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A prospective study of newly incident cannabis use and cannabis risk perceptions: Results from the United States Monitoring the Future study, 1976–2013

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ABSTRACT

Background: A prevailing epidemiological theory about drug use occurrence among secondary school students is that trends in perceived risk of drug-related harms can drive use. If so, cannabis risk perceptions during one school year should predict newly incident cannabis use in the same school the following year. We aimed to study trends in incidence and epidemiological clustering of cannabis use among United States (US) 12th-graders, and a novel prediction that incidence in school-year 't' is influenced by school-specific cannabis risk perceptions (CRP) of 12th-graders a year prior at 't-1'.

Methods: US schools sampled each year from 1976 to 2013 (~130 schools per year) yielded an annual nationally representative sample of ~15–16,000 12th-graders with questionnaire assessments. Analyses involved Alternating Logistic Regressions (ALR) to study trends in school-level clustering and slopes that estimate the degree to which CRP levels at 't-1' might predict newly incident cannabis use at 't'.

Results: School-level CRP levels at 't-1' predict newly incident cannabis use in the next year's 12th-grade class. For each unit CRP increment, the next year's class shows tangibly reduced incidence of starting to use cannabis (overall odds ratio, OR = 0.10; 95% CI: 0.03, 0.33). Within-school clustering of newly incident cannabis smoking also can be seen (e.g., pairwise odds ratio, PWOR = 1.11; 95% CI: 1.07, 1.15).

Conclusions: Programmatic manipulation of perceived risk in one year's senior class via public health/school alliances might dampen the subsequent risk of newly incident cannabis use in the next year's class.

1. Introduction

Twentieth-century social psychologists produced a novel theory about the rise and fall of drug epidemics. A basic observation is that drug use prevalence trends follow trend lines for changes in risk perceptions about drug use. The theory asserts the perceived risk trend drives subsequent use. If so, implications for public health action are clear. If population-level rates of newly incident drug use are determined, in part, by prior population-level risk perceptions, the public health leaders might be able to prevent and reduce incidence rates via deliberate campaigns to change risk perceptions (Bachman et al., 1998, 1988; Fleary et al., 2010; Hall and Weier, 2015; Kilmer et al., 2007; Lopez-Quintero and Neumark, 2010; Schuermeyer et al., 2014).

Literature review on this topic mainly discloses evidence from ecological analyses of annual survey data on drug risk perceptions in adolescent populations in the United States (US), with concurrent or time-lagged estimates for prevalence of being an active drug user (Bachman et al., 1998; Johnston et al., 2016; Keyes et al., 2016a; Miech et al., 2015). A few individual-level studies of adolescents over time show that risk perceptions of individuals are predictive of their later drug involvement, and there is one supportive prevention experiment with focus on cannabis and other drug risk perceptions, all with credible local area samples of school-attending adolescents (Ellickson et al., 2004; Grevenstein et al., 2015; Jungaberle and Nagy, 2015; Stacy et al., 1994; Terry-McElrath et al., 2017).

Analyzed in relation to epidemiology's clear distinctions between incidence and prevalence (Doull, 1962; Kramer, 1957; Lapouse, 1967), the mass of available evidence falls somewhat short because it has failed to draw a distinction between 'being an active drug user' and 'becoming a newly incident drug user'. For example, in any given year, the prevailing level of risk perception in a mix of never-users, past-onset users, and newly incident users might be heavily determined by the past-onset users with the shared view that drug use is not very risky. Hence, these users may well continue to use. This persistence of use, correlated with the user's view that drug use is not risky, might amplify the estimated drug use prevalence even when incidence is in steady

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state, and may create a feedback loop with risk perceptions influenced by the prevalence of use or by the persistence of use.

Despite critiques of this nature, it seems worthwhile to speculate that people who perceive higher risk in behavior will be less likely to start engaging in that behavior. As for the 'scale' of this hypothesized contextual influence, there is some evidence of local area social sharing of risk perceptions in US neighborhoods, which may be more influential than risk perceptions studied at the level of a nation, a state, or a city (Petronis and Anthony, 2000). Nonetheless, we are unable to find any evidence of the degree to which such *socially shared risk perceptions* in a local area population might be predictive of future odds of becoming a newly incident drug user.

Seeing this gap in evidence about *incidence*, we set out to study the risk perception proposition in relation to the epidemiology of cannabis involvement. We selected cannabis (marijuana, hashish) because it is the most commonly used internationally regulated drug (World Health Organization, 2015), and because the causal influence of cannabis risk perceptions recently has been called into question in the media (Ingraham, 2015; Sullum, 2016).

Recent estimates suggest approximately 180–185 million current cannabis users worldwide, with apparent increasing prevalence among young people in many countries (United Nations Office on Drugs and Crime, 2015), largely based on nationally representative sample data on cannabis use and cannabis risk perceptions modeled after the US annual 'Monitoring the Future' (MTF) surveys of 12th-grade secondary school students from 1976 through 2013 (hereinafter, called 'high schools'; Johnston et al., 2016). In the US, this series of observations started some 15–20 years after cannabis incidence estimates showed a climb toward what has been a fairly stable 'endemic' level of cannabis use for most of the past four decades (Johnson and Gerstein, 1998).

An interesting but under-studied feature of the MTF project is that it has a two-year overlap in high schools sampled for its annual assessments (Johnston et al., 2014). The result is not a longitudinal study of individual 12th-graders assessed and then re-assessed one year later. Rather, it is a prospective study of the school as an entity, with an assessment of 12th-graders in one academic year followed by an assessment of the same school's new cohort of 12th-graders the next year. This school-wise prospective design has made it possible for us to estimate the degree to which the odds of becoming a newly incident cannabis user during school-year 't' might be influenced by cannabis risk perceptions that prevailed in that same school's 12th-grade class in the prior year 't-1'. Using this design, a predictive association can be estimated, and the feedback as mentioned earlier is constrained to the extent that the school sample of 12th-graders who answer risk perception questions in one year are not included in the school sample of 12th-graders in the next school year. Furthermore, incidence estimates for any given year can be derived by excluding from numerators and denominators all of the 12th-graders who had started cannabis use before 12th-grade so that there is a clear temporal sequence of one class's risk perceptions in one year to cannabis onsets during 12th-grade of the next year, conditional on no cannabis use prior to 12th-grade. Therefore, with the school as context, the odds of becoming a newly incident cannabis user can be estimated for 12th-graders at time 't' and regressed on levels of cannabis risk perceptions as observed for that same school's separate class of 12th-graders at time 't-1'.

We have framed this study's main aim in terms of a predictive question: "To what extent does a 12th-grader's risk of starting to smoke cannabis in a given year depend upon cannabis risk perceptions of 12th-graders in the prior school year?" Given the school-wise data structure, we secondarily sought to estimate local area school-level clustering of newly incident cannabis smoking among 12th-graders, with an expectation that within-school processes (e.g., sharing of cannabis from student to student) might yield epidemiological clustering of newly incident cannabis users within schools. The ability to estimate the clustering of cannabis incidence between students in the same school compared to other schools is meaningful because it can motivate new research and insights into how incidence might be "spreading" within schools.

To the extent that any country, local jurisdiction, or school seeks to reduce cannabis-related health harms via school-based cannabis prevention programs, it may be of public health importance to estimate the degree to which a downward (or upward) shift in cannabis risk perceptions in one graduating class of students might be connected with an increased (or reduced) odds of future cannabis use in the next year's graduating class. To the extent that peer influence and peer-to-peer sharing of cannabis are salient influences, there also is value in the generalized estimating equations (GEE) clustering parameter in the form of the epidemiologically familiar pairwise odds ratio (PWOR; Bobashev and Anthony, 1998). The PWOR allowed us to address our secondary aim by quantifying the degree of association of 12th-graders' first cannabis use within schools. As is the case with the general odds ratio (OR) estimate, a PWOR = 1.0 reflects no clustering (our null hypothesis). A PWOR estimate greater than 1.0 conveys tangible clustering, as when there is social sharing of an illness within a community (or peer-to-peer sharing of cannabis). An inverse PWOR less than 0.1 can be seen in some instances but is less common.

2. Methods

2.1. Study population and sampling

MTF represents a continuing study of US secondary school students and their behaviors and attitudes about drug use and other social issues. Each year between 1976 and 2013, the MTF research team sampled and recruited roughly 130 public and private high schools for a US nationally representative sample survey, with schools recruited for two years of participation as described in this paper's introduction. Each springtime, roughly 15–16,000 12th-graders have been assessed, using Institutional Review Board-approved self-report questionnaires administered in group settings, typically within normal classroom environments (Johnston et al., 2016).

As depicted in Fig. 1, not all MTF schools have participated in the second year of assessment when invited to do so. In addition, MTF assessments have been organized into "questionnaire forms" to reduce the questionnaire length and broaden the topic areas. Six questionnaire forms are distributed to participants in an ordered sequence to ensure identical random subsamples (Johnston et al., 2014). Consequently, whereas essentially all students have been asked whether they have tried cannabis, only about half of the MTF participant-students have been asked about the grade of first cannabis use, which is required for estimation of the odds of becoming a newly incident cannabis user in the MTF context (Fig. 1).

Evaluated in relation to sampled study populations, 2,142 schools participated in two successive school years. Each MTF year's student participation overall has been > 75%, with missing and invalid individual survey items considered (Johnston et al., 2014). Resulting effective unweighted sample size for estimation of the odds of newly incident cannabis use in the second year of each school's MTF participation is 52,775, with n = 4,415 newly incident cannabis users and n = 48,360 never-users. For a focus on incidence estimates, experiences of past-onset cannabis users are set aside (i.e., students with cannabis onsets before 12th-grade).

2.2. Assessment and measures

All newly incident users had cannabis onset in 12th-grade. This status was elicited by asking "When (if ever) did you FIRST do each of the following things?" Answer choices were Grade 6 or below; Grade 7…Grade 12 (Johnston et al., 2016).

Cannabis risk perceptions (CRP) for 'trial use' and 'regular use' are based on 105,019 12th-graders, irrespective of cannabis use history, who answered these standardized items at 't-1': "How much do you