Assessment of Simultaneous Alcohol and Cannabis Use and Its Related Consequences and Cognitions in College Students: A Narrative Review

Jennifer L. Shipley
Old Dominion University, jship002@odu.edu

Abby L. Braitman
Old Dominion University, abraitma@odu.edu

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Assessment of simultaneous alcohol and cannabis use and its related consequences and cognitions in college students: A narrative review

Jennifer L. Shipley1 | Abby L. Braitman1,2

Abstract
As rates of students using cannabis continue to rise, simultaneous use of alcohol and cannabis (such that their effects overlap; commonly referred to as simultaneous alcohol and marijuana [SAM] use) is prevalent among college students who use both substances. Although research focusing on SAM use and related cognitions and consequences continues to grow, there are no common established measures, as approaches vary across studies. This narrative review identifies current methods for assessing SAM use and measures of SAM-related consequences and cognitions (motives and expectancies) among college students, evaluates how they were developed, identifies gaps in the literature, and provides recommendations for future directions of assessment. We conclude that the assessment of SAM use is limited by difficulties in the assessment of cannabis quantity and potency. However, and the lack of a psychometrically validated measure of SAM consequences. However, measures of SAM motives and expectancies have been published with support from psychometric examinations such as exploratory factor analysis, confirmatory factor analysis, and measurement invariance. Research is needed that incorporates qualitative approaches in the development of SAM use measures so that unique items specific to SAM use rather than single-substance use can be identified. Additionally, validation of these measures is needed across different samples that vary demographically, such as by race and gender or sex. Future research should consider the development of a measure of protective behavioral strategies specific to SAM use to inform interventions that target the reduction of negative consequences of SAM use.

KEYWORDS
assessment, measurement, psychometrics, simultaneous alcohol and cannabis use

INTRODUCTION
Alcohol and cannabis use is prevalent among college students, with 77% reporting alcohol use and 45% reporting cannabis use in the past year (Schulenberg et al., 2021). Individuals who use both alcohol and cannabis can use them concurrently (using both but their effects do not overlap; also known as dual use) or simultaneously (using both so that their effects do overlap; Lee et al., 2022). Simultaneous...
alcohol and cannabis (commonly known as simultaneous alcohol and marijuana [SAM]) use is prevalent among college students, more so than concurrent or dual use (Bravo et al., 2021; Looby et al., 2021), and is increasing over time (Hai et al., 2022). Among college students who report using both alcohol and cannabis, 73%–77% report SAM use (Looby et al., 2021; White et al., 2019). A review by Lee et al. (2022) examined the prevalence of SAM use among young adults (18–30 years old), as well as related consequences and cognitions (e.g., motives and expectancies). Overall, young adults (including college students) who participate in SAM use report more consequences than those who only consume alcohol (e.g., Egan et al., 2019; Jackson et al., 2020; Lee et al., 2020), and reporting SAM use or using SAM more frequently was associated with greater negative consequences (Lee et al., 2022). Although 84% of US institutions of higher education address college drinking with incoming students (Riordan & Carey, 2021), no empirically supported interventions specifically to SAM use have been developed to date. Understanding how and why students engage in SAM use is critical to the development of effective interventions.

Certain demographic characteristics have seen a larger increase in the prevalence of SAM use than others. For example, Hai et al. (2022) found that the prevalence of SAM use among college students from 2006 to 2019 increased significantly for Black students and female students, but not male students or students who identify as other racial/ethnic groups. This suggests there may be reasons why some individuals engage in this behavior more than others. However, findings in this burgeoning area of research have been mixed, possibly due to inconsistencies in how SAM use and related constructs are assessed (Lee et al., 2022). For example, the association between conformity and coping motives with SAM use is at times significant (daily general or substance-specific motives relating to likelihood of SAM use [Patrick et al., 2019] or SAM-specific motives relating to using more alcohol on SAM occasions [Patrick et al., 2020]), and other times these motives are not (cannabis-specific motives unrelated to likelihood of SAM use in unadjusted models; Arterberry et al., 2021). This article reviews the current methods of assessment for SAM use behaviors (i.e., frequency, quantity) as well as current measures of consequences and cognitions (i.e., motives and expectancies; see Figure 1) among college students given that rates of use are escalating among this already high-risk population, including if and/or how specific SAM assessment measures were developed, noting strengths and weaknesses for different approaches. We also identify gaps in the literature and provide recommendations for future research focused on SAM use assessment.

It is important to understand if there are certain reasons or motives as to why college students choose to participate in SAM use to inform interventions, as well as what they expect to happen, or expectancies. These constructs are typical components of alcohol and cannabis interventions (e.g., Halladay et al., 2019; Scott-Sheldon et al., 2014). However, findings for these constructs were less consistent for SAM use among young adults. For example, a recent review on the prevalence of SAM use among young adults found that although enhancement motives were consistently positively associated with the likelihood of SAM use, the associations between SAM use and conformity, coping, and social motives were not consistent across studies (Lee et al., 2022). Similarly, positive expectancies specific to SAM use but not positive expectancies for alcohol were positively associated with SAM use (Lee et al., 2022). Lee et al. (2022) noted that inconsistent findings across studies may be due to differences in how SAM use and related constructs were assessed. For SAM use itself, there are not yet widely accepted indicators or consistent definitions across studies. For many related constructs, there are not yet psychometrically validated measures specific to SAM use, or the method in which SAM-specific measures were developed varies. Often, researchers pool measure items that assess constructs related to separate alcohol or cannabis use, or adapt existing measures designed for alcohol or cannabis to be SAM-specific.

Specific measures for SAM use need to be developed from the ground up, as researchers have identified unique motives and consequences for SAM use that are not relevant for single substance use in college student and young adult samples. Boyle et al. (2023) conducted a qualitative examination of young adults and found that there were specific positive consequences of SAM use that were different from single substance use consequences. For example, participants reported that SAM use improved preexisting relationships. Unique combinations of positive consequences were also reported for SAM use, such as lower inhibition and increased creativity as well as having more energy while also feeling relaxed (Boyle et al., 2023). These may translate directly to unique expectancies students hold for SAM use. Interviews of college students specifically yielded unique motives for engaging in SAM use, in addition to motives.
that were similar to single substance use, such as harm reduction motives (e.g., deciding to use cannabis to reduce alcohol use; Boyle et al., 2021).

As Boyle et al. (2021) stated, these motives can be mapped onto hypotheses regarding substitution and complementary use of alcohol and cannabis (e.g., Risso et al., 2020; Subbaraman, 2016), with results pointing toward the hypothesis for substitution. Substitution proposes that alcohol is used instead of cannabis, and vice versa, whereas complementary use suggests that alcohol or cannabis are used to enhance the effects of the other (Hursh et al., 2005; Risso et al., 2020; Subbaraman, 2016). However, evidence for substitution versus complementary use varies across studies. Ito et al. (2021) found that alcohol and cannabis were used as complements rather than substitutes, with more alcohol consumed on days when cannabis was used. Whether college students use alcohol and cannabis as substitutes or complements, these studies provide evidence that motives are different for SAM use compared to single substance use.

**Purpose and approach of the narrative review**

Previous research demonstrates that SAM use is prevalent among college students; yet, more measures specific to SAM use are needed, rather than using single substance use measures. To understand how previous research has assessed SAM use and its related constructs among college students, this review aims to provide an in-depth review specifically for the current assessment of SAM use and measures of related constructs. The aims of this article are to (1) review the current methods of assessment for SAM use, (2) review current measures or scales used to assess SAM use-related consequences, (3) review the current measures or scales used to assess SAM use cognitions (i.e., motives and expectancies), including if and/or how specific SAM assessment measures were developed, (4) identify strengths and limitations of how these measures or scales were developed, and (5) identify gaps in the literature and provide recommendations for future research focused on SAM use assessment.

**SEARCH STRATEGY**

SAM-specific measures included in this review were found via PsycTests ("simultaneous alcohol and marijuana"; "simultaneous alcohol and cannabis"), PsycArticles, PsycInfo, and Web of Science ("simultaneous alcohol and marijuana" AND measure or scale or inventory or assessment or questionnaire or instrument; "simultaneous alcohol and cannabis" AND measure or scale or inventory or assessment or questionnaire or instrument). We also reviewed the reference sections of articles that were identified through this search. The search was conducted in Fall 2022 and updated in Spring 2023. Articles needed to be peer reviewed; dissertations and theses were not included. Articles reviewed here either introduced a new measure of SAM use-related consequences or cognitions, or provided a psychometric examination of an existing measure. We did not restrict the original search based on population, as we focused on measures that could be used with a college student population even if they were not validated in that population. However, data used in the development of the measures found were mainly from college student and young adult samples, consistent with the focus of this article on what measures exist for use with college students.

**RESULTS**

**Overview of the assessment of SAM use frequency and quantity**

Although this article focuses on measures of SAM use-related consequences and cognitions, we would be remiss to not briefly discuss assessment of SAM use itself. SAM use frequency among college students has been assessed by asking participants about their alcohol and cannabis co-use, such as, “How often do you use cannabis and alcohol at the same time – that is, so that their effects overlap?” (e.g., Waddell et al., 2022, p. 814), “Do you use marijuana when you are using alcohol?” (Cummings et al., 2019, p. 353), or “indicate ... how often you used alcohol and marijuana simultaneously (i.e., during the same session)” (e.g., Bravo et al., 2021, p. 4). These are slightly different interpretations of SAM use (i.e., effects overlapping vs same session), which may lead to differences in results across studies, especially when looking at between-person effects (i.e., the effects across individuals [e.g., people who tend to engage in more frequent SAM use vs. not] rather than effects one person may have day to day [e.g., on a day someone engages in SAM use vs. not]). Additionally, “effects overlap” is subjective and may lead to inaccurate or inconsistent reporting of SAM use. At the same time, an objective time window, such as within a specific number of hours (e.g., Martin et al., 1996; Meisel et al., 2021; Sokolovsky et al., 2020), may fail to take into account individual differences such as rate of metabolizing, where there could be overlapping effects for some individuals within a specific window but not others. And as noted by Lee et al. (2022), many of these approaches also do not account for the intensity, or quantity, of SAM use. Kopol et al. (2023) recently addressed this issue by developing the Alcohol and Cannabis Simultaneous Use Scale (ACSUS) using data from a sample of college students (Study 1: ages 18–28 years old [N = 534]; Study 2: ages 18–47 years old [N = 258]) who reported past-year alcohol and cannabis use. The ACSUS is a 2-factor, 9-item measure developed by adapting items from previous research, including consequences measures (i.e., Alcohol Use Disorders Identification Test [AUDIT; Saunders et al., 1993] and Cannabis Use Disorder Identification Test-Revised [CUDIT-R; Adamson et al., 2010]). The new measure was psychometrically validated using exploratory factor analysis (EFA) and confirmatory factor analysis (CFA), and validity was established via correlations with other single substance and SAM use measures (e.g., motives). The first factor asks participants to report the frequency of simultaneous use in the past year, as well as the quantity of alcohol and cannabis on a typical day when using both
substances (effects overlapped; Kolp et al., 2023). Researchers have assessed SAM use intensity and quantity in different ways across studies, but similar to Kolp et al. (2023), this often requires assessment of individual substance use, which has its own limitations, such as not having a standard measure of cannabis potency or quantity.

Standard drink sizes are used to estimate alcohol quantity, accounting for potency (or alcohol by volume). A common measure for this is the Daily Drinking Questionnaire (DDQ; Collins et al., 1985); participants report how many standard drinks they have consumed in a typical week. However, there is not currently a standardized measure for cannabis quantity and potency. Quantity of cannabis use has been assessed among college students using the Marijuana Use Grid (Bravo et al., 2019; Pearson & Marijuana Outcomes Study Team, 2021), a modified version of the DDQ (Collins et al., 1985). Participants are asked to report the amount of cannabis (in grams) they used in a typical week. Each day of the week is broken down into six 4-hour time blocks (Bravo et al., 2019). The ACSUS (Kolp et al., 2023) also assesses quantity of cannabis in a typical day via number of grams. Among the greater young adult population, researchers have also asked participants to report the estimated number of joints they used or could have rolled (e.g., Linden-Carmichael & Allen, 2021) and the number of hits (e.g., Cloutier et al., 2022; Linden-Carmichael et al., 2020). However, estimates of quantity may not be accurate. Preparation and packing tasks indicate both adults (Prince et al., 2018) and college students (Mian et al., 2021) tend to overestimate cannabis quantity.

An alternative estimate of cannabis quantity used in research is hours high (Calhoun et al., 2022). In a sample of young adults (ages 18–25 years old; over half were enrolled in postsecondary education), Calhoun et al. (2022) conducted a daily diary study and assessed cannabis use quantity multiple ways, including across modes of administration. For example, participants were asked to report the number of grams for smoking or vaping, number of hits they took for dabbing, and number of milligrams of delta-9-tetrahydrocannabinol (THC) for edibles. Calhoun et al. (2022) found that number of grams, hits, and milligrams were positively associated with hours high, which demonstrated criterion validity at the daily level. Thus, using hours high may be a good estimate of cannabis quantity, and may both be easier for participants to accurately estimate as well as provide a universal metric regardless of mode of administration. However, this is a subjective measure of SAM use and may be more beneficial for daily diary designs, in which within-person examinations are conducted (e.g., assessing changes within an individual; Calhoun et al., 2022). Taken together, objective measures of cannabis typically suffer from systematic overestimates (Mian et al., 2021; Prince et al., 2018), whereas the subjective nature of hours high has limitations for between-person examinations, as each person may interpret hours high differently.

Potency estimates are complicated by the fact that different routes of administration may be more concentrated than others, for example, flower having lower percent of THC than concentrated products (Prince & Conner, 2019). One method used to measure potency has been to ask participants to report the percent of THC in the products they used, such as in a sample of adult cannabis users (Prince & Conner, 2019) or in a sample of young adult cannabis users (Calhoun et al., 2022); however, labeling of cannabis products varies, and percent of THC may not be included on the packaging (Hammond, 2021). How college students obtain cannabis may also impact if they know the potency of the product. Data from California indicate that about half of young adults (ages 18–21 years; about 52% college students) obtained cannabis from family or friends (D’Amico, Rodriguez, Dunbar, et al., 2020); they may not have packaging with labels and therefore may not know the potency of the product. Assessment of cannabis use is complicated by varying potency across different routes of cannabis administration (Linden-Carmichael & Wardell, 2021), and inaccuracies in self-reported estimation of cannabis quantity. As assessment of SAM use quantity and intensity is dependent on measuring single substance use quantity and intensity, more research is needed to establish a standardized approach to assess cannabis use in a common metric across multiple routes, or modes, of administration. This will also help to determine if there is a dose-dependent relationship between alcohol and cannabis use during simultaneous use.

Assessment of SAM use consequences

SAM use consequences have been assessed among college students by using single substance alcohol and cannabis use consequences measures, sometimes combining them (e.g., Bravo et al., 2021; Cummings et al., 2019). For example, Bravo et al. (2021) asked participants to report alcohol- and cannabis-related problems from the previous 30 days using established alcohol (The Brief Young Adult Alcohol Consequence Questionnaire [BYAAQ; Kahler et al., 2005]) and cannabis (The Brief Marijuana Consequences Questionnaire [BMACQ; Simons et al., 2012]) consequences measures. Items were summed individually for the two measures; conclusions regarding SAM use and consequences were drawn separately for alcohol or cannabis consequences. These two measures of alcohol- and cannabis-related consequences have also been combined, directing college student participants (N = 678 SAM users; 18–24 years old) to select if they experienced consequences associated with alcohol use only, cannabis use only, or both substances “together so that their effect overlapped” (Jackson et al., 2020, p. 373). The combined scale resulted in 28 unique items. Combining the measures in this manner allowed for a single measure of consequences that could be narrowed to consequences specific for SAM use (by summing only items endorsed for this reason), or specific to alcohol alone or cannabis alone. The internal consistency of this measure was relatively high (Cronbach’s alphas 0.87–0.88 for alcohol, cannabis, and SAM consequences). Jackson et al. (2020) stated that a limitation of measuring SAM consequences in this way is that asking participants to assess if a consequence occurred because of just one substance or SAM use relies on participants’ perceived attributions (Jackson et al., 2020). Sokolovsky et al. (2020) created a measure for daily assessment by selecting seven consequences from previous measures.
of single substance use consequences; the questions were identical for alcohol only, cannabis only, or SAM use days. This was different from the way in which Jackson et al. (2020) assessed consequences, in which participants could attribute using a single substance, or both, to a specific consequence. Instead, Sokolovsky et al. (2020) attributed all consequences on the list based on whether it was an alcohol only, cannabis only, or SAM use day. More recently, Kolp et al. (2023) adapted items from the AUDIT (Saunders et al., 1993) and CUDIT-R (Adamson et al., 2010) to develop the second factor of the ACSUS (five items). All questions were about simultaneous use occasions (“using both alcohol and marijuana on the same occasion so that the effects of alcohol and marijuana overlapped” [Kolp et al., 2023, p. 2]), but some were specific to alcohol or cannabis effects.

Although these studies have adapted single substance consequence measures to capture if these same consequences were experienced after SAM use, currently, there is not a measure specifically for SAM use consequences that has been developed using mixed methods (e.g., qualitative data collection and psychometric analysis of quantitative data). Qualitative approaches would allow for the inclusion of negative and positive consequences that may be unique to or particularly relevant for SAM use, such as those outlined by Boyle et al. (2023; e.g., feeling nauseated after a particular order of use). More research is needed to develop a comprehensive consequences measure specific to SAM use that can capture its unique characteristics.

**Assessment of SAM use cognitions**

Greater strides have been made in the development of measures specifically for SAM use motives and expectancies. Previous research has assessed SAM use motives by asking about alcohol or cannabis use motives separately (e.g., Arterberry et al., 2021). However, two studies have more comprehensively developed and psychometrically validated measures for SAM use motives. Patrick et al. (2018) developed the 4-factor, 22-item SAM Motives Measure based on a combination of existing single substance use motives measures, reviewing previous literature on single substance use motives and new qualitative data from a sample of young adults (students and nonstudents). Open-ended survey questions asked participants why they participated in SAM use (“...use alcohol and marijuana at the same time, that is so their effects overlap” [Patrick et al., 2018, p. 364]), resulting in six broad categories of motivations for SAM use and a total of 26 items.

Patrick et al. (2018) conducted an EFA with data from 286 young adults (ages 18–23 years old) who reported SAM use at least once in their lifetime. The EFA identified four factors: conformity (eight items, e.g., “pressure from others”), positive effects (six items, e.g., “to get a better high”), calm/coping (three items, e.g., “to cope with anxiety”), and social motives (five items, e.g., “to be sociable”). Internal consistency for the subscales was good (Cronbach’s alphas 0.77–0.88).

The SAM Motives Measure (Patrick et al., 2018) was then validated among college students (n = 1014 at baseline, n = 904 at follow-up; ages 18–24 years) by Conway et al. (2020). The SAM Motives Measure (Patrick et al., 2018) had relatively good to high internal consistency across the subscales (Cronbach’s alphas 0.70–0.91). Concurrent incremental validity was confirmed via associations with SAM use frequency and three of the SAM Motives Measure (Patrick et al., 2018) subscales (all but positive effects). Additionally, Conway et al. (2020) developed a brief, 11-item version of the measure. The items with the three highest factor loadings were selected for each factor, except for one factor that only had two items (calm/coping). A CFA confirmed that the model had good fit for this reduced measure maintaining four factors. The new Brief SAM Motives Measure (B-SMM; Conway et al., 2020) demonstrated concurrent incremental validity, again correlating with SAM use over and above single substance use motives, and predictive validity (for three of the four subscales), correlating with SAM consequences over and above single substance use motives. This pair of studies produced two validated measures of SAM-specific motives, a longer and a briefer measure with four identical factors, that were developed incorporating qualitative exploration with SAM users to capture any potential unique experiences. These measures have also been used in full in other studies with college student samples; Kolp et al. (2023) used the SAM Motives Measure (Patrick et al., 2018) and Waddell et al. (2022) used the B-SMM (Conway et al., 2020).

Assessment of SAM use expectancies has also varied. Some studies have examined only alcohol expectancies (e.g., Lipperman-Kreda et al., 2018) and/or cannabis expectancies (e.g., D’Amico, Rodriguez, Tucker, et al., 2020) in young adult samples. However, three SAM expectancy or perceived effects measures have been developed. Barnwell and Earleywine (2006) assessed SAM use expectancies in the general population (N = 2637; 13–86 years old, M = 34 years) by combining two single substance expectancy measures and adding follow-up questions to assess SAM use expectancies. First, participants were asked about single substance use expectancies, using items from the Alcohol Expectancy Questionnaire (Brown et al., 1987) and Marijuana Effect Expectancy Questionnaire (Schafer & Brown, 1991). Only the global effects and relaxation and tension reduction subscales were used from each questionnaire. If an item was endorsed, a follow-up question was asked, “How does (alcohol or marijuana) alter this effect?” (Barnwell & Earleywine, 2006, p. 4). Participants could select from −3 (Makes it less intense) to 3 (Makes it more intense). Note that although Barnwell and Earleywine (2006) indicated this follow-up question was asked “if an item was endorsed” (p. 4), they did not report the response options provided or what “endorsement” reflected. They confirmed via pilot testing that the measure and its instructions were clear and understandable to participants. Barnwell and Earleywine (2006) calculated the sum of the scores (after recoding the response scale into 1 to 7), so that higher scores would reflect expecting that simultaneous use intensifies drug use experiences. However, this approach does not differentiate between less intense expectancy versus expectancies that were not endorsed, with participants with lower scores potentially reporting less intense expectancies, or potentially not endorsing
many expectancies. Barnwell and Earleywine (2006) stated that more research would be needed to confirm the validity and reliability of the new measure. Additionally, more research is needed to validate the updated measure in a college student sample. Lee et al. (2017) also modified a single substance use measure (the 7-item Subjective High Assessment Scale [Eng et al., 2005]) to assess SAM perceived effects in a sample of young adults. Participants were asked to provide ratings for eight effects (i.e., “feeling alcohol effects,” “high,” and “dizzy”) on a scale of 0 (not at all) to 4 (extremely). An average score was calculated. However, this modified measure has not been psychometrically validated, and the definition of expectancies was not entirely consistent with other measures (i.e., based on what one typically experiences rather than what one expects to experience [likely based on previous use]).

More recently, the Anticipated Effects of Simultaneous Alcohol and Cannabis Use Scale (AE-SAM; Waddell et al., 2022) was developed. The AE-SAM is a 5-factor, 26-item measure developed by combining and reducing the Anticipated Effects of Alcohol Scale (Morean et al., 2012) and the Anticipated Effects of Cannabis Scale (Waddell et al., 2020). The AE-SAM was psychometrically validated in a sample of 434 college students (mean age = 19.82) who participated in past-month SAM use. After combining the measures, a total of 37 unique items were present. Participants are asked to “rate the extent to which you expect to feel each of the following effects after simultaneously using alcohol and cannabis (i.e., at the same time, `cross-fading’)” (Waddell et al., 2022, p. 814). An EFA was conducted, and parallel analysis and factor loadings were examined to determine the factor structure and which items to retain or remove. A 5-factor model, with 26 items, was suggested: high arousal positive (e.g., “Talkative”), high arousal negative—alcohol (e.g., “Demanding”), high arousal negative—cannabis (e.g., “Panicke”), low arousal positive (e.g., “Relaxed”), and low arousal negative (e.g., “Woozy”). All factors had reasonably high internal consistency (Cronbach’s alphas 0.83–0.95 for the full sample). A CFA indicated the data fit well with the 5-factor model. Next, three tests of measurement invariance were conducted for sex (male vs. female), race/ethnicity (non-Hispanic White vs racial/ethnic minority), and SAM use frequency (frequent vs less frequent). Measurement invariance was established across all groups. Additionally, convergent, discriminant, concurrent, and incremental validity were established by demonstrating associations with relevant constructs (e.g., associations with SAM use over and above single-use expectancies; Waddell et al., 2022).

Motives and expectancies measures specific to SAM use have been developed and have undergone psychometric examination using data from college student samples. Further, psychometric analyses may be needed for both SAM motives measures (Conway et al., 2020; Patrick et al., 2018), particularly tests of measurement invariance, to ensure that measurement is not biased across gender or sex or across race. More psychometric analyses are needed for Barnwell and Earleywine’s (2006) expectancy measure, as noted by the authors, and the Lee et al. (2017) expectancy measure. Waddell et al. (2022) advanced the field of SAM expectancy measurement, specifically for college students, by developing the AE-SAM and supporting multiple forms for validity. Although establishing measurement invariance across sex and frequency of SAM use, the AE-SAM (Waddell et al., 2022) may also benefit from further tests of measurement invariance, specifically examining race across specific groups rather than combining racial/ethnic minority groups as this could mask unique findings specific to one race or ethnicity (Burlew et al., 2019). Many study variables have demonstrated different directions of effect in comparisons to White individuals in prior research (e.g., Native American and Black students drinking less [e.g., Gardner et al., 2020; Hagler et al., 2017; Looby et al., 2017], Black emerging adults reporting higher cannabis use frequency [e.g., D’Amico et al., 2022], etc.), which could be masked when combined. In addition, all three SAM expectancy measures have not been used in other published research studies and were created using items from single substance use expectancy measures without qualitative supplementation. Thus, further research may be needed to determine if there are unique SAM expectancies, as noted by Waddell et al. (2022).

**DISCUSSION**

The purpose of this article was to provide a review of the assessment of SAM use and measures of its related constructs (consequences, motives, and expectancies). The review highlighted publications of SAM-specific constructs, differentiating between those that have psychometrically validated measures and those that are using measures that have been relatively unexamined. For all measures, we overviewed how the constructs were developed and previously assessed. This review identified three measures of SAM consequences (including a daily measure), a full and brief measure of SAM motives, and three measures of SAM expectancies. There were multiple strengths to the development of these measures (see Table 1). First, a mixed-methods approach was used for the development of the SAM Motives Measure (Patrick et al., 2018), which is considered a best practice for scale development (e.g., Boateng et al., 2018; Zhou, 2019). Because Conway et al. (2020) further validated the SAM Motives Measure (Patrick et al., 2018) in a sample of college students, a full mixed-methods approach may not have been needed for the development of the B-SMM (Boateng et al., 2018). The development of the SAM consequences (Jackson et al., 2020; Kolp et al., 2023) and expectancy measures (Barnwell & Earleywine, 2006; Lee et al., 2017; Waddell et al., 2022) did not include a qualitative component for item development. Rather, items were combined and collapsed or modified from established single substance use consequences and expectancy measures. This may lead to inconsistencies in the literature, as noted by Lee et al. (2022). Moreover, this approach (adapting single substance use measures) ignores unique consequences and expectancies when using multiple substances suggested by formative qualitative work in this area (Boyle et al., 2021), and acknowledged by measure authors (Waddell et al., 2022). Thus, employing a mixed-methods approach, although not a new recommendation for scale development, is important for the development of future SAM use measures specifically, as validation examinations can be conducted throughout both the qualitative
and quantitative steps (Zhou, 2019). Additionally, deductive (e.g., literature reviews) and inductive (e.g., focus groups) methods are both recommended for item generation, as it allows for a theoretical basis gathered from the literature to become more defined (Boateng et al., 2018). Then, content validation can occur, such as with an expert panel of researchers who can evaluate the items generated in the previous step and determine if they fit with the suggested domain(s) (Boateng et al., 2018).

Four measures were analyzed using multiple psychometric approaches (consequences [Kolp et al., 2023]; motives [Conway et al., 2020; Patrick et al., 2018]; and expectancies [Waddell et al., 2022]). All four studies included an EFA and CFA and three (Conway et al., 2020; Kolp et al., 2023; Waddell et al., 2022) conducted various validity examinations. Future research should conduct tests of measurement invariance with the ACSUS (Kolp et al., 2023), SAM Motives Measure (Patrick et al., 2018), and B-SMM (Conway et al., 2020) to determine if they perform similarly across different groups, such as across sex or gender and across race or ethnicity.

Measurement invariance is critical to establish if mean differences for these constructs will be compared across groups (Chen, 2007; Lopez-Vergara et al., 2021; Putnick & Bornstein, 2016), which should be considered for future research. This is particularly relevant as differences in SAM use across gender and race have been documented (e.g., Hai et al., 2022; White et al., 2019). The majority of the consequences and cognitive measures in this review were conducted among samples with over 50% of participants identifying as White, Non-Hispanic, and female, which may have made it difficult to examine measurement invariance. Future research should seek to examine psychometric properties of measures among diverse samples.

A strength of many of the measures was that SAM use was defined in the instructions so that it was clear to the participants how to best complete the measure. However, some of the definitions were different. Five of the measures defined SAM use as “effects overlapped” (Conway et al., 2020; Jackson et al., 2020; Kolp et al., 2023; Lee et al., 2017; Patrick et al., 2018) and/or “at the same time” (Conway et al., 2020; Lee et al., 2017; Patrick et al., 2018). Waddell et al. (2022) defined SAM use as “at the same time, ‘cross-fading,’” whereas Barnwell and Earleywine (2006) asked how participants expected for one substance to alter the effect of the other. It is important that future measures for SAM use have a common definition, such as the suggestion by Lee et al. (2022) to define SAM use as using both substances “at the same time so that their effects overlap” (p. 11). This may help to reduce discrepancies in outcomes across future studies.

**Recommendations for future research**

More research is needed using the measures for expectancies and motives, as these measures have either not been used in other published studies or have only been used a few times (e.g., Conway et al., 2020; Kolp et al., 2023). As previously noted, specific measures for SAM use motives and expectancies have been developed and validated in samples of college students, but standard measures for SAM use frequency, quantity (incorporating potency and allowing for different routes of administration), and consequences (including unique SAM consequences) are still needed. Although using hours high is promising as a measure of quantity (Callhoun et al., 2022), we echo the calls for more research to determine a measure of SAM use quantity that reliably and objectively assesses cannabis use across routes of administration for between-subject examinations (e.g., who uses more vs. less). This would also help to further understand if there is a dose-dependent relationship between alcohol and cannabis use for SAM use occasions. For some research questions (e.g., if SAM use is associated with specific social contexts), it may be sufficient to know whether it was

### TABLE 1 Components of the development of the SAM consequences and cognitions measures.

<table>
<thead>
<tr>
<th>SAM consequences and cognitions</th>
<th>Number of factors (items)</th>
<th>Qualitative components?</th>
<th>Factor analyses?</th>
<th>Validity examinations?</th>
<th>Measurement invariance examinations?</th>
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<tbody>
<tr>
<td>Consequences (Jackson et al., 2020)</td>
<td>One (28)</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Consequences (Kolp et al., 2023)</td>
<td>Two (9 total; five consequences items)</td>
<td></td>
<td>X</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Consequences (Sokolovsky et al., 2020)</td>
<td>One (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Motives (Patrick et al., 2018)</td>
<td>Four (22)</td>
<td></td>
<td>X</td>
<td>X (for college students)</td>
<td>n/a</td>
</tr>
<tr>
<td>Motives (Conway et al., 2020)</td>
<td>Four (11)</td>
<td></td>
<td>X</td>
<td>X</td>
<td>n/a</td>
</tr>
<tr>
<td>Expectancies (Barnwell &amp; Earleywine, 2006)</td>
<td>One (56; plus follow-up question if endorsed)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expectancies (Lee et al., 2017)</td>
<td>One (7)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expectancies (Waddell et al., 2022)</td>
<td>Five (26)</td>
<td></td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Abbreviations: SAM, simultaneous alcohol and cannabis (commonly known as simultaneous alcohol and marijuana).
a SAM use occasion or single substance use occasion. For other research questions (e.g., how SAM use associates with anxiety, stress, or consequences), it would be helpful to know if there is a dose-dependent relationship. In addition, more formative work is needed for SAM-related consequences. As noted above, future research should examine potential unique consequences for SAM use via qualitative work; in addition to unique consequences, this work could also reveal if the intensity of some consequences differs from single substance use.

It is important to note that the psychometrically validated measures used data from cross-sectional survey designs. Researchers conducting studies examining person-level characteristics (e.g., general motives for SAM use or expectancies about SAM use) can rely on the formative work conducted in these development studies to inform their own research design. Due to the nature of SAM use, many research questions (e.g., contextual examinations) will require momentary or daily assessment to examine within-person changes, and the psychometric properties of the scales will change if adapted for momentary or daily assessment. It is recommended that momentary or daily assessments should minimize survey length to reduce participant burden as more assessments are needed throughout the study period (Smyth & Heron, 2013). Following examples of previous adaptations for daily assessment, researchers may choose items based on specific criteria of interest (e.g., acute consequences; Sokolovsky et al., 2020) or the highest loading item(s) on a factor or subscale (e.g., Conway et al., 2020). However, more research is needed to validate daily or momentary assessment of SAM use constructs. This could also help researchers to understand if participants can correctly attribute a consequence experienced to their SAM use rather than single substance use (i.e., did it truly occur because of the use of two substances together, or was it due to only one substance’s effects?).

With SAM use increasing among college students (Hai et al., 2022), and participants reporting that more consequences are experienced with SAM use than with single substance use (e.g., Jackson et al., 2020), specific interventions are needed to address simultaneous use. Single substance use interventions typically include components such as assessing consequences experienced, motives for use, expectancies of use, and social norms (e.g., for reviews, see Halladay et al., 2019; Scott-Sheldon et al., 2014). Notably absent in previous assessment of SAM-related behaviors and related cognitions, and a component of efficacious single substance use interventions, researchers have called for a measure of protective behavioral strategies (PBS) specific to SAM use (Boyle et al., 2021; Bravo et al., 2019). PBS are strategies people can use to decrease their single substance alcohol and cannabis use and/or consequences (Martens et al., 2005; for a review, see Peterson et al., 2021). Measures of PBS for alcohol and cannabis single substance have a long history in research for single substance use (see Peterson et al., 2021 for a review). A single study to date has examined PBS within the context of co-use of alcohol and cannabis among college students using established measures for single substance PBS use (Bravo et al., 2019). A PBS measure developed specifically for SAM use has not been published. Development of a novel assessment rather than an adaptation of existing single substance use measures is particularly important, as previous research has identified strategies specific to SAM use, such as patterns of use (i.e., drinking before using cannabis), as a way that college students who participate in SAM use try to avoid negative consequences (Boyle et al., 2021).

Limitations

Limitations of this narrative review should be addressed. This review focused on peer reviewed articles that were accessible during a specific time period. SAM use research is rapidly expanding; newer research may be missing from this review, as well as dissertations and theses. Additionally, this review focused mainly on assessment of SAM use for college student research, given both high prevalence of SAM use and access to health promotion resources in this population. Although this review did not limit measures identified by population, the predominance of measures identified were developed with college student or young adult samples. Future research should develop new or validate existing SAM use assessment and measures across other populations (e.g., including adolescents, adults, and high-risk populations).

CONCLUSION

SAM use is prevalent among emerging adult college students, but inconsistent assessment approaches across studies makes it difficult to establish consistent associations in the literature. Psychometrically validated measures for SAM use consequences, motives, and expectancies have been developed, but appropriate measures specific to SAM use for consequences, expectancies, and protective behavioral strategies are needed that include qualitative data collection and analysis in the development of the measure, allowing for the inclusion of items that capture unique SAM use characteristics. A better understanding of how these measures were developed may help address inconsistencies in the literature and provide more information for researchers who want to develop SAM-specific measures, such as how to best develop SAM use measures and any potential limitations that need to be addressed.

CONFLICT OF INTEREST STATEMENT

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ORCID
Jennifer L. Shipley https://orcid.org/0000-0002-5203-4486
Abby L. Braitman https://orcid.org/0000-0003-2259-1094
REFERENCES


psychosocial correlates, and consequences. Alcohol Research: Current Reviews, 42, 1–27.


