Temporal trends in alcohol, cannabis, and simultaneous use among 12th grade US adolescents from 2000 to 2020: Differences by sex, parental education, and race and ethnicity

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Abstract

Background—Simultaneous use of alcohol and cannabis to enhance each other's effect can cause potential harm. Time trends are diverging in adolescent use of alcohol, which is declining, and cannabis, which is increasing among certain subgroups. However, little is known about trends in their simultaneous and non-simultaneous use. Racial and socio-economic disparities are emerging in cannabis use, which may portend consequences to public health.

Methods—The 2000–2020 Monitoring the Future surveys included approximately 38,000 US 12th grade students with information on simultaneous use and pertinent demographic factors. A 5-level alcohol/cannabis measure included past-year simultaneous use (i.e., alcohol and cannabis

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use at the same time), non-simultaneous alcohol and cannabis use, alcohol-use-only, cannabis-use-only, and no use. Multinomial logistic regressions estimated associations (adjusted relative risk ratios; aRRR) with time period (2000–2004, 2005–2009, 2010–2014, 2015–2020). Models were adjusted and included interactions with sex, race/ethnicity, and parental education.

Results—Between 2000–2020, simultaneous alcohol/cannabis use among 12th graders decreased from 24.4% to 18.7%. In 2015–2020 compared to 2000–2004, odds of simultaneous use (adjusted relative risk ratio (aRRR) vs. no use =0.57, 95% CI: [0.50, 0.66]) and alcohol-use-only (aRRR=0.55, 95% CI: [0.49, 0.61]) decreased, while cannabis-use-only odds increased (aRRR=2.59, 95% CI: [1.87, 3.59]). Indeed, prevalence of cannabis-use-only more than doubled from 2011 to 2019. Simultaneous use, alcohol-use-only, and non-simultaneous use of alcohol and cannabis odds declined more rapidly for males than females, whereas odds for cannabis-use-only increased faster for females than males. Increases in cannabis-use-only are faster for non-white adolescents.

Conclusion—Simultaneous use of alcohol and cannabis is declining among US adolescents, but this decline is slower among females than males. Declines in simultaneous use are largely concomitant with historical declines in alcohol use, indicating that continued focus on reducing alcohol use among adolescents and young adults has extended benefits to other adolescent substance use. However, cannabis use without any reported past-year alcohol use more than doubled in the last decade, a concerning trend.

Introduction

Alcohol and cannabis are the most commonly used substances by US adolescents (Miech, R. A., Johnston, L. D., O'Malley and Bachman, J. G., Schulenberg, J. E., & Patrick, 2020), and can be used simultaneously for enhanced psychoactive effects of each (Terry-McElrath et al., 2013). Simultaneous use of alcohol and cannabis affects THC absorption and intoxication (Lukas and Orozco, 2001), and is positively associated with high intensity substance use (Patrick et al., 2017), injury and impaired driving (Gonçalves et al., 2021; Subbaraman and Kerr, 2015) and other harms (D'Amico et al., 2022; Patrick et al., 2017). Motivations to use alcohol and cannabis simultaneously among young people include to enhance intoxication ("cross fading") (Patrick et al., 2020), to enhance and facilitate social experiences with peers (Arterberry et al., 2021; Linden-Carmichael and Wardell, 2021; Patrick et al., 2020), and to increase positive affect (Arterberry et al., 2021; Linden-Carmichael and Wardell, 2021). Long-term consequences of simultaneous use include disruptions to social connections (Subbaraman and Kerr, 2015), decreased educational attainment prospects (Patrick et al., 2018), and continued use is associated with changes in neurological morphometrics (Medina et al., 2007; Schweinsburg et al., 2011). Thus, simultaneous use of alcohol and cannabis represents an important concern for adolescent health.

Time trends in past-year adolescent use of alcohol and cannabis have diverged. Among 12th grade students in the US, past-year alcohol use declined from 73.2% in 2000 to 52.1% in 2019 (Miech, R. A., Johnston, L. D., O'Malley and Bachman, J. G., Schulenberg, J. E., & Patrick, 2020), while past-year cannabis use has stayed relatively stable (36.5% in 2000 to 35.7% in 2019) (Miech, R. A., Johnston, L. D., O'Malley and Bachman, J. G., Schulenberg, J. E., & Patrick, 2020), and frequent cannabis use (6+ times per month) has

increased (Hamilton et al., 2019). Trends in simultaneous use of alcohol and cannabis largely paralleled trends in alcohol use through the 2000s (Terry-McElrath et al., 2013), and remained relatively stable through the 2010s (Patrick et al., 2019), but trends in recent years have not been well documented. Diverging trends in alcohol and cannabis use among adolescents suggest different underlying mechanisms. Medical use appears to be an unlikely explanation, given that state allowances for medical cannabis use among adolescents remain restrictive (Boyd et al., 2015), and no US state has legalized non-medical cannabis use for adolescents. However, the surge in popularity of vaping cannabis may appeal to adolescents (Gupta and Kalagher, 2021; Miech et al., 2020a; Palamar, 2021), while higher parental engagement and monitoring are associated with reductions in alcohol use (Keogh-Clark et al., 2021; Pape et al., 2018; Patrick and Schulenberg, 2013; Sellers et al., 2018; Vashishtha et al., 2020). Whether diverging trends in alcohol and cannabis use influence time trends in simultaneous use remains unclear.

The extent to which time trends in simultaneous use differ by sex is also critical to identify adolescents at higher risk. Historically, males have had higher rates of alcohol and cannabis use than females (Keyes et al., 2020). However, in recent years, initiation of alcohol use has been higher among female adolescents compared with males (Cheng and Anthony, 2018a, 2018b), and while alcohol use is declining overall in adolescence, these declines are greater among males compared with females, resulting in greater convergence by sex (Jang et al., 2017). This convergence may be due to changes in normative gender roles (Inglehart and Baker, 2000) (which are correlated, although not synonymous, with self-identified sex) and an increase in alcohol marketing towards female consumers (Mosher, 2012), as well as faster increases in preference for risk-taking behavior among females (Keyes et al., 2015). In contrast, increases in frequent cannabis use have been consistent across sex (Hamilton et al., 2019), thus, potential sex differences in trends in simultaneous use of alcohol and cannabis, as well as non-simultaneous use, are difficult to predict, yet continue to be important to identify.

Simultaneous alcohol/cannabis trends may also differ by race/ethnicity and parental education. Non-Hispanic Black adolescents, for example, have lower rates of alcohol use and alcohol/cannabis co-use compared to white students (Purcell et al., 2021), but cannabis use is increasing faster among Black adolescents (Banks et al., 2017; Hamilton et al., 2019; Keyes et al., 2017), suggesting that patterns of use and co-use may be shifting in ways that portend racialized health disparities. Disparities may also be emerging across social class; among adolescents, parental education is an indicator of social class, and robustly associated with substance use and mental health (Reiss, 2013; Thomson et al., 2017). Differences in frequent cannabis use by parental education have accelerated in recent decades (Hamilton et al., 2019). These changes suggest that the demographic groups at risk for simultaneous use of alcohol and cannabis, as well as use of each substance alone, are dynamic and changing amidst a rapidly shifting contextual environment.

In summary, alcohol and cannabis use have had divergent trends in prevalence over time, yet trends in high-risk patterns such as simultaneous use in the past decade remain understudied, including whether there are emergent disparities by demographic subgroups over time. Therefore, we conducted an exploratory study that assessed trends in past-year alcohol

and cannabis use (including simultaneous use), alcohol-use-only, and cannabis-use-only, including tests for interactions in trends over time by sex, race/ethnicity, and parental education. Findings could elucidate the substances for which public health efforts should be focused, as well as the emergence of high risk groups.

Methods

Sample

MTF includes annually administered cross-sectional surveys of students in the contiguous US. The survey is conducted at approximately 400 U.S. public and private high schools selected using a multi-stage random sampling design. Selected schools are invited to participate in MTF for 2 years, and schools that decline to participate are replaced with schools that have similar size, geographic location, and urbanicity. A detailed description of MTF design and procedures is provided elsewhere (Bachman et al., 2015; Miech, R. A., Johnston, L. D., O'Malley and Bachman, J. G., Schulenberg, J. E., & Patrick, 2020). We used sampling weights provided by MTF in all calculations to take into account differing inclusion probabilities.

The present study used annual cross-sectional data collected between 2000–2020. All 2020 data were collected prior to the pandemic onset. Among students surveyed, 12th grade respondents were included due to overlaps in relevant questions across survey forms as well as higher rates of simultaneous use of alcohol and cannabis. Student response rates for 12th graders within schools ranged from 79% to 85%, with most non-response due to absence from school; less than 1% of students refused to participate (Miech, R. A., Johnston, L. D., O'Malley and Bachman, J. G., Schulenberg, J. E., & Patrick, 2020). MTF uses a self-administered questionnaire comprising a core form given to all participants that includes assessment of substance use and other key modules, and secondary forms randomly assigned to each participant that contain additional questions. We analyzed data from students who received survey forms that included simultaneous use of alcohol and cannabis, yielding a sample with a total of 37,799 students that had complete data. Among eligible students, missing covariate data due to nonresponse ranged from 2.1% for data on race and ethnicity to 5.2% for data on parental education; analysis was conducted among those with complete data. Demographic information on the sample is provided in Supplement Table 1; in 2015–2020, 53.2% of respondents were female, 55.8% white, and 53.4% had at least one parent with a college degree or higher.

Measures

Alcohol use and Cannabis use.—Frequency of alcohol and cannabis use in the past year were assessed in separate questions about the number of occasions of use. Any use of these substances in the past year was dichotomized as past-year use. Frequencies of alcohol and cannabis use in the past year were assessed in separate questions about the number of occasions of use. Any use of these substances in the past year was dichotomized as past-year use. Adolescents were queried regarding whether cannabis use was medical or non-medical; 1% of adolescents who reported cannabis use reported only using based on

their own prescription. All adolescents' cannabis use, regardless of source, was included in the analysis.

Simultaneous use of alcohol and cannabis.—Past-year simultaneous use of alcohol and cannabis was assessed with the following question: "How many of the times when you used cannabis or hashish during the last year did you use it along with alcohol—that is, so that their effects overlapped?" Responses were on a Likert scale (1=Not at all, 2=A few of the times, 3=Some of the times, 4=Most of the times, 5=Every time). We dichotomized these responses into no simultaneous use vs. any use. We also examined trends in simultaneous use by frequency of use, including those who report using alcohol and cannabis simultaneously most/every time (more frequent) or a few/some times (less frequent).

We combined the past-year alcohol, cannabis, and simultaneous use measures to create a 5-level variable of past-year use comprised of alcohol-use-only (past-year alcohol use and no report of past-year cannabis or simultaneous use), cannabis-use-only (past-year cannabis use and no report of past-year alcohol or simultaneous use), past-year cannabis and alcohol use but not simultaneously, simultaneous use, and no use.

Socio-demographics and other covariates.—Other self-identified measures included: sex (binary option of male vs. female), race/ethnicity (non-Hispanic white, non-Hispanic Black, other), respondent-reported parental education (either parent had completed college vs. all others), and survey mode (paper vs. tablet). Survey years 2000–2020 were categorized in 5-year groups with the exception of the last group which contained 6 years (2000–2004, 2005–2009, 2010–2014, 2015–2020). We used 5-year groupings of survey year to balance sample size, interpretability, efficiency, and granularity while not assuming a linear relationship between year and the outcome. We assessed the linearity of the relationship between year and simultaneous alcohol/cannabis use using Joinpoint analysis, which assesses the model fit of a series of permutations with an increasing number of inflection points, that is, change in the linear slope. The results of the Joinpoint analysis for the best fitting model are provided as Supplementary Figure 1. Results indicated that 3 linear slopes best fit the data, indicating non-linearity of the total time series. Due to the non-linearity, we proceeded with categorical 5-year groupings for subsequent analyses.

Statistical analysis

The population prevalence of past-year alcohol and cannabis use was calculated each year for the following patterns: alcohol-use-only, cannabis-use-only, past-year cannabis and alcohol use but not simultaneously, and simultaneous use. Multinomial logistic regressions estimated the association between survey year and past-year use as a 5-level variable (simultaneous use of alcohol and cannabis; past-year alcohol and cannabis use but not simultaneously; alcohol-use-only; cannabis-use-only; no use). Cannabis-use-only was infrequent and for years in which there were fewer than 30 adolescents, we suppressed descriptive prevalence results, but all data in all years were included in regression models. Several multinomial logistic regressions were fit. The model first adjusted for time period, sex, parental education, race/ethnicity, and survey mode. Then, separate models were run

to test each of the following interaction terms: between time period and sex, time period and race/ethnicity, and time period and parental education (one interaction term per model). Adjusted relative risk ratios (aRRR) are reported with 95% confidence intervals. No p-value adjustments were made for multiple comparisons were made given the exploratory nature of the study (Rothman, 2014, 1990). Data management was conducted in SAS (SAS Institute Inc., 2014) and data analysis was conducted in Stata (StataCorp, 2019).

Results

National trends in alcohol and cannabis use in the US among 12th grade students

Between 2000–2020, past-year simultaneous use decreased from 24.4% [95% CI: 21.4%, 27.6%] to 18.7% [13.7%, 25.1%]. Over the same time period, past-year alcohol-use-only decreased from 37.7% [35.0%, 40.5%] to 27.9% [21.4%, 35.3%], while past-year cannabis-use-only increased from 1.5% [1.1%, 2.2%] in 2011 (the first year where the cell size was large enough to report due to data suppression) to 4.5% [3.4%, 5.8%] in 2019 (the last year where cell size was large enough to report). Use of both cannabis and alcohol but not simultaneously increased slightly from 11.0% [9.3%, 13.0%] to 12.1% [9.2%, 15.7%] (Figure 1). As a supplement, we divided simultaneous cannabis and alcohol use into more frequent (those who engaged in simultaneous use most or every time they used marijuana) and less frequent (those who engaged in simultaneous use a few or some of the times (Supplemental Figure 2). More frequent simultaneous use declined from 5.6% [4.4%, 7.3%] in 2000 to 1.7% [1.2%, 2.5%] in 2019, the last reportable year (2020 prevalence not reportable due to cell sizes). Less frequent simultaneous use remained relatively stable, from 18.7% [16.0%, 21.8%] in 2000 to 17.7% [12.8%, 24.2%] in 2020.

Table 1 shows that while past-year simultaneous and alcohol-use-only decreased over time, past-year cannabis-use-only increased after adjusting for sex, parental education, race/ethnicity, and survey mode. For example, compared to 2000–2004, 12th graders in 2015–2020 had 0.57 [adjusted relative risk ratio, 95% C.I. 0.50, 0.66] times decreased odds of past-year simultaneous use, 0.55 [0.49, 0.61] times decreased odds of past-year alcohol-use-only, and 2.59 [1.87, 3.59] times increased odds of past-year cannabis-use-only versus no use after adjusting for sex, parental education, race/ethnicity, and survey mode.

Table 1 also shows that, controlling for year as well as other covariates, female adolescents were less likely to simultaneously use alcohol and cannabis compared with males (aRRR=0.80, 95% C.I. 0.74–0.86), but more likely to use alcohol only (aRRR=1.15, 95% C.I. 1.08–1.22) as well as more likely to use alcohol and cannabis but not simultaneously (aRRR=1.10, 95% C.I. 1.01–1.20). Black and "other" students were less likely to use alcohol and cannabis simultaneously, use alcohol only, or use alcohol and cannabis but not simultaneously compared with white students, but more likely to use cannabis only (Black: aRRR=2.41, 95% C.I. 1.84–3.17; Other: aRRR=1.61, 95% C.I. 1.27–2.04). Compared to students with at least one college-educated parent, those whose parents had less education were slightly more likely to use alcohol and cannabis.

National trends in alcohol and cannabis use in the US among 12th grade students by sex

Trends by sex are shown in Figure 2. Interaction tests between time period and sex are reported in Table 2. Considering past-year simultaneous use and alcohol-use-only outcomes, the decrease in odds was faster among males than females in 2015–2020 (Interaction term aRRR=1.31 [1.06, 1.61] and aRRR=1.21 [1.01, 1.44], respectively). The same was true for non-simultaneous past year use of cannabis and alcohol (aRRR = 1.31 [1.03, 1.68]).

Because there were significant interactions between sex and survey year, Table 3 presents the sex-specific association between survey year and substance use from the multinomial logistic model with an interaction term between year and sex. Comparing effect size between males and females, there was a faster decline among males in simultaneous use (e.g., males: aRRR [2015–2020 vs 2000–2004]=0.48 [0.40, 0.58]; females: aRRR=0.67 [0.56, 0.80]), past year alcohol-use-only (males: aRRR=0.48 [0.42, 0.56]; females: aRRR=0.61 [0.53, 0.70]), and past year alcohol and cannabis use but not simultaneously (males: aRRR=0.73 [0.60, 0.89]; females: aRRR=1.02 [0.85, 1.23]). Further, comparing effect size between males and females, there was a faster increase in cannabis-use-only among females compared with males (females: aRRR [2015–2020 vs 2000–2004]=3.11 [1.95, 4.94]; males: aRRR=2.15, [1.43, 3.21]).

National trends in alcohol and cannabis use in the US among 12th grade students by race/ethnicity and parental education

Interactions by race/ethnicity (Supplemental Table 2) and parental education (Supplemental Table 3), are shown in Supplementary Tables 2 and 3, respectively. Several interactions emerged, but none with the consistency across time we observed for sex. By race, Black and 'other' adolescents had accelerated increases at various timepoints compared to their white peers for cannabis-use-only (e.g., interaction aRRR [2005–2009 vs 2000–2004] = 2.62 [1.16, 5.90] for Black adolescents) and simultaneous use (e.g., interaction aRRR [2010–2014 vs 2000–2004] = 1.43 [1.09, 1.89] for 'other' adolescents). By parental education, several (although no consistent) interactions emerged; for example, adolescents in homes where the highest level of parental education completed was high school or some college had a faster increase in cannabis-use-only compared to adolescents in homes where the highest level of parental education completion was college (interaction aRRR [2015–2020 vs 2000–2004]=2.28 [1.21, 4.28]).

Discussion

Since 2000, past-year simultaneous use of cannabis and alcohol has declined in the United States among 12th grade students. The decline was concentrated among frequent simultaneous users, i.e., those engaging in simultaneous use most or every time they use cannabis. The odds of using alcohol only, or using alcohol and cannabis but not simultaneously, also declined. In contrast, while reporting cannabis use with no report of past year alcohol use remained relatively rare, the odds of cannabis use without alcohol more than doubled from 2011 to 2019. We expand previous studies of trends in cannabis and alcohol use to reflect the past decade, a time in which numerous policies and provisions related to cannabis use have undergone change (Borodovsky et al., 2017; Coley et al., 2021;

Yu et al., 2020). Observed trends varied across sex, with steeper declines in alcohol use with cannabis for males as well as steeper increase in the prevalence of cannabis use without alcohol for females. Trends by race/ethnicity and parental education were largely parallel, although there were indications that non-White adolescents had faster increases in cannabis use without alcohol.

Our findings indicate faster increases in past-year cannabis use only and slower declines in past-year simultaneous use and alcohol-use-only among female adolescents. This suggests that sex convergence trends (Hamilton et al., 2019; Jang et al., 2017) are changing, with females catching up to and potentially surpassing males in their cannabis use only and males diverging in prevalence from females in simultaneous use and alcohol-use-only. Indeed, once we control for year, female adolescents are more likely than males to use alcohol only (no cannabis), and use alcohol and cannabis (but not simultaneously). Sex convergences are occurring in many substances, such as alcohol, which may be indicative of changing gender norms and expectations among females with regard to substance use (Dir et al., 2017; Kuhn, 2015; Mrug and McCay, 2013; Pérez et al., 2010). Female adolescents are now more likely than males to initiate alcohol use early in life (Cheng and Anthony, 2018a, 2018b,) and further sex convergences in cannabis use and simultaneous cannabis and alcohol use suggest that intervention and prevention efforts that focus on problems and issues facing today's adolescent females may be important for reducing adolescent use. It is important to note that these data are among high-school students; substance use remains dynamic during the transition to adulthood (Boden et al., 2020; Cerdá et al., 2016; Jager et al., 2022), thus tracking how these trends persist and change across the life course is critical.

By race/ethnicity, Black and other non-white adolescents had lower alcohol use, and simultaneous use, but higher cannabis-use-only (without alcohol), and there was some indication that increases in cannabis-use-only was accelerating for non-white adolescents. Other studies have reported higher cannabis use and lower alcohol use among adolescents of color compared to white adolescents ("Alcohol use in adolescence across U.S. race/ethnicity: Considering cultural factors in prevention and interventions," 2021; Banks et al., 2017; Dai, 2019; Purcell et al., 2021), as well as acceleration of increases in cannabis use prevalence (Hamilton et al., 2019). Non-white adolescents face harsher punitive consequences of substance use (Bottiani et al., 2017; Gase et al., 2016; Kakade et al., 2012; Morris and Perry, 2016), including cannabis use, compared to their white peers. Promoting a public health approach that focuses on informing and educating adolescents about the potential health consequences of cannabis use rather than a criminalization approach is especially imperative given the increases in prevalence. We caution against overinterpretation of results for the "other" category, due to heterogeneity of racial/ethnic representation that exists within this group.

Compared to adolescents in households where at least one parent had completed college, those whose parents had less education had higher prevalence of alcohol use, cannabis use, and simultaneous use. While trends in adolescent substance use by parental education were largely parallel, the group with less educated parents evidenced faster acceleration of cannabis-use-only. Ensuring consistent access to prevention and intervention initiatives across adolescents at all socioeconomic levels, especially with regard to simultaneous use

of alcohol and cannabis which is of great consequence to adolescent health and injury risk (Hartman et al., 2015; Hartman and Huestis, 2013; Terry-McElrath et al., 2013), is a significant public health priority.

Further, future studies should examine additional substances that are frequently co-used with cannabis and potentiate harm to adolescents, particularly tobacco and cannabis co-use, which is increasing among US adolescents (Cohn et al., 2019; Johnston et al., 2020; Miech et al., 2020b; Smith et al., 2021) and associated with substantial health consequences (Cooper and Haney, 2009; Fairman, 2015; Viveros et al., 2006). Additionally, simultaneous use of alcohol and cannabis is modestly increasing among young adults (Patrick et al., 2019; Terry-McElrath and Patrick, 2018); the same cohorts among whom prevalence declined across historical time in adolescence. This is consistent with data on alcohol use, whereby declines in prevalence in adolescence are offset by faster increases in use in those same cohorts among young adults (Jager et al., 2022). Attention is needed to substance use prevention and intervention efforts aimed towards young adulthood after high school and/or college, when different substance use education and prevention methods must be used than those available for classroom use.

While these analyses are strengthened by the large and representative sample as well as adjustment for several confounders and analysis of potential sources of heterogeneity, data limitations exist. Surveys were administered in school, thus exclude those who have dropped out; although school dropout rates among 15–24 year old adolescents during our study period were low (4.8% in 2000 to 4.7% in 2017) (National Center for Educational Statistics, 2018), study findings may not generalize to different ages, or to adolescents not actively enrolled in the school system or who missed school the day of the survey. Additionally, data were self-reported and thus subject to reporting and recall bias. However, studies show that adolescents are more likely to report substance use in surveys administered in a school setting such as MTF than at home, suggesting that results from our study are less influenced by reporting and recall bias than other surveys (Gfroerer et al., 1997; Kann et al., 2002). In our sex stratified analyses, we were not able to examine gender apart from sex assigned at birth and disentangle the unique effects of gender and sex. Furthermore, race/ethnicity was defined here as white, Black, or other, and so we lacked the ability to explicitly describe the patterns and trends of the many groups that comprise the "other" category. Finally, we dichotomized substance use as any use in past year versus none, but the MTF data allow for disaggregation of levels of use, which may be informative for future research on trends among adolescents with established substance use.

In sum, the risk of past-year cannabis-use-only has been increasing over time among US adolescents, and risk of past-year alcohol-use-only and simultaneous use have decreased over time. Our results suggest that declines in simultaneous use are largely driven by historical declines in alcohol use, portending further harm reduction associated with decreased adolescent simultaneous use. Given that changes in substance use since the onset of the COVID-19 pandemic may have influenced subsequent trajectories of adolescent substance use(Layman et al., 2022), the impact of pandemic-related changes on simultaneous use will be an important research area moving forward. While simultaneous use is declining, it remains prevalent and associated with substantial potential health effects,

and thus clinicians should remain attentive to substance use in adolescent patients, and public health efforts should remain focused on developing and evaluating strategies for reducing substance use, including both alcohol and cannabis use, among adolescents.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Grants:

Abbreviations:

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MTF	Monitoring the Future Survey
aRRR	Adjusted relative risk ratio

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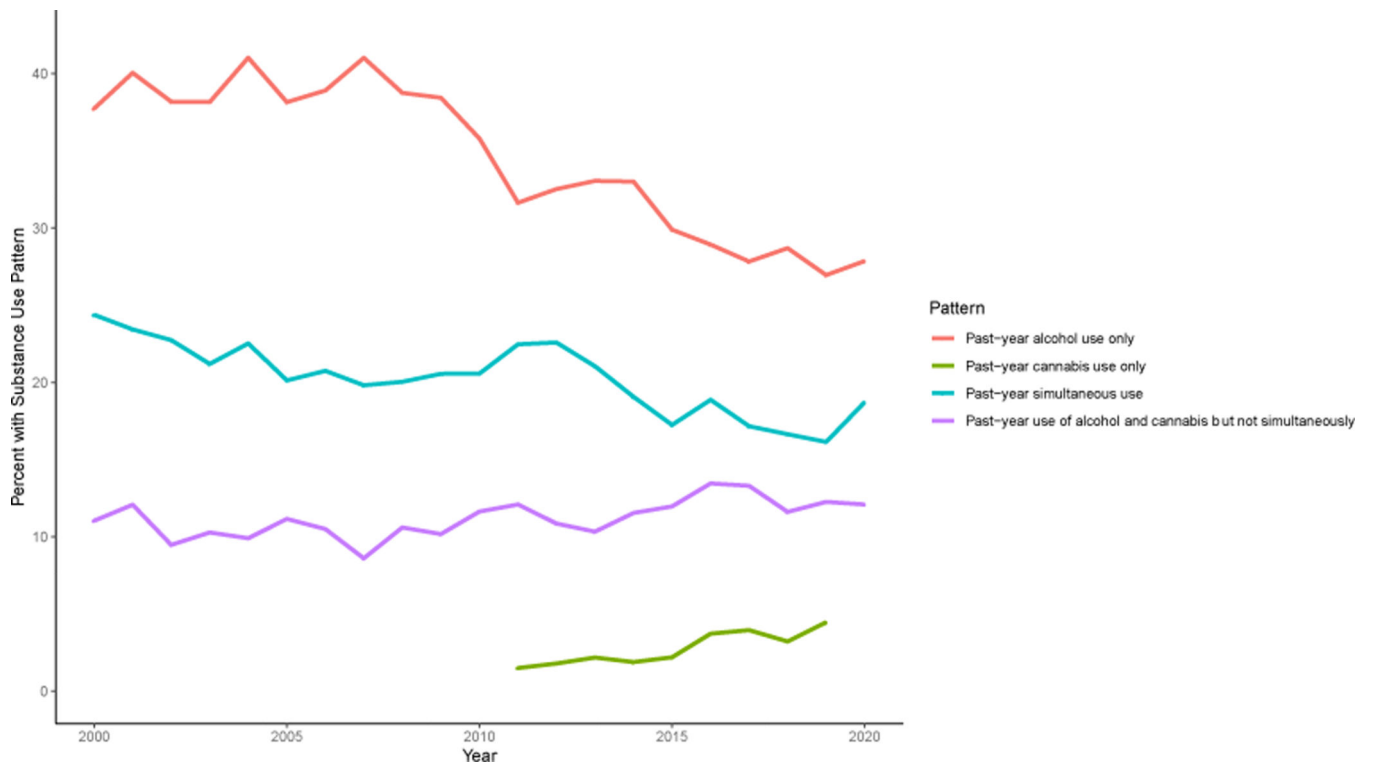
Figure 1:
Trends in past-year simultaneous use, alcohol and cannabis use but not simultaneously, cannabis-use-only, and alcohol-use-only among 12th graders from 2000–2020
Note: Alcohol-use-only is defined as past-year alcohol use and no report of past-year cannabis or simultaneous use. Cannabis-use-only is defined as past-year cannabis use and no report of past-year alcohol or simultaneous use. Certain years of cannabis-use-only censored due to small sample sizes. Prior to 2011 and in 2020, there were not sufficient numbers of adolescents who used cannabis only to report prevalence.
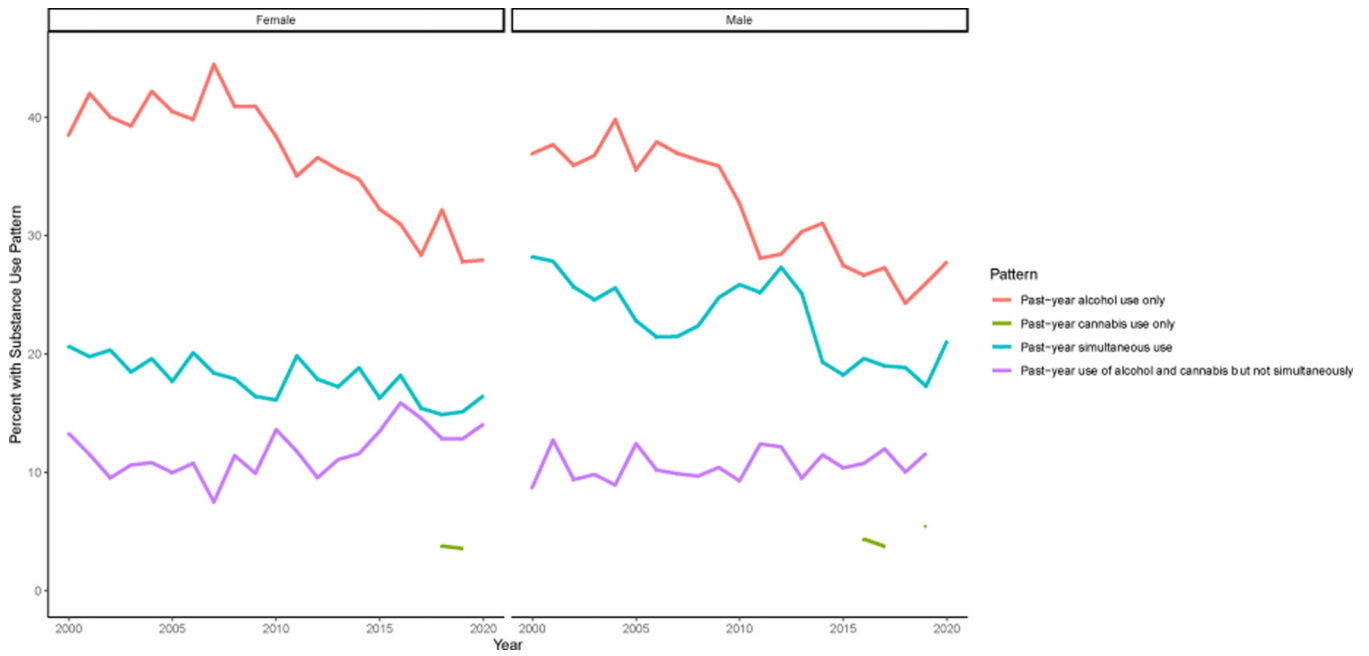
Figure 2:

Trends in past-year simultaneous use, alcohol and cannabis use but not simultaneously, cannabis-use-only, and alcohol-use-only among 12th graders from 2000–2020, by sex

Note: Alcohol-use-only is defined as past-year alcohol use and no report of past-year cannabis or simultaneous use. Cannabis-use-only is defined as past-year cannabis use and no report of past-year alcohol or simultaneous use. Certain years of cannabis-use-only censored due to small sample sizes. In most years, there were not sufficient numbers of adolescents who used cannabis only to report prevalence.

Table 1.

Multinomial logistic regressions of past-year alcohol and/or cannabis use (N= 37,799)

Covariate	Past-year simultaneous use (N=7,833) Vs. no use (N=11,586)	Past-year alcohol-use-only (N=13,509) Vs. no use	Past-year cannabis-use-only (N=608) Vs. no use	Past-year alcohol and cannabis use but not simultaneously (N=4,263) Vs. no use
	aRRR [95% CI]	aRRR [95% CI]	aRRR [95% CI]	aRRR [95% CI]
Survey year (ref=2000–2004)				
2005–2009	0.82 [0.71, 0.94]	0.92 [0.82, 1.03]	1.03 [0.72, 1.48]	0.90 [0.78, 1.04]
2010–2014	0.78 [0.68, 0.89]	0.70 [0.63, 0.77]	1.40 [1.01, 1.94]	0.89 [0.78, 1.02]
2015–2020	0.57 [0.50, 0.66]	0.55 [0.49, 0.61]	2.59 [1.87, 3.59]	0.88 [0.76, 1.01]
Sex (ref=male)				
Female	0.80 [0.74, 0.86]	1.15 [1.08, 1.22]	0.87 [0.72, 1.06]	1.10 [1.01, 1.20]
Parental education (ref=finished college or more)				
Some high school or lower	0.97 [0.83, 1.13]	0.93 [0.84, 1.04]	1.31 [0.93, 1.85]	1.07 [0.91, 1.25]
Finished high school or some college	1.16 [1.07, 1.25]	1.05 [0.98, 1.12]	1.37 [1.10, 1.71]	1.20 [1.10, 1.32]
Race/ethnicity (ref=white)				
Black	0.41 [0.36, 0.47]	0.56 [0.50, 0.62]	2.41 [1.84, 3.17]	0.78 [0.68, 0.90]
Other	0.70 [0.64, 0.78]	0.85 [0.78, 0.92]	1.61 [1.27, 2.04]	0.95 [0.85, 1.05]
Survey Mode (ref = Paper)				
Tablet	0.93 [0.73, 1.19]	0.86 [0.70, 1.06]	1.19 [0.81, 1.74]	0.92 [0.75, 1.13]

Note: aRRR=Adjusted relative risk ratio. Alcohol-use-only is defined as past-year alcohol use and no report of past-year cannabis or simultaneous use. Cannabis-use-only is defined as past-year cannabis use and no report of past-year alcohol or simultaneous use. Models adjusted for sex, parental education, race/ethnicity, and survey mode.

Table 2.

Multinomial logistic regressions of past-year use alcohol and/or cannabis use, adjusting for the interaction between sex and survey year (N= 37,799)

Covariate	Past-year simultaneous use (N=7,833) Vs. no use (N=11,586) aRRR [95% CI]	Past-year alcohol-use-only (N=13,509) Vs. no use aRRR [95% CI]	Past-year cannabis-use-only (N=608) Vs. no use aRRR [95% CI]	Past-year alcohol and cannabis use but not simultaneously (N=4,263) Vs. no use aRRR [95% CI]
Survey year (ref=2000–2004)				
2005–2009	**0.78 [0.66, 0.93]**	0.89 [0.76, 1.03]	0.96 [0.59, 1.57]	0.97 [0.80, 1.17]
2010–2014	**0.79 [0.66, 0.94]**	**0.66 [0.58, 0.76]**	1.53 [0.99, 2.36]	0.91 [0.76, 1.10]
2015–2020	**0.50 [0.42, 0.60]**	**0.49 [0.43, 0.57]**	**2.30 [1.55, 3.40]**	**0.76 [0.62, 0.91]**
Sex (ref=male)				
Female	**0.74 [0.64, 0.85]**	1.05 [0.93, 1.19]	0.82 [0.51, 1.32]	1.07 [0.89, 1.28]
Sex × Survey year				
Female × 2005–2009	1.10 [0.91, 1.34]	1.07 [0.91, 1.27]	1.13 [0.59, 2.15]	0.88 [0.69, 1.13]
Female × 2010–2014	0.97 [0.79, 1.19]	1.09 [0.92, 1.31]	0.83 [0.44, 1.55]	0.95 [0.74, 1.22]
Female × 2015–2020	**1.31 [1.06, 1.61]**	**1.21 [1.01, 1.44]**	1.26 [0.72, 2.21]	**1.31 [1.03, 1.68]**
Parental education (ref=finished college or more)				
Some high school or lower	0.97 [0.83, 1.14]	0.94 [0.84, 1.05]	1.32 [0.93, 1.86]	1.08 [0.92, 1.26]
Finished high school or some college	**1.16 [1.07, 1.25]**	1.05 [0.98, 1.12]	**1.37 [1.09, 1.70]**	**1.20 [1.10, 1.32]**
Race/ethnicity (ref=white)				
Black	**0.41 [0.36, 0.47]**	**0.56 [0.50, 0.62]**	**2.41 [1.84, 3.17]**	**0.78 [0.68, 0.90]**
Other	**0.70 [0.64, 0.78]**	**0.85 [0.78, 0.92]**	**1.61 [1.27, 2.04]**	0.95 [0.85, 1.05]
Survey mode (ref=paper)				
Tablet	0.93 [0.73, 1.19]	0.86 [0.70, 1.06]	1.19 [0.81, 1.74]	0.92 [0.75, 1.13]

Note: aRRR=Adjusted relative risk ratio. Alcohol-use-only is defined as past-year alcohol use and no report of past-year cannabis or simultaneous use. Cannabis-use-only is defined as past-year cannabis use and no report of past-year alcohol or simultaneous use. Models also adjusted for parental education, race/ethnicity, and survey mode.

Table 3.

Multinomial logistic regressions of past-year alcohol and/or cannabis use by sex

Subgroup	Survey year (ref=2000–2004)	Past-year simultaneous use Vs. no use	Past-year alcohol-use-only Vs. no use	Past-year cannabis-use-only Vs. no use	Past-year alcohol and cannabis use but not simultaneously Vs. no use
		aRRR [95% CI]	aRRR [95% CI]	aRRR [95% CI]	aRRR [95% CI]
Male (N= 17,771)	2005–2009	**0.78 [0.66, 0.93]**	0.89 [0.76, 1.03]	0.96 [0.59, 1.55]	0.96 [0.79, 1.16]
	2010–2014	**0.78 [0.66, 0.94]**	**0.66 [0.58, 0.76]**	1.51 [0.98, 2.34]	0.91 [0.75, 1.10]
	2015–2020	**0.48 [0.40, 0.58]**	**0.48 [0.42, 0.56]**	**2.15 [1.43, 3.21]**	**0.73 [0.60, 0.89]**
Female (N= 20,028)	2005–2009	0.86 [0.73, 1.02]	0.95 [0.83, 1.09]	1.10 [0.68, 1.77]	0.85 [0.71, 1.03]
	2010–2014	**0.77 [0.65, 0.90]**	**0.73 [0.64, 0.83]**	1.28 [0.80, 2.06]	0.87 [0.73, 1.05]
	2015–2020	**0.67 [0.56, 0.80]**	**0.61 [0.53, 0.70]**	**3.11 [1.95, 4.94]**	1.02 [0.85, 1.23]

Note: aRRR=Adjusted relative risk ratio. Alcohol-use-only is defined as past-year alcohol use and no report of past-year cannabis or simultaneous use. Cannabis-use-only is defined as past-year cannabis use and no report of past-year alcohol or simultaneous use. Models adjusted for parental education, race/ethnicity, and survey mode.