# Greener Pastures, Continued Poorer Performance for Secondary Students

Julio Caesar[1,2], Stacy R. Karl[3],
Pablo Vivas Corrales[2], and Michael C. Rodriguez[2]

[1]Bloomington Public Schools
[2]University of Minnesota
[3]Minnesota State

Minnesota Youth Development Research Group
www.mnydrg.com

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## Abstract

Building upon previous research, we examined the association between marijuana use and academic performance among adolescents through secondary data analyses of the Minnesota Student Survey data (*n* = 125,366 in 2019; *n* =100,836 in 2022). Employing propensity score matching to control for potential confounding factors for students in Grades 8, 9, and 11, we found a consistent negative association between marijuana use and academic performance. Students who reported regular marijuana use (six or more times in the past 30 days) exhibited significant average GPA deficits of approximately 0.4 and 0.5 points, respectively, compared to non-marijuana users, even after accounting for background variables.


## Introduction

Over the past decade, the United States has witnessed a substantial shift in marijuana use policy, with an increase of marijuana legalization for both medicinal and especially recreational use. As of 2024, 24 states, three territories, and the District of Columbia have legalized adult recreational marijuana use, whereas 38 states, three territories, and the District of Columbia permit medicinal marijuana use (National Conference of State Legislatures, 2024). Moreover, 27 states and the District of Columbia have enacted decriminalization laws for small amounts of marijuana (NORML, 2024). Minnesota exemplifies this broader trend, having decriminalized possession in 1976, established a medical cannabis program in 2014, and legalized recreational use in 2023. Nevertheless, legislative bills proposing recreational marijuana legalization have occurred in every legislative session since 2017 (Minnesota Legislative Reference Library, 2024).

This expanding legal landscape has coincided with a decline in perceived marijuana risks among young adults (Wallis, 2017; Romm et al., 2021). According to the Monitoring the Future survey results of secondary school students, 31% of 12th-grade students in 2023 reported perceiving regular marijuana use as a great risk, a significantly lower perception compared to other illicit drugs (Miech et al., 2024). After the onset of the COVID-19 pandemic, the prevalence of marijuana use in the last 12 months has decreased for high school students resulting in the largest 1-year decline since the Monitoring the Future study began. In 2023, 29.0% of 12th-grade students, 17.8% of 10th-grade students, and 8.3% of eighth-grade students in the United States reported using marijuana in the past 12 months—a substantial percentage (Miech et al., 2024). The increased availability of marijuana for both recreational and medicinal purposes has continued to prompt critical inquiry into its potential consequences for student academic performance, particularly among middle and high school students.

## Literature Review

Medical marijuana researchers have suggested potential cognitive benefits, or, at a minimum, a lack of detrimental effects associated with its use. Gruber et al. (2018) reported enhanced cognitive task performance and altered brain activation patterns within the cingulate cortex and frontal regions among study participants. They further cited evidence suggesting that the intake of CBD prior to THC might augment cognitive abilities. Gruber et al. (2016) investigated the cognitive implications of medical marijuana use and revealed no significant decline in executive functioning measures after a 3-month treatment period. These researchers challenged the conventional wisdom regarding marijuana use resulting in cognitive impairment and suggested a potential distinction between medical and recreational marijuana use in terms of academic performance.

Although the potential medical benefits of marijuana have garnered significant attention, a contrasting body of evidence has emerged concerning the cognitive consequences of recreational marijuana consumption. Longitudinal researchers consistently demonstrate that recreational marijuana use has been associated with cognitive impairments, including deficits in verbal memory, processing speed, attention, and executive function (Feeney & Kampman, 2016; Gruber et al., 2018; Lisdahl et al., 2014). These impairments were particularly pronounced among adolescent users.

Researchers employing functional magnetic resonance imaging have identified distinct patterns of brain activation patterns between recreational users and non-users during executive function tasks. These discrepancies are primarily localized to prefrontal, orbitofrontal, and cingulate cortex regions, as well as subcortical and limbic areas (Gruber et al., 2018). Moreover, the timing of the start of regular marijuana use has been a critical factor. Early-onset use (before age 16) has been linked to significant impairments in cognitive performance on tasks assessing the ability to inhibit cognitive inference compared to both late-onset users and non-using control participants (Sagar et al., 2015). These researchers collectively underscore the detrimental impact of regular marijuana use on the developing adolescent brain.

Given the well-documented negative association between recreational use and cognitive performance, it is hypothesized that middle and high school students who report regular marijuana consumption will experience lower academic performance compared to their non-consuming peers as demonstrated on our past research (Caesar et al., 2020). In this study, we investigated and replicated the association between marijuana use and academic achievement in a large adolescent sample, utilizing data from 2019 and 2022 to provide updated insights into this critical issue.

## Methodology

### Data Source

The data for this study were from the 2019 and 2022 administrations of the Minnesota Student Survey (MSS), a comprehensive survey administered anonymously every 3 years to public school students in Minnesota. The MSS targets students in grades 5, 8, 9, and 11. For this study, 125,366 in 2019 and 100,836 students in 2022 participated in grades 8, 9, and 11.

### Procedures

To assess the association between regular marijuana use and academic achievement, as measured by self-reported school grades, multiple regression analyses were conducted using data from students in grades 8, 9, and 11. The 2019 dataset included 44,911 eighth-grade students, 45,232 ninth-grade students, and 35,223 11th-grade students. The sample was predominantly White (68.7%), followed by Latino (9.3%), African American/Black (5.6%), Asian American/Pacific Islander (4.6%), Multiracial (3.2%), Hmong (2.3%), and Somali (2.2%) students. Female students comprised half (50.0%) of the sample.

The 2022 dataset consisted of 37,896 eighth-grade students, 35,553 ninth-grade students, and 27,387 11th-grade students. The demographic composition of the 2022 cohort was similar to that of the 2019, with White students representing the largest group (65.9%), followed by Latino (10.5%), African American/Black (6.2%), Asian American/Pacific Islander (4.7%), Multiracial (4.1%), Somali (2.5%), and Hmong (1.9%) students. As with the 2019 data, female students constituted half (49.8%) of the sample. Students who did not report their race were excluded from all analyses.

#### *Propensity Score Matching*

To control for potential confounding variables, propensity score matching was employed to create a comparable comparison group by accounting for demographic and baseline factors (Rosenbaum & Rubin, 1984). The propensity score model included race/ethnicity, grade level, age, and Commitment to Learning (CTL) as covariates. CtL, a proxy for student engagement, encompasses learning engagement, including academic motivation, class participation, preparation, interest, perceived usefulness, and self-identity as a student (Rodriguez, 2023). By creating groups similar on these key characteristics, propensity score matching enables comparisons while alleviating concern for baseline differences.

#### *Dependent Variable*

The dependent variable in this study was academic performance, operationalized as school grades (GPA). Students reported the grades they received during the school year on the MSS, which were then converted to a 4.0 scale (2019: $M$ = 3.17, $SD$ = 0.97; 2022: $M$ = 3.16, $SD$ = 1.01).

### *Regression Analyses*

Regression analyses were conducted using R 4.4.0 statistical software (R Core Team, 2024). Two multiple regression models were fitted to the data for each year.

The first model included the following control variables: sex, grade level, race/ethnicity (dummy coded with White students as the reference group: American Indian, Asian/Pacific Islander, African American/Black, Multiracial, Latino, Somali, and Hmong), school attendance (dummy coded with no days skipped in the past 30 days as the reference group: skipped a partial day once or twice, skipped school three or more times), a measure of mental distress (summation of significant emotional, behavioral, and mental health problems; Rodriguez, 2017), and CtL.

The second model included all variables from the preceding model and incorporated an independent dichotomous variable derived from a single MSS item indicating the frequency of marijuana use in the past 30 days (where 0 = *0 number of days of marijuana use*; 1 = *6 to 30 days of marijuana use*). This allowed us to estimate the unique additive effect of regular marijuana use (weekly or more).

## Results

Propensity score matching was employed to construct comparable groups of students: those who reported no marijuana use in the past 30 days and those who did, for both survey administration years (2019 and 2022). Prior to matching, 4,374 (3.5%) in 2019 and 2,309 (2.3%) students in 2022, out of 125,366 and 100,836 total participants, respectively, reported marijuana use at least six times in the past 30 days—indicative of at least weekly consumption. A subset of these students—1,136 (0.9%) in 2019 and 698 (0.7%) in 2022—reported daily use. Conversely, 102,278 (81.6%) and 77,988 (77.3%) students in 2019 and 2022, respectively, reported no marijuana use in the past 30 days. A notable proportion of students (10.8% in 2019 and 17.8% in 2022) did not respond to the marijuana use item across both administrations. Following propensity score matching, the analytic sample was reduced to 4,143 students per group in 2019 and 2,278 per group in 2022.

From both multiple regression analyses, we found significant negative associations between regular marijuana use and academic performance, as measured by GPA, after controlling for demographic and other relevant covariates (see Tables 1 and 2). Specifically, marijuana use was associated with a significant main effect on GPA in both the 2019 sample, $b = -0.38$, $p < .001$, partial $\boldsymbol{\eta}^2 = 0.03$, and the 2022 sample, $b = -0.45$, $p < .001$, partial $\boldsymbol{\eta}^2 = 0.03$. These models explained 20.3% and 20.2% of the variance in GPA for 2019 and 2022, respectively, controlling for sex, grade level, race/ethnicity, skipping school, mental distress, and CtL.

Table 1

*Multiple regression results of the relation between marijuana use and grade point average for the 2019 cohorts*

| | | Model 1 | | Model 2 | |
|---|---|---|---|---|---|
| | | *b* | SE(*b*) | *b* | SE(*b*) |
| Intercept | | 2.70 | 0.04 | 2.80 | 0.04 |
| Sex (Ref = Male) | | 0.40 *** | 0.02 | 0.34 *** | 0.02 |
| Grade (Ref = Grade 8) | | | | | |
| | Grade 9 | 0.04 | 0.04 | 0.04 | 0.04 |
| | Grade 11 | 0.13 *** | 0.03 | 0.12 *** | 0.03 |
| Race/Ethnicity (Ref = White) | | | | | |
| | American Indian | -0.37 *** | 0.04 | -0.40 *** | 0.04 |
| | Asian American | -0.19 * | 0.08 | -0.20 * | 0.08 |
| | African American / Black | -0.39 *** | 0.05 | -0.39 *** | 0.05 |
| | Multiple Races | -0.12 * | 0.06 | -0.13 * | 0.06 |
| | Latino | -0.42 *** | 0.04 | -0.43 *** | 0.04 |
| | Somali | -0.37 *** | 0.11 | -0.37 *** | 0.11 |
| | Hmong | -0.15 | 0.16 | -0.14 | 0.16 |
| Skipped School (Ref = None) | | | | | |
| | Once or twice | -0.13 *** | 0.03 | -0.09 ** | 0.03 |
| | 3 or more times | -0.39 *** | 0.03 | -0.27 *** | 0.03 |
| Mental Distress | | -0.10 *** | 0.01 | -0.07 *** | 0.01 |
| Commitment to Learning | | 0.57 *** | 0.02 | 0.60 *** | 0.02 |
| Marijuana (6 or more times past 30 days) | | | | -0.38 *** | 0.02 |
| $\Delta adj\ R^2$ | | | | 2.32% | |
| $adj\ R^2$ | | 17.98% | | 20.30% | |

*Note.* * $p < .05$; ** $p < .01$; *** $p < .001$

Table 2

*Multiple regression results of the relation between marijuana use and grade point average for the 2022 cohorts*

| | Model 1 | | Model 2 | |
|---|---|---|---|---|
| | *b* | SE(*b*) | *b* | SE(*b*) |
| Intercept | 2.71 | 0.06 | 2.80 | 0.06 |
| Sex (Ref = Male) | 0.34 *** | 0.04 | 0.29 *** | 0.04 |
| Grade (Ref = Grade 8) | | | | |
| Grade 9 | -0.07 | 0.05 | -0.07 | 0.05 |
| Grade 11 | 0.14 ** | 0.05 | 0.14 ** | 0.05 |
| Race/Ethnicity (Ref = White) | | | | |
| American Indian | -0.40 *** | 0.07 | -0.41 *** | 0.07 |
| Asian American | 0.19 | 0.12 | 0.21 | 0.12 |
| African American / Black | -0.30 *** | 0.08 | -0.30 *** | 0.08 |
| Multiple Races | 0.01 | 0.07 | 0.01 | 0.07 |
| Latino | -0.34 *** | 0.05 | -0.35 *** | 0.05 |
| Somali | 0.14 | 0.25 | 0.17 | 0.25 |
| Hmong | -0.18 | 0.22 | -0.16 | 0.22 |
| Skipped School (Ref = None) | | | | |
| Once or twice | -0.01 | 0.04 | 0.03 | 0.04 |
| 3 or more times | -0.40 *** | 0.04 | -0.28 *** | 0.04 |
| Mental Distress | -0.11 *** | 0.01 | -0.07 *** | 0.01 |
| Commitment to Learning | 0.65 *** | 0.04 | 0.69 *** | 0.04 |
| Marijuana (6 or more times past 30 days) | | | -0.45 *** | 0.04 |
| $\Delta adj\ R^2$ | | | 2.73% | |
| $adj\ R^2$ | 17.49% | | 20.22% | |

*Note.* * $p < .05$; ** $p < .01$; *** $p < .001$

In summary, students who reported regular marijuana use—defined as six or more occasions within the 30 days prior to survey administration—exhibited significantly lower GPAs compared to their statistically matched peers who reported no marijuana use during the same period. After controlling for relevant covariates, the average GPA difference was -0.38 in 2019 and -0.45 in 2022. When comparing the baseline models (including only control variables) and the full models (including marijuana use) we found that marijuana use contributed significant incremental variance in the prediction of GPA, over and above the control variables ($p < .001$).

## Educational Significance

The burgeoning legalization of marijuana and emerging researchers highlighting its potential cognitive benefits warrant cautious interpretation. A significant disparity exists between research results on medical and recreational marijuana. Although researchers investigating medical marijuana use, often limited by federal regulations, have shown promise, the effects of recreational use, particularly among adolescents, are more detrimental. In this study, we found substantial academic performance gaps between regular and non-users of marijuana for two different survey administration years, even after controlling for confounding factors.

Given the rapid circulation of information via social media outlets, coupled with the evolving legal landscape and adolescent brain development, it is imperative to exercise prudence in communicating positive research findings on marijuana. Oversimplifying complex research to convey positive outcomes without acknowledging the potential harms of recreational use may have unintended consequences for public perception and adolescent behavior, especially for academic performance.

One cautionary note is that we employed a correlational cross-sectional design in this study—we caution against drawing causal inferences. However, an important step in building a causal argument is the establishment of associations among the relevant factors and outcomes. A difference in GPA of 0.4 or 0.5 is nonignorable and may mean the difference between access to future educational opportunities or participation in academic enrichment programs.

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