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Medical marijuana laws and adolescent use of marijuana and other substances: Alcohol, cigarettes, prescription drugs, and other illicit drugs



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ABSTRACT

Background: Historical shifts have taken place in the last twenty years in marijuana policy. The impact of medical marijuana laws (MML) on use of substances other than marijuana is not well understood. We examined the relationship between state MML and use of marijuana, cigarettes, illicit drugs, nonmedical use of prescription opioids, amphetamines, and tranquilizers, as well as binge drinking.

Methods: Pre-post MML difference-in-difference analyses were performed on a nationally representative sample of adolescents in 48 contiguous U.S. states. Participants were 1,179,372 U.S. 8th, 10th, and 12th graders in the national Monitoring the Future annual surveys conducted in 1991–2015. Measurements were any self-reported past-30-day use of marijuana, cigarettes, non-medical use of opioids, amphetamines and tranquilizers, other illicit substances, and any past-two-week binge drinking (5+ drinks per occasion).

Results: Among 8th graders, the prevalence of marijuana, binge drinking, cigarette use, non-medical use of opioids, amphetamines and tranquilizers, and any non-marijuana illicit drug use decreased after MML enactment (0.2–2.4% decrease; p -values: < 0.0001 – 0.0293). Among 10th graders, the prevalence of substance use did not change after MML enactment (p -values: 0.177 – 0.938). Among 12th graders, non-medical prescription opioid and cigarette use increased after MML enactment (0.9–2.7% increase; p -values: < 0.0001 – 0.0026).

Conclusions: MML enactment is associated with decreases in marijuana and other drugs in early adolescence in those states. Mechanisms that explain the increase in non-medical prescription opioid and cigarette use among 12th graders following MML enactment deserve further study.

1. Introduction

Since 1996, 29 states and Washington, D.C. (as of November 2017) enacted legislation permitting the medical use of marijuana. While multiple studies examined the impact of medical marijuana legalization (MML) on adolescent marijuana use (Harper et al., 2012; Hasin et al., 2015; Wall et al., 2011), less is known about MML effects on adolescent use of other substances. If marijuana and other substances are complementary, then increased marijuana use (e.g., through changes in availability and/or price) should increase alcohol and other substance use. This could occur if combined use produces a synergistic psychoactive effect or if marijuana serves as a gateway to other drugs (Kandel and Kandel, 2015; Kandel et al., 1992; Moore, 2010).

Alternatively, if marijuana and other substances are substitutes, then increased marijuana use should decrease other substance use, which could occur if the substances have similar psychoactive properties and marijuana becomes more accessible. These relationships are usually investigated when a policy directly affects the substance it targets. Virtually all evidence indicates no effect of state MML on adolescent marijuana use (Anderson et al., 2013; Choo et al., 2014; Harper et al., 2012; Hasin et al., 2015; Lynne-Landsman et al., 2013; Schuermeyer et al., 2014; Wall et al., 2011; Wen et al., 2015). However, Colorado studies show that a 2009 federal policy change (reduction in likelihood of prosecution for medical use in MML states; Ogden, 2009) was associated with increased use among adolescents (Salomonsen-Sautel et al., 2014; Schuermeyer et al., 2014). This suggests possible heterogeneous

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MML effects across periods, warranting exploration of cross-substance effects. Further, prior to enactment, MML states have higher rates of marijuana use than non-MML states (Hasin et al., 2015; Keyes et al., 2016; Martins et al., 2016; Wall et al., 2016; Wall et al., 2011), which, according to the gateway hypothesis, could contribute to later initiation of other substances.

Studies of abused substances as substitutes or complements mainly focus on alcohol and marijuana. Some found substitution after change in alcohol prices (Cameron and Williams, 2001; Chaloupka and Laixuthai, 1997) and in the legal drinking age (Crost and Guerrero, 2012; DiNardo and Lemieux, 2001), while others showed complementarity after change in alcohol price (Pacula, 1998; Saffer and Chaloupka, 1999; Williams et al., 2004) and legal drinking age (Yoruk and Yoruk, 2011b). The two studies that examined MML and adolescent use of alcohol and other non-marijuana substances also did not agree. One study (Pacula et al., 2013) did not show MML effects overall on alcohol use, but found a positive relationship between home cultivation provisions and alcohol use and between dispensary provisions and alcohol treatment admissions. This study's inconsistent results were only found at the extremes of alcohol severity. Further, each dataset included different states and age groups, making comparisons difficult. In the second study (Wen et al., 2015), MML did not affect alcohol or other substance use (cocaine, heroin, non-medical use of prescription opioids) among those aged 12–20. However, this study included only eight years and a small number of MML states. Thus, the evidence is inconsistent, warranting further study.

Some studies show a relationship between MML enactment and adult decreases in opioid-related harm (Bachhuber et al., 2014; Kim et al., 2016; Pacula et al., 2015), which is potentially explained if marijuana provides a substitute for opioids to treat chronic pain, ameliorate opioid withdrawal symptoms, or assist in recovery from opioid dependence (Lynch and Ware, 2015; Scavone et al., 2013). However, no prior studies examined MML effects on non-medical prescription opioid use across the full range of MML states or addressed MML effects on other types of prescription drugs.

We know of no study that examined pre-post MML differences in adolescent binge drinking and use of other non-marijuana substances in all 48 contiguous U.S. states with data that pre-dated the first MML. Our study addressed two questions. First, were participants generally at higher risk for use of marijuana, cigarettes, non-medical use of prescription drugs, illicit drugs, or binge drinking in states that ever passed a MML by 2015 than in other states? This question extends our prior work by examining whether states that ever passed MML are generally at higher risk for use of a wide spectrum of substances. Second, did states that enacted MML exhibit greater change in the prevalence of marijuana use, cigarette use, non-medical prescription drug use, illicit drug use or binge drinking following MML enactment than states that never enacted MML? While results for marijuana were previously reported (Hasin et al., 2015), we include them here because of the additional year of data (2015) available and to evaluate whether MML impacts marijuana and other substances the same way (complementarity) or in opposite ways (substitution). As a sensitivity analysis, we also examined potential differences in the effect of MML enactment on substance use following the 2009 change in federal prosecution policy in MML states (Ogden, 2009).

2. Methods

2.1. Study design and participants

Monitoring the Future (MTF) is an annual, nationally representative, cross-sectional survey of students attending public and private schools in the 48 contiguous U.S. states (Bachman et al., 2015; Miech et al., 2016). Consistent design methodology from its inception allows robust examination of historical trends. Since 1991, students were sampled from 8th, 10th and 12th grades.

MTF employs a complex survey design; from a sample of randomly selected geographic units, eligible schools are selected to participate with probability proportional to school size. Non-responding schools are replaced with a similarly-sized school from the same geographic area; schools are asked to participate in the study for two consecutive years.

Between 1991 and 2015, 1,179,372 middle and high school students participated in the Monitoring the Future study (423,899 8th graders; 386,596 10th graders; and 368,877 12th graders). Student response rates ranged from 79 to 91% (mean = 86.5%), with the majority of non-response due to absence. Less than 1.7% of students refused to participate in the survey (Miech et al., 2015b).

While most drug use was assessed on all questionnaires in MTF, non-medical prescription opioid use was not, out of a concern that 8th and 10th graders were over-reporting use of prescription opioids, due to difficulty with the definitions. Of the total sample, 82.9% of 8th and 10th graders were randomly assigned to forms that included questions about non-medical prescription opioid use.

Analysis of the effects of medical marijuana laws on each substance use behavior excluded participants with missing data for that outcome. The final analytic sample included the following percentages of participants for each substance: binge drinking, 92.3% (N = 1,088,923); cigarette use, 97.3% (N = 1,147,963); non-medical prescription opioid use among those randomized to a form querying use, 96.6% (N = 944,546); non-medical prescription amphetamine use, 97.1% (N = 1,144,618); non-medical prescription tranquilizer use, 97.0% (N = 1,144,029); any illicit drug other than marijuana, 94.3% (N = 1,116,951); and marijuana use, 96.7% (N = 1,140,768).

Data were collected from students during normal class periods via paper-and-pencil questionnaires. Participation was anonymous for 8th and 10th graders, and confidential for 12th graders, as some identifying information was collected for follow-up purposes. All study procedures are annually approved by University of Michigan's Institutional Review Board (Johnston et al., 2014).

2.2. Measures

The outcome variables were: participant reports of any marijuana use, any binge drinking (five or more drinks in a row), any cigarette use, prescription opioid, amphetamine and tranquilizer use without a prescription or doctor's permission, and any other illicit substance use. The most recent timeframe, use within the last 30 days (or in the case of binge drinking, in the past two weeks) was used for best recall (Bachman et al., 2015; Miech et al., 2015b).

Given the interest in change in non-medical prescription opioid use following MML enactment (Miech et al., 2016; Yoruk and Yoruk, 2011a), prescription drugs including opioids (e.g., morphine, codeine, Vicodin, etc.), amphetamines (e.g., Adderall, Ritalin, etc.), and tranquilizers (e.g., Librium, Valium, Xanax, etc.) were examined separately.

Illicit drugs included LSD and other hallucinogens, crack and other cocaine, heroin, amphetamines, tranquilizers, and, among 12th graders only, nonmedical use of sedatives and narcotics other than heroin (Johnston et al., 2017).

The exposure variable was state-level medical marijuana law, i.e., whether the respondent lived in a state with a MML when surveyed. The year that MML was passed was determined by review of publicly available state policies conducted by a team of legal scholars, policy analysts and economists from the RAND corporation (Pacula et al., 2014). Dates of MML enactment are included in Appendix S1, and range from 1996 to 2014, providing for 1–19 years of post-legalization follow-up time, depending on the state.

Individual-level covariates included grade, age, sex, race/ethnicity (black, Hispanic, white, Asian, or other), and socioeconomic status (highest parental education as reported by the student: less than high school, high school graduate or equivalent, some post-secondary education, or a 4-year college degree or higher). School-level covariates

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