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Marijuana Use among Adolescents and Emerging Adults in the Midst of Policy Change: Introduction to the Special Issue

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Introduction

The marijuana policy landscape in the US has changed rapidly at the state level over the past 25 years. The first state-level medical marijuana law (MML) was passed in California in 1996, and the first laws legalizing marijuana for non-medical use for those over the age of 21 (i.e., "recreational" marijuana laws, RMLs) were passed in Colorado and Washington State in 2012. As of October 2018, 31 states and the District of Columbia have comprehensive MMLs and 9 of these states and the District of Columbia also have RMLs (National Conference of State Legislatures [NCSL] 2018). There have also been significant changes in marijuana policy in Canada and Mexico, the countries that border the US. Canada legalized marijuana for non-medical use in 2018 (Bilefsky 2018), and Mexico legalized medical use of low-THC (i.e., < 1%) marijuana in 2017 (Hecht 2018). Developing a comprehensive understanding of marijuana use within the context of policy changes is a public health priority. Such research is particularly needed for adolescents and emerging adults because they have among the highest rates of marijuana use across the lifespan (Fig. 1), and because more than 80% of adults (aged 26 and older) who report past-year marijuana use initiated use by 21 years of age (Substance Abuse and Mental Health Services Administration [SAMHSA] 2018).

With this special issue, we seek to advance prevention science research on marijuana use among adolescents and emerging adults. The 10 original articles in this issue describe patterns of use among young people and provide new information about associated risk and protective factors at multiple ecological levels (Brooks-Russell et al. 2019; Cavazos-Rehg et al. 2019; Fairman et al. 2019; Guttmannova et al. 2019a; Johnson et al. 2019; Mauro et al. 2019; Nguyen et al. 2019; Reboussin et al. 2019; Thompson et al. 2019; Wen et al. 2019). An additional commentary describes the importance of using existing data to characterize the epidemiology of marijuana use in response to state laws (Guttmannova et al. 2019b).

Changes in Use among Adolescents and Emerging Adults

It had been hypothesized that loosening restrictions on marijuana use would result in increased use among adolescents, but there is limited evidence of such an increase. Trend studies show that marijuana use among youth in the US has decreased significantly in the past 15–20 years (Johnson et al. 2015; Kann et al. 2018). Data from the National Youth Risk Behavior Surveillance System (YRBS) show large declines in the prevalence of lifetime (47.2–35.6%) and past 30-day marijuana use (26.7–19.8%) among US high school students from 1999 to 2017 (Kann et al. 2018). Findings from quasi-experimental studies evaluating the effects of changes in state-level marijuana policies are consistent with trend studies; they do not suggest that there have been changes in use as a result of MMLs (Kimmel and Lopez 2018; Leung et al. 2018; Sarvet et al. 2018). Because of the recency of passage and implementation of RMLs, few quasi-experimental studies have assessed their impact (Darnell 2015; Darnell and Bitney 2017; Guttmannova et al. 2019b).

The original studies in this special issue are largely consistent with the existing literature in that, overall, they do not indicate increases in adolescent and emerging adult marijuana use. Brooks-Russell et al.'s (2019) study of 9th–12th graders in Colorado did not indicate a difference in past 30-day use

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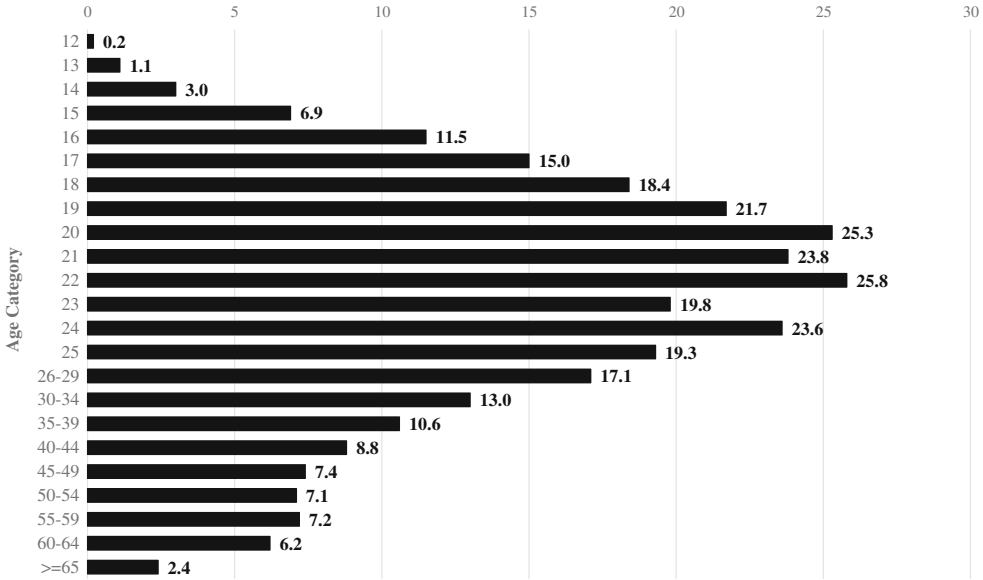

Fig. 1 Prevalence of past 30-day marijuana use by age, 2017. Source: Center for Behavioral Health Statistics and Quality (2018). National Survey on Drug Use and Health, Table 1.16B, Marijuana Use in Lifetime, Past Year, and Past Month among Persons Aged 12 or Older, by Detailed Age Category: Percentages, 2016 and 2017. Substance Abuse and Mental Health Services Administration, Rockville, MD. Available online: https://www.samhsa.gov/data/report/2017-nsduh-detailed-tables

before versus after initiation of retail marijuana sales in 2014 (20.9% in 2013 vs. 21.2% in 2015). Importantly, some studies in this issue offer new evidence of possible increases in marijuana use among subgroups of youth. Mauro et al.'s (2019) quasi-experimental study concluded that changes in past-month and past-year marijuana use among 12–17 and 18–25-year-olds before versus after passage of MMLs were not statistically significant. However, that same study showed that there was a modest post-MML increase in daily use among 18–25-year-old men, conditional on reporting past-year marijuana use (21–23.5%, $p = 0.047$); this finding was not observed for women. Results from Johnson et al.'s (2019) trend study of adolescents in Washington State showed a decrease in past 30-day marijuana use from 2004 to 2016 among 8th graders (9.2–6.4%), no changes in use among 10th graders (17–17.2%), and an increase in use among 12th graders (19.4–26.5%).

Marijuana, Alcohol, and Cigarette Use

Marijuana has consistently been the most frequently used illicit drug, and historically its prevalence of use has been lower than the prevalence estimates for alcohol and tobacco (Miech et al. 2018). However, patterns of substance use have shifted dramatically in response to targeted public health efforts to limit youth access to cigarettes and alcohol; estimates of the prevalence of use of all three drugs are now remarkably similar (Fig. 2). The prevalence of past 30-day marijuana use among US high school students has been higher than past 30-day cigarette use since the early 2010s (Johnson et al. 2015; Kann et al. 2018; Miech et al. 2018), and 2017 data show just a modest difference in past 30-day alcohol and marijuana use among 12–17-year-olds (9.1% vs. 6.4%; SAMHSA 2018). In fact, it has been proposed that there has been a "spillover effect," meaning that decreases in alcohol and cigarette use may have mitigated increases in marijuana use that would have otherwise occurred (Fleming et al. 2016; Ingraham 2014).

Some people use multiple substances—either simultaneously, concurrently, or throughout the life course—and the use of one drug likely affects trajectories of use for other drugs, including initiation, escalation, and desistance of use. Two articles in this special issue address the interconnectedness of alcohol, cigarette, and marijuana use. Fairman et al.'s (2019) study of 12–21-year-olds in the US showed that the proportion of those who report having used cigarettes as their first drug declined from 21.4% in 2004 to 8.9% in 2014, whereas the proportion reporting that marijuana was their first drug increased from 4.8 to 8% during the same time period. Nguyen et al. (2019) analyzed data from National Longitudinal Study of Adolescent to Adult Health (Add Health) and used propensity score matching to investigate whether marijuana use in adolescence contributed to increases in cigarette smoking in early adulthood. Their results showed an increased risk among girls, suggesting that adolescent marijuana use may be a marker of risk for cigarette smoking in adulthood.

Because there are substantial detrimental public health consequences associated with underage alcohol and cigarette use, changes in use of those substances is highly relevant to quantifying the public health impact of MMLs and RMLs. Specifically, if there is a reversal of the decades-long declines in alcohol or cigarette use because of changes in marijuana policy, the negative impact of loosened restrictions on marijuana could increase considerably. Future studies on marijuana policy should aim to enhance our understanding of concurrent and simultaneous use of marijuana with alcohol and

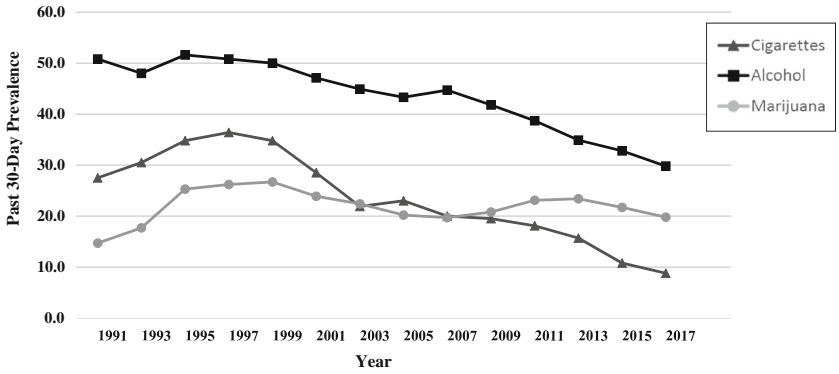

Fig. 2 Prevalence of past 30-day use of marijuana, cigarettes, and alcohol among US high school students, by year (1991–2017). Source: Centers for Disease Control and Prevention (CDC). *1991–2017 High School Youth Risk Behavior Survey Data.* Available at http://nccd.cdc.gov/youthonline/. Accessed on October 25, 2018

cigarettes, as well as with other commonly used substances, such as opioids, e-cigarettes, and non-cigarette tobacco products. Research characterizing the extent to which marijuana use contributes to an increase (the "complementary hypothesis") or decrease (the "substitution hypothesis") in use of the other substances is also needed.

Predictors of Marijuana Use from Multiple Ecological Domains

To foster healthy outcomes and prevent problem behaviors, the prevention science framework focuses on identification of factors that influence health risk behaviors, followed by the development and testing of programs that decrease risk and increase protective factors (e.g., Catalano et al. 2011; Catalano et al. 2012; Coie et al. 1993; Cordova et al. 2014). Therefore, special attention to the predictors of marijuana use in the changing marijuana policy context is an important step toward developing effective prevention programs aimed at adolescent marijuana use. Several articles in this issue focus on risk and protective factors for marijuana use across multiple ecological domains, including perceived harmfulness and wrongfulness of marijuana use; perceived approval or disapproval of marijuana use by parents and peers; and other factors at the family, school, and neighborhood or community levels. Because much of the existing research focuses on individual-level factors and policy change, this increased emphasis on factors at other ecological levels is an important contribution to the literature.

Wen et al. (2018) used cross-sectional data from the National Survey on Drug Use and Health (NSDUH) to investigate changes in marijuana-related attitudes and perceptions among adolescents and young adults in 10 states that passed MMLs between 2004 and 2012. They found that MML implementation was associated with an increase in low perceived harmfulness associated with use, but also with a decrease in perceived parental approval of marijuana use. Using longitudinal panel data from youth in 12 communities in seven states, Guttmannova et al. (2019a) examined the dynamic relationship between marijuana-specific risk factors spanning multiple socializing domains including peers, parents, and community—in addition to individual norms and perceptions of harm—and adolescent marijuana use. They found that the associations were often reciprocal and more salient in some developmental periods but not in others. Reboussin et al. (2019) used data from a Baltimore-based cohort study and showed that residence in neighborhoods characterized by social disorder (e.g., violence, incivilities) was associated with problematic use of marijuana in emerging adulthood, and also that living further away from alcohol outlets was protective. These studies underscore the importance of developing intervention strategies that focus on risk comprehensively, i.e., across the ecological domains in which the lives of youth are embedded, with close attention to timing of risk and developmental transitions.

In states with MMLs or RMLs, the presence of dispensaries or retail outlets and how marijuana is marketed represent additional contextual factors that can influence marijuana use among adolescent and emerging adults. Cavazos-Rehg et al. (2019), in this issue, examined online promotion of marijuana by randomly selecting 100 dispensaries from 10 states that had RMLs or MMLs and that also had at least 10 operational dispensaries. Their work showed that 75% of the sites for dispensaries did not require age verification to view their website and that 67% included unwarranted claims about health effects of marijuana. In their study of Colorado high school students, Brooks-Russell et al. (2019) demonstrated that youth in municipalities that permitted legal sales of retail marijuana had a higher prevalence of marijuana use than those in areas that prohibited sales. However, the prevalence of use was already higher in 2013, before the opening of retail marijuana stores. This finding serves as an important reminder that the association between the presence of stores, community norms, and demand for marijuana is likely reciprocal and each can function as a predictor as well as a consequence of policy change. Disentangling cause and effect is a methodological challenge to testing

associations between marketing, availability, and changes in marijuana use.

Longitudinal Research

Most research examining changes in marijuana use in relation to MMLs and RMLs relies on repeated cross-sectional data; this limits the ability to investigate developmental change within individuals over time. Longitudinal studies are necessary to test hypotheses about marijuana-specific risk and protective factors and about drug use trajectories, such as the sequential ordering of initiation of use of different substances and patterns of escalation and desistance in use. They are also necessary for identifying short- and long-term health, social, educational, and economic outcomes associated with marijuana use. This special issue includes four longitudinal studies that provide new information about predictors and outcomes associated with marijuana use from adolescence to emerging adulthood. As described previously, Nguyen et al.'s (2019) study with Add Health data showed that marijuana use in adolescence may increase risk for cigarette smoking in emerging adulthood for women, and Reboussin et al.'s (2019) study indicated that neighborhood-level social disorder is linked to problem marijuana use among 18–21-year-olds in Baltimore, MD. Findings from Guttmannova et al. (2019a) highlight the importance of examining the dynamic interplay between risk factors and marijuana use over time to disentangle complex influences (e.g., peer selection versus peer socialization) and to understand the salience of developmental transitions in the associations between risk factors and use. An additional article by Thompson et al. (2019) used data from a community-based cohort study in Victoria, Canada, and found that early initiation and frequent or increasingly-persistent use of marijuana in adolescence and emerging adulthood was associated with poor educational and occupational outcomes in young adulthood. Their findings are consistent with other studies that have demonstrated links between marijuana use and education-related outcomes (e.g., Kelly and Vuolo 2018; Homel et al. 2014; Scholes-Balog et al. 2016). Longitudinal research shows that marijuana use—and heavy use in particular—can have a detrimental impact on the transition to adulthood.

There are few state- or nationally-representative datasets that allow for longitudinal assessments of marijuana use among adolescents, which limits opportunities to examine developmental changes in the midst of a dynamic legal and normative environment for marijuana use. The longitudinal studies in this special issue are geographically-limited; for example, Reboussin et al. (2019) used data from a cohort of 18–21-year-olds based in one city. Add Health is a national longitudinal study that has been used extensively to study etiology of heath and health risk behaviors among US youth (see Nguyen et al. 2019), but it is not well suited for research aiming to examine recent marijuana policy changes. Add Health items on marijuana use are limited, and data collection paused in 2008 (Wave 4) and did not resume until 2016–2017 (Wave 5), missing the key decade of proliferation of medical marijuana markets and the onset of state-level legalization of nonmedical or recreational marijuana.

Table 1 Number of journal articles in *Prevention Science* referencing alcohol, cigarettes/tobacco, and marijuana in the title, in 2000–2008 and 2009–2018

Years	Words in article title		
	Cigarettes or tobacco	Marijuana or Cannabis	Alcohol or Drinking
2000–2008	12	4	33
2009–2018	21	23	86

The first issue was published in March 2000. Numbers are from a search of PubMed, specifying words in the title by using the "TI" search term. There were 19 additional articles with "smoking" in the title; 7 in 2000–2008 and 12 in 2009–2018

To evaluate the pressing public health questions in this era of state-level marijuana policy liberalization, new cohort studies need to be established. The recent initiative by the National Institutes of Health to fund the Adolescent Brain and Cognitive Development (ABCD) study could greatly expand the understanding of etiology of adolescent substance use and substance use disorders, associated risk and protective factors, and related consequences. Although the baseline data on ABCD participants (ages 9–10; *N*~4500) were released in 2018, it will take several years before there is usable longitudinal data on substance use and related factors. In the meantime, funding for smaller-scale studies of specific subgroups or geographic regions and advances in data analysis and methodology that allow researchers to pool multiple independent data sources, such as integrative data analysis (IDA), could help address the need for longitudinal data that require both historical and current information about substance use (e.g., Curran and Hussong 2009; Hofer and Piccinin 2009; McArdle et al. 2009; Marcoulides and Grimm 2017).

Conclusion

Despite its significance as a risk behavior for adverse outcomes, prevention science has not prioritized research on marijuana use, particularly as compared to the research attention focused on alcohol and tobacco (Table 1). Consequently, we have limited foundational knowledge about the epidemiology and etiology of youth marijuana use in a time when such information is very much needed. At this point, our goal should be to work toward developing a comprehensive

understanding of the secular trends and developmental patterns of marijuana use in the rapidly changing social, normative, and policy context, including identification of marijuana-specific risk and protective factors from multiple domains, e.g., community, school, family, peers, and mass media (e.g., Catalano et al. 2018). As the liberalization of marijuana laws becomes more commonplace, a continued focus on the effects on adolescents and emerging adults is needed, with an increased emphasis on RMLs and a consideration of subgroups that may be disproportionately affected by policy changes, either by virtue of their location (e.g., proximity to retail outlets), school characteristics, or individual characteristics (e.g., exposure to parental substance use). Prevention science research about marijuana use is critical to addressing future challenges and can enable the public health sector to anticipate how the patterns of use may change and what factors influence the change, so as to implement programs and policies to mitigate adverse consequences.

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Compliance with Ethical Standards

Conflict of Interest The authors declare that they have no conflict of interest.

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