Outcomes Associated with Adolescent Marijuana and Alcohol Use Among Urban Young Adults: A Prospective Study

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Abstract

Objective—This study identifies and compares outcomes in young adulthood associated with longitudinal patterns of alcohol and marijuana use during adolescence among urban youth.

Method—Data come from a cohort of 678 urban, predominantly Black children followed from ages 6–25 (1993–2012). Analyses are based on the 608 children who participated over time (53.6% male). Longitudinal patterning of alcohol and marijuana use were based on annual frequency reports from grades 8–12 and estimated through latent profile analysis.

Results—We identified four classes of alcohol and marijuana use including Non-Use (47%), Moderate Alcohol Use (28%), Moderate Alcohol/Increasing Marijuana Use (12%) and High Dual Use (13%). A marijuana only class was not identified. Analyses show negative outcomes in adulthood associated with all three adolescent substance use classes. Compared to the non-use class, all use classes had statistically significantly higher rates of substance dependence. Those in the 'High Dual Use' class had the lowest rate of high school graduation. Comparing classes with similar alcohol but different marijuana patterns, the 'Moderate Alcohol/Increasing Marijuana Use' class had a statistically significant increased risk of having a criminal justice record and developing substance use dependence in adulthood.

Conclusion—Among urban youth, heterogeneous patterns of alcohol and marijuana use across adolescence are evident, and these patterns are associated with distinct outcomes in adulthood.

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These findings suggest a need for targeted education and intervention efforts to address the needs of youth using both marijuana and alcohol, as well as the importance of universal early preventive intervention efforts.

Keywords

African Americans; Blacks; cannabis; latent profile analysis; longitudinal patterns; substance use effects

1. Introduction

1.1 Joint Patterns of Alcohol and Marijuana Use and Comparative Outcomes

Alcohol and marijuana are two commonly used substances during adolescence, and yet longitudinal patterns of joint use and associated outcomes have rarely been explored. Recently to identify specific subgroups of adolescent alcohol and marijuana users, a number of studies have applied person-centered methods and found four or more distinct patterns of use (e.g., Conway et al., 2013; Dierker et al., 2007; Harrington et al., 2012). For example, Moss and colleagues (2014) analyzed national data (Wave 4 only of the Add Health Survey) using latent class analysis to identify classes using retrospective reports of onset prior to age 16 of alcohol, marijuana, and cigarettes. They found non-users of alcohol and marijuana (40%), two alcohol only classes (18%), two marijuana only classes (10%), and two classes of alcohol and marijuana users (32%), emphasizing how common dual-use of marijuana and alcohol is during adolescence. Their work also points out the importance of dual-use of marijuana and alcohol as this group had the highest rate of marijuana and other illegal drug use in young adulthood.

Patton and colleagues (2007) in a rare longitudinal study extended our understanding of adolescent alcohol and marijuana patterning by examining use over time in an Australian cohort (ages 15–24). They classified adolescents in four categories: non-risk use, moderate-risk marijuana only, moderate-risk alcohol only and concurrent moderate-risk of both substances and found more negative outcomes in terms of education/training, relationship status, and illegal drug use associated with moderate marijuana use than with moderate-risk alcohol use compared to non-risk use. Interestingly, concurrent moderate-risk of both substances did not elevate risk over moderate marijuana use only, which is in contrast to work of others that have found worse outcomes associated with dual use of alcohol and marijuana than use of either substance alone among adults (Harrington et al., 2012; Midanik, Tam & Weisner, 2007). For example, Shillington and Clapp (2006) interviewed college students and found poorer academic performance, greater substance use problems, and more criminal justice system involvement among dual users compared to alcohol only users. Thus, there remains much to be learned about potential adverse outcomes associated with adolescent marijuana use and drinking patterns, as most studies rely on cross-sectional patterns and have examined outcomes separately for marijuana and alcohol, limiting our understanding of outcomes associated with dual use patterns over time.

1.2 Focus on Black Youth

The present study utilizes a predominantly Black sample of urban youth as little is known about dual use among this population despite their at-risk status. Evidence suggests that the strength of the association between marijuana use and heavy drinking has increased in recent years among black, but not white, adolescents (Lanza et al., 2015). Previous work also shows that Blacks are disproportionately impacted by substance use, including higher rates of co-occurring alcohol and marijuana use disorders than Whites (French et al., 2002; Pacek et al., 2010). Blacks also have twice the risk of marijuana arrests than Whites despite similar rates of use (Lurigio & Loose, 2008). Importantly, Blacks experience less economic success in adulthood overall, and substance use disorders and substance use arrests may exacerbate this pattern (Alexander et al., 2014).

1.3 Current Study

This study analyzes prospective data from an urban cohort of predominantly Black Americans followed from childhood to young adulthood. We seek to determine (1) what are typical patterns of alcohol and marijuana use from grades 8–12, (2) what adult outcomes are associated with typical use patterns of adolescent marijuana and alcohol use?, (3) how do outcomes for marijuana use patterns compare to those for alcohol use patterns? We focus on educational, economic, substance use and crime outcomes as previous work examining outcomes separately for adolescent marijuana and for alcohol use have found adverse effects in these domains (Brook et al., 2013; Ellickson et al., 2003; Fergusson & Boden, 2008; Green & Ensminger, 2006; Green et al., 2010; Green et al., 2011; Hill et al., 2000; Lynskey & Hall, 2000; Sloan et al., 2001; Viner & Taylor, 2007; Wells et al., 2004).

2. Materials and Methods

2.1 Sample

The analytic sample consisted of 608 participants initially recruited in first grade for a randomized universal preventive trial, whose immediate targets were improving academic performance and preventing aggressive behavior (Ialongo et al, 1999). Nearly half were female (47.4%), and 87.2% were Black. The majority of the sample (69.7%) received free or reduced price lunch in first grade. The original sample consisted of 678 children, representative of students entering first grade in nine Baltimore City public schools in fall 1993. Three first grade classrooms in each of nine schools were randomly assigned to one of two interventions or a control condition. Interventions were provided throughout first grade. This research was reviewed and approved by the Institutional Review Board of the Johns Hopkins Bloomberg School of Public Health. Signed consent was obtained from parents prior to age 18, along with youth assent. Signed consent was obtained from each participant at age 18 and thereafter at each interview. For more information about the sample and interventions, see Ialongo and colleagues (1999).

The 608 participants in the analytic sample had (1) baseline academic achievement and teacher ratings of behaviors in first grade; (2) at least one annual report of past year frequency of marijuana and alcohol use from grades 8–12; and (3) at least one assessment of substance use dependence, employment history, income, and educational attainment during

the seven year period following high school (approximately ages 19–25). These 608 participants make up 89.7% of the original cohort. Of these, 65.5% participated in all five annual assessments in grades 8–12, whereas 63.5% participated in all seven assessments post high school graduation. Participants in the analytic sample (N=608) did not differ from the initial sample (N=70) in terms of gender, free or reduced-price school lunch, intervention status, or age at entry into the study. Full information maximum likelihood estimation is used to take into account any missing data among the 608 participants.

2.2 Measures

Data on substance use were collected using an audio-computer assisted interview to increase accurate reporting of sensitive behavior. Past-year frequency of use of alcohol and marijuana for grades 8–12 was used in this analysis (0=none, 1=once, 2=twice, 3=3–4 times, 4=5–9 times, 5=10–19 times, 6=20–39 times, 7=40 or more times) to identify patterns from approximately ages 13 to 18.

Substance use dependence diagnoses were based on the questions and scoring algorithms used in the National Survey on Drug Use and Health (NSDUH; Substance Abuse and Mental Health Services Administration, 2011), both of which were consistent with the Diagnostic and Statistical Manual of Mental Disorders 4th edition (DSM-IV; American Psychiatric Association, 2000). Substance use dependence was coded as present if the individual met DSM-IV criteria for an alcohol disorder or any illegal drug at any of the annual assessments between the ages of 19 and 25.

Additional young adult outcomes included work status, educational attainment, income, and involvement with the criminal justice system. Work status was measured with the following question: "In the past year, did you work a full-time job (30 to 40 hours a week) for more than a one month period?" Education attainment was measured with the following question: "What is the last year of schooling that you have completed?" This item was dichotomized to high school degree or higher compared to less than a high school. Income during a given year was measured using the following item: "How much of this total household income was earned or brought in by you personally – considering all of the sources?" Participants chose from one of 15 categories ranging from "no income" to "$160,000 or more." Participants' records were gathered from the Maryland Criminal Justice Information System in 2009 when participants were about 22 and reflected whether or not the participant had an adult arrest record or a history of incarceration in the state.

In addition to gender, models adjusted for intervention status, free/reduced price lunch status (an indicator of family economic status), and teacher ratings of student academic performance and behavior in first grade using the Teacher Observation of Classroom Adaptation Scale (TOCA-R; Werthamer-Larsson et al., 1991). The coefficient alphas for the 5 TOCA-R subscales included were 0.94 (Aggressive/Disruptive Behavior), 0.97 (Attention/Concentration Problems), 0.79 (Impulsivity), 0.80 (Hyperactivity), and 0.78 (Likeability/Rejection). For these, higher scores indicate poorer adaptation. Teacher's rating of academic achievement was based on a single item measured on a 5-point scale with higher scores indicating better performance. We did not include other illegal drug use as only two percent of participants had used inhalants, cocaine, crack, and/or heroin by 12th grade.

2.3 Analysis

A longitudinal latent profile analysis was performed to model the joint frequency of annual marijuana and alcohol use from 8th-12th grade using Mplus Version 7.11 (Muthén & Muthén, 2012). The underlying assumption of this approach is that participants could be clustered into distinct groups based on their alcohol and marijuana use patterns over the five time points from grades 8 to 12. Model building began with class enumeration, and with the addition of each subsequent latent class goodness-of-fit indices were compared. Consideration was also given to interpretability of additional classes as well as class size. Goodness-of-fit indices examined included the Bayesian Information Criterion (BIC), the Vuong-Lo-Mendell-Rubin likelihood ratio test, the bootstrap likelihood ratio test, and entropy (Nylund et al., 2007).

The auxiliary facility was used to test for differences in the prevalence of distal outcomes across the classes describing the longitudinal patterns of alcohol and marijuana use in 8th-12th grades. This explores overall differences and pairwise differences across classes. More specifically, Mplus 7.11 carries out equality tests overall and one degree of freedom pairwise tests of means across classes using posterior probabilities-based on multiple imputations (Muthén & Shedden, 1999). We used full information maximum likelihood estimation as implemented in Mplus 7.11 to adjust the estimates of the parameters to reflect missingness (Schafer & Graham, 2002).

3. Results

Fit statistics for a one through five-class model are provided in Table 1. The BIC value decreased through the addition of five latent classes, but reached an elbow at four classes, suggesting that a four-class model was appropriate for the data. Similarly, Lo-Mendel-Rubin indicated that a four-class model fit better than a five-class model. The Bootstrapped Loglikehood Ratio Test did favor a larger model; however, the addition of a fifth class did not prove meaningful and resulted in a small class of low level alcohol users who decline in use over time (7.9%). Based on the BIC and the Lo-Mendel-Rubin, as well as considerations of class size and interpretability, a four-class model was selected. As shown in Figure 1, the largest class comprised 47% of the sample and showed minimal involvement with either marijuana or alcohol across grades 8–12. We termed this class the 'No Use' class. The second largest class, 'Moderate Alcohol' class (28%), is characterized by low but increasing levels of alcohol use across grades 10–12 and little marijuana use. The third largest class, 'High Dual Use' class (13%) comprised individuals who used both alcohol and marijuana relatively frequently in high school. The smallest class was comprised of individuals who used marijuana relatively frequently in grades 11 and 12 and lower but increasing levels of alcohol across high school (12%, 'Moderate Alcohol/Increasing Marijuana' class). In comparing across classes, rates of marijuana in grades 11 and 12 are similar in the 'Moderate Alcohol/Increasing Marijuana' class and the 'High Dual Use" class while rates of alcohol across high school are comparable in the 'Moderate Alcohol/Increasing Marijuana' and the 'Moderate Alcohol' classes.

Table 2 provides the demographic characteristics of the study participants by class membership. While most classes have a relatively even gender split, we find the 'Moderate

Alcohol/Increasing Marijuana' class is comprised primarily of male participants (75.4%). Other notable differences between classes include a higher rate of students receiving free/reduced priced school meals (77.3%) and the lowest percentage of Black students (77.7%) in the 'High Dual Use' class. We also see the lowest percentage of students in the intervention condition in the 'Moderate Alcohol/Increasing Marijuana' class (53.8%).

Table 3 compares the prevalence of young adult outcomes across adolescent latent classes. Significant overall differences across classes were found in terms of substance use dependence (χ^2=45.57, p<0.001). Both the 'High Dual Use' class (35%) and the 'Moderate Alcohol/Increasing Marijuana' class (23%) had significantly higher rates of dependence than the 'Moderate Alcohol' class (12%) and the 'Non-Use' class (5%). The 'Moderate Alcohol' class also had higher rates of substance dependence than the 'Non-Use' class.

There were also statistically significant differences in educational attainment across latent classes (χ^2=13.43, p=0.004). The 'High Dual Use' class was the least likely to have either graduated from high school or received a GED (63%), and this was significantly lower than the 'Non-Use' class (86%) and the 'Moderate Alcohol' class (84%). However, there were no statistically significant differences overall in full-time employment or income across the latent classes.

The presence of a criminal justice record showed significant overall differences among the four classes (χ^2=21.15, p<0.001), with an estimated 44% of those in the 'Moderate Alcohol/Increasing Marijuana' class and those in the 'High Dual Use' classes having a criminal justice record, which was significantly higher than the 'Non-Use' class (19%) and 'Moderate Alcohol' class (21%). Overall, incarceration did not differ significantly across the latent classes.

4. Discussion

In this study, we aimed to elucidate and compare young adult outcomes associated with adolescent drinking and marijuana use patterns in a sample of predominantly urban African American participants. It is important to point out up front that findings point to associations not effects due to the observational nature of the study. Despite this limitation, this study has specific advantages over previous work. First, to identify patterns over time, we draw on prospectively gathered substance use data, which limits recall bias. Second, we focus on change across adolescence instead of on a single snapshot of time. Third, we include frequency of use instead of the typical dichotomy of use/no use, providing insight regarding escalation in use. Finally, we examine a predominantly Black sample of urban youth, who may be at greatest risk of the negative outcomes of substance use (Caetano, 2003; Godette et al., 2006; Mulia et al., 2010; Wallace, 1999) and describe associations with a range of outcomes up to age 25.

We identified four latent classes, or naturally occurring typologies of alcohol and marijuana use between 8th–12th grades. Nearly half of the urban youth in this sample were in a class characterized by non-use of alcohol or marijuana throughout grades 8–12, which is higher than what has been found in population-based samples (Connell et al., 2009; Dierker et al., 2007; Moss et al., 2014). The second largest class was a 'Moderate Alcohol' class (28%),

characterized by increasing levels of drinking over high school. The remaining two classes involved marijuana use and were relatively equal in size. The 'Moderate Alcohol/Increasing Marijuana' class consisted of moderate-level drinkers with frequent marijuana use in grades 11–12 and were disproportionately male. Participants in the 'High Dual Use' class used both alcohol and marijuana earlier in life and more frequently than other classes and had the greatest racial diversity. Interestingly, there was not a class of individuals who used marijuana without at least moderate levels of alcohol use, as found in national samples (Dierker et al., 2007; Moss et al., 2014), but not in Patton et al.'s (2007) Australian cohort.

To identify long-term outcomes associated with these patterns of alcohol and marijuana use in adolescence, we examined differences in six outcomes in young adulthood by latent class membership. Significant associations were found for meeting criteria for substance use dependence, not completing high school, and having an arrest record. Consistent with research on the negative consequences of adolescent substance use, non-users of alcohol and marijuana in high school were the least likely to have a substance use disorder or an arrest record, and they were the most likely to have completed high school (Hall, 2015; McCambridge et al., 2011; Volkow et al., 2014).

To compare the outcomes associated with marijuana with those of alcohol, we compared the two classes with similar alcohol patterns but divergent marijuana patterns – in essence holding alcohol constant. Two findings emerged. Those in the 'Moderate Alcohol/Increasing Marijuana' class were significantly more likely to meet substance use dependence criteria (alcohol and/or drug) and to have a criminal justice record in young adulthood than those in the 'Moderate Alcohol' class. These negative outcomes, if found to be causally linked, are noteworthy as the long-term consequence associated with substance use dependence and arrest records are detrimental and well known (Bernburg & Krohn, 2003; Degenhardt & Hall, 2012). Notably, we did not find statistically significant differences for any outcomes between the two classes that had somewhat similar marijuana patterns later in high school but differed on alcohol frequency as well as the age of onset of marijuana use (i.e., 'Moderate Alcohol/Increasing Marijuana' and 'High Dual Use'), which is interesting as previous work highlights the importance of early onset marijuana use (Anthony & Petronis, 1995; Chen, Storr & Anthony, 2009).

There are a number of potential mechanisms that may explain why we identified more negative outcomes associated with 'Moderate Alcohol/Increasing Marijuana class' than with the 'Moderate Alcohol' class that should be considered in future work. First, the increasing rate of marijuana use in this class may represent an upward trajectory of use that continued after high school, with many studies suggesting worse outcomes with heavier use (see Volkow et al., 2014). Specific to crime outcomes, the addition of marijuana, an illegal substance, may directly put an individual at risk for interactions with the criminal justice system. Although Blacks and Whites are equally likely to use marijuana, Blacks are more likely to engage in risky buying habits (Ramchand et al., 2006). Further, low-income urban neighborhoods have greater law enforcement surveillance making drug arrests more likely (Beckett et al., 2006). Alternatively, affiliations with deviant/drug-using peers may be an important mechanism (D'Amico et al., 2005) as these affiliations may increase the risk of illegal activities in general. In terms of substance dependence, there is growing evidence that

not only is marijuana addictive but increases the risk of addiction to other substances (Panillo et al., 2013) and the use of two substances instead of one likely puts an individual at increased risk of dependence.

It is important for future work to tease out whether it is the marijuana specifically, the illegal status of marijuana, the use of multiple substance more generally, or if selection factors are operating for these outcomes. This understanding would inform decriminalization efforts (i.e., reducing penalties for marijuana possession and use) as sensible decriminalization could have a major, positive effect on Black communities, in particular.

Interestingly, no associations were found between alcohol and marijuana use classes and income or employment. This was unexpected given that several studies have shown differences in lifetime earnings and employment based on adolescent substance use (Brooks et al., 2013; Ellickson et al., 2003; Fergusson & Boden, 2008; Green & Ensminger, 2006; Sloan et al., 2001; Viner & Taylor, 2007). The reason that we did not observe such differences may be due to the assessment occurring between ages 19 and 25, when many young adults, especially those in low-income, urban areas, have few opportunities for employment regardless of their substance use histories (Alexander et al., 2014; Huizinga & Henry, 2008). In fact only about one third of the study participants gained full time employment between ages 19 and 25.

While this study focused on a low-income, urban, predominantly Black sample, which is highly relevant given work suggesting that Blacks disproportionately suffer from the negative consequences of substance use (Caetano, 2003; Godette et al., 2006; Mulia et al., 2010), it is unclear how generalizable the findings are to other populations, such as non-urban areas and higher income youth. The sample is representative of students entering public schools in Baltimore in the 1990s and using marijuana in the early to mid-2000s, but caution should be taken when generalizing, for example, to those with lower risk of criminal justice interactions.

If future research is able to establish the associations found as causal, results suggest that prevention of dual use of alcohol and marijuana should be a priority as it was associated with the worst outcomes. This recommendation aligns with the work of Leatherdale and Ahmed (2010) who call for more multi-substance prevention programs. Further, increased screening for dual use and effective, early treatment seems critical. Because results provide preliminary evidence that frequent adolescent marijuana use along with alcohol may lead to worse outcomes than alcohol alone, it is critical for future work to investigate underlying mechanisms. As the United States continues to expand the availability of marijuana either through legalization or medicalization, there are increased opportunities to begin to tease out potential negative effects of marijuana as an illegal substance from marijuana as a psychoactive substance. Further, as states move towards softening policies on marijuana, joint patterns of alcohol and marijuana use among adolescents may change, and these need to be monitored.

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Highlights

- We model patterns (latent classes) of alcohol and marijuana use for an urban, predominantly Black cohort based on self-reported frequency in grades 8 through 12.

- We examine young adult outcomes associated with these substance use patterns across adolescence.

- We find heavy, dual use of marijuana and alcohol across adolescence is associated with an increased risk of having substance use dependence in adulthood, dropping out of high school, and criminal justice system involvement.

- For this sample of youth, marijuana use with moderate levels of alcohol is associated with more negative outcomes in adulthood than alcohol use without marijuana.
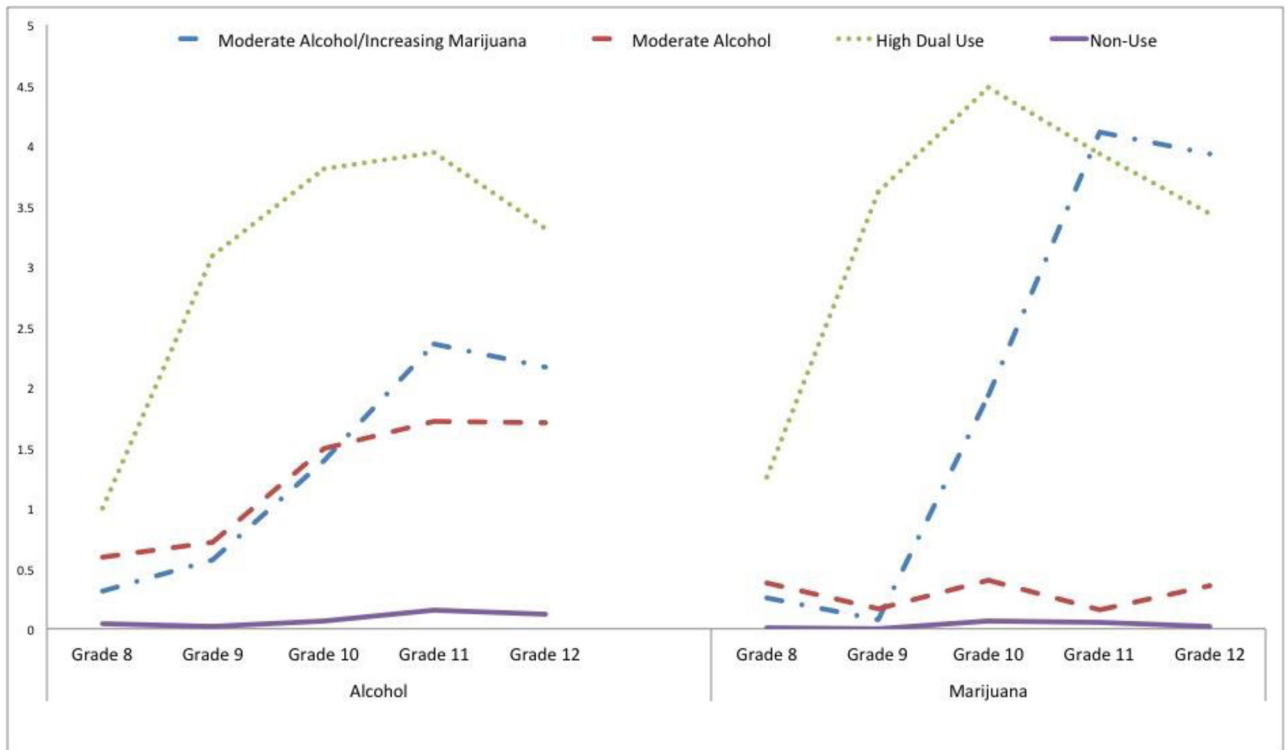
Figure 1.
Frequency of Past Year Alcohol Use and Marijuana Use from Grades 8 through 12 by Class Membership
X-axis = Substance Use by Grade
Y axis = Mean Frequency of Past Year Use (0=none, 1=once, 2=twice, 3=3–4 times, 4=5–9 times, 5=10–19 times, 6=20–39 times, 7=40 or more times)

Table 1

Class Enumeration Test Statistics

	Bayesian Information Criteria		Lo-Mendel-Rubin		Bootstrapped Loglikelihood Ratio Test		Entropy
Number of Classes	Statistic		Statistic	P-Value	Statistic	P-Value	
1	18400.01						
2	13632.75	1 vs 2	4773.32	<0.001	4639.45	<0.001	0.937
3	12777.61	2 vs 3	899.91	<0.001	927.33	<0.001	0.885
4	12439.05	3 vs 4	401.99	0.01	402.24	<0.001	0.881
5	12208.37	4 vs 5	296.42	0.25	302.87	<0.001	0.873

Table 2

Class Membership by Background Variables

	High Dual Use	Moderate Alcohol/Increasing Marijuana Class	Moderate Alcohol Class	Non-Use Class
Gender (% male)	49.7	75.4	47.0	53.2
Ethnicity (% Black)	77.7	91.5	87.7	87.9
Free/Reduced Priced School Meals (%)	77.3	71.0	69.2	67.0
Intervention (% In Intervention Condition)	72.3	53.8	68.5	69.8
Academic Achievement (mean)	4.27	4.12	4.20	4.17
Aggressive/Disruptive Behavior (mean)	1.65	1.62	1.58	1.64
Attention/Concentration Problems (mean)	2.77	2.93	2.84	2.87
Impulsivity (mean)	2.38	2.28	2.35	2.26
Hyperactivity (mean)	2.07	2.33	2.13	2.06
Likeability/Rejection (mean)	2.30	2.28	2.33	2.42

Table 3

Distal Outcomes across Four Latent Classes of Alcohol and Marijuana Use: Proportions/Means, Standard Errors, Overall Model Statistics and Statistically Significant Pairwise Comparisons

Outcome	High Dual Use (class 1)	Moderate Alcohol/Increasing Marijuana Class (class 2)	Moderate Alcohol (class 3)	Non-Use Class (class 4)	Overall Statistic (χ^2)	Significant Pairwise Comparisons
	Proportion (SE)	Proportion (SE)	Proportion (SE)	Proportion (SE)		
Substance Dependence	0.35 (0.05)	0.23 (0.05)	0.12 (0.03)	0.05 (0.01)	45.57**	1 vs. 3**, 4** 2 vs. 3*, 4* 3 vs. 4*
High School Graduate	0.63 ((0.06)	0.77 (0.05)	0.84 (0.03)	0.86 (0.02)	13.43**	1 vs. 3**, 4**
Full Time Employment	0.34 (0.05)	0.29 (0.05)	0.33 (0.04)	0.30 (0.03)	13.43**	n/a
Income Scale (mean)[a]	4.91 (0.40)	5.58 (0.39)	6.06 (0.26)	5.89 (0.20)	4.93	1 vs. 3*, 4*
Criminal Justice Record	0.44 (0.05)	0.44 (0.05)	0.21 (0.03)	0.19 (0.02)	21.15**	1 vs. 3*, 4** 2 vs. 3**, 4**
Ever Incarcerated	0.19 (0.04)	0.15 (0.04)	0.10 (0.02)	0.09 (0.02)	5.41	1 vs. 4*

Note:

*
$p < 0.05$,

**
$p < 0.01$.

[a]Income is on a 15 point scale (1=no income, 15=$160,000 or more) and means for each class are presented.