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Simultaneous alcohol and marijuana use among young adult drinkers: Age-specific changes in prevalence from 1977-2016

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Abstract

Background: The overall prevalence of United States young adult alcohol use has decreased, but less is known about historical change in related behaviors such as simultaneous alcohol and marijuana (SAM) use that may increase alcohol-related risks and societal costs. The purpose of this paper is to examine historical change in SAM use prevalence among U.S. young adult alcohol users from 1977–2016, and consider the extent to which observed historical change in SAM use among alcohol users reflects co-occurring change in marijuana use during these years.

Methods: Data on past 12-month alcohol, marijuana, and SAM use at up to six modal ages (19/20, 21/22, 23/24, 25/26, 27/28, 29/30) were collected from 11,789 individuals (45.0% men) participating in the Monitoring the Future panel study. Annual prevalence estimates within modal age group were obtained; historical SAM use trends among alcohol and marijuana users were estimated.

Results: From 2014 to 2016, SAM use was reported by approximately 30% of alcohol users aged 19/20 and 21/22, and 20% to 25% of alcohol users aged 23/24 through 29/30. Since the mid-1990s, age-specific historical trends in SAM use prevalence among alcohol users followed one of four patterns: significant increase followed by oscillating increases/decreases (at modal age 19/20); consistent and significant increases (at modal ages 21/22, 23/24, and 25/26); stability followed by increase (at modal ages 27/28); or stability (at modal ages 29/30). In contrast, SAM use trends among marijuana users primarily reflected stability, with some evidence of a decrease across time at modal ages 19/20 and 23/24. Historical change in SAM prevalence among alcohol users was strongly and positively correlated with changes in overall marijuana use prevalence.

Conclusions: A growing proportion of early- and mid-young adult alcohol users reported SAM use, with the highest risk among those in the early years of young adulthood. Young adult SAM use may continue to increase in proportion to the degree that young adult marijuana use continues to increase.

Keywords

young adult; alcohol; marijuana; simultaneous use

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INTRODUCTION

The worldwide economic, health, and societal costs of alcohol-related harms are staggering (Anderson & Baumberg, 2006; Centers for Disease Control and Prevention [CDC], 2016; Institute of Alcohol Studies [IAS], 2016, 2017a,b; Manning et al., 2013; Sacks et al, 2015; World Health Organization [WHO], 2014). Average high-volume consumption, as well as drinking patterns characterized by heavy episodic drinking and high-intensity drinking, are particularly likely to be associated with alcohol-related harms (Hingson et al., 2017; Linden-Carmichael et al., 2017; Miller et al., 2007; Patrick et al., 2016a; Rossow et al., 2013; Sacks et al., 2015; WHO, 2014).

The normative developmental trajectories for alcohol behaviors commonly associated with increased risk, such as heavy episodic and high-intensity drinking, increase from age 18 through 21/22, and decrease thereafter (Miech et al., 2017; Patrick et al., 2016b, 2017a). Thus—due to a range of both developmental and cultural reasons—the age group most likely to engage in these risky behaviors is young adults, or those aged 19–30 (Schulenberg & Mags, 2002). Monitoring change in both volume and prevalence of alcohol use among this subgroup is important; such information is critical for effective planning and provision of future health service and treatment needs (Dawson et al., 2015). Recent research indicates that, among young adults overall, prevalence of heavy episodic and high-intensity drinking has been decreasing (Centers for Behavioral Health Statistics and Quality, 2015). Data that examine differential rates of change across young adulthood provide a more nuanced picture, indicating that heavy episodic and high-intensity drinking have been decreasing historically for individuals in their early 20s (Patrick & Terry-McElrath, 2017; Patrick et al., 2017a), but holding steady for those in their mid-20s (Patrick et al., 2017a; Terry-McElrath & Patrick, 2016), and actually increasing for individuals at the end of young adulthood (ages 29/30; Patrick et al., 2017a).

Alcohol consumption risk also differs by the presence or absence of simultaneous use with other substances. The most common form of such simultaneous use involves using alcohol together with marijuana (Collins et al., 1998; Earleywine and Newcomb, 1997; Martin et al., 1996; Midanik et al, 2007; SAMHSA, 2009). Simultaneous alcohol and marijuana (hereafter referred to as SAM) use involves the use of both substances at the same time, such that effects of the two substances overlap. SAM use has significant additive (and possibly synergistic) effects on cognitive, perceptual and motor functions, over and above that of either alcohol or marijuana use alone (Belgrave et al., 1979; Chesher et al., 1976, 1977; Hartman & Huestis, 2013; Kelly et al., 2004; Lamers & Ramaekers, 2001; Ramaekers et al, 2000; Robbe, 1998). SAM use is associated with a range of serious public health concerns, including unsafe driving (Subbaraman & Kerr, 2015; Terry-McElrath et al., 2014); social consequences, depression, and physical health problems (Earleywine & Newcomb, 1997; Midanik et al., 2007; Subbaraman & Kerr, 2015); high rates of alcohol consumption (Patrick et al., 2017b; Subbaraman & Kerr, 2015); and substance dependence (Agosti et al, 2002; Martin et al., 1996; Midanik et al., 2007).

The literature on the extent of SAM use among the general adult population indicates that young adulthood has consistently been a period of elevated prevalence. The 1982 National Household Survey on Drug Abuse found that, among those aged 12 and older, the prevalence of SAM use was higher among those aged 18–25 and 26–34 than younger or older individuals (Norton & Colliver, 1988). The 2000 National Alcohol Survey found while 7% of all U.S. adults reported past 12-month SAM use, rates were highest (14.8%) among those aged 18–29 (Midanik et al., 2007). Research combining the 2005 and 2010 National Alcohol Surveys found those aged 18–29 continued to report the highest prevalence of SAM use among U.S. adults at 15.3% (Subbaraman & Kerr, 2015). While research to date indicates that young adulthood is a key age for the risks and associated harms of SAM use, no data have been available that examine the extent to which this behavior is changing over time, and thus potentially affecting overall levels of harm associated with alcohol use.

While SAM use prevalence has been found to be significantly higher among those who consume high quantities of both alcohol and marijuana (Patrick et al., 2017b), SAM use is not confined to individuals reporting high consumption levels (Patrick et al., 2018; Terry-McElrath et al., 2013). SAM use is, to some degree, likely incidental to the general use of both substances (i.e., both alcohol and marijuana use prevalence may be high enough that simultaneous use is not uncommon; Hoffman et al., 2000). To the extent that SAM use is incidental to both alcohol and marijuana use, historical changes in marijuana use may be expected to be associated with changes in SAM use among alcohol users (both high- and low-frequency users). Published historical trend data indicate that, since the late 1970s, prevalence of past 12-month alcohol use has generally decreased for those aged 19/20, generally remained stable for those aged 21/22 through 27/28, and slightly increased for those aged 29/30 (Schulenberg et al., 2017). In contrast, historical trends for past 12-month marijuana use over the same time period show strong declines in marijuana use prevalence from the late 1970s through the early 1990s across ages. Thereafter, historical trends for marijuana use increase at varying levels and for different lengths of time across ages 19/20 through 29/30, with virtually all age groups reporting increasing prevalence from 2010 onwards (Schulenberg et al., 2017). These historical increases in marijuana use prevalence bring with them the possibility that SAM use prevalence also may be increasing, thus raising the potential risk for adverse consequences among alcohol users even if overall alcohol use has been decreasing or holding steady.

The current paper aims to contribute to the literature on young adult alcohol use risk by examining historical change from 1977 through 2016 in the proportion of young adult alcohol drinkers in a general U.S. young adult sample who engaged in SAM use. Three research aims guided the analysis: (1) estimate recent SAM prevalence levels among past 12-month alcohol users, by six modal age groups; (2) model historical SAM use trends by modal age group among past 12-month alcohol users; and (3) examine the degree to which observed historical SAM use trends appear to reflect historical changes in marijuana use prevalence.

MATERIALS AND METHODS

Data, Setting, and Study Population

The study utilizes data from Monitoring the Future (MTF), a national cohort-sequential study (for detailed methodology, see Bachman et al., 2015; Schulenberg et al., 2017). Briefly, a nationally representative sample of approximately 15,000 12th graders (modal age 18) from about 130 schools in the contiguous 48 states has been surveyed annually since 1976 yielding sequential cohorts. Students complete self-administered surveys, typically during a normal class period. A sub-sample of about 2,400 12th graders is selected from each annual sample for longitudinal follow-up by mail; substance users are over-sampled (analyses include weights accounting for sampling procedures). Respondents are randomly divided with half surveyed one year after graduation (modal age 19) and then every two years after that to age 29, and half surveyed two years after graduation (modal age 20) and then every two years following to age 30, resulting in six follow-up surveys: one at each of modal ages 19/20, 21/22, 23/24, 25/26, 27/28, and 29/30. Follow-up questionnaires are mailed in the spring with a modest monetary incentive. A University of Michigan Institutional Review Board approved the study.

SAM use was included on only one of the six different questionnaire forms used in the study (randomly distributed within classroom at age 18; respondents were sent the same survey questionnaire form they responded to at age 18 for all follow-up surveys through age 30). The analytic sample was limited to 12th-grade cohorts from 1976–2015 who received the relevant form and responded to at least one young adult survey from 1977–2016. The average age 18 response rate for these cohorts was 82.7%. A total of 16,797 individuals from the 1976–2015 cohorts responded to the relevant form at age 18 and were selected for longitudinal participation. Of these individuals, 12,763 (76.0%) responded to at least one of the six follow-up surveys. Data on the outcomes of interest on at least one follow-up survey were available for 11,798 responding individuals (70.2% of those selected for follow-up). Men made up 45.0% of the analytic sample. Attrition adjustments are discussed below.

Measures

At each follow-up, respondents self-reported past 12-month alcohol use and marijuana use frequency; any/none use dichotomies were coded for analysis. Respondents who reported any past 12-month marijuana use were asked, "How many of the times when you used marijuana or hashish during the last year did you use it along with alcohol—that is, so that their effects overlapped?" Responses were coded as any or no SAM use (respondents reporting no past 12-month marijuana use were coded as non-SAM users).

Analysis

All analyses were conducted using SAS 13.2 or Joinpoint 4.6.0.0 (National Cancer Institute [NCI], 2018). SAS SURVEY procedures enabled appropriate modeling of the MTF study's complex sampling design. For Research Aim (RA) 1 (estimation of recent SAM prevalence levels by modal age group), proportions of alcohol users within each modal age group reporting SAM use for the most recent three years combined (2014–2016) were estimated using SURVEYMEANS.

For RA2 (historical trends), proportions of past 12-month alcohol users reporting any SAM use were estimated by calendar year within modal age group using SURVEYMEANS. Using the obtained estimates, trends within modal age group were modeled using Joinpoint, wherein trend lines are connected together at "joinpoints," where a significant change in slope occurs (Kim et al., 2000). In these models (as well as those described below for RA3), the focus was on the prevalence of SAM use at the specified age across sequential cohorts: age 19/20 trends included 1976–2015 12th grade cohorts; age 21/22 trends included 1976–2013 cohorts; age 23/24 trends included 1976–2011 cohorts; age 25/26 trends included 1976–2009 cohorts; age 27/28 trends included 1976–2007 cohorts; and 29/30 trends included 1976–2005 cohorts. All Joinpoint models specified grid search (i.e., joinpoints were required to occur exactly at observations vs. between adjacent observed values) and required a minimum of three observations from a joinpoint to either end of the data as well as between two joinpoints (standard errors of slope parameters and associated p-values cannot always be calculated with less than three observations per line segment [NCI, n.d.a]). Model selection was based on permutation testing (NCI, n.d.b), with the goal of selecting the most parsimonious model. The method uses sequential permutation tests (based on Monte Carlo draws, here set at the default of 4,499 permutations) to select the final model while ensuring that the probability of overall Type I error is less than the specified significance level (here set at .05). For the final selected model, joinpoints are identified and slope estimates and standard errors are provided. In addition, p-values for each slope change are provided from t-tests based on asymptotic normality. There are times when the p-value for an identified slope is greater than 0.05, but the permutation test procedure identifies a slope that is significantly different from the preceding slope. This is due to the permutation test procedure not requiring asymptotic normality while maintaining correct Type I error probability; the number of joinpoints determined by the software is more reliable in such situations (NCI, n.d.d).

For RA3 (comparison of extent to which SAM use trends reflect marijuana use trends), proportions of past 12-month marijuana users reporting any SAM use were estimated by calendar year within modal age group using SURVEYMEANS, and trends within modal age group then were modeled using Joinpoint as described above. In addition, proportions of past 12-month marijuana users and past 12-month alcohol users reporting SAM use were estimated by calendar year within modal age group using SURVEYMEANS, and correlations between annual outcome prevalence estimates were estimated using PROC CORR.

All analyses were weighted using previously calculated follow-up specific attrition weights, calculated as the inverse of the probability of responding at each modal age based on covariates measured at age 18 (sex, race/ethnicity, college plans, high school grades, number of parents in the home, religiosity, parental education, alcohol use, cigarette use, marijuana use, region of country, cohort, and sampling weight correcting for over-sampling of age 18 substance users).

RESULTS

Young adult SAM use estimates across age among alcohol users (RA1)

Among young adult alcohol users from 2014–2016 combined, SAM use prevalence was highest among early young adults, averaging 30% at ages 19/20 to 21/22, and then decreased throughout the remainder of young adulthood, reaching 19% at age 29/30 (see Table 1).

Young adult SAM use across historical time among alcohol users (RA2)

Slope estimates for historical trends from 1977–2016 for SAM use among past 12-month alcohol users by young adult age group are provided in Table 2; trends are presented graphically in Figure 1.

Among alcohol users aged 19/20, SAM prevalence decreased significantly from 1977 through 1991 (modal age 19/20 Slope 1 = −0.0174, p<.001; joinpoint 1 = 1991), and then increased significantly from 1991 through 2003 (Slope 2 = 0.0114, p<.001; joinpoint 2 = 2003). SAM use among those aged 19/20 then entered a period of oscillating increasing and decreasing trends (decreasing SAM use from 2003 through 2007 [Slope 3 = −0.0202]; increasing SAM use from 2007 through 2012 [Slope 4 = 0.0190]; decreasing SAM use from 2012 through 2016 [Slope 5 = −0.0274]). During these oscillating years, t-test p-values of slope change assuming asymptotic normality were not significant, but permutation tests indicated meaningful change in trends between joinpoints.

Among alcohol users aged 21/22, 23/24, and 25/26, values for Slope 1 in Table 2 show that SAM prevalence decreased significantly through the early- to mid-1990s (joinpoint 1 = 1990, 1994, and 1993, for age groups 21/22, 23/24, and 25/26, respectively). For each of these three age groups, SAM prevalence then significantly increased from the first joinpoint through 2016 (see values for Slope 2).

Among alcohol users aged 27/28, SAM prevalence decreased significantly through 1991 (Slope 1 = −0.0237, p<.001). From 1991 through 2011, SAM prevalence remained statistically flat for those in this age group (Slope 2 = −0.0007), and from 2011 through 2016, the slope indicated increasing prevalence (Slope 3 = 0.0240; while the p-value of slope change was not significant, permutation tests indicated a meaningful difference in trend starting in 2011).

In contrast to age groups 19/20 through 27/28, SAM prevalence among alcohol users aged 29/30 remained statistically unchanged from 1977 through 2016 (Slope 1 = −0.0007), with no joinpoints identified.

Comparison of extent to which SAM use trends reflected marijuana use trends (RA3)

Slope estimates for historical trends from 1977–2016 for SAM use among past 12-month marijuana users by young adult age group are provided in Table 3; trends are presented graphically in Figure 2. Any SAM use was reported by approximately three-quarters of marijuana users across all young adult age groups. Significant but small decreases in SAM use prevalence among marijuana users were observed for two age groups: 19/20 (Slope 1 = −0.0015, p< .05) and 23/24 (Slope 1 = −0.0025, p< .001), with no joinpoints identified. For

all other age groups (21/22, 25/26, 27/28, and 29/30), SAM use remained statistically unchanged, with no joinpoints identified.

Thus, while prior research showed significant changes in overall marijuana use prevalence for these age groups (significant declines from the late 1970s through the early 1990s, followed by varying levels and durations of significant increase [Schulenberg et al., 2017]), among marijuana users, the prevalence of any SAM use within age groups appeared either to remain relatively consistent across time, or to reflect significant but relatively small decreases across time. Pearson correlations between year-level aggregated proportions of past 12-month marijuana users and past 12-month alcohol users reporting SAM use were significant (p<.001) and positive for all age groups (ranging from $r = 0.845$ to 0.954). Such high correlations clearly indicated that the prevalence of any SAM use among alcohol users was strongly linked with changes in the prevalence of past 12-month marijuana use.

DISCUSSION

On average from 2014 to 2016, any SAM use was reported by approximately 30% of alcohol users ages 19/20 and 21/22, and between approximately 20% to 25% of alcohol users ages 23/24 through 29/30. Historical trends in annual SAM prevalence among young adult alcohol users followed one of four patterns from the mid-1990s onward: (1) significant prevalence increase followed by oscillating change (ages 19/20); (2) significant and consistent prevalence increase (ages 21/22 through 25/26); (3) stability followed by increasing prevalence (ages 27/28), or (4) prevalence stability (ages 29/30). In contrast, SAM use prevalence among marijuana users was generally stable across time within age (excluding ages 19/20 and 23/24, which showed small but significant decreases across time). Among young adult alcohol users, changes in SAM prevalence were strongly and positively correlated with changes in overall marijuana use trends. Trend changes in the use of a secondary substance—including marijuana—may meaningfully affect risks associated with alcohol use.

Based on the current study, between one-fifth to almost one-third of recent U.S. young adult alcohol users reported using alcohol and marijuana so that their effects overlapped, thus placing themselves and others at risk for associated consequences. SAM use is particularly associated with situations that involve heavy episodic or high-intensity drinking (Patrick et al., 2017b). Drinking at these levels is associated with severe and even life-threatening impairment, resulting in possible alcohol poisoning and suppression of vital life functions (NIAAA, 2015 October). The additive effects of SAM use on cognitive, perceptual and motor functions (Belgrave et al., 1979; Chesher et al., 1976, 1977; Kelly et al., 2004; Lamers & Ramaekers, 2001; Ramaekers et al., 2000; Robbe, 1998) result in risk not only to individual users, but the public at large. SAM use is frequently associated with situations that involve the public, such as parks/beaches, parties, and—most alarmingly—cars (Pakula et al., 2009; Terry-McElrath et al., 2013). SAM use is strongly linked to increased drunk driving (Subbaraman & Kerr, 2015), tickets/warnings, and accidents (Terry-McElrath et al., 2014). For example, data from the state of Washington (which voted to legalize recreational marijuana use in 2012) indicated that 9% of drivers who tested positive for alcohol and drugs in fatal crashes from 2010 to 2014 tested positive for cannabinoids only, compared

with 13% who tested positive for cannabinoids and alcohol, and an additional 4% who tested positive for cannabinoids, alcohol, and other drugs (Washington Traffic Safety Commission, 2016). In both Washington and Colorado (which also voted to legalize recreational marijuana use in 2012), there have been indications that impaired driving involving marijuana—particularly marijuana combined with alcohol—is increasing (Rocky Mountain High Intensity Drug Trafficking Area, 2015; Washington Traffic Safety Commission, 2016).

The current study found that following the mid-1990s, the percentage of alcohol users also reporting SAM use significantly increased for multiple years among all but young adults in their very late 20s. Among these early to mid-young adults, the potential level of risk associated with alcohol use increased due to increasing SAM use prevalence. These findings, together with results of age-specific research on trends in heavy episodic or high-intensity drinking (Patrick et al., 2017a; Terry-McElrath & Patrick, 2016), may offer a potential explanation for at least part of the observed but unexplained recent increases in demand for alcohol-related emergency department (ED) and inpatient services at U.S. hospitals (Mullins et al., 2016; National Institutes of Health, 2013; White et al., 2018). National ED visits for U.S. adults aged 18 and older due to alcohol-related causes increased at a significantly greater rate than overall ED visits from 2001–2011 (Mullins et al. 2016), and overall ED visits involving both acute and chronic alcohol consumption rose dramatically between 2006 and 2014 (White et al., 2018). These increases have been particularly puzzling since (as noted previously) there have not been co-occurring increases observed in alcohol-related behaviors likely to result in ED use such as overall heavy episodic or high-intensity drinking (e.g., Centers for Behavioral Health Statistics and Quality, 2015; Hingson & White, 2013; Kann et al., 2016; Patrick & Terry-McElrath, 2017; Patrick et al., 2013). White et al. (2018) reported that approximately 1 in 6 alcohol-related ED visits involved alcohol use combined with other drugs. It is possible that changes in the prevalence or frequency of combining alcohol with other drugs could lead to changes in acute and chronic alcohol-related problems, whether or not alcohol intensity increases (Patrick & Terry-McElrath, 2018). While marijuana is only one of many substances that can be used simultaneously with alcohol, combined results of research on age-specific trends of heavy episodic and high-intensity drinking (Patrick et al., 2017a; Terry-McElrath & Patrick, 2016), together with the current study, indicate that overall alcohol risk indeed may have increased across young adulthood. Further research that could quantify the changes in overall alcohol-related harms —such as health services utilization—associated with trend changes in heavy episodic or high-intensity drinking compared with trend changes in SAM use is needed. Related to this issue is the need for studies examining how simultaneous use of alcohol and other substances (such as non-medical use of prescription drugs) may be impacting health services utilization.

The results of the current study indicate that the percentage of alcohol users engaging in SAM use will likely continue to increase in proportion to the degree that young adult marijuana use continues to increase. The ages of peak past 12-month marijuana use prevalence among the U.S. adult population (i.e., ages 19–21 as reported in SAMHSA, 2016) were strongly reflected in the current study's observed ages of peak SAM use among alcohol users. In addition, the strong positive correlations between annual prevalence of marijuana use and SAM use among young adult alcohol users indicates that changes in

marijuana use prevalence have had a meaningful impact on alcohol use risk. Across young adults, the prevalence of past 12-month marijuana use has increased notably since 2010: from 31% to 41% among those aged 19/20; 34%−41% among those aged 21/22; 31%−36% for those aged 23/24; 26%−29% for those aged 25/26; 22%−30% for those aged 27/28, and 22%−26% for those aged 29/30 (Schulenberg et al., 2017). These increases, together with the strong correlations between marijuana use and SAM use among alcohol users, indicate growing overall risk from alcohol use among young adults at all ages.

Contrary to these overall trends, there is some indication that SAM use prevalence decreased somewhat from 1976–2016 among marijuana users aged 19/20 and 23/24, and from 2012–2016 among alcohol users aged 19/20. The observed decreases in SAM prevalence trends for individuals in these specific subgroups may indicate increasing substitution of marijuana for alcohol use (Baggio et al., 2017; Kendall, 2016), and thus an observed decrease in SAM use. Yet, recent changes in the legal status of marijuana in various states (via medicalization, decriminalization, and legalization) have been forecasted to result in increased intentions to use and actual marijuana use (Hasin et al., 2015; Keyes et al., 2016; Miech et al., 2015; Palamar et al., 2014). Whether or not such forecasts are correct, to the extent that marijuana use increases, alcohol-related harms associated with SAM use will likely increase apace.

While SAM use prevalence was found among all young adult age groups, recent data showed that rates were highest among those ages 19/20 and 21/22. Efforts to prevent and/or reduce SAM use among all young adult alcohol users are clearly warranted that effectively communicate and seek to mitigate the risks associated with SAM use over and above those associated with use of either substance separately. The developmental processes underlying lower SAM use prevalence among alcohol users at the end of young adulthood may be similar to previously-observed developmental changes in marijuana and alcohol use. Research has proposed both circumstantial (passive settings, environmental constraints, influences) and functional (active decision making regarding substances, temporal order of use) explanations of how and why substances are used simultaneously (Pakula et al., 2009). Some research has found adolescent SAM use is incidental to general alcohol or marijuana use (Hoffman et al., 2000); other studies indicate the behavior is both incidental to general use as well as associated with specific simultaneous use reasons or expectancies (Terry-McElrath et al., 2013). Adolescent and adult SAM use is strongly associated with social contexts, negative emotional states, and perceived dependence (Pakula et al., 2009; Terry-McElrath et al., 2013). Reasons for alcohol and marijuana use (separately) change significantly with age. Moving from early to later young adulthood, individuals are (a) more likely to report using both substances to relax, using alcohol to sleep and because it tastes good, and using marijuana to get high; and (b) less likely to report use of both substances for dealing with negative emotional states, perceived dependence, and to increase the effect of other drugs (Patrick et al., 2011). While such changes in reasons for general alcohol and marijuana use could help explain the observed significant decrease in any SAM use across young adulthood in the current study, research is needed that investigates reasons for combining these substances, in particular.

Limitations

The current study's findings should be considered within their limitations. Findings may not generalize to individuals who drop out of high school prior to 12th grade; lower educational attainment is associated with higher marijuana and other substance use (Tice et al., 2017). Attrition weighting was based on variables measured at 12th grade (including substance use) and was not able to take into account that risk of dropout also likely correlates with substance use at later ages. Across the key outcomes of interest (alcohol, marijuana, and SAM use), the largest loss of data to missingness occurred between the 12th grade survey and first follow-up at age 19/20. Thereafter, the percentage of data lost to missingness on these key measures increased approximately five percentage points per follow-up. The SAM measure available did not allow for assessing SAM use frequency, so results are limited to examining any versus no SAM use. Further, all data are based on self-reports, which have been found to be reasonably reliable and valid under conditions which the MTF study strives to provide (Brener et al., 2003; Meich et al., 2017; O'Malley et al., 1983). These limitations notwithstanding, the current study contributes significantly to available knowledge on SAM use among young adults in the US.

Conclusions

A growing proportion of early- and mid-young adult drinkers report SAM use, with the highest risk belonging to those in the early years of this developmental period. Efforts to understand the costs and consequences of alcohol use may be significantly enhanced by actively seeking to model how changes in the use of a secondary substance (such as marijuana) may affect the nature of how alcohol is used (at least for some individuals), and thus the level of risk associated with use.

Acknowledgments

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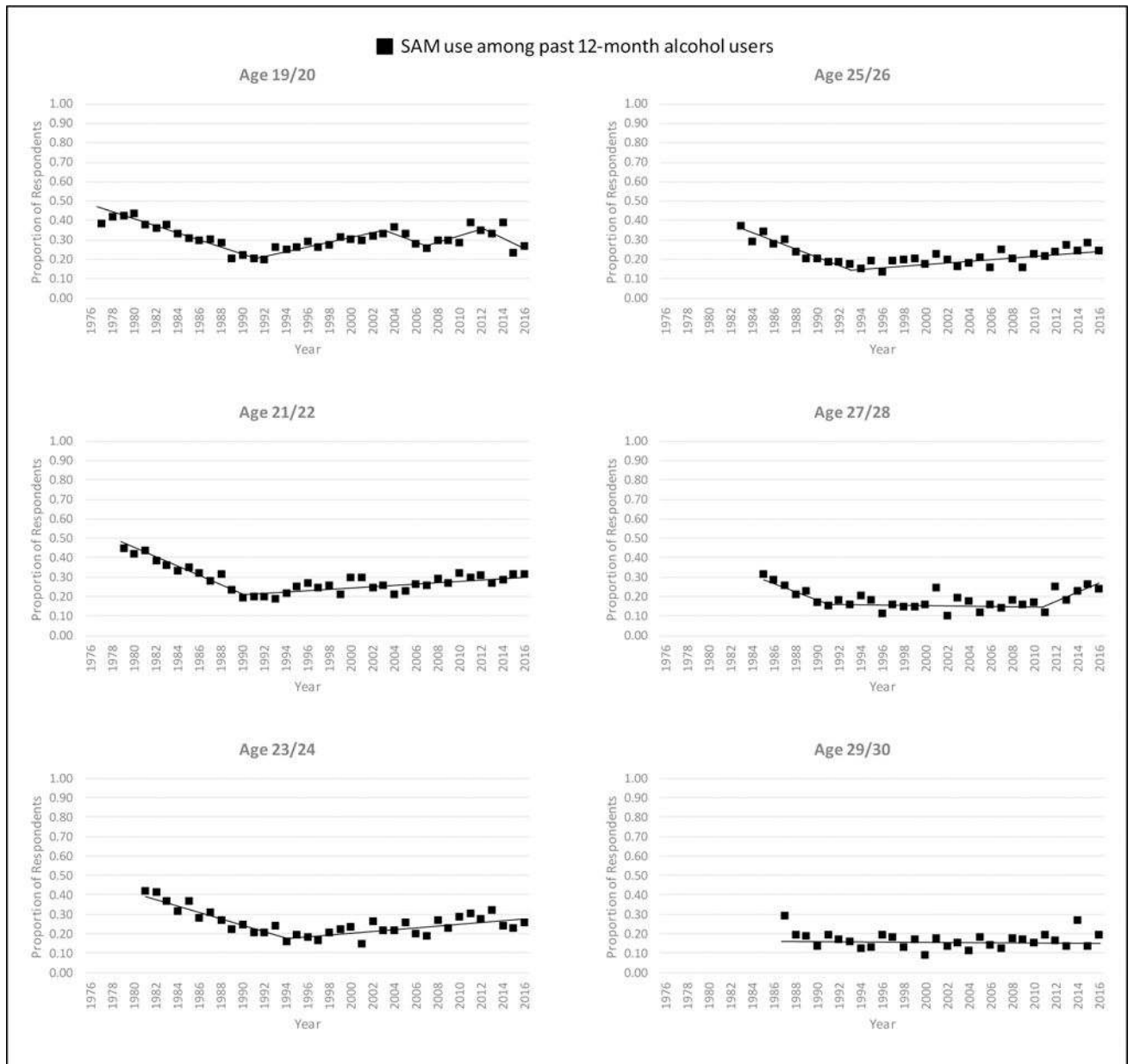
Figure 1.

Trends by Modal Age Group in Prevalence of Simultaneous Alcohol and Marijuana (SAM) Use among Past 12-Month Alcohol Users: U.S. Young Adults, 1977–2016

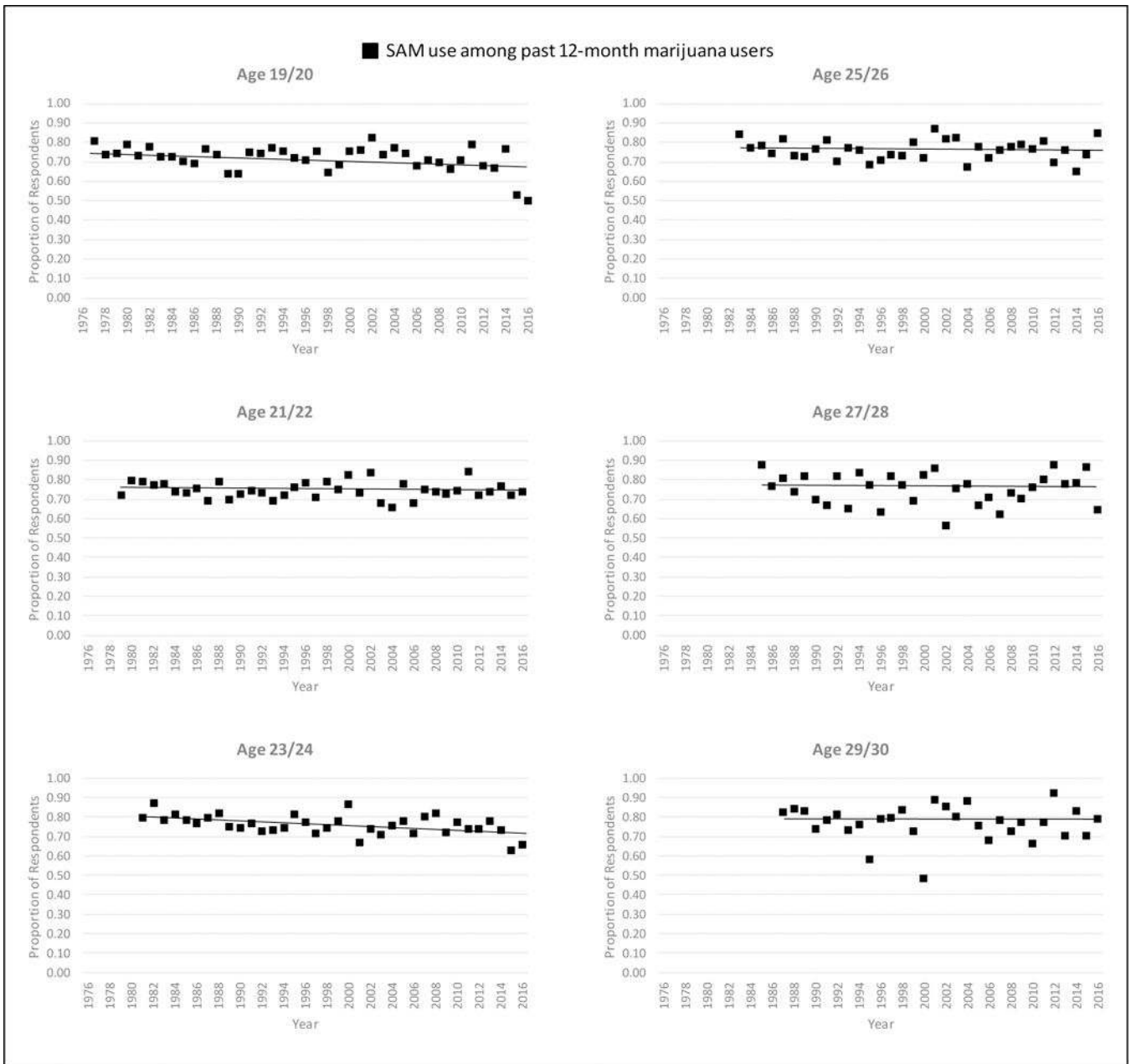*Notes*: Slope estimates for all trends are provided in Table 2.

Figure 2.

Trends by Modal Age Group in Prevalence of Simultaneous Alcohol and Marijuana (SAM) Use among Past 12-Month Marijuana Users: U.S. Young Adults, 1977–2016

Notes: Slope estimates for all trends are provided in Table 3.

Table 1.

Prevalence of Simultaneous Alcohol and Marijuana (SAM) Use among Past 12-Month Alcohol Users: U.S. Young Adults, 2014–2016

Modal Age Group	SAM Prevalence among Alcohol Users	
	%	**(95% CI)**
19/20	30.0	(24.2, 35.7)
21/22	30.5	(25.2, 35.9)
23/24	24.2	(19.7, 28.8)
25/26	25.8	(21.0, 30.5)
27/28	24.5	(19.3, 29.7)
29/30	19.4	(15.0, 23.8)

Notes: Range of unweighted total *n* per modal age group: 300–435.

Table 2.

Slope Estimates for Historical Trends in Simultaneous Alcohol and Marijuana (SAM) Use among Past 12-Month Alcohol Users: U.S. Young Adults, 1977–2016

Modal Age Group	Slope 1 (SE)	JP[a] 1	Slope 2 (SE)	JP 2	Slope 3 (SE)	JP 3	Slope 4 (SE)	JP 4	Slope 5 (SE)
19/20	-0.0174 (0.0016) ***	1991	0.0114 (0.0026) ***	2003	-0.0202(0.0221)	2007	0.0190(0.0159)	2012	-0.0274 (0.0163)
21/22	-0.0230 (0.0021) ***	1990	0.0037 (0.0007) ***						
23/24	-0.0172 (0.0023) ***	1994	0.0047 (0.0012) ***						
25/26	-0.0185 (0.0028) ***	1993	0.0037 (0.0009) ***						
27/28	-0.0237 (0.0075) **	1991	-0.0007 (0.0013)	2011	0.0240 (0.0147)				
29/30	-0.0007 (0.0008)								

Notes: A total of 11,763 respondents who reported past 12-month alcohol use provided data on past 12-month SAM use.

[a] JP = Joinpoint, or year in which significant change in slope occurred. For example, for the modal age group 19/20, SAM use among past 12-month alcohol users decreased significantly (Slope 1 = −0.0174***) from 1977 through 1991 (Joinpoint 1), and then increased significantly (Slope 2 = 0.0114***) through 2003 (Joinpoint 2). Thereafter, three slopes and two additional joinpoints were identified; *t*-test *p*-values of slope change assuming asymptotic normality were not significant, but permutation tests indicated meaningful change in trends between joinpoints. If no joinpoint is noted for a specific age group, no statistically significant change in slope estimate was observed from 1977–2016.

**
p<.01

***
p<.001

Table 3.

Slope Estimates for Historical Trends in Simultaneous Alcohol and Marijuana (SAM) Use among Past 12-Month Marijuana Users: U.S. Young Adults, 1977–2016

Modal Age Group	Slope 1 (SE)
19/20	-0.0015 (0.0007) *
21/22	-0.0005 (0.0006)
23/24	-0.0025 (0.0007) ***
25/26	-0.0005 (0.0008)
27/28	-0.0002 (0.0013)
29/30	-0.0001 (0.0017)

Notes: A total of 6,578 respondents who reported past 12-month marijuana use provided data on past 12-month SAM use.

[a]JP = Joinpoint, or year in which significant change in slope occurred. For example, for the modal age group 19/20, SAM use among past 12-month marijuana users decreased significantly (Slope 1 = −0.0015*) from 1977 through 2016. If no joinpoint is noted for a specific age group, no statistically significant change in slope estimate was observed over time.

**p<.01