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Associations of adolescent cannabis use with academic performance and mental health: A longitudinal study of upper middle class youth☆

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Abstract

Background—There is a hypothesis that low socioeconomic status (SES) may explain the link between cannabis use and poorer academic performance and mental health. A key question, therefore, is whether adolescent cannabis use is associated with poorer academic performance and mental health in high SES communities where there is reduced potential for confounding.

Methods—Youth (n = 254) from an upper middle class community were followed prospectively through the four years of high school (from age 14/15 to age 17/18). Past-year frequency of cannabis use was assessed annually. Official school records of academic performance and self-reported mental health symptoms (externalizing and internalizing symptoms) were assessed in grades 9 and 12.

Results—Persistent cannabis use across the four years of high school was associated with lower grade-point average (β = −0.18, p = .006), lower scholastic aptitude test (SAT) score (β = −0.13, p = .038), and greater externalizing symptoms (β = 0.29, p < .001) in 12th grade, but not with greater internalizing symptoms (β = 0.04, p = .53). Moreover, persistent cannabis use was associated with lower grade-point average (β = −0.13, p = .014) and greater externalizing symptoms (β = 0.24, p = .002) in 12th grade, even after controlling for 9th grade levels of these outcomes. Similar associations were observed for persistent alcohol and tobacco use. Effects for persistent cannabis use became non-significant after controlling for persistent alcohol and tobacco use, reflecting the difficulties of disentangling effects of cannabis from effects of alcohol and tobacco.

Conclusions—Low SES cannot fully explain associations between cannabis use and poorer academic performance and mental health.

☆Supplementary material can be found by accessing the online version of this paper.

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Contributors

All authors contributed to the design of the study. MHM, MLH, and SSL contributed to the writing of the manuscript and interpretation of the data. SSL and PJS lead the data collection. MHM and MLH conducted data analyses. All authors approved the final article.

Conflict of interest

No conflict declared.

Appendix A. Supplementary data

Supplementary data associated with this article can be found, in the online version, at http://dx.doi.org/10.1016/j.drugalcdep.2015.09.010.

Keywords

Cannabis; Adolescent; Longitudinal; Grade-point average; Mental health; SES

1. Introduction

Adolescents who use cannabis are at risk for experiencing a variety of problems by young adulthood, including reduced educational attainment and poor mental health (Hall, 2015; Lynskey and Hall, 2000). For example, a recent analysis of three large longitudinal studies showed that, compared with those who never used cannabis, adolescents who used cannabis daily were less likely to complete high school and attain a university degree and were more likely to attempt suicide in young adulthood (Silins et al.,2014). Associations persisted through adjustment for a broad range of covariates, suggesting that cannabis use might cause reduced educational attainment and poor mental health. The causal nature of these associations remains uncertain, however (Macleod et al.,2004; Rogeberg, 2013; Temple et al., 2011).

One hypothesis is that low socioeconomic status (SES) may explain the link between cannabis use and problems later in life (Rogeberg, 2013). That is, adolescent cannabis users show reduced educational achievement and poor mental health not because of their cannabis use, but because they come from low SES backgrounds. Low SES increases risk for reduced educational achievement and poor mental health (Caldas and Bankston, 1997; Everson et al., 2002; Walpole, 2003; Wright et al., 1999), and some studies (though not all; Danielsson et al., 2015) suggest that low SES is associated with an increased risk of cannabis use (Daniel et al.,2009). Moreover, several studies have demonstrated that associations between cannabis use and poorer educational achievement and mental health are attenuated or eliminated after controlling for SES and other related childhood risks (Degenhardt et al., 2003; Macleod et al., 2004; Stiby et al., 2014; Temple et al., 2011). Because the effects of low SES are cumulative and indirect, operating, for example, through lower expectations for educational success and greater alienation and financial strain (Everson et al., 2002; Walpole, 2003; Wright et al., 1999), low SES could contribute to decline in academic performance and mental health. Thus, low SES could explain why longitudinal studies of adolescents from diverse socioeconomic backgrounds find that cannabis use is associated with reduced educational achievement and poor mental health in young adulthood, even after accounting for childhood risk (Silins et al., 2014; Stiby et al., 2014).

A key question, therefore, is whether adolescent cannabis use is associated with poorer academic performance and mental health in high SES communities where there is reduced potential for confounding. Adolescents from high SES communities typically have higher educational aspirations than adolescents from low SES communities (Walpole, 2003), and adolescents from high SES communities may not experience the degree of financial strain or alienation that increases risk for problems later in life. Thus, a demonstration that adolescent cannabis users from high SES communities show poorer academic performance and mental health would suggest that low SES, and factors related to low SES, cannot fully account for these associations.

The only longitudinal study of high SES youth to test associations between adolescent substance use, academic performance, and mental health found that substance use was not associated with decline in these outcomes from 10th to 12th grade (McMahon and Luthar, 2006). In a re-analysis of the same data in which cannabis use was considered separately from other substance use, findings were similar (Ansary and Luthar, 2009), suggesting that low SES, and related risks that are uncommon in high SES communities, could potentially explain associations between cannabis use and poorer academic performance and mental health reported in other longitudinal studies. An alternative explanation, however, is that adolescent substance users had already begun to show poorer academic performance and mental health by 10th grade, resulting in underestimates of decline. Given that fewer adolescents today think cannabis use may be harmful, and corresponding rises in adolescent cannabis use (Johnston et al., 2015), it is important to clarify whether adolescent cannabis users from high SES communities show poorer academic performance and mental health.

The purpose of the present study was to test whether persistent cannabis use over the four years of high school was associated with poorer academic performance and mental health in a sample of youth from an upper middle class community – a community with a median income in the top 5% of United States household incomes. This study represents only the second longitudinal study of upper middle class youth to test associations between cannabis use and academic performance and mental health. Further, unlike most studies of cannabis use and academic performance, we obtained official school records of academic performance to eliminate the possibility that cannabis users have biased perceptions of their academic performance. We tested four sets of associations. First, we tested whether persistent cannabis use over the four years of high school was associated with poorer academic performance and mental health in the 12th grade. Second, we tested whether persistent cannabis use was associated with poorer academic performance and mental health in 12th grade after controlling for 9th grade levels of these outcomes. Third, we tested whether any association between persistent cannabis use and poorer academic performance and mental health remained after controlling for other potential confounders. Fourth, we tested associations of persistent alcohol and tobacco use with academic performance and mental health. Previous research suggests that alcohol and tobacco use may be associated with worse educational and mental health outcomes (Ellickson et al., 2001; Hill et al., 2000; Newcomb et al.,2002), and alcohol and tobacco use may also be associated with low SES (Goodman and Huang, 2002; Hiscock et al., 2012). By testing associations for cannabis, alcohol, and tobacco within the same study, we put effects for cannabis in context.

2. Methods

2.1. Participants

Participants are members of the New England Study of Suburban Youth (NESSY), a cohort of 319 6th graders (48% female) recruited from schools in an upper middle class New England community in 1998 and followed annually thereafter (Luthar and Barkin, 2012). The median annual family income in the community at the inception of the study in 1998 was $125,381, which represented the top 5% of U.S. household incomes at that time. Thirty-three percent of students' parents had a graduate degree. Only 3% of the students in the

school sample were eligible for free or reduced lunches. Ninety-three percent of students were Caucasian, less than 2% each were African–American and Hispanic, 3% were Asian, and the remainder were of other ethnic backgrounds.

Assessments were conducted at the end of each academic year during a 90-minute group session in the school cafeteria. Measures were read aloud by the principal investigator (S.S.L), and students marked their responses accordingly. Two members of the research team supervised each student table and were available to clarify questions. Passive consent procedures were used, as data collection was done as part of school-based initiatives on positive youth development. There was no evidence of differential attrition from 6th to 12th grade: there were no significant differences between 12th grade participants and non-participants in terms of 6th grade delinquent behavior ($F = 0.08$, $p = .78$), depression ($F = 0.82$, $p = .37$), and substance use (aggregate index of cannabis, alcohol, and tobacco use; $F = 3.60$, $p = .06$). This article focuses on the NESSY cohort during the four years of high school (ages 14/15 to ages 17/18), with $n = 279, 296, 251, 252$ students participating in the 9th–12th grades, respectively.

2.2. Substance use

Students reported on frequency of cannabis, alcohol, and tobacco use in the past year in grades 9, 10, 11 and 12. Response options were: 0 times, 1–2 times, 3–5 times, 6–9 times, 10–19times, 20–39 times, and 40+ times.

Our main exposure, persistent cannabis use, was defined as the number of high school assessments, out of four, for which a student reported using cannabis 10–19 times a year or more (i.e., approximately monthly or greater use). Students were grouped as follows:(i) never used cannabis over the four years of high school, (ii) used cannabis but never on a monthly basis, (iii) used cannabis monthly for one year of high school, (iv) used cannabis monthly for two years of high school, and (v) used cannabis monthly for 3–4 years of high school. The Supplemental Table[1] shows how we used information about past-year frequency of cannabis use to create these cannabis-use groups.

Like with cannabis use, we grouped students according to persistence of alcohol and tobacco use (Table 1). Students had to have substance-use data for three of the four years of high school to be classified. This left 254 participants for analysis ($n = 253$ for cannabis, as one participant did not report on past-year cannabis use).

2.3. Twelfth grade academic performance and mental health

We assessed 12th grade grade-point average (GPA), scholastic aptitude test performance (SAT), externalizing symptoms, and internalizing symptoms.

We obtained GPA information from students' official school records. We coded letter grades on a 1–13 scale, with an 'A+' assigned a score of '13′ and an '*F*' assigned a score of '1.' GPA was calculated as the average coded letter grade across social studies, science, math, and English ($M = 9.24$, SD = 1.72).

[1]Supplementary material can be found by accessing the online version of this paper.

SAT scores were obtained from students' official school records (M = 1225.77, SD = 175.94).

Externalizing symptoms (M = 10.11, SD = 6.82) and internalizing symptoms (M = 8.00, SD = 7.55) were assessed with the Youth Self Report (Achenbach and Rescorla, 2001).

2.4. Ninth grade covariates

We included the following covariates, assessed in 9th grade, as proxies for the 12th grade outcomes: GPA, delinquency, depression symptoms, and anxiety symptoms. GPA in 9th grade was assessed in the same way as GPA in 12th grade. As expected, 9th grade GPA was significantly associated with 12th grade GPA (r = 0.52, p < .001).

Delinquency was assessed with the Self-Reported Delinquency Checklist (Elliott et al., 1987). As expected, 9th grade delinquency was significantly associated with 12th grade externalizing symptoms (r = 0.32, p < .001).

Internalizing symptoms were assessed with the Children's Depression Inventory (Kovacs, 1992) and the Revised Children's Manifest Anxiety Scale (Reynolds and Richmond, 1985). As expected, 9th grade depression symptoms and 9th grade anxiety symptoms were significantly associated with 12th grade internalizing symptoms (r = 0.22, p = .002 and r = 0.37, p < .001, respectively).

2.5. Statistical analysis

We tested for a dose-response association between persistent cannabis use and academic performance and mental health, under the hypothesis that more persistent cannabis use would be associated with poorer academic performance and mental health. We did not test differences between adolescents following divergent trajectories of cannabis use (e.g., increasing versus decreasing trajectories) for a number of reasons. First, we did not have specific hypotheses about how students following divergent trajectories might differ, beyond the obvious hypothesis that students following a high-chronic trajectory would be worse-off than students following a low-use/no-use trajectory. Second, group-based trajectory modeling has come under scrutiny recently, with experts questioning its appropriateness as a tool for psychological science (Bauer, 2007; Sher et al., 2011). Third, our sample size is modest for group-based trajectory modeling.

To test whether more persistent cannabis use throughout high school was associated with poorer academic performance and mental health in 12th grade, we used ordinary least squares regression and regressed each 12th grade outcome (GPA, SAT, externalizing symptoms, and internalizing symptoms) on the cannabis-use groups (entered as a 5-level independent variable) (Model 1). We subsequently expanded the regression model to control for 9th grade level of the outcome (Model 2). In models predicting 12th grade SAT scores, 9th grade GPA was used as the covariate (the correlation between 9th grade GPA and 12th grade SAT was 0.65, p < .001). Next, we further expanded the regression model to control for all 9th grade covariates (Model 3). Finally, we added persistent alcohol and tobacco use as covariates (Model 4). We repeated analyses with persistent alcohol and tobacco use, considered separately, as our exposures. All analyses controlled for sex.

3. Results

Table 1 shows the number of students in each persistent substance-use group. For example, 97 students (38%) had never used cannabis in high school (i.e., they reported using cannabis '0 times' in the past year in 9th, 10th, 11th, and 12th grade), whereas 48 students (19%) had used cannabis on an approximately monthly basis for two or more years of high school.

3.1. Associations between persistent substance use across the high school years and 12th grade GPA

Persistent cannabis use across the four years of high school was associated with lower 12th grade GPA (Table 2, Model 1: $\beta = -0.18$, $p = .006$), even after controlling for 9th grade GPA (Table 2, Model 2:$\beta = -0.13$, $p = .014$). Effects held after additionally controlling for 9th grade externalizing and internalizing symptoms (Table 2, Model 3: $\beta = -0.13$, $p = .042$), but not after controlling for persistent alcohol and tobacco use (Table 2, Model 4: $\beta = -0.06$, $p = .43$). Similar associations were observed for persistent alcohol and tobacco use, considered separately.

3.2. Associations between persistent substance use across the high school years and 12th grade SAT score

Persistent cannabis use across the four years of high school was associated with lower 12th grade SAT score (Table 3, Model 1: $\beta = -0.13$, $p = .038$), though the effect became non-significant after controlling for 9th grade GPA (Table 3, Model 2: $\beta = -0.09$, $p = .07$). Persistent alcohol use was not associated with lower SAT scores, whereas persistent tobacco use was associated with lower SAT scores even after controlling for 9th grade GPA (Table 3, Model 2: $\beta = -0.11$, $p = .036$) and after additionally controlling for 9th grade externalizing and internalizing symptoms (Table 3, Model 3: $\beta = -0.12$, $p = .036$). The association between persistent tobacco use and lower SAT scores became non-significant after controlling for persistent cannabis and alcohol use (Table 3, Model 4: $\beta = -0.08$, $p = .24$).

3.3. Associations between persistent substance use across the high school years and 12th grade externalizing symptoms

Persistent cannabis use across the four years of high school was associated with greater externalizing symptoms in 12th grade (Table 4, Model 1: $\beta = 0.29$, $p < .001$), even after controlling for 9th grade externalizing symptoms (Table 4, Model 2: $\beta = 0.24$, $p = .002$). Associations held after additionally controlling for 9th grade GPA and internalizing symptoms (Table 4, Model 3: $\beta = 0.26$, $p < .001$) but not after additionally controlling for persistent alcohol and tobacco use (Table 4, Model 4: $\beta = 0.16$, $p = .06$). Similar associations were observed for persistent alcohol and tobacco use, though effects for persistent tobacco use held even after controlling for persistent cannabis and alcohol use.

3.4. Associations between persistent substance use across the high school years and 12th grade internalizing symptoms

Persistent substance use in high school was not statistically significantly associated with internalizing symptoms in 12th grade (Table 5).

4. Discussion

Adolescents from an upper middle class community who used cannabis persistently had lower GPA and more externalizing symptoms in 12th grade, even after accounting for 9th grade GPA and externalizing symptoms. These findings suggest that socioeconomic disadvantage, and related risks that tend to be uncommon in upper middle class communities, cannot fully account for associations of cannabis use with poorer academic performance and mental health. Findings are consistent with studies of adolescents from diverse socioeconomic backgrounds that demonstrate that associations between cannabis use and poorer educational achievement and greater externalizing behavior are robust to controls for SES (Fergusson and Horwood, 1997; Horwood et al., 2010; Silins et al., 2014).

Associations were not specific to cannabis; persistent alcohol and tobacco use were each associated with lower GPA and greater externalizing symptoms in 12th grade. In nearly all instances, effects for each substance became non-significant after controlling for persistent use of other substances, reflecting the difficulties of disentangling effects of cannabis, alcohol, and tobacco. Intriguingly, associations were generally larger or more robust for tobacco than for cannabis. These findings are consistent with prior research linking tobacco use to reduced educational achievement and greater externalizing behavior (Ellickson et al., 2001; Mathers et al., 2006; Newcomb et al., 2002). Furthermore, though relatively few studies have reported effects for cannabis and tobacco within the same cohort, a recent report from the Avon Longitudinal Study of Parents and Children (ALSPAC) showed that adolescent tobacco use was more strongly associated with later poor educational outcomes than adolescent cannabis use (Stiby et al., 2014).

The mechanisms underlying associations between substance use, poorer academic performance, and externalizing symptoms are unclear. Substance use might directly or indirectly cause poorer grades and externalizing behavior. For example, cannabis and alcohol use may impair neuropsychological functioning, leading to poorer grades (Meier et al., 2012; Moffitt et al., 2013; Squeglia et al.,2009). Whether adolescent tobacco use impairs neuropsychological functioning is uncertain, though there is some evidence that tobacco use is associated with neuropsychological decline in older adults (Weuve et al., 2012; Whalley et al., 2005). Neuropsychological impairment might not explain our findings, however, because persistent alcohol use was not associated with poorer SAT scores, and persistent cannabis use was not associated with poorer SAT scores after accounting for 9th grade GPA.

Substance use may indirectly influence academic performance and externalizing behavior through increasing affiliation with anti-social peers – peers who discourage engagement in academic pursuits and instigate externalizing behavior (Battin-Pearson et al.,2000; Fergusson and Horwood, 1997; Townsend et al., 2007). Alternatively, findings could be explained by other uncontrolled factors. Notably, we controlled for 9th grade GPA, externalizing symptoms, and internalizing symptoms. Thus, reverse causation and general deviance explanations are unlikely to account for findings (Griffith-Lendering et al., 2011; Jessor and Jessor, 1977). We cannot rule out all possible alternative explanations, however. For example, participants were all from an upper middle class community, but within this context, those at the lower levels of SES may have been more likely than others to both use

cannabis and to show poorer academic performance and mental health (Odgers et al., 2015), leading to a spurious association between cannabis use and poorer academic performance and mental health.

In future research, other designs, such as discordant twin designs, could better account for unobserved confounders. Along these lines, a recent study found that twins who used cannabis were no more likely to leave school early than their non-using co-twin, suggesting that the link between cannabis use and school drop-out may not be causal (Verweij et al., 2013). Whether or not adolescent cannabis use causes later academic and behavioral problems, results of the current study suggest that adolescent cannabis use is a signal for impending difficulties, even among adolescents traditionally considered “low risk.”

The exception is that cannabis use may not indicate risk of internalizing problems in upper middle class youth. Cannabis use was not statistically significantly associated with greater internalizing symptoms in our sample. This result contrasts with findings from several longitudinal studies and a recent meta-analysis demonstrating that cannabis use is associated with increased risk of developing depression (Gage et al., 2015; Lev-Ran et al., 2014). However, our results are broadly consistent with previous studies showing that associations between cannabis use and internalizing symptoms are generally weaker and less robust than associations between cannabis use and externalizing symptoms (Fergusson and Horwood, 1997; Fergusson et al., 2002; Monshouwer et al., 2006). It is unclear if the lack of association between cannabis use and internalizing symptoms in our study can be explained by socioeconomic advantage, as opposed to other aspects of our sample and methodology, such as the relative youth of the sample, the extent of their cannabis exposure, or by our measure of internalizing symptoms that combines depression and anxiety symptoms.

Our findings also conflict with reports from the only other longitudinal study of upper middle class youth to test associations between adolescent substance use, academic performance, and mental health (Ansary and Luthar, 2009; McMahon and Luthar,2006). Reports from that study showed that substance use was not associated with decline in academic performance and mental health. Reasons for this discrepancy are uncertain but might be attributable to differences in methodology. For example, the previous study followed adolescents over a shorter period than the present study.

This study has several limitations. First, findings are based on a modestly-sized sample of mostly white youth from one upper middle class community in New England. Additional research is needed to determine if results generalize to youth of different ethnic backgrounds from other upper middle class communities. Second, data were collected in schools. Because substance users may be less likely to attend school, we might have underestimated the magnitude of associations between substance use and academic performance and mental health. This is unlikely, however, because there was little evidence of differential attrition from the study. Third, assessments of substance use were based on self-reports. Under-reporting of substance use would mitigate against finding an association between substance use and poorer academic performance and mental health.

This study has two main implications. First, although this study cannot definitively demonstrate causality, we think it is important that high school students from upper middle class communities know that frequent use of substances could potentially affect prized outcomes, specifically good grades, a key determinant of college acceptance and scholarship decisions. Similarly, parents and teachers in upper middle class communities should not be lulled into a false sense of security. Even in these communities, adolescent sub-stance use may serve as a signal for youth in need of additional support and preventive intervention. Second, though adolescent cannabis use currently receives substantial attention given policy changes in the United States, results of this study remind us of the need for vigilance to not only adolescent cannabis use but also alcohol and tobacco use.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Persistent substance use across the four years of high school.

Persistent substance-use groups	Cannabis *N* (%)	Alcohol *N* (%)	Tobacco *N* (%)
Never used	97 (38.34)	29 (11.42)	115 (45.28)
Used but never on a monthly basis	71 (28.06)	71 (27.95)	60 (23.62)
Used monthly 1×	37 (14.62)	44 (17.32)	33 (12.99)
Used monthly 2×	29 (11.46)	53 (20.87)	28 (11.02)
Used monthly 3^{+}×	19 (7.51)	57 (22.44)	18 (7.09)

Table 2

Associations between persistent substance use across the high school years and 12th grade GPA.

Persistent substance use	Model 1: adjusted for sex			Model 2: additionally adjusted for 9th grade GPA			Model 3: additionally adjusted for 9th grade externalizing and internalizing symptoms			Model 4: additionally adjusted for persistent use of other substances[a]		
	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*
Cannabis	**−0.18**	**−0.30, −0.05**	**.006**	**−0.13**	**−0.24, −0.03**	**.014**	**−0.13**	**−0.26, −0.005**	**.042**	−0.06	−0.21, 0.09	.43
Alcohol	**−0.15**	**−0.27, −0.03**	**0.015**	**−0.15**	**−0.26, −0.05**	**.005**	**−0.17**	**−0.30, −0.04**	**.009**	−0.11	−0.26, 0.04	.16
Tobacco	**−0.29**	**−0.41, −0.17**	**<.001**	**−0.19**	**−0.30, −0.08**	**<.001**	**−0.19**	**−0.33, −0.07**	**.003**	−0.13	−0.28, 0.01	.07

Note: GPA, grade-point average. Estimates are standardized beta coefficients. Each substance was examined separately. Statistically significant associations are bolded. When effects were non-significant, subsequent models (which added covariate controls) were not tested, as indicated by a dash.

[a]Analyses of cannabis control for persistent alcohol and tobacco use. Analyses of alcohol control for persistent cannabis and tobacco use. Analyses of tobacco control for persistent cannabis and alcohol use.

Table 3

Associations between persistent substance use across the high school years and 12th grade SAT score.

Persistent substance use	Model 1: adjusted for sex			Model 2: additionally adjusted for 9th grade GPA			Model 3: additionally adjusted for 9th grade externalizing and internalizing symptoms			Model 4: additionally adjusted for persistent use of other substances[a]		
	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*
Cannabis	**−0.13**	**−0.26, −0.007**	**.038**	−0.09	−0.19, 0.008	.07	–	–	–	–	–	–
Alcohol	−0.08	−0.21, 0.05	.22	–	–	–	–	–	–	–	–	–
Tobacco	**−0.23**	**−0.36, −0.10**	**<.001**	**−0.11**	**−0.22, −0.007**	**.036**	**−0.12**	**−0.24, −0.008**	**.036**	−0.08	−0.21, 0.05	.24

Note: SAT, scholastic aptitude test. Estimates are standardized beta coefficients. Each substance was examined separately. Statistically significant associations are bolded. When effects were non-significant, subsequent models (which added covariate controls) were not tested, as indicated by a dash.

[a]Analyses of cannabis control for persistent alcohol and tobacco use. Analyses of alcohol control for persistent cannabis and tobacco use. Analyses of tobacco control for persistent cannabis and alcohol use.

Table 4

Associations between persistent substance use across the high school years and 12th grade externalizing symptoms.

Persistent substance use	Model 1: adjusted for sex			Model 2: additionally adjusted for 9th grade externalizing symptoms			Model 3: additionally adjusted for 9th grade GPA and internalizing symptoms			Model 4: additionally adjusted for persistent use of other substances[a]		
	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*
Cannabis	**0.29**	**0.17, 0.42**	**<.001**	**0.24**	**0.09, 0.38**	**.002**	**0.26**	**0.12, 0.41**	**<.001**	0.16	−0.01, 0.33	.06
Alcohol	**0.28**	**0.16, 0.40**	**<.001**	**0.24**	**0.09, 0.38**	**.002**	**0.25**	**0.10, 0.39**	**<.001**	0.13	−0.04, 0.30	.15
Tobacco	**0.30**	**0.18, 0.42**	**<.001**	**0.28**	**0.14, 0.42**	**<.001**	**0.28**	**0.13, 0.42**	**<.001**	**0.20**	**0.04, 0.37**	**.015**

Note: Estimates are standardized beta coefficients. Each substance was examined separately. Statistically significant associations are bolded. When effects were non-significant, subsequent models (which added covariate controls) were not tested, as indicated by a dash.

[a]Analyses of cannabis control for persistent alcohol and tobacco use. Analyses of alcohol control for persistent cannabis and tobacco use. Analyses of tobacco control for persistent cannabis and alcohol use.

Table 5

Associations between persistent substance use across the high school years and 12th grade internalizing symptoms.

Persistent substance use	Model 1: adjusted for sex			Model 2: additionally adjusted for 9th grade internalizing symptoms			Model 3: additionally adjusted for 9th grade GPA and exernalizing symptoms			Model 4: additionally adjusted for persistent use of other substances[a]		
	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*	β	95% CI	*p*
Cannabis	0.04	−0.09, 0.18	.53	-	-	-	-	-	-	-	-	-
Alcohol	0.02	−0.11, 0.14	.82	-	-	-	-	-	-	-	-	-
Tobacco	0.06	−0.07, 0.19	.39	-	-	-	-	-	-	-	-	-

Note: Estimates are standardized beta coefficients. Each substance was examined separately. Statistically significant associations are bolded. When effects were non-significant, subsequent models (which added covariate controls) were not tested, as indicated by a dash.

[a]Analyses of cannabis control for persistent alcohol and tobacco use. Analyses of alcohol control for persistent cannabis and tobacco use. Analyses of tobacco control for persistent cannabis and alcohol use.