



The Interplay Between Marijuana-Specific Risk Factors and Marijuana Use Over the Course of Adolescence

Katarina Guttmannova¹ · Martie L. Skinner² · Sabrina Oesterle² · Helene R. White³ · Richard F. Catalano² · J. David Hawkins²

Published online: 5 March 2018
© Society for Prevention Research 2018

Abstract

Permissive attitudes and norms about marijuana use and perceptions of low harm from use are considered risk factors for adolescent marijuana use. However, the relationship between risk and use may be reciprocal and vary across development and socializing domains. We examined the bidirectional relationships between marijuana-specific risk factors in individual, parent, peer, and community domains and adolescent marijuana use. Longitudinal data came from a sample of 2002 adolescents in 12 communities. Controlling for sociodemographic covariates and communities in which the individuals resided, autoregressive cross-lagged models examined predictive associations between the risk factors and marijuana use. After accounting for concurrent relationships between risk and use and stability in behavior over time, early adolescence and the transition to high school were particularly salient developmental time points. Specifically, higher risk in all four domains in grades 7 and 9 predicted greater use 1 year later. Moreover, youth's perception of lax community enforcement of laws regarding adolescent use at all time points predicted increases in marijuana use at the subsequent assessment, and perceived low harm from use was a risk factor that prospectively predicted more marijuana use at most of the time points. Finally, greater frequency of marijuana use predicted higher levels of risk factors at the next time point in most socializing domains throughout adolescence. Prevention programs should take into account developmental transitions, especially in early adolescence and during the transition to high school. They also should focus on the reciprocal relationships between use and risk across multiple socializing domains.

Keywords Marijuana-specific risk factors · Marijuana use · Adolescence · Dynamic relationship

Over the past 2 decades, several US states have loosened their policies regarding restrictions on adult use of marijuana for medical and, more recently, nonmedical purposes. The associated public health concerns include possible increases in marijuana-related risk factors, including permissive norms and attitudes about marijuana and increases in adolescent

marijuana use (for review, see e.g., Miech et al. 2015; Wu et al. 2015). Understanding the interplay between marijuana-specific risk factors and marijuana use over the course of adolescence is essential for guiding the development of preventive interventions to reduce the unintended consequences for youth from marijuana legalization.

Indeed, the assessment of risk factors that predict marijuana use is crucial for prevention of substance misuse among youth and adults (Hawkins et al. 1992), and the link between marijuana use and permissive norms and attitudes about marijuana has been well established in cross-sectional studies. These risk factors include perception of harm from use, youth and community norms favorable to marijuana use (e.g., Fleming et al. 2016), parental norms about children's involvement in marijuana use (Wen et al. 2018, present issue), peer norms and involvement in marijuana use, and enforcement of laws regarding underage use in the community (e.g., Arthur et al. 2002; Beyers et al. 2004; Guttmannova et al. 2017). However, it is unclear whether these risk factors predict marijuana use, are

✉ Katarina Guttmannova
kg27@uw.edu

¹ Center for the Study of Health and Risk Behaviors, Department of Psychiatry and Behavioral Sciences, University of Washington, Box 356560, Seattle, WA 98195-6560, USA

² Social Development Research Group, School of Social Work, University of Washington, 9725 3rd Ave. NE, Suite 401, Seattle, WA 98115, USA

³ Center of Alcohol Studies and Sociology Department, Rutgers – The State University of New Jersey, 607 Allison Rd, Piscataway Township, NJ 08854, USA

simply associated with recent use, or are the consequence of previous use because few studies have examined these associations longitudinally. A longitudinal study of the relationships between permissive norms and attitudes and marijuana use could inform prevention by identifying what risk factors matter the most, and in which social domains and developmental periods. In the present study, we examined the dynamic relationship between marijuana use in adolescence and marijuana-specific risk factors in four socialization domains: individual, family, peer, and community.

The focus on *malleable* risk factors—among them beliefs, attitudes, and norms—helps identify targets for prevention and intervention programs. Identifying and intervening with risk factors before problem behaviors develop is a key premise of prevention science (Catalano et al. 2012; Coie et al. 1993). Social development is influenced by a range of socializing agents, including families, peers, and communities, as well as individual traits or characteristics (Catalano and Hawkins 1996; Catalano et al. 1999). Risk factors occur in all these domains and need to be considered to understand their contribution to problem behaviors across development. Moreover, per developmental theory (Cicchetti 1990), focusing on the *dynamic* interplay over time permits examination of potential waning and waxing of developmental influences. As children develop, learn new skills, and become more independent, their social environments expand, and they are exposed to more diverse influences (Catalano and Hawkins 1996). Accordingly, it is possible that the salience of various substance use-specific risk factors changes over the course of development. For example, studies have shown that as children progress from childhood to adolescence, the importance of peer influences increases (Ellickson et al. 2004; Gardner and Steinberg 2005), and as they become more active members of their communities, interacting with others outside their families and peer networks, neighborhood or community influences may become more prominent (Catalano and Hawkins 1996).

Over time, substance use behavior may also influence risk factors such as marijuana-related beliefs, attitudes, and norms. For example, having substance-using peers is a risk factor for substance use because youth tend to adopt the beliefs, attitudes, and behaviors of their friends through *peer socialization* (e.g., Gardner and Steinberg 2005). Once substance use is initiated, use also increases the chance of having substance-using peers because *peer selection* drives youth to seek out friends with similar behaviors, attitudes, and beliefs (e.g., Jaccard et al. 2005). Studies have found empirical support for both mechanisms, although most have focused on alcohol and tobacco use or a composite measure of substance use that combined marijuana use with other substances (e.g., Becker and Curry 2014; Sieving et al. 2000; Simons-Morton and Chen 2006; Simons-Morton and Farhat 2010). Becker and Curry (2014) examined alcohol and marijuana use separately and found evidence of peer selection in marijuana use;

however, their data came from a clinical sample of treated adolescents who met diagnostic criteria for cannabis or alcohol use disorder. It is unclear how these marijuana-specific mechanisms unfold over the course of adolescence in a community sample of youth. We hypothesize that, over time, youth's own use and peers' use likely reinforce each other. To capture this dynamic process, it is important to model the prospective associations in both directions—from the risk factor to problem behavior *and* from the problem behavior to the risk factor (Catalano and Hawkins 1996)—which has not been done in studies of marijuana use alone. Furthermore, no study to date has focused on multiple domains of development and considered comprehensively the reciprocal relationships between marijuana-specific risk factors in individual, peer, family, and community contexts and marijuana use over time.

In the present study, we examined a set of marijuana-specific risk factors from multiple domains of development (Bronfenbrenner 1994), starting with youth's own perception of harm from using marijuana regularly and youth's favorable attitudes towards marijuana use as the most proximal risk factors for marijuana use over the course of adolescence. We also examined risk factors from various socializing domains, including peer, parental, and community favorable attitudes about adolescent marijuana use, peer use, and enforcement of laws regarding adolescent marijuana use in the community. We modeled the dynamic relationship between marijuana use and risk factors from grades 7 to 12 to understand the extent to which (a) marijuana-related risk factors prospectively predict changes in marijuana use over the course of adolescence; and (b) there are changes in the salience of risk factors from different domains across adolescence, while controlling for stability in behavior and the possibility that substance use behavior may influence later levels of risk. Because previous studies have shown that both sets of outcomes—the risk factors and substance use—are associated with youth's demographic characteristics (i.e., gender, age, race/ethnicity, and parental education; e.g., Arthur et al. 2002; Beyers et al. 2004; Fleming et al. 2016), these variables were included as covariates in the present study. We also included rebelliousness, a proxy for behavioral disinhibition or youth's propensity to engage in risky behavior (e.g., Hill et al. 2010), as a control in the models because it has been shown to be associated with marijuana and other drug use and drug-related risk factors (Epstein et al. 2015).

Methods

Sample

We used data from the longitudinal panel followed in the Community Youth Development Study (CYDS; Hawkins et al. 2008), a community-randomized controlled trial of the

Communities That Care (CTC) prevention system in 24 small towns in seven states (Colorado, Illinois, Kansas, Maine, Oregon, Utah, and Washington). These communities were all rural or small towns with population size ranging between 1578 and 40,787 (Hawkins et al. 2008). The trial showed that CTC reduced levels of risk factors and drug use in adolescence (Hawkins et al. 2012, 2014). To avoid potential confounding effects of the CTC intervention, the present study focused on youth data from the 12 control communities ($N = 2002$). The sample is gender balanced (48.5% female), and 61.4% self-identify as White and 26.6% as Latino/a. The average age at baseline (grade 6) was 11.6 years ($SD = 0.55$). Less than half (41.7%) of panel members reported having parents who completed college. We included data that spanned the period of adolescence and were collected annually between grades 7–10 (2006–09) and then again in grade 12 (2011). (No data were collected in grade 11.) Of youth eligible for participation in the control communities ($N = 2611$), 76.7% ($n = 2002$) agreed to participate (Monahan et al. 2010), and the retention rates over time have been excellent, with over 90% of the original sample completing the survey in each of the subsequent grades. In order to disentangle the directionality in the relationship between risk factors and marijuana use at the beginning of adolescence, the present study focused on youth who had not initiated marijuana use by grade 7, and, therefore, excluded the small number of youth who reported very early initiation (5.8% of the sample; when compared to the rest of the sample, these participants were somewhat older for their grade and had higher scores on rebelliousness but did not differ on other background characteristics). Thus, the risk factors in grade 7 were used to prospectively predict marijuana use in grade 8. This also means that the results of the present study generalize to youth with relatively normative patterns of marijuana use. The final analytic sample also excluded 14 youth (0.2% of the sample) who had missing data on all predictors, while other patterns of missingness were accounted for by implementing diagonally weighted least square estimation with mean and variance correction (Hox et al. 2010; Muthén et al. 1997). The resultant data analytic sample size was 1873.

Data were collected using the Youth Development Survey (based on the Communities That Care Youth Survey [CTC-YS]; Arthur et al. 2002; Guttmannova et al. 2017) that was designed to be used as a community prevention planning tool to identify elevated risk factors and depressed protective factors within the community. The survey was administered to the students during a classroom period (about 45 min). The study protocol was reviewed and approved by the University of Washington's Human Subjects Review Committee. Identification numbers, but no other identifying information, were included on the surveys in order to ensure confidentiality. Students received small incentives valued approximately \$5 to \$8 after completing the surveys.

Measures

Marijuana use and marijuana-specific risk factors were assessed over the course of adolescence (grades 7–10 and 12).

Marijuana Use In this study, the frequency of past-month marijuana use was measured using a 7-point ordinal scale (none, 1–2, 3–5, 6–9, 10–19, 20–39, 40+).

Marijuana-specific risk factors were measured on 4-point Likert scales with the exception of perceived peer norms, which were assessed on a 5-point scale. In the individual domain, we assessed two risk factors: (a) youth's *perception of harm from smoking marijuana regularly* (4 = no risk, 3 = slight risk, 2 = moderate, 1 = high risk) and (b) *youth's favorable attitudes toward marijuana use*. Youths were asked how wrong they think it is for someone their age to smoke marijuana (4 = not wrong at all, 3 = little bit, 2 = wrong, 1 = very wrong). The peer domain included two items: (a) perceived *peer marijuana use*, assessed by youth's report of how many of their best friends used marijuana in the past year (0–4); and (b) perceived *peer norms favorable to adolescent marijuana use*, assessed by the youth's report of what the chances were that they would be seen as cool if they smoked marijuana (5 = very good, 4 = pretty good, 3 = some, 2 = little, 1 = no/very little chance). Risk factors in the family domain included youth's perception of their *parents' favorable attitudes toward adolescent marijuana use*. Youth were asked "How wrong would your parents feel it would be for you to smoke marijuana?" (4 = not at all, 3 = little bit wrong, 2 = wrong, 1 = very wrong). Similarly, the community domain included a measure of *favorable attitudes towards adolescent substance use in the community* ("How wrong would most adults (over 21) in your neighborhood think it is for kids your age to use marijuana?"; 4 = not at all, 3 = little bit wrong, 2 = wrong, 1 = very wrong). We also assessed youth's perception of *law enforcement of marijuana laws in the community* ("If a kid smoked marijuana in your neighborhood, would he or she be caught by the police?; 4 = NO!, 3 = no, 2 = yes, 1 = YES!").

Covariates Analyses included variables measured at baseline to adjust for variation in demographic and socioeconomic characteristics of youth and confounding factors that may account for the relationship between marijuana use and risk factors. They included youth's gender (male = 1, female = 0); age (in years); parent education (ranging 1 = grade school through 6 = graduate or professional degree); race (1 = White; 0 = other); if the youth is Latino(a) (1 = yes, 0 = no); and youth's rebelliousness, assessed as an average of responses to three items (1 = very false through 4 = very true): (a) "I ignore rules that get in my way," (b) "I do the opposite of what people tell me just to get them mad," (c) "I like to see how much I can get away with." To account for clustering of youth within their communities, analyses included 11 dummy variables indicating the communities in which the youth lived (with one community serving as the reference).

This approach was chosen over nested random effects modeling because it is more conservative and does not make an assumption about the normal distribution of random effects.

Analysis

We estimated cross-lagged models with effects between adjacent years to assess the reciprocal relationship between risk and later marijuana use as well as between marijuana use and later risk, separately for each risk factor. Models also included autoregressive relationships to capture stability over time in each of the measures. To capture any residual association between risk and marijuana use not accounted for by stability and cross-lagged relationships, the concurrent residuals were allowed to correlate. Figure 1 illustrates the structure of tested models. Because the outcomes were ordered categorical data, the estimated models were ordered probit regressions (Agresti 2013). All analyses were conducted with Mplus 7.11 (Muthén and Muthén 1998–2013). Even though the retention rates were exceptionally high, we implemented diagonally weighted least square estimation with mean and variance correction to account for the small amount of missing data and to accommodate the distributional properties of the outcomes and model complexity (Hox et al. 2010; Muthén et al. 1997). While parsimony was not the main goal of the present analyses and, thus, indices of model fit are less informative than in a traditional structural equation or path modeling setting (Marsh and Hau 1996), we provide the comparative fit index (CFI; Bentler 1990) and the point estimate for the root mean square error of approximation (RMSEA; Browne and Cudeck 1993) as well as its 90% confidence interval (MacCallum et al. 1996) in the text.

Results

Descriptive Analyses

Table 1 shows descriptive statistics on all variables in the model. In grade 8, only 3% of the sample reported any use

of marijuana in the past month, steadily increasing over the course of adolescence to 5.6% in grade 9, 12.7% in grade 10, and 17.3% by the time they were high school seniors. As would be expected, the marijuana-related risk in each domain also steadily increased over the course of adolescence. For example, 14.2% reported no or low harm (i.e., high risk) for perception of harm in grade 7, and this risk gradually increased to 33.2% by grade 12. The same pattern of increasing risk over time was evidenced for youth’s favorable attitudes (no or slight risk increasing from 1.9 to 26.9% between grades 7 and 12, respectively), the perception of parents’ favorable attitudes (from 3.2 to 8.5%, respectively), and community favorable attitudes (from 3.8 to 15.6%, respectively), as well as the perception of community enforcement of laws being low (no or NO! on the likelihood of a child smoking marijuana being caught by police) increasing from 33.4 to 69% between grades 7 and 12. Similarly, peer favorable attitudes increased over time (with the percentage of those reporting very good or pretty good chance of being seen as “cool” increasing from 5.4 to 16.4% between grade 7 and 12). Finally, in grade 7, 10.4% of adolescents reported having at least one best friend who used marijuana, which increased to 56.6% by grade 12.

Cross-Lagged Models

All models represented an acceptable fit to the data, with the CFI index ranging between 0.91 and 0.96 and the RMSEA between 0.02 and 0.03 (with all upper bounds of the 90% confidence intervals being below 0.04 and the *p* values associated with the RMSEA point estimate approaching 1.0, meaning that the hypothesis that the estimate is less than or equal to 0.05 could not be rejected) across all tested models. Table 2 summarizes the results from the cross-lagged models testing the associations between risk factors and marijuana use over time. After accounting for the covariates, stability over time, and residual concurrent relationships between risk and marijuana use, early risk (grade 7) in all four domains (all risk factors) predicted increases in marijuana use 1 year later, as well as from grade 9 to grade 10 in all domains (and all but two risk factors). The

Fig. 1 Cross-lagged model of the relationship between marijuana-specific risk and marijuana use across adolescence

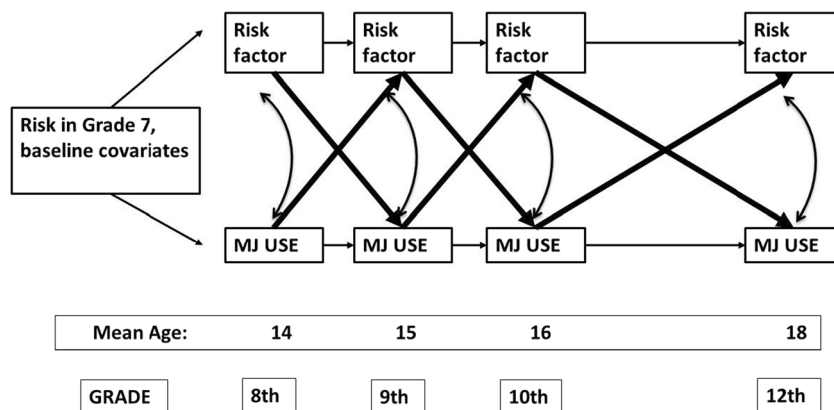


Table 1 Descriptive statistics on the study variables

	Mean (SD) or prevalence				
	Grade 7 [#]	Grade 8	Grade 9	Grade 10	Grade 12
Risk factors					
Perception of harm					
High risk	76.4%	73.1%	65.3%	52.7%	41.3%
Moderate risk	9.3%	13.0%	19.9%	22.1%	25.4%
Slight risk	2.5%	6.2%	8.4%	15.7%	20.3%
No risk	11.7%	7.7%	6.4%	9.4%	12.9%
Youth favorable attitudes					
Very wrong	91.8%	81.4%	73.7%	61.9%	51.7%
Wrong	6.2%	11.4%	14.8%	18.6%	21.4%
Little bit wrong	1.1%	5.1%	7.8%	12.3%	16.1%
Not wrong at all	0.8%	2.2%	3.7%	7.3%	10.8%
Parents favorable attitudes					
Very wrong	95.0%	93.6%	91.1%	84.6%	79.0%
Wrong	1.8%	4.5%	6.2%	9.6%	12.5%
Little bit Wrong	1.1%	1.1%	2.0%	4.0%	6.3%
Not wrong at all	2.1%	0.8%	0.7%	1.8%	2.2%
Peer marijuana use					
No friends	89.5%	76.0%	66.1%	52.6%	43.3%
One	5.1%	10.3%	13.2%	16.1%	14.9%
Two	2.3%	6.3%	7.5%	11.4%	11.7%
Three	1.4%	2.7%	4.4%	7.0%	10.3%
Four or more friends	1.6%	4.8%	8.8%	12.9%	19.7%
Peer favorable attitudes					
No/very little chance	80.6%	69.0%	61.0%	46.2%	43.8%
Little	8.8%	13.9%	15.9%	20.8%	20.9%
Some	5.3%	9.0%	13.2%	18.5%	18.9%
Pretty good	3.5%	5.0%	6.6%	9.5%	10.6%
Very good	1.9%	3.1%	3.3%	5.0%	5.8%
Community favorable attitudes					
Very wrong	84.5%	79.5%	72.9%	63.7%	55.9%
Wrong	11.7%	15.1%	20.1%	25.6%	28.5%
Little bit wrong	2.0%	4.2%	5.5%	8.0%	12.0%
Not wrong at all	1.8%	1.3%	1.5%	2.7%	3.6%
Community enforcement of laws					
YES!	32.3%	26.7%	17.0%	12.3%	10.0%
Yes	34.4%	30.0%	26.0%	22.1%	21.0%
No	21.2%	26.8%	36.7%	43.3%	43.2%
NO!	12.2%	16.6%	20.3%	22.3%	25.8%
Past-month marijuana use					
None	NA	97.0%	94.4%	87.3%	82.7%
1–2 times	NA	1.4%	2.5%	5.3%	6.1%
3–5 times	NA	0.7%	0.7%	2.7%	2.8%
6–9 times	NA	0.2%	0.9%	1.3%	2.7%
10–19 times	NA	0.4%	0.6%	1.4%	1.5%
20–39 times	NA	0.1%	0.4%	1.1%	1.2%
40+ times	NA	0.2%	0.5%	1.0%	3.0%
Demographics and baseline covariates					
Male	51.0%	NA	NA	NA	NA

Table 1 (continued)

	Mean (SD) or prevalence				
	Grade 7 [#]	Grade 8	Grade 9	Grade 10	Grade 12
White	62.1%	NA	NA	NA	NA
Hispanic	25.6%	NA	NA	NA	NA
Parental education	4.07 (1.30)	NA	NA	NA	NA
Rebeliousness	−0.23 (0.68)	NA	NA	NA	NA

[#] or baseline (grade 6) for covariates, *SD* standard deviation, *NA* not applicable

perception of lax community enforcement of marijuana laws regarding adolescent use was related to subsequent increases in marijuana use at all time points, and low perception of harm was related to later higher levels of marijuana use at all but one time point (i.e., grades 8, 10, and 12). In contrast, greater marijuana use predicted increases in the levels of risk at the next time point in all domains across all ages.

The associations of covariates to risk and use at the beginning of the cross-lagged series (grade 8) indicated that rebelliousness (as a proxy for behavioral disinhibition) was positively associated with both marijuana use and all of the risk factors. Furthermore, being male was related to youth's lower perception of harm and more favorable attitudes, as well as perception of their peers' attitudes about use. Being Hispanic as well as being non-White predicted lower perception of harm and greater number of peers using marijuana; being Hispanic also predicted youth's more favorable attitudes about use. Similarly, lower parental education predicted greater risk in terms of youth's perception of harm, favorable attitudes about use, and community enforcement of laws. Finally, being older in the grade predicted lower perception of harm from and youth's more favorable attitudes about marijuana use, and a higher number of marijuana-using peers. Being male, non-White, and having parents with lower education (in addition to the aforementioned higher behavioral disinhibition) was related to greater marijuana use. No other associations between the control variables and outcomes were statistically significant.

Discussion

This study examined the dynamic relationship between marijuana-specific risk factors from multiple socializing domains and marijuana use over the course of adolescence in order to understand whether these risk factors prospectively predict increases in marijuana use and vice versa. The main findings of this study are that, even after accounting for continuity in behavior over time as well as concurrent associations between risk factors and marijuana use, higher risk in all four domains—individual, parents, peers, and community—in grade 7 predicted greater use 1 year later. Furthermore, the developmental period between grades 9 and 10 was a

particularly salient time for the influence of risk factors from all of the domains; specifically, youth's favorable attitudes, and parents' favorable attitudes about children's marijuana use predicted greater use 1 year later, as did a higher number of close friends using marijuana. Youth's perception of lax community enforcement of laws regarding adolescent use at all time points predicted increases in marijuana use at the subsequent assessment, and perception of low harm from marijuana use was a risk factor that prospectively predicted more marijuana use at most of the time points, including the transition from mid to late adolescence.

Importantly, we also found that more frequent marijuana use predicted increases in marijuana-related risk factors over time for all risk factors at most of the time points. The number of statistically significant associations from marijuana use to later risk was greater than the number of significant associations from earlier risk to later use.

These findings are consistent with the developmental and interactional theory (Thornberry 1996) that posits that socializing agents such as family and peer networks influence deviant behavior, and deviant behavior in turn influences these factors. The finding that parent approval of children's marijuana use in grade 7 predicts increases in marijuana use in grade 8 corresponds to recent empirical studies reporting decreasing parental influence over the course of adolescence, with the risk and protective role of parents being particularly salient in early adolescence (Tang and Orwin 2009). The fact that greater perceived peer use in grade 9 predicted increases in marijuana use in grade 10 supports the influence of peer socialization processes on marijuana use in mid-adolescence, consistent with other studies that have found these processes predict substance use during this developmental period (e.g., Mercken et al. 2012, for alcohol use). Similarly, risk factors in all the other domains were also particularly salient during this developmental period. These findings correspond to research that has shown that the year of transition to high school (grade 9) is often a “make or break” period of adolescence. That is, elevated risk and depressed protection during this time predicts later detrimental outcomes in many areas of youth development and functioning, including substance use and educational attainment (for review, see e.g., Donovan 2004; Zaff et al. 2016).

Table 2 Cross-lagged, autoregressive (i.e., stability), and concurrent relationships between marijuana-related risk factors and marijuana use over the course of adolescence

	Time (t)											
	Grade 8			Grade 9			Grade 10			Grade 12		
	Beta	<i>b</i>	SE	Beta	<i>b</i>	SE	Beta	<i>b</i>	SE	Beta	<i>b</i>	SE
Youth perception of harm model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.14</i>	0.18	0.04	–0.08	–0.12	0.11	<i>0.18</i>	0.20	0.06	<i>0.14</i>	0.12	0.05
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	<i>0.32</i>	<i>0.37</i>	0.08	<i>0.32</i>	<i>0.29</i>	0.05	<i>0.32</i>	0.26	0.05
Risk factor over time	<i>0.34</i>	0.41	0.03	<i>0.46</i>	<i>0.55</i>	0.06	<i>0.49</i>	0.51	0.04	<i>0.36</i>	0.32	0.04
Use over time	NA	NA	NA	<i>0.83</i>	1.11	0.17	<i>0.66</i>	0.63	0.08	<i>0.53</i>	0.43	0.06
Concurrent relationship risk and use	<i>0.47</i>	0.47	0.06	0.20	0.20	0.10	<i>0.27</i>	0.27	0.07	<i>0.44</i>	0.44	0.04
Youth favorable attitudes model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.15</i>	0.43	0.08	0.08	0.12	0.14	<i>0.14</i>	0.14	0.07	0.11	0.09	0.06
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	0.14	0.18	0.09	<i>0.28</i>	0.26	0.07	<i>0.19</i>	0.16	0.06
Risk factor over time	<i>0.25</i>	0.74	0.06	<i>0.65</i>	0.85	0.10	<i>0.54</i>	0.54	0.06	<i>0.50</i>	0.42	0.06
Use over time	NA	NA	NA	<i>0.73</i>	1.03	0.20	<i>0.66</i>	0.63	0.10	<i>0.54</i>	0.44	0.07
Concurrent relationship risk and use	<i>0.75</i>	0.75	0.03	<i>0.50</i>	0.50	0.07	<i>0.47</i>	0.47	0.06	<i>0.63</i>	0.63	0.04
Parents favorable attitudes model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.11</i>	0.25	0.06	0.10	0.14	0.12	<i>0.22</i>	0.26	0.06	–0.02	–0.02	0.05
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	<i>0.26</i>	0.31	0.09	<i>0.27</i>	0.23	0.05	<i>0.33</i>	0.27	0.05
Risk factor over time	<i>0.12</i>	0.27	0.06	<i>0.50</i>	0.63	0.10	<i>0.51</i>	0.52	0.06	<i>0.40</i>	0.38	0.06
Use over time	NA	NA	NA	<i>0.72</i>	0.99	0.16	<i>0.65</i>	0.66	0.09	<i>0.62</i>	0.49	0.06
Concurrent relationship risk and use	<i>0.51</i>	0.51	0.07	0.15	0.15	0.10	<i>0.23</i>	0.23	0.08	<i>0.40</i>	0.40	0.06
Peer marijuana use model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.17</i>	0.31	0.04	–0.16	–0.23	0.21	<i>0.15</i>	0.16	0.07	0.05	0.05	0.06
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	<i>0.24</i>	0.30	0.10	<i>0.24</i>	0.21	0.06	<i>0.28</i>	0.22	0.06
Risk factor over time	<i>0.27</i>	0.46	0.04	<i>0.53</i>	0.67	0.10	<i>0.54</i>	0.53	0.05	<i>0.40</i>	0.35	0.05
Use over time	NA	NA	NA	<i>0.92</i>	1.26	0.29	<i>0.67</i>	0.64	0.11	<i>0.59</i>	0.48	0.07
Concurrent relationship risk and use	<i>0.73</i>	0.73	0.05	<i>0.56</i>	0.56	0.08	<i>0.50</i>	0.50	0.05	<i>0.50</i>	0.50	0.05
Peer favorable attitudes model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.08</i>	0.11	0.05	0.12	0.17	0.09	0.02	0.02	0.06	0.07	0.07	0.04
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	0.05	0.06	0.06	0.07	0.06	0.04	<i>0.10</i>	0.07	0.03
Risk factor over time	0.36	0.51	0.03	<i>0.67</i>	0.77	0.05	<i>0.64</i>	0.62	0.04	<i>0.52</i>	0.47	0.03
Use over time	NA	NA	NA	<i>0.73</i>	1.04	0.16	<i>0.77</i>	0.74	0.10	<i>0.59</i>	0.48	0.05
Concurrent relationship risk and use	<i>0.45</i>	0.45	0.05	<i>0.23</i>	0.23	0.08	<i>0.21</i>	0.21	0.07	<i>0.29</i>	0.29	0.05
Community favorable attitudes model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.10</i>	0.20	0.07	0.07	0.10	0.11	0.09	0.10	0.06	0.04	0.04	0.05
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	<i>0.27</i>	0.31	0.06	<i>0.21</i>	0.16	0.04	<i>0.28</i>	0.22	0.04
Risk factor over time	<i>0.22</i>	0.45	0.08	<i>0.51</i>	0.61	0.06	<i>0.51</i>	0.49	0.04	<i>0.38</i>	0.36	0.03
Use over time	NA	NA	NA	<i>0.77</i>	1.07	0.15	<i>0.72</i>	0.68	0.08	<i>0.60</i>	0.50	0.05
Concurrent relationship risk and use	<i>0.31</i>	0.31	0.06	0.04	0.04	0.11	0.08	0.08	0.07	<i>0.32</i>	0.32	0.05
Community enforcement of laws model												
Risk factor (<i>t</i> – 1) predicting use (<i>t</i>)	<i>0.23</i>	0.28	0.06	<i>0.16</i>	0.21	0.08	<i>0.16</i>	0.19	0.05	<i>0.13</i>	0.13	0.04
Use (<i>t</i> – 1) predicting risk factor (<i>t</i>)	NA	NA	NA	<i>0.19</i>	0.21	0.06	<i>0.26</i>	0.20	0.04	<i>0.26</i>	0.20	0.03
Risk factor over time	<i>0.46</i>	0.59	0.05	<i>0.53</i>	0.55	0.04	<i>0.49</i>	0.47	0.03	<i>0.41</i>	0.39	0.03
Use over time	NA	NA	NA	<i>0.70</i>	0.93	0.12	<i>0.69</i>	0.66	0.08	<i>0.58</i>	0.49	0.05
Concurrent relationship risk and use	<i>0.17</i>	0.17	0.06	–0.20	–0.20	0.09	–0.12	–0.12	0.07	<i>0.24</i>	0.24	0.05

Coefficients in italics are statistically significant at *p* < 0.05

beta standardized coefficient, *b* probit coefficient, *SE* standard error, *NA* not applicable

However, the lack of predictive relationships between marijuana-specific risk and marijuana use at other time points in adolescence was unexpected. The cross-lagged models with autoregressive paths are a conservative test of prospective associations (e.g., Finkel 1995; Rogosa 1980). It is likely that after accounting for the stability in behavior and risk and their concurrent relationships, as well as the other covariates in the model, little variance in the outcomes remained to explain at later time points. The finding that youth's perception of lax enforcement of laws regarding restrictions on adolescent marijuana use predicted increases in marijuana use across adolescence is particularly important in the era of marijuana decriminalization or outright legalization. Over the past 2 decades, many municipalities have made marijuana offenses a low law enforcement priority (e.g., Pacula et al. 2015), and a number of states have recently legalized marijuana use for nonmedical purposes for those over age 21 (e.g., Cambron et al. 2017). Recent studies have also shown that there is a considerable amount of misunderstanding regarding marijuana laws, especially the minimum legal age for recreational use (e.g., Kilmer et al. 2015; Kosterman et al. 2016). However, a well-designed media campaign can improve the public's knowledge of the state law, particularly as it relates to marijuana-related permissions and restrictions (Brooks-Russell et al. 2017). The present findings underscore the importance of education for law enforcement personnel on the need to be consistent in enforcing laws regarding adolescent use, but also of continued education of parents and youth about the adverse effects of adolescent marijuana use as well as the marijuana laws.

The findings of reciprocal relationships between marijuana use and marijuana-related risk factors are consistent with reports from studies on perceptions and misperceptions of substance use-related attitudes, norms, and behaviors of others that suggest that those who engage in risky behaviors are more likely to perceive these behaviors as normative (e.g., Martens et al. 2006; Perkins et al. 1999). Furthermore, our findings suggest that in order to isolate the predictive influence of risk factors on use, the reciprocal relationships between use and risk must be accounted for in the models. Finally, the significant coefficients from adolescents' own use to their report of peer use support the importance of peer selection processes for adolescent marijuana use; again, a finding that has been suggested in other studies (e.g., Becker and Curry 2014).

A recent time-series study of trends in the association between marijuana-specific risk factors and adolescent marijuana use among 10th- and 12th-grade students provided evidence that the strength of these associations has remained stable or even increased in recent years (Fleming et al. 2016). This finding was good news for prevention science and practice, particularly in light of recent nationwide

increases in the prevalence of marijuana-related risk factors (Hughes et al. 2015; Lipari et al. 2015; Miech et al. 2015), because it signaled that marijuana-related risk factors may still be salient targets for prevention and intervention efforts. However, these findings were preliminary because they involved cross-sectional, concurrent relationships between the risk factors and use. The present study adds a much needed piece of developmental evidence about the association between marijuana-specific risk factors and marijuana use over the course of adolescent development in terms of salience of marijuana-specific risk factors from multiple domains of development as well as the reciprocal relationships between risk and marijuana use. The present findings highlight (a) the importance of early risk factors in predicting marijuana use in early adolescence; (b) the salience of risk factors in all developmental domains in prospectively predicting increases in use in later adolescence; and (c) the reciprocal relationship between use and risk wherein higher use predicted increases in high-risk attitudes, norms, and socialization behaviors at a later time point, which is likely to contribute to perpetuation and even escalation of future marijuana misuse.

Limitations and Strengths

The present study is not without limitations. Parental, peer, and community attitudes and norms about marijuana and peer involvement in marijuana use were not reported by parents, peers, or community members, but assessed by youth report. However, studies have found a correspondence between youth's reports of others' use and others' self-reports of their own use (e.g., Deutsch et al. 2015). Moreover, there is strong theoretical and empirical support for the importance of youths' *perceptions and misperceptions* of attitudes, norms, and substance use of others in predicting future substance use behavior (e.g., social learning theory [Bandura 1986], problem behavior theory [Jessor and Jessor 1977], and the social development model [Catalano and Hawkins 1996]). Importantly, we also controlled for the reciprocal relationships between marijuana risk and use and the possibility that prior or current use could affect perceptions of risk. Even so, however, the reported relationships in the present study reflect longitudinal correlations, and not necessarily causal associations. The present study used data from annual (or biennial) assessments; studies with more temporally proximal assessments might find stronger associations between risk and use. Moreover, one's subjective experiences during the first time of using marijuana may influence future use (e.g., Agrawal et al. 2014; Fergusson et al. 2003; Grant et al. 2005). However, data on subjective experiences were not collected in this study. Future studies that include data on marijuana-specific risk factors, subjective experiences,

and use over time could explore the nature of such associations. The present study also did not collect data on parental marijuana use, which is a strong marijuana-specific predictor of youth marijuana use (e.g., Fleary et al. 2010; Tang and Orwin 2009). Future studies that include parent report of substance use should examine the dynamics of association between parental and youth use. Moreover, past studies (Dever et al. 2012; Epstein et al. 2017; Slater 2003) have shown that behavioral disinhibition may exacerbate the effects of family and peer factors on adolescent marijuana use. While this was not our research question and the complexity of the present models precluded interaction analyses, future studies utilizing different methodology (e.g., time-varying effects models; Epstein et al. 2017) could examine potential moderating effects of behavioral disinhibition as well as other variables, such as gender, on the dynamic relationship between marijuana-specific risk and marijuana use over the course of adolescence. Next, the present study involved multiple comparisons, increasing the possibility of type I error. However, all of the comparisons were theory based and a priori hypothesized, and significant on the bivariate level, decreasing the likelihood of chance findings. Finally, the sample is limited to youth growing up in small towns and rural communities (average population size of 14,646, according to the 2000 census; Hawkins et al. 2008) in seven states and may not generalize to other populations, such as urban youth with different ethno-demographic backgrounds.

Despite these limitations, the present study had several important strengths. The data came from prospective assessments of risk and marijuana use over the course of adolescence and the sample retention rates have been high. The analyses examine *longitudinal* associations between marijuana-specific risk in *multiple domains* and marijuana use, which has not been done as comprehensively in previous studies. The analyses controlled for concurrent and reciprocal relationships as well as baseline risk in order to isolate the specific predictive relationships between risk and use. The analyses focused on frequency of marijuana use throughout adolescence, an important outcome given its detrimental consequences for healthy development.

The results of this study, together with the evidence of the relatively stable magnitude of relationships between marijuana-specific risk factors and use in recent years (Fleming et al. 2016), are encouraging for the prevention science paradigm that relies on identifying malleable factors that predict changes in problem behaviors in order to target these factors in preventive interventions. It is unclear, however, to what extent existing prevention programs are still relevant in the new context of legalized marijuana (Mason et al. 2016). Future studies that have longitudinal data on risk and protective factors and substance use in the new era of legalization, as well as studies testing the efficacy of

existing and new programs aimed at reducing adolescent substance use, are critically needed.

Prevention Implications

As of November 2016, eight states have legalized possession, sale, and use of marijuana for recreational purposes by those over age 21, and more states are likely to follow. Despite the differences in their position on legalization of marijuana for adults, most proponents and opponents of marijuana legalization agree on the goal of preventing adolescent substance use (e.g., Pacula and Sevigny 2014). This study, while using data from a time period before any states legalized nonmedical marijuana, contributes nonetheless a key piece of information regarding salient targets for prevention programming. The findings from this study underscore the importance of focus on the prevention of early risk and use. It is also apparent from these results that the period of transition to high school, which can be a challenging time for many students, is associated with increased risk that is positively related to subsequent marijuana use. This increased risk can potentially cascade into difficulties in other areas of development (e.g., Zaff et al. 2016). Thus, this transition point represents a key target for prevention. Furthermore, a focus on the reciprocal relationships between use and risk in multiple socializing influences throughout adolescence is also important. Because we found evidence of both peer selection and peer socialization processes, our findings support prevention programming that targets peer ecologies in order to be effective (e.g., Dishion and Owen 2002). Programs that help adolescents resist peer influences to use marijuana and promote exposure to peers who model prosocial behaviors are likely to be more effective than programs that focus on one process only. These prevention programs should have multiple components and include other domains of socializing influences, such as parents as well as youth's communities, and be sustained over time in order to address the underpinnings and processes in the etiology of adolescent substance use.

Acknowledgements The authors gratefully acknowledge CYDS panel participants for their continued contribution to the longitudinal study, the Social Development Research Group Survey Research Division for their hard work maintaining high panel retention, and Ms. Tanya Williams and Ms. Diane Christiansen for their editorial and administrative support. An earlier version of this paper was presented at the Society for Longitudinal and Life Course Studies meeting held in Dublin, Ireland, in October 2015; and at the Society for Prevention Research annual meeting held in San Francisco, CA in June 2016.

Funding Funding for this study was provided by the National Institute on Drug Abuse of the National Institutes of Health under award # R01 DA015183-12 to Dr. Oesterle. These organizations had no role in study design; in the collection, analysis, and interpretation of data; in the writing of the report; or in the decision to submit the paper for publication. The content of this paper is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

Compliance with Ethical Standards

Conflict of Interest Richard F. Catalano is a board member of Channing Bete Company, distributor of *Supporting School Success*® and *Guiding Good Choices*®. Although the intervention effects are not studied here, these programs were tested in the study that produced the data set used in this paper.

Ethical Approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. Activities related to this study were approved by the University of Washington Institutional Review Board.

Informed Consent Informed consent was obtained for all participants in the study.

References

- Agrawal, A., Madden, P. A., Bucholz, K. K., Heath, A. C., & Lynskey, M. T. (2014). Initial reactions to tobacco and cannabis smoking: A twin study. *Addiction, 109*, 663–671.
- Agresti, A. (2013). *Categorical data analysis* (3rd ed.). Hoboken: Wiley.
- Arthur, M. W., Hawkins, J. D., Pollard, J. A., Catalano, R. F., & Baglioni Jr., A. J. (2002). Measuring risk and protective factors for substance use, delinquency, and other adolescent problem behaviors: The Communities That Care Youth Survey. *Evaluation Review, 26*, 575–601.
- Bandura, A. (1986). *Social foundations of thought and action*. Englewood Cliffs: Prentice-Hall.
- Becker, S. J., & Curry, J. F. (2014). Testing the effects of peer socialization versus selection on alcohol and marijuana use among treated adolescents. *Substance Use & Misuse, 49*, 234–242.
- Bentler, P. M. (1990). Comparative fit indexes in structural models. *Psychological Bulletin, 107*, 238–246.
- Beyers, J. M., Toubourou, J. W., Catalano, R. F., Arthur, M. W., & Hawkins, J. D. (2004). A cross-national comparison of risk and protective factors for adolescent substance use: The United States and Australia. *Journal of Adolescent Health, 35*, 3–16.
- Bronfenbrenner, U. (1994). Ecological models of human development. In: *International encyclopedia of education* (2nd ed., Vol. 3, pp. 1643–1647). Oxford: Elsevier.
- Brooks-Russell, A., Levinson, A., Li, Y., Roppolo, R. H., & Bull, S. (2017). What do Colorado adults know about legal use of recreational marijuana after a media campaign? *Health Promotion Practice, 18*, 193–200.
- Browne, M. W., & Cudeck, R. (1993). Alternative ways of assessing model fit. In K. A. Bollen & J. S. Long (Eds.), *Testing structural equation models* (pp. 136–162). Newbury Park: Sage.
- Cambron, C., Guttmanova, K., & Fleming, C. B. (2017). State and national contexts in evaluating cannabis laws: A case study of Washington State. *Journal of Drug Issues, 47*, 74–90.
- Catalano, R. F., & Hawkins, J. D. (1996). The social development model: A theory of antisocial behavior. In J. D. Hawkins (Ed.), *Delinquency and crime: Current theories* (pp. 149–197). New York: Cambridge University Press.
- Catalano, R. F., Oxford, M. L., Harachi, T. W., Abbott, R. D., & Haggerty, K. P. (1999). A test of the social development model to predict problem behaviour during the elementary school period. *Criminal Behaviour and Mental Health, 9*, 39–56.
- Catalano, R. F., Fagan, A. A., Gavin, L. E., Greenberg, M. T., Irwin, C. E., Ross, D. A., & Shek, D. T. L. (2012). Worldwide application of the prevention science research base in adolescent health. *The Lancet, 379*, 1653–1664.
- Cicchetti, D. (1990). A historical perspective on the discipline of developmental psychopathology. In J. E. Rolf, A. S. Masten, D. Cicchetti, K. H. Nuechterlein, & S. Weintraub (Eds.), *Risk and protective factors in the development of psychopathology* (pp. 2–28). New York: Cambridge University Press.
- Coie, J. D., Watt, N. F., West, S. G., Hawkins, J. D., Asarnow, J. R., Markman, H. J., ... Long, B. (1993). The science of prevention: A conceptual framework and some directions for a national research program. *American Psychologist, 48*, 1013–1022.
- Deutsch, A. R., Chernyavskiy, P., Steinley, D., & Slutske, W. S. (2015). Measuring peer socialization for adolescent substance use: A comparison of perceived and actual friends' substance use effects. *Journal of Studies on Alcohol and Drugs, 76*, 267–277.
- Dever, B. V., Schulenberg, J. E., Dworkin, J. B., O'Malley, P. M., Kloska, D. D., & Bachman, J. G. (2012). Predicting risk-taking with and without substance use: The effects of parental monitoring, school bonding, and sports participation. *Prevention Science, 13*, 605–615.
- Dishion, T. J., & Owen, L. D. (2002). A longitudinal analysis of friendships and substance use: Bidirectional influence from adolescence to adulthood. *Developmental Psychology, 38*, 480–491.
- Donovan, J. E. (2004). Adolescent alcohol initiation: A review of psychosocial risk factors. *Journal of Adolescent Health, 35*, 529.e527–529.e518.
- Ellickson, P. L., Tucker, J. S., Klein, D. J., & Saner, H. (2004). Antecedents and outcomes of marijuana use initiation during adolescence. *Preventive Medicine, 39*, 976–984.
- Epstein, M., Hill, K. G., Nevell, A. M., Guttmanova, K., Bailey, J. A., Abbott, R. D., ... Hawkins, J. D. (2015). Trajectories of marijuana use from adolescence into adulthood: Environmental and individual correlates. *Developmental Psychology, 51*, 1650–1663.
- Epstein, M., Hill, K. G., Roe, S. S., Bailey, J. A., Iacono, W. G., McGue, M., ... Haggerty, K. P. (2017). Time-varying effects of families and peers on adolescent marijuana use: Person-environment interactions across development. *Development and Psychopathology, 29*, 887–900.
- Fergusson, D. M., Horwood, L. J., Lynskey, M. T., & Madden, P. A. F. (2003). Early reactions to cannabis predict later dependence. *Archives of General Psychiatry, 60*, 1033–1039.
- Finkel, S. E. (1995). *Causal analysis with panel data*. Thousand Oaks: Sage.
- Fleary, S. A., Heffer, R. W., McKyer, E. L. J., & Newman, D. A. (2010). Using the bioecological model to predict risk perception of marijuana use and reported marijuana use in adolescence. *Addictive Behaviors, 35*, 795–798.
- Fleming, C. B., Guttmanova, K., Cambron, C., Rhew, I. C., & Oesterle, S. (2016). Examination of the divergence in trends for adolescent marijuana use and marijuana-specific risk factors in Washington State. *Journal of Adolescent Health, 59*, 269–275.
- Gardner, M., & Steinberg, L. (2005). Peer influence on risk taking, risk preference, and risky decision making in adolescence and adulthood: An experimental study. *Developmental Psychology, 41*, 625–635.
- Grant, J. D., Scherrer, J. F., Lyons, M. J., Tsuang, M., True, W. R., & Bucholz, K. K. (2005). Subjective reactions to cocaine and marijuana are associated with abuse and dependence. *Addictive Behaviors, 30*, 1574–1586.
- Guttmanova, K., Wheeler, M. J., Hill, K. G., Evans-Campbell, T. A., Hartigan, L. A., Jones, T. M., ... Catalano, R. F. (2017). Assessment of risk and protection in Native American youth: Steps toward conducting culturally relevant, sustainable prevention in Indian Country. *Journal of Community Psychology, 43*, 346–362.
- Hawkins, J. D., Catalano, R. F., & Miller, J. Y. (1992). Risk and protective factors for alcohol and other drug problems in adolescence and early

- adulthood: Implications for substance abuse prevention. *Psychological Bulletin*, 112, 64–105.
- Hawkins, J. D., Catalano, R. F., Arthur, M. W., Egan, E., Brown, E. C., Abbott, R. D., & Murray, D. M. (2008). Testing communities that care: The rationale, design and behavioral baseline equivalence of the community youth development study. *Prevention Science*, 9, 178–190.
- Hawkins, J. D., Oesterle, S., Brown, E. C., Monahan, K. C., Abbott, R. D., Arthur, M. W., & Catalano, R. F. (2012). Sustained decreases in risk exposure and youth problem behaviors after installation of the Communities That Care prevention system in a randomized trial. *Archives of Pediatrics and Adolescent Medicine*, 166, 141–148.
- Hawkins, J. D., Oesterle, S., Brown, E. C., Abbott, R. D., & Catalano, R. F. (2014). Youth problem behaviors 8 years after implementing the Communities That Care prevention system: A community-randomized trial. *JAMA Pediatrics*, 168, 122–129.
- Hill, K. G., Hawkins, J. D., Bailey, J. A., Catalano, R. F., Abbott, R. D., & Shapiro, V. (2010). Person-environment interaction in the prediction of alcohol abuse and alcohol dependence in adulthood. *Drug & Alcohol Dependence*, 110, 62–69.
- Hox, J. J., Moerbeek, M., & van de Schoot, R. (2010). *Multilevel analysis: Techniques and applications*. New York: Routledge.
- Hughes, A., Lipari, R. N., & Williams, M. (2015). *The CBHSQ Report: State estimates of adolescent marijuana use and perceptions of risk of harm from marijuana use: 2013 and 2014*. Rockville: Substance Abuse and Mental Health Services Administration, Center for Behavioral Health Statistics and Quality.
- Jaccard, J., Blanton, H., & Dodge, T. (2005). Peer influences on risk behavior: An analysis of the effects of a close friend. *Developmental Psychology*, 41, 135–147.
- Jessor, R., & Jessor, S. L. (1977). *Problem behavior and psychological development: A longitudinal study of youth*. New York: Academic Press.
- Kilmer, J. R., Geisner, I. M., Gasser, M. L., & Lindgren, K. P. (2015). Normative perceptions of non-medical stimulant use: Associations with actual use and hazardous drinking. *Addictive Behaviors*, 42, 51–56.
- Kosterman, R., Bailey, J. A., Guttmanova, K., Jones, T. A., Eisenberg, N., Hill, K. G., & Hawkins, J. D. (2016). Marijuana legalization and parents' attitudes, use, and parenting in Washington State. *Journal of Adolescent Health*, 59, 450–456.
- Lipari, R., Kroutil, L. A., & Pemberton, M. R. (2015). *Risk and protective factors and initiation of substance use: Results from the 2014 National Survey on Drug Use and Health*. Rockville: Substance Abuse and Mental Health Services Administration.
- MacCallum, R. C., Browne, M. W., & Sugawara, H. M. (1996). Power analysis and determination of sample size for covariance structure modeling. *Psychological Methods*, 1, 130–149.
- Marsh, H. W., & Hau, K.-T. (1996). Assessing goodness of fit: Is parsimony always desirable? *The Journal of Experimental Education*, 64, 364–390.
- Martens, M. P., Page, J. C., Mowry, E. S., Damann, K. M., Taylor, K. K., & Cimini, M. D. (2006). Differences between actual and perceived student norms: An examination of alcohol use, drug use, and sexual behavior. *Journal of American College Health*, 54, 295–300.
- Mason, W. A., Fleming, C. B., & Haggerty, K. P. (2016). Prevention of marijuana misuse: School-, family-, and community-based approaches. In M. T. Compton (Ed.), *Marijuana and mental health* (pp. 199–225). Arlington: American Psychiatric Association Publishing.
- Mercken, L., Steglich, C., Knibbe, R., & Vries, H. (2012). Dynamics of friendship networks and alcohol use in early and mid-adolescence. *Journal of Studies on Alcohol and Drugs*, 73, 99–110.
- Miech, R. A., Johnston, L. D., O'Malley, P. M., Bachman, J. G., & Schulenberg, J. E. (2015). *Monitoring the Future national survey results on drug use, 1975–2014: Volume I, Secondary school students*. Ann Arbor: Institute for Social Research, The University of Michigan.
- Monahan, K. C., Oesterle, S., & Hawkins, J. D. (2010). Predictors and consequences of school connectedness: The case for prevention. *The Prevention Researcher*, 17, 3–6.
- Muthén, L. K., & Muthén, B. O. (1998–2013). *Mplus user's guide*. Los Angeles: Muthén & Muthén.
- Muthén, B. O., du Toit, S. H. C., & Spisic, D. (1997). Robust inference using weighted least squares and quadratic estimating equations in latent variable modeling with categorical and continuous outcomes. http://www.statmodel.com/download/Article_075.pdf.
- Pacula, R. L., & Sevigny, E. L. (2014). Marijuana liberalization policies: Why we can't learn much from policy still in motion. *Journal of Policy Analysis and Management*, 33, 212–221.
- Pacula, R. L., Powell, D., Heaton, P., & Sevigny, E. L. (2015). Assessing the effects of medical marijuana laws on marijuana use: The devil is in the details. *Journal of Policy Analysis and Management*, 34, 7–31.
- Perkins, H. W., Meilman, P. W., Leichliter, J. S., Cashin, J. R., & Presley, C. A. (1999). Misperceptions of the norms for the frequency of alcohol and other drug use on college campuses. *Journal of American College Health*, 47, 253–258.
- Rogosa, D. (1980). A critique of cross-lagged correlation. *Psychological Bulletin*, 88, 245–258.
- Sieving, R. E., Perry, C. L., & Williams, C. L. (2000). Do friendships change behaviors, or do behaviors change friendships? Examining paths of influence in young adolescents' alcohol use. *Journal of Adolescent Health*, 26, 27–35.
- Simons-Morton, B., & Chen, R. S. (2006). Over time relationships between early adolescent and peer substance use. *Addictive Behaviors*, 31, 1211–1223.
- Simons-Morton, B. G., & Farhat, T. (2010). Recent findings on peer group influences on adolescent smoking. *The Journal of Primary Prevention*, 31, 191–208.
- Slater, M. D. (2003). Sensation-seeking as a moderator of the effects of peer influences, consistency with personal aspirations and perceived harm on marijuana and cigarette use among younger adolescents. *Substance Use & Misuse*, 38, 865–880.
- Tang, Z., & Orwin, R. G. (2009). Marijuana initiation among American youth and its risks as dynamic processes: Prospective findings from a national longitudinal study. *Substance Use & Misuse*, 44, 195–211.
- Thornberry, T. P. (1996). Empirical support for interactional theory: A review of the literature. In J. D. Hawkins (Ed.), *Delinquency and crime: Current theories* (pp. 198–235). New York: Cambridge University Press.
- Wen, H., Hockenberry, J. M., & Druss, B. G. (2018). The effect of medical marijuana laws on marijuana-related attitude and perception among U.S. adolescents and adults. *Prevention Science*. (in press).
- Wu, L.-T., Swartz, M. S., Brady, K. T., & Hoyle, R. H. (2015). Perceived cannabis use norms and cannabis use among adolescents in the United States. *Journal of Psychiatric Research*, 64, 79–87.
- Zaff, J. F., Donlan, A., Gunning, A., Anderson, S. E., McDermott, E., & Sedaca, M. (2016). Factors that promote high school graduation: A review of the literature. *Educational Psychology Review*, 29, 447–476.