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Planting the seed for marijuana use: Changes in exposure to medical marijuana advertising and subsequent adolescent marijuana use, cognitions, and consequences over seven years

Elizabeth J. D'Amico[a,*], Anthony Rodriguez[a], Joan S. Tucker[a], Eric R. Pedersen[a], Regina A. Shih[b]

[a] RAND Corporation, 1776 Main St., Santa Monica, CA 90401, USA
[b] RAND Corporation, 1200 S Hayes St, Arlington, VA 22202, USA

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ABSTRACT

Background: Marijuana use during adolescence is associated with neurocognitive deficits and poorer functioning across several domains. It is likely that more states will pass both medical and recreational marijuana legalization laws in the coming elections; therefore, we must begin to look more closely at the longitudinal effects of medical marijuana (MM) advertising on marijuana use among adolescents so that we can better understand effects that this advertising may have on their subsequent marijuana use and related outcomes.

Methods: We followed two cohorts of 7th and 8th graders (mean age 13) recruited from school districts in Southern California from 2010 until 2017 (mean age 19) to examine effects of MM advertising on adolescents' marijuana use, cognitions, and consequences over seven years. Latent growth models examined trajectories of self-reported exposure to medical marijuana ads in the past three months and trajectories of use, cognitions, and consequences.

Results: Higher average exposure to MM advertising was associated with higher average use, intentions to use, positive expectancies, and negative consequences. Similarly, higher rates of change in MM advertising exposure were associated with higher rates of change in use, intentions, expectancies, and consequences over seven years.

Conclusions: Results suggest that exposure to MM advertising may not only play a significant role in shaping attitudes about marijuana, but may also contribute to increased marijuana use and related negative consequences throughout adolescence. This highlights the importance of considering regulations for marijuana advertising, similar to regulations in place for the promotion of tobacco and alcohol in the U.S.

1. Introduction

California became the first state to pass a comprehensive medical marijuana law (MML) in 1996, and as of 2017, 29 states in the United States and Washington, DC have legalized marijuana for medical purposes. Recent high-quality epidemiological studies have examined changes in overall marijuana use rates among adolescents before and after the passage of medical marijuana legalization laws in an attempt to examine whether marijuana use rates have increased, decreased, or stayed the same following legalization. Due to heterogeneity across studies (e.g., national versus single state) and nuances in policy (Pacula et al., 2013), there is no definitive conclusion (Borodovsky et al., 2017; Choo et al., 2014; Hall and Lynskey, 2016). What research has shown, however, is a strong trend towards more positive views of marijuana among teens over the past 14 years (Cavazos-Rehg et al., 2015; Fleming et al., 2016). For example, more than 50% of 10th and 12th graders across the United States now endorse the belief that *smoking* marijuana regularly does not carry great risk (note that this question does not address other ways of using marijuana, such as vaping or edibles) (Miech et al., 2016). Research has also shown that more positive views about marijuana among teens are associated with increased marijuana use rates in this age group (Merianos et al., 2017).

Many of these positive beliefs about marijuana may come from exposure to marijuana-positive messages on social media and through advertising (e.g., billboards, online), which has increased as MMLs have passed (D'Amico et al., 2017). For example, a 2014 social media study showed that among people ages 17–19 years, the popular pro-marijuana Twitter handle @stillblazingtho was in the top 10% of all Twitter handles followed (Cavazos-Rehg et al., 2014). One recent cross-sectional study asked 742 young adult marijuana users about the number

Abbreviations: AOD, alcohol and other drug use; MM, medical marijuana; MML, medical marijuana legalization laws

* Corresponding author at: RAND Corporation, 1776 Main St Santa Monica, CA 90407-2138, USA.
E-mail address: damico@rand.org (E.J. D'Amico).

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of times they had seen or heard information about advertisements/promotions, coupons or discounts for a dispensary or for buying marijuana in the past 30 days (Krauss et al., 2017). Over half of those surveyed were exposed to marijuana advertising in the past month: 28% passively observed advertisements; 26% actively sought advertisements. Further, most respondents (77%) reported digital media (i.e., social media, online, text/emails) sources for advertisements, and about half observed advertisements via print, television, radio, and on dispensary storefronts. Cross-sectional results also indicated that young adults seeking advertisements (e.g., to find a dispensary to buy marijuana) were more likely to report the medical use of marijuana and to use marijuana several times per day compared to those who did not actively seek out ads (Krauss et al., 2017). Other work in this area has examined health claims made about marijuana use on Weedmaps, and demographics of Weedmaps' followers on social media sites (Bierut et al., 2017). Results indicated that 61% of retailers in Colorado and 44% of retailers in Washington made health claims about the benefits of using marijuana, including reduced anxiety and treatment for depression, insomnia, and pain/inflammation. The study also showed that most followers of Weedmaps on Twitter and Instagram were male (60%) and age 20–29 (70%); however, about 1 in 6 followers of Weedmaps on Twitter were under age 20.

In the only longitudinal study to date to assess exposure to medical marijuana (MM) advertising among adolescents (n = 8000), D'Amico and colleagues (D'Amico et al., 2015b) found that middle school students' exposure to MM advertising was related to both increased intentions to use marijuana and marijuana use one year later. This work has been used to inform public policy surrounding advertising for this drug, and is cited in an act to amend Section 26152 of the Business and Professions Code relating to cannabis in California (Bill SB-162 Cannabis: Marketing), and has also been used to inform a recent cannabis advertising ordinance for the city of Los Angeles (CPC-2017-4546-CA), which both seek to regulate such advertising.

Marijuana use during adolescence is associated with numerous issues, including poorer mental health and academic performance, increased delinquency, higher likelihood of abuse or dependence in adulthood, and neurocognitive deficits (D'Amico et al., 2005, 2016b; Lisdahl and Price, 2012). It is likely that more states will pass both medical and recreational marijuana legalization laws in coming elections (D'Amico et al., 2017); therefore, we must begin to look more closely at the longitudinal effects of MM advertising on marijuana use among adolescents so that we can better understand the extent to which youth are exposed to advertising and the effects that this advertising may have on their subsequent marijuana use and related outcomes. Thus, the current study is highly significant as it is the first to directly examine the conjoint longitudinal change in MM advertising and adolescents' 1) marijuana use, 2) future intentions to use marijuana, 3) positive expectancies about marijuana use, and 4) negative consequences from marijuana use. These associations are examined over a seven-year period using parallel process growth curve models. Furthermore, this analysis will be informative for other states that may want to examine the effects of legislation on outcomes and must do so in the context of a fast-changing marketing landscape.

2. Method

2.1. Participants and procedures

This study focuses on two cohorts of youth who were in 6th and 7th grade (age 11–12) in 2008 and were followed until 2017 (age 19). Participants were initially recruited from 16 middle schools across three school districts in Southern California (D'Amico et al., 2012). Responses are protected by a Certificate of Confidentiality from the National Institutes of Health, and procedures were approved by schools and the institution's internal review board.

Schools were selected to obtain a diverse sample and have similar alcohol and other drug use rates at baseline. Schools were matched to their nearest neighbor school based on the squared Euclidean distance measure, estimated using publicly available information on ethnic diversity, approximate size, and standardized test scores (D'Amico et al., 2012). Detailed procedures are reported in the original prevention trial (D'Amico et al., 2012) and other trajectory work (D'Amico et al., 2016b; Dunbar et al., 2018). Briefly, adolescents completed waves 1 through 5 in middle school during PE class (wave 1: fall 2008, wave 2: spring 2009, wave 3: fall 2009, wave 4: spring 2010, and wave 5: spring 2011); follow-up rates ranged from 74% to 90%, excluding new youth that could have come in at a subsequent wave. Adolescents transitioned from 16 middle schools to over 200 high schools and were re-contacted and re-consented to complete annual web-based surveys. At Wave 6, 61% of teens participated in the follow-up survey. We retained 80% of the sample from wave 6–7, 91% of the sample from wave 7–8, and 89% of the sample from wave 8–9. If a participant did not complete a wave of data collection, they were still eligible to complete all subsequent waves. That is, they did not "dropout" of the study once they missed a survey wave; rather we fielded the full sample at every wave so that all participants had an opportunity to participate in each survey. Failure to complete a certain wave was not significantly associated with demographics or risk behaviors, such as drinking and marijuana use (D'Amico et al., 2016b; Dunbar et al., 2018).

The current study focuses on wave 4 (2010) through 9 (2017). We began to collect data on exposure to MM advertising at wave 4 because a proposition to legalize marijuana was being discussed in the California Senate in January 2010 and was added to the California ballot in November 2010 (California Proposition 19, also known as the Regulate, Control, and Tax Cannabis Act). The mean age of the sample at wave 4 was 13. Youth are ethnically and racially diverse (e.g., 53% Hispanic; 18% Asian), and rates of marijuana use across waves are comparable to national samples (Table 1). Specifically, in Monitoring the Future, 16.4% of eighth graders reported lifetime marijuana use in 2011 (Johnston et al., 2012) compared with 15.8% in our 8th grade sample. The trajectory sample comes from a sample of youth who were in 6th or 7th grade at wave 1. As noted above, we use waves 4 through 9, and adolescents (N = 4946) were in 7th or 8th grade at wave 4.

2.2. Measures

2.2.1. Covariates

Covariates included age, gender, race/ethnicity, and intervention status. Race/ethnicity categories included non-Hispanic White, Hispanic, Asian, Black, and Other. For all analyses, these were dummy coded with non-Hispanic White as the reference group. Of note, there were no intervention effects on marijuana use, and initial intervention effects on alcohol use were no longer significant after wave 3 of the study (when we began collecting data on exposure to medical marijuana advertising); nonetheless, we controlled for intervention participation in present analyses.

2.2.2. Intentions and expectancies

Intentions for marijuana use were measured using one item asking adolescents, "Do you think you will use any marijuana in the next six months?" (response options ranged from 1 = *definitely no* to 4 = *definitely yes*) (D'Amico et al., 2015b). *Positive expectancies* comprised six items (e.g., using marijuana relaxes you, helps you get away from your problems) rated from 1 = *strongly disagree* to 4 = *strongly agree* (Pedersen et al., 2014). This scale has been used extensively with adolescents and is reliable ($\alpha = 0.88$) and valid.

2.2.3. Marijuana use and consequences

Marijuana use and consequences were assessed using well-established measures with adolescents (D'Amico et al., 2016a). Youth reported number of days they used marijuana in the past month (1 = *0 days* to 8 = *20–30 days*), which was dichotomized (1 = *any use*

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