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An Epidemiological Hypothesis of Policy-Shaped Drug Use Onset Curves

Barrett Wallace Montgomery[1]*, Olga Vsevolozhskaya[2] and James C Anthony[1]

[1]*Department of Epidemiology and Biostatistics, College of Human Medicine, Michigan State University, United States*

[2]*Department of Biostatistics, College of Public Health, University of Kentucky, 205 MDS Building, Lexington, KY, United States*

***Corresponding author:** Barrett Wallace Montgomery, Department of Epidemiology and Biostatistics, College of Human Medicine, Michigan State University, United States

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Abbreviations: EMIRD: Extra-Medical Use of Internationally Regulated Drugs; LMA: Legal Minimum Age; NSDUH: National Surveys on Drug Use and Health; R-DAS: Restricted Data Access Portal; CI: Confidence Intervals; CSWS: Colorado State and Washington State; PDPD: Peak-Decline-Peak-Decline

ABSTRACT

Introduction: For most drugs, age-specific incidence peaks during the mid-adolescent years and then declines. Alcohol is the exception with a viable explanatory theory of heterogeneous subgroups within the US population regarding attention to the law. A natural experiment of this hypothesis is underway as states legalize and regulate cannabis similarly to alcohol. We forecast the emergence of a bimodal cannabis incidence pattern as states set minimum cannabis purchase age at 21 years.

Methods: The population under study for these analyses are non-institutionalized civilian residents of the U.S., 12 years of age and older, as sampled and assessed for the National Surveys on Drug Use and Health (NSDUH), from 2010 to 2017. The sample is stratified by cannabis LMA policy- Colorado State and Washington State (CSWS) are the experimental group compared to the other 48 states as controls. We use two different methods of comparing age-specific cannabis incidence estimates by policy group.

Results: The estimates using the panel study method for the 48 US states produced the traditional age-specific cannabis incidence pattern. In CSWS, however, the estimated cannabis incidence rises sharply at age 21, descending afterward. The incidence estimates at age 21 after implementation in CSWS quadrupled (from 5% to 21%).

Discussion: These contrasting estimates do not yet qualify as strong evidence supporting the hypothesis that cannabis policy is shaping age-specific incidence in our hypothesized bimodal pattern. The lag time for seeing such policy effects might be as long as 5-10 years if cannabis follows the US experience with alcohol LMA.

Introduction

United States (US) estimates show that ages 14 to 18 years old is the interval of peak risk for starting extra-medical use of tobacco and most internationally regulated drugs (EMIRD), with extra-medical use defined to encompass using the drug to get high and otherwise outside boundaries intended by a prescribing clinician (EMIRD as defined in supplemental material appendix S1; e.g., [1-4]). US estimates generally show that consuming the 'first full drink' of an alcoholic beverage is an exception to this pattern of a single mid-adolescent peak. Age-specific incidence of drinking alcohol follows a distinctive bimodal pattern with the mid-adolescent peak followed by a sharp decline, a second peak at the US legal minimum drinking age of 21 years, and then a continuous decline as age increases [5-7]. In this paper, we use the acronym PDPD to denote this specific peak-decline-peak-decline bi-modal pattern. Cheng, et al. [7] focused on the legal minimum drinking age (LMA) in their explanation of the PDPD pattern in the age-specific estimates.

They posited existence of two heterogeneous subgroups within each birth cohort. A more law-abiding subgroup of adolescents

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might tend to delay onset of drinking a 'first full drink' until LMA is reached at age 21 years. Another subgroup of cohort members give less attention to the LMA policy, with drinking onset soon after the first chance to try [i.e., first alcohol exposure opportunity, as discussed by Chen, et al. [8]]. If this hypothesis is correct, readers in countries with no LMA policy might find no bimodal pattern (cf. [9]). With respect to cannabis, a natural LMA experiment is underway in the United States, with some jurisdictions setting cannabis LMA at age 21 years [10]. If Cheng and colleagues are correct, the age-specific incidence patterns in these jurisdictions might shift, eventually, toward the bimodal pattern seen for alcohol. In this short communication, we present starting estimates on this policy topic as a forecast of what might become a congruent PDPD pattern for age-specific cannabis incidence rates. Our results depict recent age-specific cannabis use incidence patterns in Colorado and in Washington State by year, each with age 21 LMA for cannabis, and we compare incidence rates in states with no cannabis LMA [11,12].

Material and Methods

For this epidemiological study, the population was specified to include non-institutionalized US civilian residents, sampled and assessed for successive National Surveys on Drug Use and Health (NSDUH), 2010 through 2017. These NSDUH cross-sectional surveys were conducted with multistage area probability sampling to draw state-level representative samples and to over-sample 12-to17-year-olds, with overall interview participation levels of 67%-75%, slightly lower than corresponding levels for the 12-to-22-year-olds in this study's sub-samples. Standardized audio computer-assisted self-interview modules assessed month and year of first cannabis use, from which age-specific incidence rates can be estimated from the NSDUH Restricted Data Access portal (R-DAS). The R-DAS portal provides analysis weights and variance estimate capabilities for state-specific and national estimates and 95% confidence intervals (CI).

For this research, the primary estimate is age-specific first-time cannabis use (incidence), calculated as $\psi = X_r / N_r$, where X_r is the number of individuals starting to use cannabis within the 1-12 month interval before assessment, age-by-age, and N_r is all persons who had not started using cannabis before that interval, stratified by cannabis LMA policy. Estimates described in this report are not readily available in R-DAS. The estimated prevalence rates ($p_1 = X_r / N$, where N is the total projected population size) and the estimated proportion of the population at risk ($p_2 = N_r / N$), with the corresponding standard errors can be obtained. We note that the incidence can be calculated in term of p_1 and p_2 as:

$$\psi = \frac{p_1}{p_2} = \frac{X_r / N}{N_r / N}.$$

The corresponding variance can be calculated using the standard statistical procedures as:

$$Var(\psi) = \frac{1}{p_2^2} Var(p_2) + \frac{p_1^2}{p_2^4} Var(p_1).$$

Furthermore, we discovered that R-DAS estimates can often be produced for the entire population of interest (e.g., age-specific cannabis incidence over all 50 states), and for a sub-population that includes a relatively large, unweighted numerator and denominator (e.g., first-time cannabis use in every state except Colorado and Washington). Nevertheless, estimates for the other subpopulation (e.g., age-specific cannabis incidence in Colorado or Washington) may often be suppressed due to privacy concerns. In the instance when two sub-populations can be considered mutually exclusive, we have developed a method for estimating the suppressed output "by hand" (Vsevolozhskaya, et al. 2014). Specifically, if we let ψ be the incidence of cannabis use in all 50 states, and ψ_{CW} be the incidence of cannabis use in every state except Colorado and Washington, we can estimate the suppressed output as:

$$\psi_{CW} = \frac{N}{N - N_{NCW}} \psi - \frac{N_{NCW}}{N - N_{NCW}} \psi_{NCW},$$

Where N is the projected population size in all 50 states and N_{NCW} is the projected population size in every state except Colorado and Washington. Then, the corresponding variance of can be calculated as:

$$Var(\psi_{CW}) = \left(\frac{N}{N - N_{NCW}} \right)^2 Var(\psi) - \left(\frac{N_{NCW}}{N - N_{NCW}} \right)^2 Var(\psi_{NCW})$$

Given Colorado State and Washington State (CSWS) LMA policies implemented in 2014, we looked for PDPD patterns during 2010 through 2017 using two approaches. The first approach involved a panel study method with sample restriction to participants in the birth cohort born in either 1995 or 1996, successively re-sampled to secure a new sample each year. The panel approach has constrained statistical power, given its focus on that one birth cohort. The second approach is more tightly focused on what happens at age 21 years. The expectation is that cannabis incidence at age 21 years in CSWS will show an increase, versus relatively stable cannabis incidence at age 21 years in the other 48 states.

Results

Panel Study Approach

Figure 1 shows cannabis incidence estimates based on the panel study approach restricted to the 1995-96 birth cohorts, with state contrasts based on cannabis LMA policies. No PDPD bimodal pattern is seen for the non-LMA policy states (red lines). A hint of bimodality is seen in the CSWS data (blue lines), sufficient to motivate our proposed plan to analyze the more complete NSDUH sample data that is being withheld until after the COVID pandemic has ended, but not yet with statistical precision to warrant firm conclusions (Figure 1).

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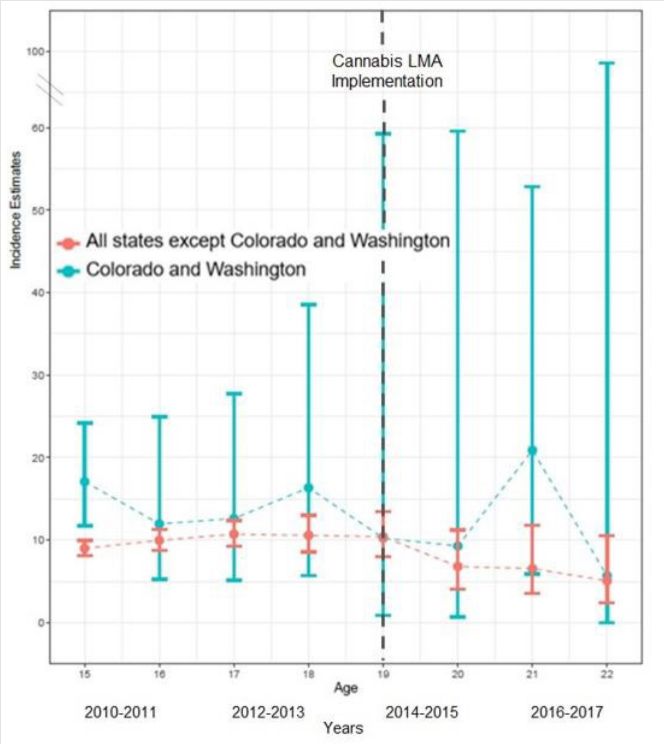

Figure 1: Trends in past year cannabis incidence by age in CSWS and all other states in the US, 2010-2017.

LMA-Stratification at Age 21

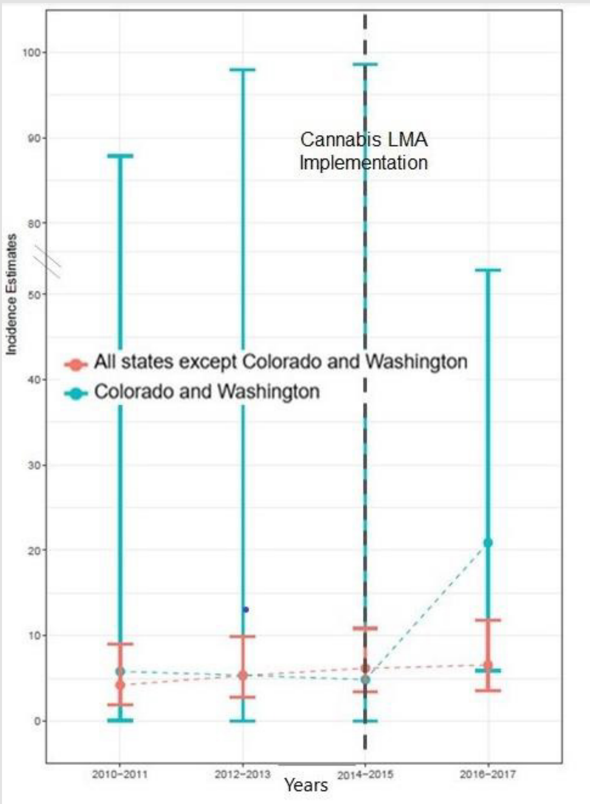

Figure 2: Trends in cannabis incidence at age 21 in CSWS and all other states in the US, 2010-2017.

Figure 2 shows LMA-stratified year-pair-specific estimated cannabis incidence with focus on the NSDUH participants assessed at age 21. The mean cannabis incidence rate expectation for non-LMA states is relatively stable at about 5% becoming new users. For CSWS, the corresponding estimate is close to the estimate for the other states until after 2014-2015; the rate estimate for 2016-17 is just above 20%. Here, again, the statistical precision of estimates based on the R-DAS datasets is constrained. We must express hope for earlier rather than later access to the larger NSDUH samples and more recent data now sequestered in the restricted data enclaves until the COVID pandemic has ended.

Discussion

In this short communication, we build from the recent alcohol LMA hypothesis offered by Cheng, et al. [7] and we present evidence that a corresponding cannabis LMA hypothesis might deserve attention in future research. Acknowledging constraints on the statistical precision of the cannabis incidence estimates presented in Figures 1 & 2, we look forward to pursuit of this research line once we are allowed to tap the more complete NSDUH data in the now-restricted federal enclaves. In the meantime, readers might be interested to know how an LMA policy might exert an influence on epidemiology's patterns of age-specific incidence rates. In turn, the epidemiologically disclosed age-specific patterns can be used to guide organization and deployment of public health tactics of early outreach and intervention, as well as prevention initiatives intended to reduce hazards of drug use onsets during adolescence and the transition to early adulthood.

Limitations of the research include reliance upon self-reports about age and timing of cannabis onsets as well as uncontrolled confounding between states. In time, the public use dataset sample sizes also will be addressed when the enclave datasets become available, and re-opening of the data enclaves will make it possible to investigate sub-state variations, given that some within-CSWS jurisdictions do not permit retail cannabis sales.

Notwithstanding these limitations, these analyses demonstrate the potential for a large shift in long-standing patterns in age of first use for cannabis in the US. Additionally, the study findings are of interest because the hypothesis that LMA may be shaping age-specific drug use incidence has never been tested. However, the lag time for seeing such policy effects might take 5-10 years if cannabis follows the experience with alcohol legal minimum age in the US [13].

If this pattern continues to develop, there are new public health considerations for this age group as well as the design and implementation of cannabis prevention campaigns. Targeted prevention campaigns for alcohol and tobacco use have been one of the larger successes of public health and prevention, partly due to age-specific and appropriately timed targeting [14,15]. In a deviation from the traditional perspective that early adolescence is the optimal window for prevention, if the hypothesized development of the PDPD pattern continues, public health campaigns that seek to reduce cannabis use may be optimized in separate approaches for the law-ignoring teens who first use cannabis illegally vs. the 21-year-olds who wait until cannabis use is legal for them. Although more research is needed to investigate the theorized policy-induced curve, if a sufficient number of states follow in the footsteps of Colorado and Washington, we may see the age-specific incidences for first time cannabis use begin to resemble the PDPD pattern in the country overall [16,17].

Supplemental Appendix

Supplementary Appendix 1.

Supporting Information

Support

- BWM: MSU Graduate School University Enrichment Fellowship
- JCA: None to declare.
- OV: None to declare.

Conflicts of Interest

- BWM: None to declare.
- JCA: None to declare.
- OV: None to declare.

References

1. Kandel DB, Logan JA (1984) Patterns of Drug Use from Adolescence to Young Adulthood: 1. Periods of Risk for Initiation, Continued Use, and Discontinuation. Am J Public Health 74(7): 660-666.
2. Labouvie E, Bates ME, Pandina RJ (1997) Age of first use: its reliability and predictive utility. Journal of Studies on Alcohol 58(6): 638-643.
3. Wagner F (2002) From First Drug Use to Drug Dependence Developmental Periods of Risk for Dependence upon Marijuana, Cocaine, and Alcohol. Neuropsychopharmacology 26(4): 479-488.
4. Substance Abuse and Mental Health Services Administration (2019) Key substance use and mental health indicators in the United States: Results from the 2018 National Survey on Drug Use and Health (HHS Publication No. PEP19-5068, NSDUH Series H-54). Rockville, MD: Center for Behavioral Health Statistics and Quality, Substance Abuse and Mental Health Services Administration.
5. Prescott CA, Kendler KS (1999) Age at First Drink and Risk for Alcoholism: A Noncausal Association. Alcoholism: Clinical and Experimental Research 23(1): 101-107.
6. Dawson DA, Goldstein RB, Patricia Chou S, June Ruan W, Grant BF (2008) Age at First Drink and the First Incidence of Adult-Onset DSM-IV Alcohol Use Disorders. Alcoholism: Clinical and Experimental Research 32(12): 2149-2160.
7. Cheng HG, Lopez Quintero C, Anthony JC (2018) Age of onset or age at assessment-that is the question: Estimating newly incident alcohol drinking and rapid transition to heavy drinking in the United States, 2002-2014. International Journal of Methods in Psychiatric Research 27(1): e1587.

8. Chen CY, Dormitzer CM, Gutiérrez U, Vittetoe K, González GB, et al. (2004) The adolescent behavioral repertoire as a context for drug exposure: behavioral autarcesis at play. Addiction 99(7): 897-906.
9. Degenhardt L, Chiu WT, Sampson N, Kessler RC, Anthony JC, et al. (2008) Toward a global view of alcohol, tobacco, cannabis, and cocaine use: findings from the WHO World Mental Health Surveys. PLoS medicine 5(7): e141.
10. National Conference of State Legislatures [NCSL] (2019) State medical marijuana Laws.
11. (2012) Colorado Constitution, Amendment 64.
12. Washington State Liquor control Board, Initiative 502.
13. Cheng HG, Augustin D, Glass EH, Anthony JC (2019) Nation-scale primary prevention to reduce newly incident adolescent drug use: the issue of lag time. PeerJ 7: e6356.
14. Haggerty RJ, Mrazek PJ (1994) Reducing risks for mental disorders: Frontiers for preventive intervention research. National Academies Press.
15. Nation M, Crusto C, Wandersman A, Kumpfer KL, Seybolt D, et al. (2003) What works in prevention: Principles of effective prevention programs. American psychologist 58(6-7): 449-456.
16. Parker MA, Anthony JC (2015) Epidemiological evidence on extra-medical use of prescription pain relievers: transitions from newly incident use to dependence among 12-21 year old in the United States using meta-analysis, 2002-13. PeerJ 3: e1340.
17. Cheng HG, Lopez Quintero C, Anthony JC (2017) Age of onset or age at assessment—that is the question: Estimating newly incident alcohol drinking and rapid transition to heavy drinking in the United States, 2002–2014. Int J Methods Psychiatr Res 27: e1587.

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