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Patterns of Simultaneous and non-Simultaneous Use of Cannabis and Alcohol Among American Indian Adolescents

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Abstract

Background: American Indian (AI) adolescents report earlier initiation and higher rates of cannabis and alcohol use compared to their non-AI peers. Simultaneous cannabis and alcohol (SCA) use is increasingly common. A primary goal of our research was to identify profiles of cannabis and alcohol use, including SCA use, among AI adolescents using latent class analysis (LCA).

Method: Data from 1,673 7th – 12th grade students attending 45 reservation-area schools throughout the U.S. who reported using alcohol and/or cannabis in the past year were used to identify the latent classes. Multinomial logistic regression analysis determined associations of sex, grade, and multiethnicity to class membership.

Results: A four-class solution was found: 1) SCA-Heavier Use (16.1%); 2) SCA-Lighter Use (25.2%); 3) Primarily Cannabis Use (33.3%); and 4) Primarily Alcohol Use (25.4%). Multinomial regression showed higher grade, identifying as multiethnic, and being female were associated with higher likelihood of membership in the SCA class.

Conclusion: AI adolescents were more likely to be classified in the Primarily Cannabis Use class as compared to all other classes. Characterizing profiles of use may help identify those engaging in risky or co-use and help researchers and clinicians better understand how AI adolescents engage with alcohol and marijuana.

Keywords

American Indian; Adolescents; Latent Class Analysis; Simultaneous Use; Cannabis; Alcohol

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Ethics Statement: All procedures were approved by the university Institutional Review Board and by appropriate tribal research review boards, school boards, and school staff.

Disclosure Statement: The authors report no conflict of interest.

Introduction

Adolescent substance use is a public health concern in the United States with nationally representative data from 2020 indicating that 16.1% of youth ages 12–20 used alcohol in the past month and 10.6% used cannabis (Center for Behavioral Health Statistics and Quality [CBHSQ], 2020). Substance use is of particular concern among American Indian (AI) adolescents, who experience significant substance use disparities compared to the general population. AI 8th graders are twice as likely to use alcohol (Stanley et al., 2014) and five times more likely to report cannabis use in the past 30 days than their non-AI peers (Swaim & Stanley, 2018). Additionally, they report initiating both substances approximately three years earlier than White peers (Alcover & Thompson, 2020; Whitbeck & Armenta, 2015). These disparities are alarming, given that adolescent substance use and early initiation relate to many harmful physical and mental health consequences (Magid & Moreland, 2014 & Soundararajan et al., 2017). Several of these consequences are disproportionately severe among AI adolescents; for example, they experience significantly higher rates of alcohol-related deaths than their non-AI peers (Greenway, 2014) and higher rates of SUDs (Park-Lee et al., 2021; SAMHSA, 2021). Note that substance use disparities among AI adolescents reflect disparities in social determinants of health and historical trauma, including colonization, residential education programs, and forced relocations, which have been linked to poor physical and emotional health (Brave Heart, 2003; Crabtree et al., 2023; McLeigh, 2010).

Single substance use is no longer normative among young people, with 50% reporting use of multiple substances (Zuckermann et al., 2019). Adolescents frequently engage in co-use of cannabis and alcohol, where “co-use” includes *concurrent use* - using alcohol and cannabis separately, as well as *simultaneous use* - using alcohol and cannabis at the same time (Subbaraman & Kerr, 2015). Simultaneous cannabis and alcohol (SCA¹) use is especially common in youth, with national data showing that approximately one in five 12- to 20-year-olds engage in SCA (LoParco et al., 2023). SCA in adolescence is associated with higher intensity use of both substances (Patrick et al., 2018; Patrick et al. 2017), and negative outcomes including lower academic performance (Kelly et al., 2015b), increased risk of an alcohol use disorder (Waddell, 2021), cognitive impairment (Jacobus et al. 2015), greater likelihood of risky driving (Subbaraman and Kerr, 2015), increased psychological distress (Kelly et al., 2015a), and mental health difficulties (Thompson et al., 2021).

Within the U.S., the Monitoring the Future survey² (MTF) found four classes of substance use among 12th graders, with 56.4% in the alcohol-only use class, 21.6% in the simultaneous lighter use class, 11.2% in the simultaneous heavy use class, and 10.7% in the concurrent use class (Patrick et al., 2018). This suggests that, despite co-use becoming more normative among the general U.S. population, adolescents are still more likely to engage primarily in single-substance alcohol use. When they do engage in SCA, it tends to be less risky (i.e., lower probability of recent binge drinking and cannabis use). Notably, most SCA

¹Simultaneous Cannabis and Alcohol use (SCA) is also commonly referred to as simultaneous alcohol and marijuana use (SAM). However, given the negative connotations that have been historically associated with the term marijuana, we have opted to use SCA throughout this manuscript.

²Monitoring the future is a long-term epidemiological study of substance use that surveys U.S. 8th, 10th, and 12th grade adolescents.

adolescent research has focused on White non-Hispanic youth (Lee et al., 2022). Research has yet to explore patterns of SCA use among AI adolescents despite findings indicating that AI adolescents report higher levels of substance use compared to other ethnic/racial groups (Stanley et al., 2017). Understanding SCA substance use patterns has implications for substance use assessment by researchers and practitioners, adjustments in prevention and intervention programs, and future research into the etiology and consequences of such patterns.

A primary goal of the current study was to identify classes of alcohol and cannabis substance use, including simultaneous use, among AI adolescents using latent class analysis (LCA). Further, previous literature suggests that age, sex, and race/ethnicity may contribute to variations in substance use with older age, male sex, and White ethnicity predicting higher rates of use (Johnston et al., 2017). Accordingly, we examined relationships of grade, sex, and ethnicity to latent class membership.

Methods

Sample

Study data come from 45 schools participating in the *Our Youth Our Future* (YOOF) study during Spring 2021, Fall 2021 and Spring 2022 school semesters. A description of the sampling frame, sample and recruitment procedures, and survey procedures is found in the supplement. Specific identities of tribes and reservations are kept confidential.

Procedures

All procedures were approved by the university Institutional Review Board and by tribal research review boards, school boards, and school staff.

Before survey administration, parents/guardians could opt their child out (<1%). Surveys were administered online with Qualtrics software to all 6th-12th grade students enrolled and attending school on the survey dates. During Spring 2021, schools modified operational procedures in response to COVID-19 - operating remotely, in-person, or in hybrid forms. Due to difficulties in online access, schools operating 100% remotely were not surveyed. Responses were anonymous, and students were instructed to skip questions they did not wish to answer.

Participants

All enrolled 6th – 12th grade students attending participating schools were eligible to be surveyed. For this study, participants were restricted to 7th graders and above (6th graders did not receive questions pertaining to simultaneous alcohol and cannabis use) who self-reported as American Indian/Native American and who reported last 12-month alcohol and/or cannabis use (N=1673; 40.3% male; 54.2% female; 5.6% another; $M_{age} = 16.4$; $M_{grade}=9.9$). Respondents reporting AI as their only race/ethnicity were 50.4% (n=843) of participants while 49.6% (n=830) reported an additional race/ethnicity. Table 1 provides sample sizes, mean age, and sex, by grade, race/ethnicity, and region.

Measures

Alcohol and cannabis use.—Alcohol use in the last 12 months was assessed with “How many times (if any) have you had any alcohol to drink -- more than just a few sips...during the last 12 months?” while binge drinking was assessed with “During the last two weeks, how many times (if any) did you have 5 or more drinks in a row?”. Cannabis use in the last 12 months was assessed with, “How many times (if any) have you used marijuana (weed, cannabis, pot) or hashish (hash, hash oil) ... during the last 12 months?” while 30-day cannabis use used the same question with “30 days” replacing “12 months”. Responses were coded as 1=any use and 0=no use.

Simultaneous Cannabis and Alcohol use.—Two questions measured SCA use. Past 12-month users of alcohol were asked “Of the times you used alcohol in the last 12 months, how often did you use it with marijuana (weed, cannabis, pot) – so that their effects overlapped?” (SCA-alcohol). Past 12-month users of cannabis were asked the same question with alcohol and cannabis transposed (SCA-cannabis). Respondents reporting SCA use for SCA-alcohol and SCA-cannabis were coded as SCA users (1) while those reporting no SCA use for both questions were coded as no SCA use (0). Some respondents (15.4%) were inconsistent in their responses, answering SCA use for one and no SCA use for the other. Instead of assuming which answer was correct, SCA use was coded as missing.

Covariates.—Sex was measured with “how do you describe yourself?” with responses of male, female, and another. Grade was included as a continuous variable, with values from 7 to 12. Multiethnicity measured whether the respondent self-identified as AI/NA plus at least one other race/ethnicity (multiethnicity=1) or whether they identified solely as AI/NA (multiethnicity=0).

Analysis

Latent Class Analysis (LCA) identified groups of individuals with qualitatively distinct patterns of cannabis and alcohol use, including SCA use. Analyses were conducted using *Mplus*, version 8.8 (Muthén and Muthén, 1998–2022). Nesting of students within schools was accounted for by adjusting standard errors using a sandwich estimator (White, 1980) with the *Mplus* complex command. Unconditional models were specified first with number of classes chosen using the Bayesian Information Criterion (BIC; smaller values indicate better fit), sample-size adjusted Bayesian Information Criterion (SABIC), entropy (> .80), and size of classes (> 5% of sample) along with interpretability. LCA was initially performed separately for 7–8 grades and 9–12 grades. Because class structures were nearly identical, students were combined into one LCA. Missing data were handled with full information maximum likelihood (FIML). Missing data ranged from .1% (12-month alcohol use) to 18.1% (SCA use), with no missing data for covariates.

Once the number of classes was determined, we examined which variables predicted latent class membership, with covariates (sex, grade, and multiethnicity) included in each model. An automated 3-Step approach was implemented within *Mplus* to estimate relationships between latent class status and the predictors (R3STEP; (Muthén & Muthén, 2018; Asparouhov & Muthén, 2014). Briefly, R3STEP involves three steps: 1) an unconditional

latent class model is estimated without covariates; 2) the latent class posterior distribution derived in step 1 is used to create most likely class membership; and 3) a multinomial regression is estimated wherein most likely class membership, a categorical latent variable, is regressed onto the covariates after accounting for misclassification in the second step. This approach is a robust method for testing explanatory covariates of class membership (Vermunt, 2010).

Results

Table 2 presents percentages of students among alcohol and/or cannabis users endorsing each LCA indicator. Within this sample of students who reported 12-month alcohol and/or cannabis use, 69.2% reported 12-month alcohol use; 75.9% reported 12-month cannabis use; and 25% responded consistently that they used alcohol and cannabis simultaneously.

Latent Class Analysis

Both the three- and four-class models provided the best fit to the data (3 classes: BIC=6935.1, SABIC=6881.1, Entropy=.88; 4 classes: BIC=6961.1; SABIC=6888.0; Entropy=.86), with a difference in SABIC of 0.1%. Class sizes for each model were well over 5%. Based on interpretability, the 4-class model was chosen because it split SCA use into two classes differentiated by binge drinking and recent cannabis use.

Figure 1 presents conditional probabilities that, given membership in a particular class, a measure of use was endorsed (i.e., indicator variable equals 1). These probabilities suggested the following user classes:

1. (*SCA-Heavier Use*; 16.1%): Probabilities of .97 for SCA use; .98 for binge drinking; and .90 for 30-day cannabis use.
2. (*SCA-Lighter Use*; 25.2%): Probabilities of .66 for SCA use; 1.0 for 12-month alcohol use; .04 for binge drinking; and .73 for 30-day cannabis use.
3. (*Primarily Cannabis Use*; 33.3%): Probabilities of 0.0 for SCA use; .08 for 12-month alcohol use; and 1.0 and .58 for 12-month and 30-day cannabis use, respectively.
4. (*Primarily Alcohol Use*; 25.4%): Probabilities of 0.0 for SCA use; 1.0 and .14 for 12-month alcohol use and binge drinking, respectively; and 1.0 for 12-month and 0.0 for 30-day cannabis use.

eTable 1 in the Supplement gives the percentage endorsement of each substance use indicator by class, given likely class membership of each student.

Demographic Associations with Latent Classes

Table 3 presents odds ratios (ORs) and 95% confidence intervals (95CI) from multinomial logistic regression models of latent class membership on sex, multiethnicity, and grade.

Grade.—Higher grade was associated with lower likelihood of membership in the Primarily Cannabis Use class as compared to membership in SCA-Heavier Use and SCA-

Lighter Use classes and higher likelihood of membership in the Primarily Alcohol Use class as compared to the Primarily Cannabis Use class.

Multiethnicity.—Being multiethnic (as compared to AI only) was associated with greater likelihood of classification as SCA-Heavier Use as compared to SCA-Lighter Use (OR: 0.58; 95CI: 0.37–0.91) and Primarily Cannabis Use (OR=0.37; 95CI: 0.27–0.59) and greater likelihood of SCA-Lighter Use as compared to Primarily Cannabis Use (OR=0.64; 95CI: 0.47–0.86). Finally, multiethnicity was associated with greater likelihood of classification as Primarily Alcohol Use as compared to Primarily Cannabis Use (OR=1.91; 95CI: 1.07–3.40).

Sex.—Identifying as a female adolescent (as compared to male adolescent) was associated with lower likelihood of classification as Primarily Cannabis User as compared to SCA-Heavier Use (OR=0.60; 95CI: 0.42–0.86) or SCA-Lighter Use (OR=.68; 95CI: 0.47–0.86). Identifying as another sex (as compared to male) did not predict class membership.

Discussion

Consistent with the MTF national sample (Patrick et al., 2018), four classes of alcohol and/or cannabis users were found, with two classes of simultaneous users – lighter users and heavier users. However, there were important differences between the two samples. Among AI students who use either alcohol or cannabis, a greater percentage were classified as simultaneous users (42.3%) compared to the MTF national sample (32.8%; Patrick et al., 2018). Additionally, among the AI sample, 16.1% were classified as SCA-Heavier Use compared to the MTF national sample rate of 11.2%. These numbers are concerning, in part, because while the MTF national sample included only 12th graders, the AI sample included 7th-12th grades, and a higher grade was associated with an increased likelihood of SCA use. Finally, a relatively small (10.7%) Concurrent Use class was found for the MTF national sample but not found for the AI sample. This is not to say that there is not concurrent use in the AI sample. Rather, these students are likely also SCA users and thus are included in those classes. These findings suggest that not only are AI adolescents more likely to engage in SCA use than their non-AI peers, but when they do so, it is riskier (i.e., heavier alcohol and cannabis use). Our research also highlights an important difference in substance use profiles between the MTF national sample and our sample of AI adolescents. Specifically, despite inclusion of younger students, who typically have lower rates of substance use, the AI youth appeared more likely to engage in SCA use which, in turn, may increase risk for SCA-related consequences. These findings become even more concerning as legalization on reservations and in surrounding states occurs. Researchers exploring effects of changing legal policy on co-use patterns found that recreational cannabis legalization in California was associated with greater odds of both simultaneous and concurrent use (Paschall et al., 2022). Similarly, in a longitudinal study of U.S. youth, legalization predicted a higher likelihood of self-reported alcohol and cannabis use in the past year (Bailey et al., 2020).

The largest class for the AI sample was Primarily Cannabis Use (33.3%), where the probability of using alcohol in the last year was less than 0.10 while the probability of recent cannabis use was .60. These findings are consistent with prior literature which identifies cannabis use as more prevalent in reservation-area AI adolescents (Stanley et al., 2014;

Swaim and Stanley, 2018). Our findings show that there is a large class of cannabis users that are likely to use cannabis consistently while seldom using alcohol. Shifting policies and attitudes around cannabis may help explain the high rates of cannabis use in this population; this may be particularly relevant for AI adolescents given that prior studies found that AI youth perceive less disapproval of cannabis use from their peers and family networks than their White peers (Swaim et al., 2013). This has important implications for future research as much of the current literature on AI substance use focuses on alcohol use (McLeigh, 2010; SAMHSA, 2016). Given the size of this class, future research should examine the etiology of cannabis use among AI reservation-area youth to gain an understanding of motivations, perceived harm, sources of supply and changes in legalization effects, and consequences of use. Such knowledge could lead to better prevention programs, policies, and legislation.

Students identifying as AI only, as compared to multiethnic students, were more likely to be classified into the Primarily Cannabis Use class, as compared to all other classes. Conversely, those identifying as AI and at least one other race/ethnicity had a greater likelihood of classification as SCA-Heavier Use than SCA-Lighter Use and Primarily Cannabis Use, and as Primarily Alcohol Use as compared to Primarily Cannabis Use. In the MTF national sample, White students, as compared to other race/ethnic groups, had a greater risk of being SCA-Heavier Use compared to Concurrent Use and Primarily Alcohol Use. With 58.1% of the multiethnic respondents in the AI sample selecting “White”, results from both studies suggest that being White may increase risk for more serious SCA use.

Regarding sex, AI female adolescents (relative to male adolescents) were more likely to be assigned to the SCA-Heavier or SCA-Lighter Use classes than the Primarily Cannabis Use class. Sex-differences in class membership may be linked to substance use motives, with one study finding that SCA was more prevalent on days where young adults endorsed greater enhancement and conformity motives (Patrick et al., 2019). This may be especially relevant for AI female adolescents, as prior research has indicated they are more likely to receive drug offers from friends/family and have greater difficulty refusing drug offers compared to their male counterparts (Rayle et al., 2006). Greater drug offers and difficulty refusing may contribute to the heightened risk of simultaneous use for AI female adolescents, particularly as offers are likely to occur in social contexts. With limited research exploring sex-differences in substance use motives among AI adolescents, future research should explore why AI female identity was associated with more probable membership in the SCA use classes relative to the Primarily Cannabis Use class, which was the largest class in the current sample. For example, future research might take into consideration the intersection of AI vs. mainstream culture and sex (and/or gender) when examining why AI female identity might be associated with a higher probability of SCA.

Finally, higher grade was associated with lower likelihood of membership in the Primarily Cannabis Use class. Swaim and Stanley (2018) found that, for reservation-area AI youth, 30-day alcohol use rates steadily increased from 8th to 12th grade; however, changes in 30-day cannabis use rates leveled off in 10th – 12th grades. This suggests that, as they progress in grade level, AI adolescents’ probability of being categorized in a primarily alcohol using class will increase relative to their probability of being classified in a primarily cannabis using class.

Limitations

As with any cross-sectional study, causation between covariates and classes cannot be assumed. Although the sample is the largest of reservation-area adolescents, it has several limitations. We obtained a geographically diverse sample of reservation-area schools; however, it does not reflect a random sample due to voluntary participation. However, percentages of Southwest and Northern Plains students closely reflected actual percentages based on known total enrollment of 7th-12th grade AI students in those reservation-area schools. Because the sampling frame includes only reservation-area schools, AI students not living in these areas are excluded. Additionally, results do not include adolescents who dropped out of school. With high rates of dropout among AI youth, findings may differ for those no longer in school (Swaim et al., 1997). Those missing an SCA indicator due to inconsistencies were a relatively large percentage of the sample. However, further analysis found that coding them as an SCA user (not missing) did not change class structure or relationships between classes and covariates. Finally, those describing their sex as “another” were a small number (93) and caution must be used in interpreting findings for this group.

Implications

A key clinical implication from our results relates to substance use assessment. While screening in clinical settings often includes assessment for use of multiple substances, they often do not explicitly assess for simultaneous use in line with the DSM-5 (American Psychiatric Association, 2013; Brown et al., 1998). These results and those of others underscore the importance of a more thorough substance use assessment that includes simultaneous use, especially among reservation-based AI youth.

Additionally, our findings indicate that there are heterogeneous subgroups of AI adolescents who use alcohol and cannabis. This suggests that the effectiveness of AI adolescent substance use interventions and prevention efforts may be improved by utilizing programming that is explicitly tailored to the needs of differing groups of AI adolescents who share similar patterns of substance use.

Future research with AI adolescent would benefit from exploring additional factors which may influence substance use patterns including the etiology of gender differences in substance use for AI adolescents, and the influence of mental health and substance use related problems.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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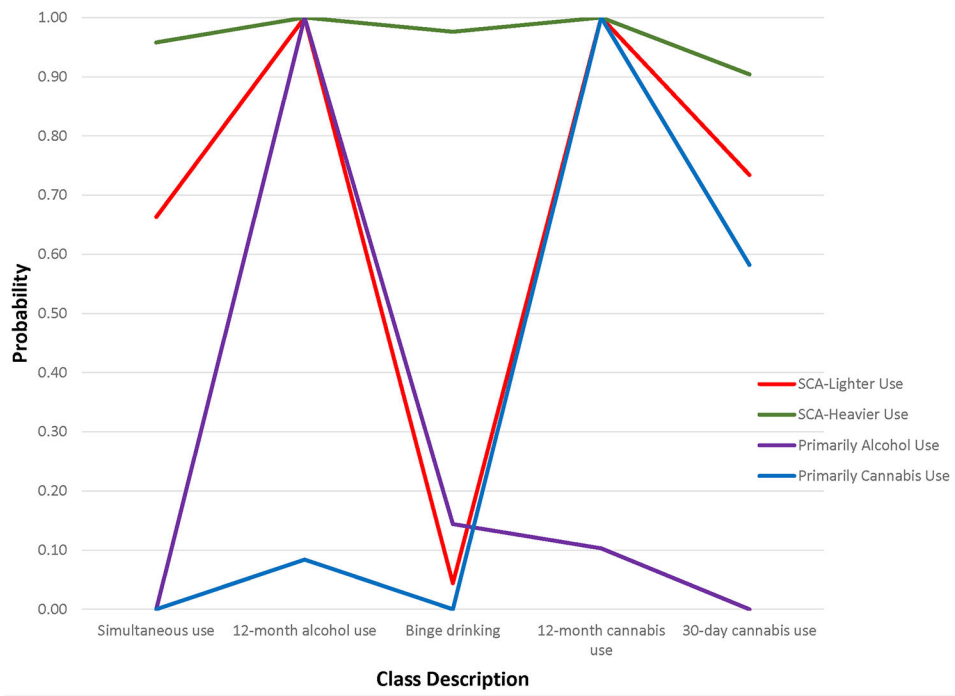


Figure 1:
Conditional probability that a measure of use was endorsed for each class

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Table 1.

Number (%) of Students By Grade and Sex, Mean Age By Grade, Race/Ethnicity, and Region.

Grade	Total	Sex			Mean age (years)
		Female	Male	Another	
7	145	83 (57.2)	50 (34.5)	12 (8.3)	12.9
8	212	119 (56.1)	80 (37.7)	13 (6.1)	13.7
9	305	167 (54.8)	114 (37.4)	24 (7.9)	14.9
10	329	170 (51.7)	142 (43.2)	17 (5.2)	15.8
11	366	195 (53.3)	147 (42.9)	14 (3.8)	16.7
12	316	172(54.4)	131 (41.5)	13 (4.1)	17.5
7–12 grades	1673	906 (54.2)	674 (40.3)	93 (5.6)	15.6
Race/ethnicity ^a					N (%)
AI only					843 (50.4)
AI plus at least one of the following:					
Alaska Native					50 (3.0)
Asian American					40 (2.4)
Black					127 (7.6)
Hawaiian/Pacific Islander					27 (1.6)
Hispanic/Latino					286 (17.1)
White					482 (30.9)
Region					
Northeast					47 (2.8)
Northern Plains					342 (20.4)
Northwest					6 (0.4)
Southeast					193 (11.5)
Southern Plains					89 (5.3)
Southwest					905 (54.1)
Upper Great Lakes					91 (5.4)

^a Respondents could select multiple race/ethnicities.

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Table 2. Percentage Frequency (% (n)) of Substance Use for American Indian Youth in Grade Levels 7–12 by Gender and Ethnicity for Academic Years 2021 and 2022 (N=1673)

Measure	AI only			Multiethnic AI			AI only and multiethnic AI		
	Male	Female	Another	Male	Female	Another	Male	Female	All genders
N	339	468	36	335	438	57			1673
Alcohol									
12-month use	58.7 (199)	67.9 (318)	47.2 (17)	73.1 (245)	76.7 (336)	73.7 (42)			69.2 (1157)
Binge drinking	14.5 (49)	15.4 (72)	5.6 (2)	22.4 (75)	24.0 (105)	24.6 (9 (14)			18.9 (317)
Cannabis									
12-month use	79.9 (271)	75.6 (354)	83.3 (30)	72.5 (243)	74.7 (327)	78.9 (45)			75.9 (1270)
30-day use	49.6 (168)	49.8 (233)	38.9 (14)	47.5 (159)	51.1 (224)	54.4 (31)			49.6 (829)
Simultaneous use ¹									
SCA	19.5 (66)	22.4 (105)	13.9 (5)	23.6 (79)	33.3 (146)	29.8 (17)			25.0 (418)

¹: SCA uses consistent responses on SCA-alcohol and SCA-cannabis.

Odds ratios (95% confidence intervals) of the association between covariates and latent classes of substance use for American Indian students.

Table 3.

<i>Predictors</i>	<u>Reference: SAM-Heavier Use</u>		<u>Reference: SAM-Lighter Use</u>		<u>Reference: Cannabis Use</u>	
	SAM-Lighter Use	Primarily Cannabis Use	Primarily Alcohol Use	Primarily Cannabis Use	Primarily Alcohol Use	Primarily Alcohol Use
Grade	1.0 (0.84, 1.14)	0.82** (0.73, 0.93)	0.95 (0.83, 1.09)	0.83** (0.77, 0.89)	0.95 (0.84, 1.09)	1.15* (1.01, 1.31)
Multieethnic	0.58* (0.37, 0.91)	0.37** (0.23, 0.59)	0.71 (0.46, 1.07)	0.64** (0.47, 0.86)	1.22 (.69, 2.16)	1.91* (1.07, 3.40)
Female	0.89 (0.57, 1.40)	0.60** (0.42, 0.86)	0.77 (0.55, 1.07)	0.68* (0.48, 0.97)	0.86 (0.61, 1.23)	1.27 (0.95, 1.71)
Another	0.92 (0.40, 2.09)	1.04 (0.61, 1.76)	0.91 (0.45, 1.84)	1.13 (0.63, 2.43)	0.99 (0.37, 2.64)	0.84 (0.46, 1.64)

*, p<.05

**, p<.01