Cannabis Use and Academic Performance in College Students: The Role of Procrastination

Cannabis
2024

researchmj.org
10.26828/cannabis/2024/000215

Christopher J. Mullin and Anita Cservenka
[1] School of Psychological Science, Oregon State University, Corvallis, United States

ABSTRACT

Objective: The current study investigated procrastination as a potential moderator of the association between cannabis use and college grade point average (GPA). Participants: 220 college students (ages 18-24; 71.8% female) in the Northwestern U.S. who were registered for classes in Fall 2021. **Methods**: Demographic questions, substance use history, the Beck Anxiety Inventory, the Center for Epidemiologic Studies Depression scale, and a Procrastination scale were completed via an online survey. Official term and cumulative GPA records were also collected. **Results**: A regression model indicated that procrastination moderated the association between lifetime cannabis use and cumulative college GPA, whereas this moderation was not present when examining the relationship between past month cannabis use and term GPA. **Conclusion**: The current study identifies a putatively modifiable factor that may be related to academic performance for students who use cannabis. These results may help inform future interventions designed to help students using cannabis succeed academically.

Key words: = cannabis; marijuana; procrastination; academic performance

The nationwide prevalence of cannabis use among young adults (ages 19-30) reached new heights in 2021, with 42.6% reporting cannabis use in the past 12 months and 28.5% reporting use in the past 30 days, representing the highest levels recorded since the late 1980s (Patrick et al., 2022). Additionally, an increasing number of states have recently voted to legalize and regulate the recreational use of cannabis, potentially normalizing cannabis use among young adults residing in those areas. Research suggests that cannabis use rates increased more among college students in Oregon following recreational cannabis legalization than in states where recreational cannabis use remains prohibited (Bae & Kerr, 2020; Kerr et al., 2018). In fact, a recent study in Oregon found 51% of young adults (ages 22-24) reported cannabis use in the past 30 days, whereas only 33% of respondents reported past 30-day use in a sample taken from the same schools 10 years prior, when recreational cannabis use was illegal (Stormshak et al., 2019). Cannabis use among young adults on this scale is even more troubling in light of research suggesting a link between cannabis use and lower college grade point average (GPA), while also underscoring that the mechanisms behind this association are not well understood (Martinez et al., 2015). As attitudes and behaviors surrounding cannabis use continue to evolve, so too must our understanding of the association between cannabis use and academic performance. Furthermore, given the widespread prevalence of cannabis use among young adults, investigations need to be conducted to identify potential moderating factors in the association between cannabis use and academic performance that can be used to inform the creation of novel interventions.

Corresponding Author: Anita Cservenka, Ph.D., School of Psychological Science, Oregon State University, 2950 SW Jefferson Way, Corvallis, OR 97331. Phone: (541) 737-1366, Email: anita.cservenka@oregonstate.edu

Cannabis and Academic Performance

Laboratory studies have repeatedly found that cannabis negatively impacts brain development, cognition, memory, and executive functioning in adolescent and young adult populations (Ashtari et al., 2009; Broyd et al., 2016; Burggren et al., 2019; Fontes et al., 2011). However, the evidence for cannabis use negatively impacting academic performance is more equivocal. For example, studies have shown that only certain patterns of cannabis use, such as younger age of initial cannabis use or increasingly frequent use, are associated with reduced educational attainment, higher dropout rates, and lower GPA among college students and young adults in general (Suerken et al., 2016; Thompson et al., 2019). Furthermore, a systematic review of 16 longitudinal studies examining the associations among cannabis use and psychosocial outcomes (including educational attainment) revealed a consistent association between cannabis use and reduced educational attainment, but the strength of the association varied considerably between studies and was substantially reduced after adjusting for potential confounds (Macleod et al., 2004). Evidence for a direct effect of cannabis use on academic performance is scarce. Rather, extant literature is replete with studies reporting indirect associations and stressing the role of additional covariates. For example, prior research suggests that academic performance is negatively affected by a culture surrounding cannabis use that includes delinquency and educational disengagement, rather than actual cognitive deficits (Fergusson et al., 2003; Lynskey & Hall, 2000). However, as cannabis use continues to become more normalized, it seems increasingly unlikely that it would necessitate membership in a specific cannabis-based subculture.

More recent research has identified additional factors to consider in the association between cannabis use and lower GPA in both high school and college students. For instance, several studies have concluded that cannabis use is related to increased rates of absenteeism, which then negatively impacts GPA (Arria et al., 2015; Caldeira et al., 2008). Other studies have produced contradictory evidence for the effects of covariates. DeCamp and Daly (2019) found that cannabis use was not related to test performance at a high-school level, and instead suggest that socioeconomic inequity was a much better predictor of academic performance. Conversely, Meier et al. (2015) examined the association between cannabis use and academic performance in a high socioeconomic status population and found that cannabis use was associated with lower test scores and GPA. Importantly, the researchers found that the impact of cannabis use on academic performance was absent when controlling for alcohol and tobacco use (Meier et al., 2015). On the contrary, Páramo et al. (2020) found that co-consumption of alcohol and cannabis together had a greater negative impact on college GPA than binge-drinking alone, suggesting cannabis use may impact academic performance above and beyond alcohol use. Other researchers have also found an association between the simultaneous use of cannabis with alcohol/tobacco and lower GPA, indicating that subsequent research into the effects of cannabis use must also account for polysubstance use (Heradstveit et al., 2017; Hernandez-Serrano et al., 2018).

Lastly, college is a stressful time and students have been known to report elevated levels of depression and anxiety. A recent survey of college students indicates that 48% report moderate-to-severe levels of depression and 38% report moderate-to-severe levels of anxiety (Wang et al., 2020). As increased levels of anxiety and depression have also been linked to lower GPAs among college students (Asher BlackDeer et al., 2023), investigations of the association between cannabis use and academic performance also need to account for these internalizing symptoms. Crucially, in order to identify the unique impact of cannabis use on academic performance, research must first control for the potentially confounding effects of important covariates related to academic performance.

Procrastination

Procrastination is another potential factor that may moderate the association between cannabis use and poor academic performance. Procrastination is quite common in college, with some studies reporting that up to 70% of college students are procrastinators (Schouwenburg et al., 2004). Furthermore, procrastination appears to be associated with cannabis use. Buckner et al. (2010) found that over 67% of frequent cannabis users identified as procrastinators, and that over

80% of cannabis users seeking treatment endorse procrastination as a problem. In addition, a recent meta-analysis indicates that a statistically significant negative correlation exists between procrastination and multiple measures of academic performance, including GPA (Kim & Seo, 2015). While there is some debate over whether procrastination always represents dysfunctional behavior or if there are contexts where delaying tasks can be adaptive, as well as whether procrastination is a trait or a behavioral response to certain task-specific antecedents (Kim & Seo, 2015), most researchers regard it as a relatively stable personality trait strongly related to low conscientiousness (Schouwenburg, 2004). It seems likely, therefore, that high levels of procrastination behavior can occur independent of cannabis use history, and that a person can be high in trait procrastination without being a cannabis user (and vice versa). Accordingly, the present study explores procrastination as a factor that may modify the relationship between cannabis use and academic performance (i.e., as a moderator), rather than as a theoretical causal mechanism (i.e., as a mediator). Specifically, it is possible that students who use cannabis and frequently engage in procrastination are more likely to turn in assignments late and delay studying for exams longer, resulting in lower GPAs, relative to non-procrastinating cannabis users.

The Present Study

The purpose of the present study was to investigate the potential moderating role of procrastination in the association between cannabis use and academic performance, assessed via college GPA. Previous research has largely focused on controlling for confounding variables in this association, but there is a need to examine potential moderators that could be related to the strength of the relationship between cannabis use and academic performance. This study was designed to determine if these moderations would be evident above and beyond the potentially confounding effects of sex, race/ethnicity, parent education level, polysubstance use, anxiety, and depression. Accordingly, this study was designed to address whether procrastination moderates the association between cannabis use and academic performance, and whether there are unique effects of lifetime cannabis use relative to more recent cannabis use on cumulative vs. term GPA, respectively. For each model, it was hypothesized that there would be a main effect of cannabis use, such that students who use cannabis more frequently would have lower GPAs than students who use cannabis less frequently. Additionally, a hypothesized main effect of procrastination behavior predicted that students with higher procrastination scores would have lower GPAs than participants with lower procrastination scores. Furthermore, a hypothesized interaction between cannabis use and procrastination predicted that students who use cannabis more frequently and have higher procrastination scores would have lower GPAs than participants who use cannabis more frequently and have lower procrastination scores.

METHODS

Participants

Participants were 18-24 year old college students at a university in the Pacific Northwest United States, and were registered for classes in the Fall 2021 term. In addition, participants were required to be US citizens, fluent in English, and not currently pregnant. After screening and data cleaning (see the Data Screening and Cleaning section of the Methods), a final sample of N = 220 was obtained. This sample was primarily female (71.8%), White (79.1%) and reported an average age of 19.48 (SD = 1.63). Descriptive statistics for demographic variables, covariate measures, and scores on primary variables of interest can be found in Table 1. Study recruitment was primarily conducted through the university's psychology department research pool website (SONA), with some additional participant recruitment via community flyers (only three participants, or 1.4% of the final sample, were recruited via flyers). Participants in the study were awarded research pool credits that could be used to satisfy course requirements, or they could take part in the study on a voluntary basis. This study was approved by Oregon State University's Institutional Review Board (IRB), Study # 2021-1132, and was conducted in accordance with all ethical guidelines of the IRB.

Table 1. *Demographics, Covariates, and Scores on Primary Variables*

		Total (*N*=220)	
Demographics		***M*(*SD*) or %**	**Range**
Age		19.48 (1.63)	6.0
Sex (% Female)		71.8%	
Race			
	American Indian/Alaskan Native	0.9%	
	Asian	9.5%	
	Native Hawaiian/Pacific Islander	0.9%	
	Middle Eastern	0.5%	
	White	79.1%	
	Black/African American	0.9%	
	More than one race	4.5%	
	Other	3.6%	
Hispanic/Latinx			
	Yes	13.2%	
	No	85.9%	
	Unknown	0.9%	
Parent Education Level			
	Some High School	2.3%	
	High School Graduate/GED	10.9%	
	Some College	7.7%	
	Associate Degree/Trade Certificate	6.4%	
	Bachelor's Degree	36.4%	
	Graduate Degree	36.4%	
Year in School			
	Freshman	50.0%	
	Sophomore	17.7%	
	Junior	20.9%	
	Senior	9.5%	
	Other	1.8%	
Past Month Cannabis Use			
	No days	61.4%	
	1-5 days	18.2%	
	6-10 days	5.5%	
	11-15 days	3.2%	
	16-20 days	0.9%	
	21-25 days	1.8%	
	More than 25 days	9.1%	
Lifetime Cannabis Use			
	None	33.6%	
	1-5 uses	13.6%	
	6-10 uses	9.5%	
	11-50 uses	15.9%	
	51-100 uses	9.5%	
	101-500 uses	7.3%	
	501-1000 uses	2.7%	
	1001-2000 uses	4.5%	
	2001-5000 uses	1.8%	
	5001-10000 uses	1.4%	
Term GPA			
	Less than 0.99	0.5%	
	1.00-1.49	1.8%	
	1.50-1.99	3.6%	
	2.00-2.49	6.8%	
	2.50-2.99	7.7%	

	3.00-3.49	23.2%	
	3.50-3.99	35.5%	
	4.0	20.9%	
Cumulative GPA			
	1.00-1.49	0.9%	
	1.50-1.99	4.1%	
	2.00-2.49	7.3%	
	2.50-2.99	8.6%	
	3.00-3.49	27.3%	
	3.50-3.99	37.7%	
	4.0	14.1%	
Covariates			
	Past 30-Day Alcohol Use (days)	4.62 (4.82)	22.0
	Past 30-Day Nicotine Use (days)	3.69 (9.11)	30.0
	Past 30-Day Illicit Drug Use (days)	0.36 (2.85)	30.0
	Anxiety	16.11 (12.31)	57.0
	Depression	20.15 (11.43)	55.0
Predictor/Outcome Variables			
	Past Month Cannabis Use (days)	4.48 (9.02)	31.0
	Lifetime Cannabis Use (uses)	267.53 (947.36)	8000.0
	Procrastination	30.47 (6.33)	32.0
	Term GPA	3.37 (0.70)	3.15
	Cumulative GPA	3.36 (0.63)	2.99

Measures

Demographics & Substance Use History

Participants completed a brief demographics questionnaire indicating their age, sex, race/ethnicity, and their parents' education levels. Prior to analysis, sex, race, and ethnicity were converted into dichotomous variables. Specifically, these covariates were recoded so that: Sex (0 = Male, 1 = Female), Race (0 = Non-White, 1 = White), and Ethnicity (0 = Not Hispanic/Unknown, 1 = Hispanic). Parent Education Level was coded as the highest education level attained by either parent on a scale from 1-6, from lowest (some high school) to highest (graduate degree). The questionnaire also measured polysubstance use by asking participants to indicate their past 30-day use of alcohol, nicotine, and illicit drugs. Past 30-day Alcohol Use was collected with a single item: Out of the past 30 days, how many days did you consume alcohol? Past 30-day Nicotine Use was also collected with a single item: Out of the past 30 days, how many days did you use any nicotine products? (e.g. – cigarettes, cigars, chewing tobacco, e-cigs, vapes), as was Past 30-day Illicit Drug Use: Out of the past 30 days, how many days did you recreationally use illicit drugs other than alcohol, nicotine, or cannabis?

Anxiety & Depression

Participants completed the 21-item Beck Anxiety Inventory (BAI) (Beck et al., 1988). This scale has shown high internal consistency ($\alpha = 0.92$) and test-retest reliability over one week, $r(81) = 0.75$, and was developed to avoid confounding with depression (Beck et al., 1988). The BAI has been found reliable in college samples in the past (Osman et al., 1997), as well as in the current sample ($\alpha = 0.93$). Additionally, participants completed the 20-item Center for Epidemiologic Studies Depression scale (CES-D) (Radloff, 1977). This measure has been found to be a reliable ($\alpha = 0.87$) and valid measure of depression in college samples in the past (Radloff, 1991), and was also found reliable in the current sample ($\alpha = 0.91$). Total scores on these two measures were used to control for the potential effects of anxiety and depression on academic performance.

Cannabis Use

Cannabis use is often assessed by frequency measures (how often cannabis was used) or

quantity measures (how much cannabis was used). Research suggests that participants have difficulty estimating the quantity of cannabis they are using and consistently overestimate quantities, even when the estimation is done immediately after preparation (Prince et al., 2018). Quantity measures are further complicated by the use of multiple forms of cannabis (flower, concentrates, edibles, etc.), and diverse methods of consumption (pipes, joints, vaporizers, foods, topical solutions, etc.), which often use different scales for quantity (e.g., grams of flower vs milligrams of THC in an edible). More recent surveys are being developed to improve quantity estimates, but have mostly been examined in samples with a high percentage of daily cannabis consumers (Borodovsky et al., 2022). Since we were interested in retrospective cannabis use over a long period and across a variety of forms and methods of consumption in a range of low to frequent cannabis users, we chose to focus on frequency of cannabis use rather than quantity. In the current study, cannabis use was operationalized in two ways: Past Month Cannabis Use and Lifetime Cannabis Use. Past Month Cannabis Use was measured using a single continuous item, (Approximately how many days of the past month did you use cannabis?). Lifetime Cannabis Use was assessed using two items: (Which of the following best captures the number of times you have used cannabis in your entire life?) with 10 ordinal categories estimating the number of lifetime cannabis uses: (1–5; 6–10; 11–50; 51–100; 101–500; 501–1000; 1001–2000; 2001–5000; 5001–10,000; 10,000+), which was selected from the Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU) (Cuttler & Spradlin, 2017). A follow-up question was used to verify participants' responses, and obtain a continuous estimation of cannabis use (Within the range you indicated in the previous question, please estimate the exact number of lifetime cannabis uses). Similar items querying estimates of lifetime number of cannabis use occasions (O'Donnell et al., 2021), lifetime number of joints (Gonzalez et al., 2012; Verdejo-Garcia et al., 2013), and lifetime number of cannabis use days (Pacheco-Colón et al., 2019) have been used to estimate lifetime cannabis consumption in young adult samples. Thus, the continuous estimation of lifetime cannabis use occasions was used as the Lifetime Cannabis Use variable. While the primary form of cannabis used was not considered a variable of interest in the current study, it is worth noting that for participants who reported cannabis use, 42.1% used primarily marijuana (flower), 21.4% used primarily concentrates (e.g., oil, wax, shatter, butane hash oil, dabs), 19.3% used primarily edibles, and 17.2% selected "none" on the DFAQ-CU, indicating that they had no preference.

Procrastination

Participants completed a 10-item Procrastination Scale (Chow, 2011). This measure's reliability has been found acceptable in college samples in the past ($\alpha = 0.69$; Chow, 2011), as well as in the current sample ($\alpha = 0.74$). This measure uses a 5-point Likert scale (1 = Not at all True, 5 = Very True) to assess the extent to which participants agree with statements about their procrastination behavior, with higher scores indicating greater levels of procrastination. A sample item is: I frequently complete tasks earlier than is required (reverse coded). The total score on this measure was used to assess the tendency to exhibit procrastination behavior.

Academic Performance

Participants provided their consent to release their official academic records as part of study participation. Specifically, the study collected the participants' Term and Cumulative GPA records for the Fall 2021 quarter from the registrar's office. These GPA records served as the primary dependent variables. Each analysis was performed with Term GPA and Cumulative GPA. This provided the opportunity to examine the effect of Past Month Cannabis Use on Term GPA, as well as an overall effect of Lifetime Cannabis Use on Cumulative GPA (although the predicted direction of the associations for both Term and Cumulative GPA were identical). While self-reported GPA was not considered in the current study, participants were asked to self-report their most recent college cumulative GPA for the purpose of comparison. For the 159 students who reported their cumulative GPA, their responses showed a moderate to strong correlation ($r = 0.67$, $p < .001$) with official GPA records. While the strength of the correlation is encouraging, this suggests that there may still be significant

variation between self-reported and official GPA records.

Procedure

Participants who signed up for the study were directed to a Qualtrics online survey. After participants provided consent, they were asked to enter their student identification number. This number was used to request official GPA records from the registrar's office at the end of the Fall 2021 term. The survey then generated a random ID number to protect confidentiality, and a second survey was automatically opened to record the participants' responses to survey measures, including the demographics/substance use history questionnaires, the Procrastination Scale, the BAI, and the CES-D.

Data Screening and Cleaning

Prior to analysis, several participants' data were excluded from analysis. A total of 310 participants completed the survey, but 27 participants were removed because they were duplicates (the same student ID number being used for multiple responses). To remove a duplicate response, survey completion percentage was considered first (with more complete responses being retained over less complete responses), and if completion was comparable between duplicates, then the chronological first survey response was retained (with subsequent duplicate responses excluded). One participant was excluded due to an invalid student ID number. Next, data were screened for missingness on measures assessing primary variables and covariates. One participant was excluded because they were the only participant who reported "Other" as their biological sex, and four participants were excluded because they reported "Unknown/Not Applicable" for both parents' education levels. An additional 51 participants were excluded for missing data, either for skipping entire measures or missing key items (the cannabis use items, the BAI, the CES-D, or the Procrastination scale). Finally, Wood et al. (2017) recommend excluding participants from online samples if they respond faster than a rate of 1 second per item. Based on research assistants' average completion time (20-40 minutes), a more conservative threshold was used, and an additional six participants were excluded for completion times less than 5 minutes.

Data Analysis

After verifying that statistical assumptions were met, data from the experiment were analyzed using IBM SPSS Statistical software version 28.0 and the PROCESS macro (Hayes, 2022). Hypothesis testing was conducted using a series of hierarchical multiple linear regressions to examine the association between substance use and GPA. For each regression analysis, sex, race/ethnicity, parent education level, past month alcohol, nicotine, and illicit drug use, anxiety, and depression were entered as covariates in the first step, with main effects and interaction terms entered in the second step. For the moderation analyses, the continuous predictors were all mean-centered before computing interaction terms, and the mean-centered predictors and their interactions were then entered into the models after first controlling for covariates. The PROCESS macro was used to conduct simple slopes analyses, which produce unstandardized coefficients (Hayes, 2022). Correlations (Pearson's r) between primary variables for the final sample can be found in Supplementary Table 1.

RESULTS

Procrastination & Term GPA

A hierarchical multiple linear regression tested Past Month Cannabis Use, Procrastination, and their interaction as predictors of Term GPA after controlling for covariates. As Table 2 indicates, Model 1 was significant, $F(9,210) = 5.56$, $p < .001$, and the covariates explained 19.2% of the variance in Term GPA. Sex and Parent Education Level emerged as significant positive predictors of Term GPA, suggesting females and students whose parents have greater levels of education earned higher grades on average in the Fall 2021 term. In addition, past 30-day alcohol use and depression scores both emerged as significant negative predictors of Term GPA, suggesting that students with more frequent alcohol use and/or greater depression levels earned lower grades that term. In Model 2, adding Past Month Cannabis Use, Procrastination, and their interaction improved

the model, $\Delta F(3,207) = 7.34$, $p < .001$, and it explained an additional 7.8% of the variance in Term GPA. The analysis showed a main effect for Procrastination, ß = -0.29, $t = -4.41$, $p < .001$, such that greater Procrastination scores predicted lower Term GPA. However, neither Past Month Cannabis Use (ß = -0.04, $p = .549$) nor the interaction term (ß = -0.09, $p = .152$) were significant predictors of Term GPA.

Table 2. *Hierarchical Multiple Linear Regression of Past Month Cannabis Use, Procrastination, and their Interaction on Term GPA*

Model	R^2 (ΔR^2)	*B* (*SE*)	ß	*t*	*p*
Step 1: Covariates	0.192*				< .001*
Constant		2.61 (0.22)			
Sex		0.26 (0.12)	0.17*	2.48	.014*
Race		0.06 (0.11)	0.03	0.51	.613
Ethnicity		0.05 (0.13)	0.03	0.38	.704
Parent Education Level		0.15 (0.03)	0.31*	4.78	< .001*
Alcohol Use		0.02 (0.01)	0.14	2.12	.035*
Nicotine Use		-0.01 (0.01)	-0.11	-1.67	.096
Illicit Drug Use		0.00 (0.02)	-0.01	-0.18	.859
Anxiety		0.00 (0.01)	0.03	0.31	.755
Depression		-0.01 (0.01)	-0.23*	-2.63	.009*
Model 2: Main Effects & Interaction	0.270 (0.078)*				< .001*
Constant		2.39 (0.21)			
Sex		0.26 (0.10)	0.17*	2.53	.012*
Race		0.07 (0.12)	0.04	0.64	.523
Ethnicity		0.05 (0.13)	0.03	0.40	.690
Parent Education Level		0.17 (0.03)	0.34*	5.38	< .001*
Alcohol Use		0.02 (0.01)	0.12	1.78	.076
Nicotine Use		-0.01 (0.01)	-0.09	-1.36	.175
Illicit Drug Use		0.00 (0.02)	-0.01	-0.08	.933
Anxiety		0.00 (0.01)	-0.03	-0.36	.718
Depression		0.00 (0.01)	-0.06	-0.68	.498
Past Month Cannabis Use		0.00 (0.01)	-0.04	-0.60	.549
Procrastination		-0.03 (0.01)	-0.29*	-4.41	< .001*
Cannabis Use X Procrastination		0.00 (0.00)	-0.09	-1.44	.152

Note. Asterisks (*) indicate significant models/predictors ($p < .05$).

Procrastination & Cumulative GPA

A second hierarchical multiple linear regression examined whether Lifetime Cannabis Use, Procrastination, and their interaction predicted Cumulative GPA after controlling for covariates. As Table 3 shows, Model 1 was significant, $F(9,210) = 3.87$, $p < .001$, and the covariates explained 14.2% of the variance in Cumulative GPA, with Sex and Parent Education Level emerging as positive predictors of Cumulative GPA, and past 30-day nicotine use emerging as a negative predictor of Cumulative GPA. In Model 2, adding Lifetime Cannabis Use, Procrastination, and their interaction improved the model, $\Delta F(3,207) = 9.98$, $p < .001$, and it explained an additional 10.8% of the variance in Cumulative GPA. The analysis indicated significant main effects for Lifetime Cannabis Use, ß = -0.26, $t = -3.20$, $p = .002$, and Procrastination, ß = -0.31, $t = -4.57$, $p < .001$. In addition, the interaction term was significant, ß = -0.19, $t = -2.55$, $p = .012$, indicating that the association between Lifetime Cannabis Use and Cumulative GPA varied with the level of Procrastination. A simple slopes analysis (Figure 1) showed that Lifetime Cannabis Use predicted lower Cumulative GPA when Procrastination scores were high (+1 *SD*), $B = -0.0003$, $p = .002$, or Procrastination scores were average, $B = -0.0002$, $p = .002$, but not when Procrastination scores were low (-1 *SD*), $B = 0.0000$, $p = .995$. In other words,

the association between Lifetime Cannabis Use and Cumulative GPA strengthened as Procrastination scores increased, and greater cannabis use predicted lower grades for students with higher levels of procrastination, but not for students with lower levels of procrastination.

Table 3. *Hierarchical Multiple Linear Regression of Lifetime Cannabis Use, Procrastination, and their Interaction on Cumulative GPA*

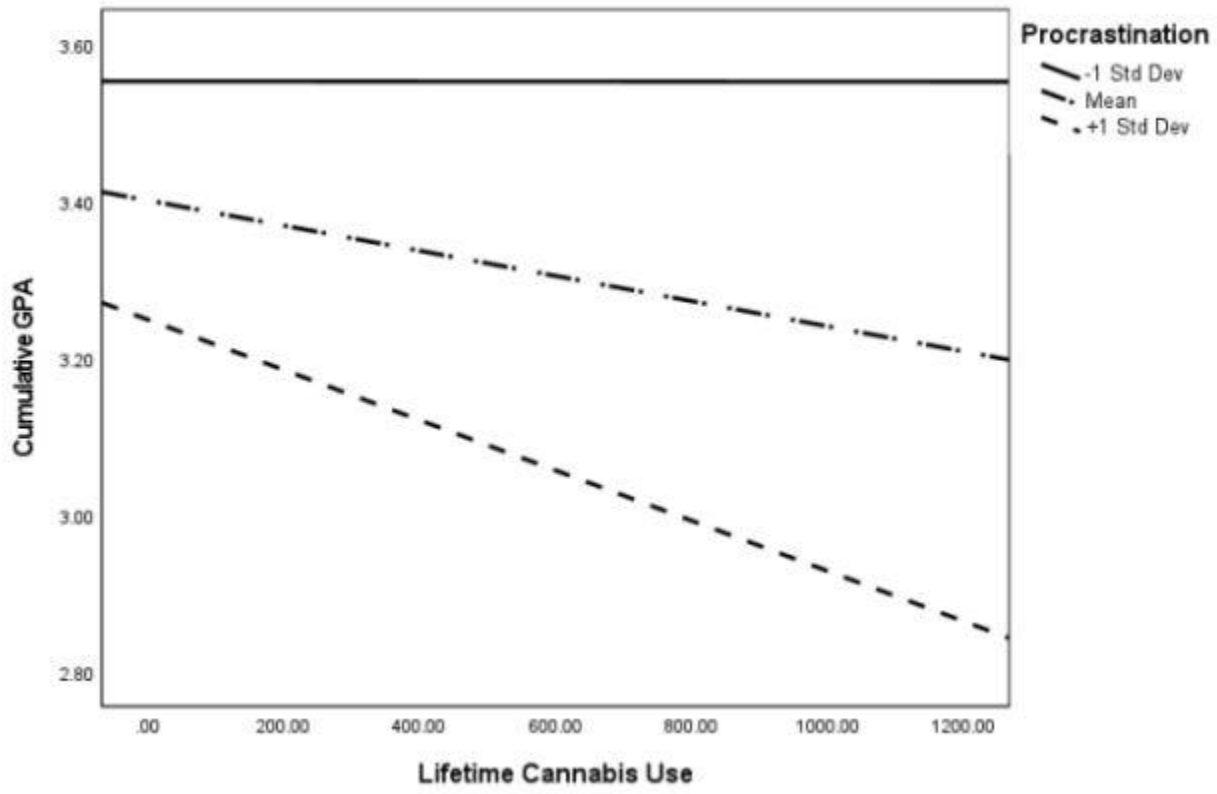
Model	R^2 (ΔR^2)	*B* (*SE*)	β	*t*	*p*
Step 1: Covariates	0.142*				< .001*
Constant		2.78 (0.20)			
Sex		0.21 (0.10)	0.15*	2.10	.037*
Race		0.09 (0.10)	0.06	0.87	.384
Ethnicity		0.01 (0.13)	0.01	0.53	.959
Parent Education Level		0.11 (0.03)	0.24*	3.57	< .001*
Alcohol Use		0.02 (0.01)	0.12	1.74	.083
Nicotine Use		-0.01 (0.01)	-0.16	-2.21	.028*
Illicit Drug Use		-0.02 (0.01)	-0.08	-1.27	.204
Anxiety		0.00 (0.01)	-0.04	-0.42	.678
Depression		-0.01 (0.01)	-0.13	-1.41	.160
Model 2: Main Effects & Interaction	0.251 (0.108)*				< .001*
Constant		2.62 (0.19)			
Sex		0.17 (0.09)	0.12*	1.81	.071
Race		0.11 (0.10)	0.07	1.15	.250
Ethnicity		-0.02 (0.12)	-0.01	-0.13	.893
Parent Education Level		0.11 (0.03)	0.26*	4.00	< .001*
Alcohol Use		0.02 (0.01)	0.13	1.90	.059
Nicotine Use		-0.01 (0.01)	-0.08	-1.20	.232
Illicit Drug Use		-0.01 (0.01)	-0.06	-0.89	.376
Anxiety		-0.01 (0.01)	-0.08	-0.88	.379
Depression		0.00 (0.01)	0.01	0.39	.969
Lifetime Cannabis Use		0.00 (0.00)	-0.26*	-3.20	.002*
Procrastination		-0.03 (0.01)	-0.31*	-4.57	< .001*
Cannabis Use X Procrastination		0.00 (0.00)	-0.19*	-2.55	.012*

Note. Asterisks (*) indicate significant models/predictors ($p < .05$).

DISCUSSION

In the present study, there was a main effect of procrastination, but no significant effects of recent cannabis use or interaction between recent cannabis use and procrastination on term GPA. There was also a main effect of lifetime cannabis use, a main effect of procrastination, as well as a significant interaction between lifetime cannabis use and procrastination on cumulative GPA. As hypothesized, more frequent cannabis use was related to lower GPA for students with higher levels of procrastination, but not for students with lower levels of procrastination. These results provide partial support for the hypothesized role of procrastination as a moderator between cannabis use and academic performance, and suggest that the strength of the association between lifetime cannabis use and cumulative GPA varies with the level of procrastination, and that students with higher levels of procrastination may be particularly vulnerable to poorer academic performance at higher levels of lifetime cannabis, relative to students with lower levels of procrastination. Accordingly, it is possible that interventions designed to address procrastination behavior (e.g., time-management strategies, keeping a daily schedule, etc.) may be particularly beneficial for students who frequently use cannabis. Helpful interventions for procrastination generally focus on training self-regulatory skills, building self-esteem, and increasing social support (Schouwenburg, 2004). Research suggests that cognitive behavioral therapy can be particularly effective for reducing procrastination behavior (van Eerde & Klingsieck, 2018). These interventions can help patients recognize patterns in their

Figure 1. *Procrastination Moderates the Association Between Lifetime Cannabis Use and Cumulative Grade Point Average*



Note. Greater lifetime cannabis use was associated with lower grades at high and average levels of procrastination, but not at low levels of procrastination. High and low procrastination scores were tested at one standard deviation above and below the mean, respectively.

procrastination behavior and the irrational thoughts that may be contributing to their procrastination, then focus on correcting those irrational thoughts and changing subsequent behavior by enhancing self-regulation (e.g., setting goals, self-monitoring, managing priorities, time-management, etc.). However, therapeutic interventions can be prohibitively expensive, are often time-consuming, and are typically reactive in nature – treatment is often sought only after problematic behavior becomes apparent. A different approach is to incorporate procrastination intervention/prevention into the curriculum itself with the help of instructors/teachers. Classroom techniques that have been shown to reduce academic procrastination include incorporating pop quizzes to encourage regular study habits, meeting with students who have late or missing assignments to develop a written plan for completing the work, assigning larger projects in more manageable chunks with frequent check-ins, and regular communications reminding students what they should be working on (Zacks & Hen, 2018). Nevertheless, classroom-based interventions for procrastination remain understudied and further research is needed to identify any potential academic benefits of these strategies for students who procrastinate and frequently use cannabis.

The present study also found negative associations between procrastination and both term and cumulative GPA. These findings are in line with previous research suggesting a negative association exists between procrastination and multiple indices of academic performance in college, including quiz and exam scores, course grades, and GPA (Kim & Seo, 2015). However, it is unclear why a significant interaction was found between cannabis use and procrastination when examining lifetime cannabis use and cumulative

GPA, but not when examining past month cannabis use and term GPA. For example, it is possible that the term GPA collected could have been influenced by history effects. After all, the Fall 2021 term marked the return to in-person instruction for many students after more than a year of remote learning during the height of the COVID-19 pandemic. However, the term and cumulative GPA scores collected in the present study were very strongly correlated ($r = 0.90$, $p < .001$), whereas the correlation between past month and lifetime cannabis use was more moderate ($r = 0.48$, $p < .001$). Therefore, it is more likely that lifetime cannabis use exhibits an association with cumulative academic performance because it reflects the residual and chronic effects of cannabis use on academic achievement. However, past month cannabis use may only provide a limited assessment of cannabis use characteristics that may change over the course of adolescence and young adulthood. Indeed, research suggests that long-term cannabis users perform significantly worse on tests of memory and attention compared to short-term users, and long-term use is also associated with impaired learning, retention, and retrieval on learning tasks (Solowij et al., 2002). It is interesting to note that in the current study lifetime cannabis use was associated with lower cumulative GPA at both high and average levels of procrastination, but not at low levels of procrastination. Thus, the current findings suggest that being low on this trait may be interpreted as protective for cannabis users in the long run. Given more variance in the measure of lifetime cannabis use vs. past 30-day cannabis use, as indicated in Table 1, it is possible that this relatively stable personality trait is more likely to moderate the relationship between a variable measuring a longer history of cannabis use and cumulative GPA. Future investigations into the impact of cannabis use on academic performance should employ measures that can capture long-term cannabis use patterns, such as lifetime cannabis use, as opposed to only examining cannabis use in the past month.

Strengths and Limitations

The present study has several strengths to consider. For instance, all analyses were performed using actual GPA records obtained from the university registrar rather than via self-report, increasing confidence in the current findings. Furthermore, the study controlled for several potential confounding variables, and the associations reported here were found *above and beyond* important covariates related to academic performance. The present findings also underscore the importance of investigating how interactions between cannabis use and additional factors are related to academic performance rather than limiting investigations to the direct effects of cannabis use alone.

Conversely, the present study has some limitations that must be considered as well. For example, the participant sample represented primarily White and female students. This limits the generalizability of the present findings. While some evidence suggests the gender gap has been closing in recent years, historically cannabis use has been more prevalent in males than females (Chapman et al., 2017), and the results of the current study also indicated that sex was a significant predictor of college GPA, with males earning lower GPAs than females. In addition, the sample contained a large proportion (50%) of first-year college students. For these students, lifetime cannabis use may be measuring predominantly adolescent cannabis use, as opposed to cannabis use in college. Moreover, if first-year participants were in their first *term* during data collection, their term and cumulative GPAs would be identical. Accordingly, future studies should strive to replicate these results in more diverse samples of college students with more male participants and upper-level students.

Additionally, the models in this study only explained about 24-26% of the variance in GPA, suggesting that unexplored factors related to personality, motivations, and other individual differences need to be examined to understand how they may contribute to academic achievement. For example, some students may use cannabis to self-medicate symptoms of psychological distress (and may also be low procrastinators). Although speculative, this reduction in negative affect may confer academic benefits for this sub-group of cannabis users. While the current study did not examine motivations for cannabis use, future investigations could consider how different motives for cannabis use (coping, social, enhancement, etc.) may differentially relate to

academic outcomes. It is also noteworthy that parental education was significantly related to student GPA in the current study and should be controlled for in future investigations related to substance use and academic performance. Furthermore, as this study is cross-sectional, causality cannot be determined. The directionality of potential associations among cannabis use, procrastination, and college GPA remains unclear. Future research employing longitudinal designs could better address the question of causality, as well as explore how dynamic patterns of cannabis use interact with factors such as procrastination to affect grades over time. Additionally, the measurement of cannabis use could have been affected by response bias. Although participants were informed that their confidentiality would be protected by de-identification procedures, the potential for identification could have resulted in underreporting of cannabis use. Moreover, even though similar assessments of cannabis use have been used in prior studies, accurately reporting the number of lifetime cannabis uses may have been more difficult for participants with more frequent cannabis use. Future investigations may benefit from more comprehensive, multi-item measures of cannabis use frequency. Finally, there are limitations inherent in using GPA as a dependent variable. For example, students who are struggling academically in a certain class often have options they can exercise (withdraw, pass/fail options, incomplete status, etc.) that may not be reflected on their term or cumulative GPA records. Future investigations could also attempt to unpack GPA into separate components of performance. For example, future studies could examine the associations between cannabis use, procrastination, and scores on tests, quizzes, assignments, term papers, and participation/attendance grades. This may provide a more fine-grained measurement of academic performance that is able to distinguish between students with the same letter grades, as well as identify specific components of academic performance that could be disproportionately affected by cannabis use.

Conclusion

In summary, the current study found that procrastination moderates the association between lifetime cannabis use and cumulative college GPA. For students with high levels of procrastination, greater lifetime cannabis use predicted lower cumulative GPAs, but not for students with low levels of procrastination. Thus, the current study identifies a putatively modifiable factor (such as procrastination) that may moderate academic performance for students who use cannabis. These results may help inform educational interventions and pedagogical techniques designed to help students using cannabis succeed academically, as well as provide guidance for future research directions.

REFERENCES

Arria, A. M., Caldeira, K. M., Bugbee, B. A., Vincent, K. B., & O'Grady, K. E. (2015). The academic consequences of marijuana use during college. *Psychology of Addictive Behaviors*, *29*(3), 564-575. https://doi.org/10.1037/adb0000108

Asher BlackDeer, A., Patterson Silver Wolf, D. A., Maguin, E., & Beeler-Stinn, S. (2023). Depression and anxiety among college students: Understanding the impact on grade average and differences in gender and ethnicity. *Journal of American College Health*, *71*(4), 1091-1102. https://doi.org/10.1080/07448481.2021.1920954

Ashtari, M., Cervellione, K., Cottone, J., Ardekani, B. A., Sevy, S., & Kumra, S. (2009). Diffusion abnormalities in adolescents and young adults with a history of heavy cannabis use. *Journal of Psychiatric Research*, *43*(3), 189-204. https://doi.org/10.1016/j.jpsychires.2008.12.002

Bae, H., & Kerr, D. C. R. (2020). Marijuana use trends among college students in states with and without legalization of recreational use: Initial and longer-term changes from 2008 to 2018. *Addiction*, *115*(6), 1115-1124. https://doi.org/10.1111/add.14939

Beck, A. T., Epstein, N., Brown, G., & Steer, R. A. (1988). An inventory for measuring clinical anxiety: Psychometric properties. *Journal of Consulting and Clinical Psychology*, *56*(6), 893-897. https://doi.org/10.1037//0022-006x.56.6.893

Borodovsky, J. T., Hasin, D. S., Shmulewitz, D., Walsh, C., Livne, O., Aharonovich, E., Struble, C. A., Habib, M. I., & Budney, A. J. (2022). Typical hits, grams, or joints: Evaluating cannabis survey measurement strategies for quantifying consumption. *Cannabis and Cannabinoid Research*. Advance online publication. https://doi.org/10.1089/can.2022.0237

Broyd, S. J., van Hell, H. H., Beale, C., Yucel, M., & Solowij, N. (2016). Acute and chronic effects of cannabinoids on human cognition - a systematic review. *Biological Psychiatry*, *79*(7), 557-567. https://doi.org/10.1016/j.biopsych.2015.12.002

Buckner, J. D., Ecker, A. H., & Cohen, A. S. (2010). Mental health problems and interest in marijuana treatment among marijuana-using college students. *Addictive Behaviors*, *35*(9), 826-833. https://doi.org/10.1016/j.addbeh.2010.04.001

Burggren, A. C., Shirazi, A., Ginder, N., & London, E. D. (2019). Cannabis effects on brain structure, function, and cognition: Considerations for medical uses of cannabis and its derivatives. *The American Journal of Drug and Alcohol Abuse*, *45*(6), 563-579. https://doi.org/10.1080/00952990.2019.1634086

Caldeira, K. M., Arria, A. M., O'Grady, K. E., Vincent, K. B., & Wish, E. D. (2008). The occurrence of cannabis use disorders and other cannabis-related problems among first-year college students. *Addictive Behaviors*, *33*(3), 397-411. https://doi.org/10.1016/j.addbeh.2007.10.001

Chapman, C., Slade, T., Swift, W., Keyes, K., Tonks, Z., & Teesson, M. (2017). Evidence for sex convergence in prevalence of cannabis use: A systematic review and meta-regression. *Journal of Studies on Alcohol and Drugs*, *78*(3), 344-352. https://doi.org/10.15288/jsad.2017.78.344

Chow, H. P. H. (2011). Procrastination among undergraduate students: Effects of emotional intelligence, school life, self-evaluation, and self-efficacy. *Alberta Journal of Educational Research*, *57*(2), 234-240. https://doi.org/10.11575/ajer.v57i2.55479

Cuttler, C., & Spradlin, A. (2017). Measuring cannabis consumption: Psychometric properties of the Daily Sessions, Frequency, Age of Onset, and Quantity of Cannabis Use Inventory (DFAQ-CU). *PLoS One*, *12*(5), e0178194. https://doi.org/10.1371/journal.pone.0178194

DeCamp, W., & Daly, K. (2019). Measuring the impact of substance use on standardized test score averages. *Journal of Articles in Support of the Null Hypothesis*, *15*(2), 81-96.

Fergusson, D. M., Horwood, L. J., & Beautrais, A. L. (2003). Cannabis and educational achievement. *Addiction*, *98*(12), 1681-1692. https://doi.org/10.1111/j.1360-0443.2003.00573.x

Fontes, M. A., Bolla, K. I., Cunha, P. J., Almeida, P. P., Jungerman, F., Laranjeira, R. R., Bressan, R. A., & Lacerda, A. L. (2011). Cannabis use before age 15 and subsequent executive functioning. *The British Journal of Psychiatry*, *198*(6), 442-447. https://doi.org/10.1192/bjp.bp.110.077479

Gonzalez, R., Schuster, R. M., Mermelstein, R. J., Vassileva, J., Martin, E. M., & Diviak, K. R. (2012). Performance of young adult cannabis users on neurocognitive measures of impulsive behavior and their relationship to symptoms of cannabis use disorders. *Journal of Clinical and Experimental Neuropsychology*, *34*(9), 962-976. https://doi.org/10.1080/13803395.2012.703642

Hayes, A. F. (2022). *Introduction to mediation, moderation, and conditional process analysis: A regression-based approach* (3rd ed.). Guilford Press.

Heradstveit, O., Skogen, J. C., Hetland, J., & Hysing, M. (2017). Alcohol and illicit drug use are important factors for school-related problems among adolescents. *Frontiers in Psychology*, *8*, 1023. https://doi.org/10.3389/fpsyg.2017.01023

Hernandez-Serrano, O., Gras, M. E., & Font-Mayolas, S. (2018). Concurrent and simultaneous use of cannabis and tobacco and its relationship with academic achievement amongst university students. *Behavioral Sciences (Basel)*, *8*(3). https://doi.org/10.3390/bs8030031

Kerr, D. C. R., Bae, H., & Koval, A. L. (2018). Oregon recreational marijuana legalization: Changes in undergraduates' marijuana use rates from 2008 to 2016. *Psychology of Addictive Behaviors*, *32*(6), 670-678. https://doi.org/10.1037/adb0000385

Kim, K. R., & Seo, E. H. (2015). The relationship between procrastination and academic performance: A meta-analysis. *Personality and Individual Differences*, *82*, 26-33. https://doi.org/10.1016/j.paid.2015.02.038

Lynskey, M., & Hall, W. (2000). The effects of adolescent cannabis use on educational attainment: A review. *Addiction*, *95*(11), 1621-1630. https://doi.org/10.1046/j.1360-0443.2000.951116213.x

Macleod, J., Oakes, R., Copello, A., Crome, I., Egger, M., Hickman, M., Oppenkowski, T., Stokes-Lampard, H., & Davey Smith, G. (2004). Psychological and social sequelae of cannabis and other illicit drug use by young people: A systematic review of longitudinal, general population studies. *Lancet*, *363*(9421), 1579-1588. https://doi.org/10.1016/S0140-6736(04)16200-4

Martinez, J. A., Roth, M. G., Johnson, D. N., & Jones, J. A. (2015). How robustly does cannabis use associate to college grades? Findings from two cohorts. *Journal of Drug Education*, *45*(1), 56-67. https://doi.org/10.1177/0047237915596606

Meier, M. H., Hill, M. L., Small, P. J., & Luthar, S. S. (2015). Associations of adolescent cannabis use with academic performance and mental health: A longitudinal study of upper middle class youth. *Drug and Alcohol Dependence*, *156*, 207-212. https://doi.org/10.1016/j.drugalcdep.2015.09.010

O'Donnell, B. F., Skosnik, P. D., Hetrick, W. P., & Fridberg, D. J. (2021). Decision making and impulsivity in young adult cannabis users. *Frontiers in Psychology*, *12*, 679904. https://doi.org/10.3389/fpsyg.2021.679904

Osman, A., Kopper, B. A., Barrios, F. X., Osman, J. R., & Wade, T. (1997). The Beck Anxiety Inventory: Reexamination of factor structure and psychometric properties. *Journal of Clinical Psychology*, *53*(1), 7-14. https://doi.org/10.1002/(sici)1097-4679(199701)53:1<7::aid-jclp2>3.0.co;2-s

Pacheco-Colón, I., Hawes, S. W., Duperrouzel, J. C., Lopez-Quintero, C., & Gonzalez, R. (2019). Decision-making as a latent construct and its measurement invariance in a large sample of adolescent cannabis users. *Journal of the International Neuropsychological Society*, *25*(7), 661-667. https://doi.org/10.1017/S1355617719000341

Páramo, M. F., Cadaveira, F., Tinajero, C., & Rodríguez, M. S. (2020). Binge drinking, cannabis co-consumption and academic achievement in first year university students in spain: Academic adjustment as a mediator. *International Journal of Environmental Research and Public Health*, *17*(2), 542. https://doi.org/10.3390/ijerph17020542

Patrick, M. E., Schulenberg, J. E., Miech, R. A., Johnston, L. D., O'Malley, P. M., & Bachman, J. G. (2022). *Monitoring the future panel study annual report: National data on substance use among adults ages 19-60, 1976-2021.* Monitoring the Future Monograph Series. Ann Arbor: Institute for Social Research, The University of Michigan. https://doi.org/10.7826/ISR-UM.06.585140.002.07.0001.2022

Prince, M. A., Conner, B. T., & Pearson, M. R. (2018). Quantifying cannabis: A field study of marijuana quantity estimation. *Psychology of Addictive Behaviors*, *32*(4), 426-433. https://doi.org/10.1037/adb0000370

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*(3), 385-401. https://doi.org/10.1177/014662167700100306

Radloff, L. S. (1991). The use of the center for epidemiologic studies depression scale in adolescents and young adults. *Journal of Youth and Adolescence*, *20*(2), 149-166. https://doi.org/10.1007/BF01537606

Schouwenburg, H. C. (2004). Perspectives on counseling the procrastinator. In H. C. Schouwenburg, C. H. Lay, T. A. Pychyl, & J. R. Ferrari (Eds.), *Counseling the procrastinator in academic settings* (pp. 197-208). American Psychological Association. https://doi.org/10.1037/10808-014

Schouwenburg, H. C., Lay, C. H., Pychyl, T. A., & Ferrari, J. R. E. (Eds.) (2004). *Counseling the procrastinator in academic settings*. American Psychological Association. https://doi.org/10.1037/10808-000

Solowij, N., Stephens, R. S., Roffman, R. A., Babor, T., Kadden, R., Miller, M., Christiansen, K., McRee, B., Vendetti, J., & Marijuana Treatment Project Research Group. (2002). Cognitive functioning of long-

term heavy cannabis users seeking treatment. *Journal of the American Medical Association*, *287*(9), 1123-1131. https://doi.org/10.1001/jama.287.9.1123

Stormshak, E. A., Caruthers, A. S., Gau, J. M., & Winter, C. (2019). The impact of recreational marijuana legalization on rates of use and behavior: A 10-year comparison of two cohorts from high school to young adulthood. *Psychology of Addictive Behavios*, *33*(7), 595-602. https://doi.org/10.1037/adb0000508

Suerken, C. K., Reboussin, B. A., Egan, K. L., Sutfin, E. L., Wagoner, K. G., Spangler, J., & Wolfson, M. (2016). Marijuana use trajectories and academic outcomes among college students. *Drug and Alcohol Dependence*, *162*, 137-145. https://doi.org/10.1016/j.drugalcdep.2016.02.041

Thompson, K., Leadbeater, B., Ames, M., & Merrin, G. J. (2019). Associations between marijuana use trajectories and educational and occupational success in young adulthood. *Prevention Science*, *20*(2), 257-269. https://doi.org/10.1007/s11121-018-0904-7

van Eerde, W., & Klingsieck, K. B. (2018). Overcoming procrastination? A meta-analysis of intervention studies. *Educational Research Review*, *25*, 73-85. https://doi.org/10.1016/j.edurev.2018.09.002

Verdejo-García, A., Fagundo, A. B., Cuenca, A., Rodriguez, J., Cuyás, E., Langohr, K., de Sola Llopis, S., Civit, E., Farré, M., Peña-Casanova, J., & de la Torre, R. (2013). COMT val158met and 5-HTTLPR genetic polymorphisms moderate executive control in cannabis users. *Neuropsychopharmacology*, *38*(8), 1598-1606. https://doi.org/10.1038/npp.2013.59

Wang, X., Hegde, S., Son, C., Keller, B., Smith, A., & Sasangohar, F. (2020). Investigating mental health of us college students during the COVID-19 pandemic: Cross-sectional survey study. *Journal of Medical Internet Research*, *22*(9), e22817. https://doi.org/10.2196/22817

Wood, D., Harms, P. D., Lowman, G. H., & DeSimone, D. A. (2017). Response speed and response consistency as mutually validating indicators of data quality in online samples. *Social Psychological and Personality Science*, *8*(4), 454-464. https://doi.org/10.1177/1948550617703168

Zacks, S., & Hen, M. (2018). Academic interventions for academic procrastination: A review of the literature. *Journal of Prevention & Intervention in the Community*, *46*(2), 117-130. https://doi.org/10.1080/10852352.2016.1198154

Funding and Acknowledgements: The authors received no financial support for the research, authorship, or publication of this article. The authors report there are no conflicts of interest to declare.

The data that support the findings of this study are available on request from the corresponding author.