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PROFILES OF ALCOHOL AND MARIJUANA USE AMONG SIMULTANEOUS ALCOHOL AND MARIJUANA USERS: INDIVIDUAL DIFFERENCES IN DEMOGRAPHICS AND SUBSTANCE USE

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Abstract

Simultaneous alcohol and marijuana (SAM) use – or use of both substances with overlapping effects – is common among emerging adults and is linked to increased risk for problematic substance use outcomes. The current study identified subgroups of emerging adult SAM users based on their typical alcohol and marijuana use patterns and compared groups on key individual characteristics. Latent profile analysis uncovered four profiles of SAM users (n=522): Light Users (LU; 49.0%), Moderate Drinkers with Frequent Marijuana Use (MDFM; 37.9%), Moderate Drinkers with High Peak Levels (MDHP; 5.4%), and Heavy/Frequent Users (HFU; 7.7%). Group differences by demographic characteristics were found, with LU more likely to be college attendees/graduates than MDFM. Additionally, HFU were more likely to be Greek-affiliated than both LU and MDFM. Groups also differed based on other drug use behavior and preferred route of marijuana administration. Findings demonstrate diversity among SAM users based on typical substance use patterns.

Keywords

simultaneous alcohol and marijuana use; substance use; emerging adults; MTurk; latent profile analysis

Simultaneous alcohol and marijuana (SAM) use – or the use of alcohol and marijuana such that the effects overlap – is prevalent among emerging adult drinkers (White, Kilmer, Fossos-Wong, Hayes, Sokolovsky, & Jackson, 2019) with 30% of emerging adult drinkers reporting SAM use (Terry-McElrath & Patrick, 2018). Relative to individuals who use alcohol but not marijuana, SAM users are at greater risk for heavy substance use (Linden-Carmichael, Stamates, & Lau-Barraco, 2019), driving under the influence (Subbaraman & Kerr, 2015), alcohol-related accidents (Arterberry, Treloar, & McCarthy, 2017), academic problems (Brière, Fallu, Descheneaux, & Janosz, 2011), and alcohol use disorder symptoms

(Midanik, Tam, & Weisner, 2007). Recent evidence points to historical increases in SAM use among individuals in this age group (Terry-McElrath & Patrick, 2018). As brief motivational interventions aimed at reducing the combined use of alcohol and marijuana have been unsuccessful (Stein et al., 2018), the development of prevention and intervention efforts targeting SAM use is critically needed.

The majority of work examining SAM-related risk has collapsed individuals into a broader category of “SAM users,” discounting potential heterogeneity within users. Prior research has capitalized on person-centered approaches to uncover latent profiles of alcohol users (e.g., Aresi, Cleveland, Marta, & Alfieri, 2018; Lau-Barraco, Braitman, Stamates, & Linden-Carmichael, 2016) and marijuana users (Krauss, Rajbhandari, Sowles, Spitznagel, & Cavazos-Rehg, 2017; Manning et al., 2019), but limited person-centered work has focused on the patterning of alcohol, marijuana, and SAM use (Arterberry et al., 2017; Cadigan, Dworkin, Ramirez, & Lee, 2019; Davis, Slutske, Martin, Agrawal, & Lynskey, 2019; Patrick, Kloska, Terry-McElrath, Lee, O’Malley, & Johnston, 2018). Arterberry and colleagues (2017) identified four classes of college students based on their typical substance use and drugged driving patterns: low-level engagers who reported low rates of substance use; alcohol-centric engagers with higher rates of alcohol use but low marijuana/SAM use; concurrent engagers with high rates of marijuana, alcohol, and SAM use; and marijuana-centric/SAM engagers. Marijuana-centric/SAM engagers reported the highest rates of marijuana use and risky driving behaviors. Among a sample of college-attending young adults who reported past-year alcohol use, Cadigan et al. (2019) identified a class of non-users, two classes of individuals who used only alcohol but at different levels, and one class of SAM users. Among adult Australians, Davis and colleagues (2019) identified four types of marijuana users based on their co-use of multiple substances: alcohol co-use, simultaneous alcohol users, simultaneous tobacco users, and simultaneous alcohol, tobacco, and drug users. Lastly, in a national sample of 12th graders who reported past-year alcohol and/or marijuana use, Patrick et al. (2018) identified a class of individuals who used only alcohol, a class of non-simultaneous alcohol and marijuana users, and two classes of simultaneous users who differed in their probability of excessive alcohol use. The SAM user classes identified by Patrick and colleagues differed on a variety of demographic and behavioral characteristics. Specifically, relative to the “lighter” SAM use class, individuals belonging to the “heavier” SAM use class were more likely to be male, White, have more evenings out, have higher truancy, report illicit drug use other than marijuana, and were less likely to have college plans. These differences between lighter and heavier SAM user classes suggest that SAM users may be a diverse subgroup of substance users.

To fully uncover the complex patterning of SAM use, the current study sought to expand upon these previous studies by identifying subgroups of emerging adult alcohol and marijuana users within a sample comprised exclusively of individuals who engaged in SAM use and binge drinking (4+/5+ alcoholic beverages in one sitting for women/men) in the past month. Specifically, we used latent profile analysis (LPA), a person-centered statistical technique that can identify distinct groups of individuals based on shared characteristics. Profiles were identified based on a wide range of participants’ typical alcohol and marijuana use behaviors and then compared on demographic characteristics (i.e., age, sex, race/ethnicity, college education status, Greek affiliation) and substance use

behavior (i.e., tobacco use, other drug use). Lastly, in light of emerging research illustrating differences in level of intoxication based on route of marijuana administration (Cooper & Haney, 2009; Spindle et al., 2018), we also compared SAM user profiles across participants' most frequently used marijuana delivery system. As our findings were exploratory in nature, no a priori hypotheses were specified.

METHOD

PARTICIPANTS AND PROCEDURE

Participants were recruited from July to September 2018 using Amazon's Mechanical Turk (MTurk), a crowdsourcing Internet marketplace for researchers to pay participants to complete online tasks, including questionnaires. MTurk has shown good reliability and validity in collecting substance use data (Kim & Hodgins, 2017; Strickland & Stoops, 2019). Eligible participants (1) were 18–25 years old, (2) reported past-month binge drinking, (3) reported past-month SAM use, (4) lived in the U.S., (5) spoke fluent English, (6) had an MTurk task approval rating >95%, and (7) completed 50 tasks on MTurk previously. Similar to the assessment of SAM use in the Monitoring the Future study (e.g., see Terry-McElrath & Patrick, 2018), to determine status as a past-month SAM user, participants were asked, "How many of the times when you used marijuana during the past month did you use it at the same time as alcohol- that is, so that their effects overlapped?". Participants who reported at least one instance of using both substances so that the effects overlapped in the past month were identified as a SAM user.

After obtaining informed consent, eligible participants completed an online survey and were compensated \$1.00. Attention checks were placed throughout the survey, and participants were removed from participation if they missed multiple checks. Study procedures were approved by the university's Institutional Review Board. Additional information on participants and procedures can be found in the parent study (Linden-Carmichael, Masters, & Lanza, 2020a).

A sample of 538 eligible emerging adults completed the survey. Sixteen participants were excluded based on conflicting responses regarding their past-year marijuana use, yielding an analytic sample of 522 participants. Demographic and substance use characteristics of the sample are listed in Table 2.

MEASURES

ALCOHOL USE.—Using the Daily Drinking Questionnaire (DDQ; Collins, Parks, & Marlatt, 1985), participants indicated how many standard alcoholic drinks they typically consumed on each day of the week in the past three months, yielding estimates for typical number of drinks consumed per day (*quantity*), typical number of drinking days per week (*frequency*), and typical number of binge drinking days per week (*binge frequency*). Participants also indicated the maximum number of drinks they consumed in one sitting in the past 30 days (*heaviest use*). Participants were provided with pictures of standard alcoholic drinks for reference.

MARIJUANA USE.—A modified version of the DDQ (Bravo, Pearson, Conner, & Parnes, 2017; Collins, Bradizza, & Vincent, 2007) assessed marijuana use during a typical week in the past three months. Participants were provided with pictures of average-sized joints and were asked to estimate the number of average-sized joints they use per day, on average. Participants were instructed to, if using a pipe or blunt instead, estimate the number of average-sized joints they could have rolled. Daily marijuana estimates during a typical week yielded estimates for typical number of joints (or equivalent) smoked per day (*quantity*) and typical number of marijuana use days per week (*frequency*). Participants also indicated the maximum number of joints (or equivalent) they smoked in one day in the past 30 days (*heaviest use*) as well as their most frequent route of marijuana administration (rolling papers/joints, hand pipes, water pipes, hookah, vaporization, edibles, or other).

OTHER SUBSTANCE USE.—Dichotomous variables were computed to represent past 12-month use of tobacco and past 12-month use of drugs other than tobacco or marijuana (opiates, barbiturates, club drugs, tranquilizers, cocaine, crack, amphetamines, steroids, inhalants, psychedelics, and other prescription drugs used nonmedically).

STATISTICAL ANALYSIS

LPAs were conducted using Mplus Version 8.1 with continuous indicators of alcohol use (quantity, frequency, binge frequency, heaviest use) and marijuana use (quantity, frequency, heaviest use). The Akaike Information Criteria (AIC), Bayesian Information Criteria (BIC), and sample size-adjusted Bayesian Information Criteria (SSA-BIC) were used to identify the optimal number of profiles, with lower values indicating improved model fit (Nylund, Asparouhov, & Muthén, 2007). The Lo-Mendell-Rubin (LMR) likelihood ratio test compared fit between models with k and $k - 1$ profiles (Wang & Wang, 2012). Higher relative entropy values, ranging from 0.0 to 1.0, indicated greater classification accuracy of each possible solution. Participants were assigned to their most likely profile based on posterior probabilities. The Bolck-Croon-Hagenaars (BCH) method (Bolck, Croon, & Hagenaars, 2004) was used to compare the profiles on demographic characteristics and substance use behaviors.

RESULTS

LATENT PROFILES OF ALCOHOL AND MARIJUANA USE AMONG SAM USERS

Table 1 outlines fit statistics for solutions with one through seven latent profiles. Although the AIC, BIC, and SSA-BIC decreased as the number of profiles increased, the LMR likelihood ratio test indicated that a four-profile solution was optimal. As seen in Table 2, Profile 1 was characterized by lower than average alcohol and marijuana use on all indicators. This profile was labeled “Light Users” (LU) and represented 49% ($n=256$) of the sample. Profile 2, representing 38% ($n=198$) of the sample, reported alcohol and marijuana use levels comparable to the sample mean and were labeled “Moderate Drinkers with Frequent Marijuana Use” (MDFM). Profile 3 was characterized by average levels of alcohol use yet particularly high levels of alcohol and marijuana use on their heaviest occasion. This profile was labeled “Moderate Drinkers with High Peak Levels” (MDHP) and represented 5% of participants in our sample ($n=28$). Finally, with the exception of marijuana use days

per week and maximum number of joints, the $n=40$ participants (8%) in Profile 4 had the highest mean values on use indicators and were labeled “Heavy/Frequent Users” (HFU).

PROFILE COMPARISONS

Latent profiles were compared on demographic characteristics (see Table 2), and significant differences were found based on college status and Greek affiliation. LU were more likely to be college attendees/graduates than MDFM. HFU were more likely to be Greek-affiliated than both LU and MDFM. Profiles did not differ based on sex, race/ethnicity, or age.

Profiles also differed based on substance use behavior. As compared to both LU and MDFM, HFU were more likely to engage in other drug use besides tobacco and marijuana use. MDFM were more likely to engage in other drug use than LU. Profiles did not differ based on tobacco use.

Several profile differences were found based on most frequent route of marijuana administration. LU and MDHP were more likely to use rolling/paper joints than MDFM. MDFM were more likely to use water pipes than both LU and MDHP. LU and MDFM were more likely to vape than HFU and more likely to use edibles than MDHP. LU, MDFM and HFU were all more likely to use a hookah than MDHP. Profiles did not differ on use of hand pipes or other routes of marijuana administration.

DISCUSSION

The current study identified latent profiles of typical alcohol and marijuana use behaviors among a sample of SAM users and compared profiles across individual-level characteristics and substance use behaviors. Findings revealed four distinct profiles: Light Users, Moderate Drinkers with Frequent Marijuana Use, Moderate Drinkers with High Peak Levels, and Heavy/Frequent Users. While prior work has largely categorized individuals as “SAM” or “non-SAM” users based on whether individuals have or have recently engaged in any SAM use, our findings demonstrate heterogeneity among SAM users based on typical alcohol and marijuana use patterns. As the field advances in identifying individuals at greatest risk for high-risk substance use and associated consequences, our findings highlight the importance of considering the quantity, frequency, and heaviness of alcohol and marijuana use.

Several noteworthy findings emerged when comparing profiles across a variety of demographic characteristics and substance use behaviors. First, with 62.3% of participants reporting past-year substance use beyond alcohol, marijuana, or tobacco use, SAM users might be likely to use other drugs such as opioids, club drugs, and stimulants. These findings are in line with other emerging evidence pointing to the high prevalence and potential for deleterious effects of the tri-use of alcohol, marijuana, and tobacco (Baggio, Deline, Studer, Mohler-Kuo, Daepfen, & Gmel, 2014; Linden-Carmichael, Van Doren, Masters, & Lanza, 2020b; Roche, Bujarski, Green, Hartwell, Leventhal, & Ray, 2019) including several recent studies using person-centered statistical analyses (i.e., Davis et al., 2019; Bailey, Farmer, & Finn, 2019). In particular, Davis and colleagues found that individuals reporting simultaneous cannabis and tobacco use may be at highest risk for problematic outcomes. Altogether, as many studies have compared SAM users to alcohol-only users on broader

negative outcomes, it is important for future research to continue to consider that SAM users could be engaging in substance use beyond alcohol and marijuana use that may account for harms, and to consider the use of person-centered statistical analyses to accommodate the potential heterogeneity that may exist among SAM users.

A second noteworthy finding concerned the MDFM group. MDFM – the profile with the most frequent marijuana use and the second-highest prevalence of other drug use – had the highest proportion of non-college-attending emerging adults. Non-college-attending emerging adults being at risk for heavy/multiple substance use is consistent with recent Monitoring the Future data indicating that prevalence of use of several drugs – particularly marijuana, cigarettes, and synthetic drugs – is higher for non-college-attending than college-attending students, and daily marijuana use has risen for non-college-attending emerging adults in the past five years (Schulenberg, Johnston, O'Malley, Bachman, Miech, & Patrick, 2019). However, when comparing profiles by Greek affiliation in the current study, it was clear that the HFU profile had a disproportionately high level of emerging adults involved in fraternities and sororities.

Finally, findings from our study revealed that profiles of SAM users differed by preferred route of marijuana administration. Route of administration has major implications for level of intoxication achieved (Cooper & Haney, 2009; Spindle et al., 2018) and risk for problematic or dependent use (Baggio et al., 2014; Chabrol, Roura, & Armitage, 2003). Assessment methods for marijuana use quantity should be adapted to incorporate the potential for multiple products used beyond joints. In addition to understanding the heterogeneity in SAM users based on their level and frequency of use, future work should also consider the type and number of routes used in identifying SAM users most at risk for high-risk substance use.

As the prevalence of SAM use increases historically among young adults (Terry-McElrath & Patrick, 2018) and SAM use is consistently linked to increased risk for negative consequences (e.g., Subbaraman & Kerr, 2015), prevention and intervention efforts need to address SAM use and be tailored to SAM users. Efforts to reduce dual alcohol and marijuana use have thus far been unsuccessful (Stein et al., 2018). In concert with recent studies documenting unique motivations for engaging in SAM use (Patrick, Fleming, Fairlie, & Lee, 2020) and unique socio-environmental contexts for engaging in SAM use (Linden-Carmichael, Allen, & Lanza, 2020; Lipperman-Kreda, Gruenewald, Grube, & Bersamin, 2017) relative to using only alcohol, findings from the current study indicate that a one-size-fits-all intervention may be less advantageous for SAM users and that interventions should consider the role of other substance use (e.g., tobacco) and other individual-level characteristics when working with higher-risk SAM users.

Findings should be interpreted in light of several caveats. First, study findings are based on self-reported, typical substance use behavior. Such reports may be impacted by participants' recall biases and/or social desirability biases. Second, our sample consisted of Amazon MTurk workers. MTurk has been available since 2005 and has been widely used for research purposes including survey research and experimental designs (Chandler & Shapiro, 2016) including studies focused specifically on addictive behaviors (e.g., Amlung, Reed, Morris,

Aston, Metrik, & MacKillop, 2019). Although MTurk has demonstrated itself to be a reliable and valid platform from which to collect substance use data (Strickland & Stoops, 2019), MTurk participants are more likely to have certain personality characteristics (e.g., lower social engagement; McCredie & Morey, 2019) which could impact generalizability to the larger population of emerging adult SAM users. Third, because the goal of the parent project was to identify language for describing subjective experiences when consuming heavy levels of alcohol, cannabis, and SAM use (Linden-Carmichael et al., 2020a), we recruited only SAM users who reported recent binge drinking. As a result, our findings may be less generalizable to lighter drinkers. Relatedly, participants must have reported *any* SAM use and binge drinking in the past month. This eligibility criterion may have implications for two important issues: (1) although the phrasing of the item to assess SAM use (“How many of the times when you used marijuana during the past month did you use it at the same time as alcohol – that is, so that their effects overlapped?”) is consistent with the measure used in the Monitoring the Future study to assess SAM use (Terry-McElrath & Patrick, 2018), the phrasing in this measure precludes us from examining SAM use frequency as an indicator or covariate in our latent profiles; further, (2) it is possible that very infrequent substance users who only engaged in SAM use once, perhaps, were included in our sample. While few of our eligible participants reported that they did not drink alcohol ($n = 2$; 0.4%) or use cannabis ($n = 23$; 4.4%) during a typical week, future work building upon these findings may benefit from recruiting a more diverse sample of SAM users to comprehensively assess SAM use patterns. Finally, our measures of typical marijuana use inquired about joints specifically. Although we also asked participants to estimate the number of joints they would have smoked if they had used a pipe or a blunt, other marijuana delivery systems (e.g., vape pens) were not incorporated in this measure. As the field continues to develop best practices for assessing marijuana use quantity, the wide variation in preferred route of marijuana administration in our study and in others suggest future work should incorporate multiple routes when developing and standardizing a measure. Limitations notwithstanding, SAM users are diverse when it comes to demographic characteristics and substance use behavior. Future research should replicate these findings among national samples of emerging adults while continuing to consider subgroups of SAM users who are in greatest need of intervention and prevention efforts.

REFERENCES

- Amlung M, Reed DD, Morris V, Aston ER, Metrik J, & MacKillop J (2019). Price elasticity of illegal versus legal cannabis: A behavioral economic substitutability analysis. *Addiction*, 114, 112–118. doi: 10.1111/add.14437 [PubMed: 30194789]
- Aresi G, Cleveland MJ, Marta E, & Alfieri S (2018). Patterns of alcohol use in Italian emerging adults: A latent class analysis study. *Alcohol & Alcoholism*, 53, 294–301. doi: 10.1093/alcalc/agx109 [PubMed: 29236958]
- Arterberry BJ, Treloar H, & McCarthy DM (2017). Empirical profiles of alcohol and marijuana use, drugged driving, and risk perceptions. *Journal of Studies on Alcohol and Drugs*, 78(6), 889–898. doi: 10.15288/jsad.2017.78.889 [PubMed: 29087824]
- Bailey AJ, Farmer EJ, & Finn PR (2019). Patterns of polysubstance and simultaneous co-use in high risk young adults. *Drug and Alcohol Dependence*, 205, 107656. doi: 10.1016/j.drugalcdep.2019.107656 [PubMed: 31706247]

- Baggio S, Deline S, Studer J, Mohler-Kuo M, Daeppen JB, & Gmel G (2014). Routes of administration of cannabis used for nonmedical purposes and associations with patterns of drug use. *Journal of Adolescent Health, 54*(2), 235–240. doi: 10.1016/j.jadohealth.2013.08.013
- Bolck A, Croon M, & Hagenaars J (2004). Estimating latent structure models with categorical variables: One-step versus three-step estimators. *Political Analysis, 12*, 3–27. doi: 10.1093/pan/mph001
- Bravo AJ, Pearson MR, Conner BT, & Parnes JE (2016). Is 4/20 an event-specific marijuana holiday? A daily diary investigation of marijuana use and consequences among college students. *Journal of Studies on Alcohol and Drugs, 78*(1), 134–139. doi: 10.15288/jsad.2017.78.134
- Brière FN, Fallu JS, Descheneaux A, & Janosz M (2011). Predictors and consequences of simultaneous alcohol and cannabis use in adolescents. *Addictive Behaviors, 36*, 785–788. doi: 10.1016/j.addbeh.2011.02.012 [PubMed: 21429672]
- Cadigan JM, Dworkin ER, Ramirez JJ, & Lee CM (2019). Patterns of alcohol use and marijuana use among students at 2- and 4-year institutions. *Journal of American College Health, 67*(4), 383–390. doi: 10.1080/07448481.2018.1484362 [PubMed: 29979925]
- Chabrol H, Roura C, & Armitage J (2003). Bongs, a method of using cannabis linked to dependence. *Canadian Journal of Psychiatry, 48*, 709. doi: 10.1177/070674370304801011
- Chandler J, & Shapiro D (2016). Conducting clinical research using crowdsourced convenience samples. *Annual Review of Clinical Psychology, 12*, 53–81. doi: 10.1146/annurev-clinpsy-021815-093623
- Collins RL, Parks GA, & Marlatt GA (1985). Social determinants of alcohol consumption: The effects of social interaction and model status on the self-administration of alcohol. *Journal of Consulting and Clinical Psychology, 53*(2), 189–200. doi: 10.1037//0022-006x.53.2.189 [PubMed: 3998247]
- Collins RL, Bradizza CM, & Vincent PC (2007). Young-adult malt liquor drinkers: Prediction of alcohol problems and marijuana use. *Psychology of Addictive Behaviors, 21*(2), 138–146. doi: 10.1037/0893-164x.21.2.138 [PubMed: 17563133]
- Cooper ZD, & Haney M (2009). Comparison of subjective, pharmacokinetic, and physiological effects of marijuana smoked as joints and blunts. *Drug and Alcohol Dependence, 103*, 107–113. doi: 10.1016/j.drugalcdep.2009.01.023 [PubMed: 19443132]
- Davis CN, Slutske WS, Martin NG, Agrawal A & Lynskey MT (2019). Identifying subgroups of cannabis users based on simultaneous polysubstance use. *Drug and Alcohol Dependence, 205*, 107696. doi: 10.1016/j.drugalcdep.2019.107696 [PubMed: 31726429]
- Kim HS, & Hodgins DC (2017). Reliability and validity of data obtained from alcohol, cannabis, and gambling populations on Amazon's Mechanical Turk. *Psychology of Addictive Behaviors, 31*(1), 85–94. doi: 10.1037/adb0000219 [PubMed: 27893213]
- Krauss MJ, Rajbhandari B, Sowles SJ, Spitznagel EL, & Cavazos-Rehg P (2017). A latent class analysis of poly-marijuana use among young adults. *Addictive Behaviors, 75*, 159–165. doi: 10.1016/j.addbeh.2017.07.021 [PubMed: 28756354]
- Lau-Barraco C, Braitman AL, Stamates AL, & Linden-Carmichael AN (2016). A latent profile analysis of drinking patterns among nonstudent emerging adults. *Addictive Behaviors, 62*, 14–19. doi: 10.1016/j.addbeh.2016.06.001 [PubMed: 27305099]
- Linden-Carmichael AN, Allen HK, & Lanza ST (2020). The socio-environmental context of simultaneous alcohol and marijuana use among young adults: Examining day-level associations. *Drug and Alcohol Review, 49*. doi: 10.1111/dar.13213
- Linden-Carmichael AN, Masters LD, & Lanza ST (2020a). "Buzzwords": Crowd-sourcing and quantifying U.S. young adult terminology for subjective effects of alcohol and marijuana use. *Experimental and Clinical Psychopharmacology, 38*. doi: 10.1037/pha0000344
- Linden-Carmichael AN, Stamates AL, & Lau-Barraco C (2019). Simultaneous use of alcohol and marijuana: Patterns and individual differences. *Substance Use & Misuse, 54*(13), 2156–2166. doi: 10.1080/10826084.2019.1638407 [PubMed: 31304834]
- Linden-Carmichael AN, Van Doren N, Masters LD, & Lanza ST (2020b). Simultaneous alcohol and marijuana use in daily life: Implications for level of use, subjective intoxication, and positive and negative consequences. *Psychology of Addictive Behaviors, 34*, 447–453. doi: 10.1037/adb0000556 [PubMed: 31971426]

- Lipperman-Kreda S, Gruenewald PJ, Grube JW, & Bersamin M (2017). Adolescents, alcohol, and marijuana: Context characteristics and problems associated with simultaneous use. *Drug and Alcohol Dependence*, 179, 55–60. doi: 10.1016/j.drugalcdep.2017.06.023. [PubMed: 28755540]
- Manning K, Garey L, Paulus DJ, Buckner JD, Hogan JBD, Schmidt NB, & Zvolensky MJ (2019). Typology of cannabis use among adults: A latent class approach to risk and protective factors. *Addictive Behaviors*, 92, 6–13. doi: 10.1016/j.addbeh.2018.12.008 [PubMed: 30553940]
- McCredie MN, & Morey LC (2019). Who are the Turkers? A characterization of MTurk workers using the Personality Assessment Inventory. *Assessment*, 26, 759–766. doi: 10.1177/1073191118760709 [PubMed: 29490470]
- Midanik LT, Tam TW, & Weisner C (2007). Concurrent and simultaneous drug and alcohol use: results of the 2000 National Alcohol Survey. *Drug and Alcohol Dependence*, 90, 72–80. doi: 10.1016/j.drugalcdep.2007.02.024 [PubMed: 17446013]
- Nylund KL, Asparouhov T, & Muthén BO (2007). Deciding on the number of classes in latent class analysis and growth mixture modeling: A Monte Carlo simulation study. *Structural Equation Modeling*, 14, 535–569. doi: 10.1080/10705510701575396
- Patrick ME, Fleming CB, Fairlie AM, & Lee CM (2020). Cross-fading motives for simultaneous alcohol and marijuana use: Associations with young adults' use and consequences across days. *Drug and Alcohol Dependence*, 213, 108077. doi: 10.1016/j.drugalcdep.2020.108077 [PubMed: 32492600]
- Patrick ME, Kloska DD, Terry-McElrath YM, Lee CM, O'Malley PM, & Johnston LD (2018). Patterns of simultaneous and concurrent alcohol and marijuana use among adolescents. *The American Journal of Drug and Alcohol Abuse*, 44(4), 441–451. doi: 10.1080/00952990.2017.1402335 [PubMed: 29261344]
- Roche DJO, Bujarski S, Green R, Hartwell EE, Leventhal AM, & Ray LA (2019). Alcohol, tobacco, and marijuana consumption is associated with increased odds of same-day substance co- and tri-use. *Drug and Alcohol Dependence*, 200, 40–49. doi: 10.1016/j.drugalcdep.2019.02.035 [PubMed: 31085377]
- Schulenberg JE, Johnston LD, O'Malley PM, Bachman JG, Miech RA, & Patrick ME (2019). *Monitoring the Future national survey results on drug use, 1975–2018: Volume II, college students and adults ages 19–60*. Ann Arbor: Institute for Social Research, University of Michigan. doi: 10.3998/2027.42/150623
- Spindle TR, Cone EJ, Schlienz NJ, Mitchell JM, Bigelow GE, Flegel R, Hayes E & Vandrey R (2018). Acute effects of smoked and vaporized cannabis in healthy adults who infrequently use cannabis: A crossover trial. *JAMA Network Open*, 1(7), e184841. doi: 10.1001/jamanetworkopen.2018.4841 [PubMed: 30646391]
- Stein MD, Caviness CM, Morse EF, Grimone KR, Audet D, Herman DS, Moitra E, & Anderson BJ (2018). A developmental-based motivational intervention to reduce alcohol and marijuana use among non-treatment-seeking young adults: A randomized controlled trial. *Addiction*, 113(3), 440–453. doi: 10.1111/add.14026 [PubMed: 28865169]
- Strickland JC, & Stoops WW (2019). The use of crowdsourcing in addiction science research: Amazon Mechanical Turk. *Experimental and Clinical Psychopharmacology*, 27, 1–18. doi: 10.1037/pha0000235 [PubMed: 30489114]
- Subbaraman MS, & Kerr WC (2015). Simultaneous versus concurrent use of alcohol and cannabis in the National Alcohol Survey. *Alcoholism: Clinical and Experimental Research*, 39(5), 872–879. doi: 10.1111/acer.12698 [PubMed: 25872596]
- Terry-McElrath YM, & Patrick ME (2018). Simultaneous alcohol and marijuana use among young adult drinkers: Age-specific changes in prevalence from 1977 to 2016. *Alcoholism: Clinical and Experimental Research*, 42(11), 2224–2233. doi: 10.1111/acer.13879 [PubMed: 30277588]
- Wang J, & Wang X (2012). *Structural equation modeling: Applications using Mplus*. John Wiley & Sons.
- White HR, Kilmer JR, Fossos-Wong N, Hayes K, Sokolovsky AW, & Jackson KM (2019). Simultaneous alcohol and marijuana use among college students: Patterns, correlates, norms, and consequences. *Alcoholism: Clinical and Experimental Research*, 43(7), 1545–1555. doi: 10.1111/acer.14072 [PubMed: 31135972]

Table 1

Summary of Model Fit Statistics for Latent Profile Models

Number of Profiles	AIC	BIC	SSA-BIC	Relative Entropy	LMR <i>p</i>
1	17109.255	17168.863	17124.424	-	-
2	16269.518	16363.187	16293.354	0.975	0.0002*
3	15745.494	15873.224	15777.997	0.962	0.0105*
4	15274.834	15436.625	15316.005	0.976	0.0450*
5	15081.713	15277.566	15131.551	0.982	0.2503
6	14950.087	15180.001	15008.593	0.938	0.6491
7	14813.374	15077.349	14880.547	0.941	0.4716

Notes. AIC = Akaike Information Criteria; BIC = Bayesian Information Criteria; SSA-BIC = sample size-adjusted Bayesian Information Criteria; LMR = Lo-Mendell-Rubin likelihood ratio test.

* $p < 0.05$.

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Table 2

Estimated Means for Four-Profile Latent Model and Profile Comparisons

	Sample	Light Users (LU; 49.0%)	Moderate Drinkers with Frequent Marijuana Use (MDFM; 37.9%)	Moderate Drinkers with High Peak Levels (MDHP; 5.4%)	Heavy/Frequent Users (HFU; 7.7%)
	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>
Latent Profile Indicator					
Drinks per day (0–13 drinks)	2.22 (2.78)	1.80 (0.07)	1.89 (0.09)	2.71 (0.29)	6.22 (0.57)
Drinking days per week (0–7 days)	4.26 (3.52)	3.75 (0.11)	4.36 (0.14)	4.96 (0.37)	6.54 (0.17)
Binge drinking days per week (0–7 days)	1.52 (2.29)	1.24 (0.08)	1.21 (0.09)	1.68 (0.21)	4.79 (0.45)
Maximum number of drinks (1–30 drinks)	7.54 (23.99)	7.00 (0.24)	6.78 (0.29)	10.67 (1.92)	12.56 (1.24)
Joints per day (0–12 joints)	1.48 (2.86)	0.39 (0.02)	2.13 (0.10)	3.36 (0.70)	3.94 (0.42)
Marijuana use days per week (0–7 days)	4.43 (6.60)	2.00 (0.08)	6.81 (0.04)	6.56 (0.21)	6.72 (0.15)
Maximum number of joints (0–30 joints)	5.18 (38.68)	2.17 (0.11)	5.39 (0.28)	26.73 (1.30)	8.04 (1.02)
Profile Comparisons					
	Sample	LU	MDFM	MDHP	HFU
	%	%	%	%	%
Demographics					
Sex (% female)	50.7	48.8	54.5	60.8	36.9
Race/ethnicity (% non-Hispanic white)	59.6	59.0	60.2	60.7	58.9
College status (% enrolled in/graduated) ^a	76.2	81.7	68.5	75.0	79.9
Greek affiliation (% Greek) ^{b,d}	26.4	27.6	19.8	29.6	51.2
Age (years)	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>	<i>M (SE)</i>
	23.0 (0.08)	22.9 (0.12)	22.9 (0.14)	23.0 (0.33)	23.5 (0.28)
Substance Use Behavior					
Tobacco use (% yes)	%	%	%	%	%
	58.8	55.1	60.8	53.5	75.6
Other drug use, besides tobacco/marijuana (% yes) ^{a,b,d}	62.3	54.1	68.2	64.2	85.3
Most frequent route of marijuana administration					
Rolling papers/joints (% most frequent) ^{a,e}	39.9	45.0	31.3	57.3	37.7
Hand pipes (% most frequent)	23.8	23.4	24.4	21.4	25.0
Water pipes (% most frequent) ^{a,e}	16.7	11.3	25.1	10.7	14.7
Vaporization (% most frequent) ^{b,d}	10.6	11.7	10.7	10.7	2.2

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Edibles (% most frequent) ^{c,e}	23.10 [*]	4.2	5.5	3.0	0.0	5.1
Hookah (% most frequent) ^{c,e,f}	19.10 ^{***}	3.5	3.1	2.5	0.0	12.9
Other (% most frequent)	7.21	1.3	0.0	3.1	0.0	2.5

Notes.

^aSignificant ($p < 0.05$) difference between LU and MDFM^bSignificant difference between LU and HFU^cSignificant difference between LU and MDHP^dSignificant difference between MDFM and HFU^eSignificant difference between MDFM and MDHP^fSignificant difference between MDHP and HFU. Other drug use includes use of opiates, barbiturates, club drugs, tranquilizers, cocaine, crack, amphetamines, steroids, inhalants, psychedelics, or other prescription drugs used nonmedically.^{*} $p < .05$.^{**} $p < .01$.^{***} $p < .001$.