	57.9 (27.2)	70.2 (22.4)	**.000**
# MRJ Times / Use Day[f]	1.5 (0.7)	2.7 (1.8)	3.8 (3.4)	**.000**
MRJ Problem Severity Index[f]	2.5 (2.0)	5.3 (2.9)	9.0 (4.1)	**.000**
Marijuana Quit Attempts [c]	0.7 (1.6)	1.2 (2.1)	3.7 (7.4)	**.000**
% (n) Current Cigarette Smoker	43.9 (50)	49.2 (63)	56.1 (37)	.284
% (n) Alcohol Abuse Criteria[f]	13.2 (15)	28.1 (36)	45.5 (30)	**.000**
% (n) Met Alc. Dep. Criteria [c]	5.5 (5)	9.4 (12)	25.8 (17)	**.000**
Mean (SD) Days Alc. (Past 90)	18.4 (16.3)	17.9 (14.6)	20.7 (19.4)	.512
% (n) Recent (90 Days) Opioid Use [c]	7.9 (9)	15.6 (20)	30.0 (20)	.059
Mean (SD) Days (Past 90) Opioid [c]	0.2 (0.9)	0.5 (1.9)	2.1 (7.1)	**.002**
% (n) Recent (90 Days) Cocaine	11.4 (13)	14.1 (18)	22.7 (15)	.114
Mean (SD) Days(Past 90)Cocaine	0.3 (1.2)	0.3 (1.0)	0.6 (1.5)	.331

[a]P-values of the F- and Pearson χ^2-statistics for comparisons of continuous and categorical characteristics, respectively. P-values < .05 are in **bold**.

[b]To facilitate interpretation percentages within categories of ethnicity were calculated and reported.

[c]Class I and Class II are significantly (Bonferroni Corrected p < .017) different than Class III.

[d]Difference between Class I and Class III is .marginally significant (.017 < p < .05).

[e]Differences between Classes I and II and between Classes I and III are marginally significant (.017 < p < .05).

[f]All pairwise comparisons between Classes are statistically significant (p < ..017).