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Measuring the Impact of Substance Use on Standardized Test Score Averages

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Literature on substance use and academic performance suggests, overall, that students' use of alcohol, marijuana, or other illicit drugs has a negative effect on academic performance, but generally has not included the full range of substances or incorporated statistical controls in a single model. Using school-level data, multilevel regression analyses are performed to explore the relationship between the prevalence of substance use in a school and standardized test scores. Results suggest that substance use does not contribute to low performance and that low standardized test scores are more strongly correlated with social inequality and poverty in the school system.

Keywords: Education, Standardized Test Scores, Alcohol Use, Drug Use, Substance Use

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The United States is one of the most prosperous nations in the world (Barnato, 2015). Yet, for all its achievements, America has fallen behind other industrialized nations in the education of its youth (Desilver, 2017). With the No Child Left Behind Act of 2001, the United States placed an increased emphasis on improving the standards of public education in an attempt to rectify educational deficiencies. The No Child Left Behind Act mandates that states must develop standardized tests of basic skills and administer them to all children in select grades in order to receive federal funding. Each state is charged with developing their standardized tests and must show improvement each year in their scores or be in jeopardy of losing federal funding. Critics of these tests argue that they negatively affect educational standards by encouraging teaching students to pass the test instead of teaching the course curriculum (Menken, 2006) and that the tests are biased and therefore actually worsen inequality gaps (Grodsky, Warren, & Felts, 2008). Nevertheless, these tests remain in place in the hopes that they may improve education.

There has been much speculation about the cause of educational deficiencies in the United States, such as a lack of qualified teachers, educational funding, parental involvement, and other factors (Ostroff, 2017; Ujifusa, 2018). One social issue that is often blamed for negative educational outcomes is drug use. A large body of work explores how the use of various drugs affects educational aspirations (Andrews & Duncan, 1997), educational outcomes such as students' grades (McCabe, Teter, Boyd, & Guthrie, 2004; Cox, Zhang, Johnson, & Bender, 2007), and the completion of school (Bray, Zarkin, Ringwalt, & Qi, 2000; Fergusson, Harwood, & Beaurais, 2003; Mensch & Kandel, 1988), as well as how various drugs affect standardized test scores (Jeynes, 2002; Flemming et al., 2005; Arthur, Brown, & Briney, 2006). Despite the large amount of research in this area, little work has examined how drug use affects students' standardized test scores at an aggregate level or with statistical controls included. The present study provides such an analysis using self-report data from students and schools' standardized test data to examine for a potential link between substance use and test performance.

Substance Use and Academic Performance

Alcohol

Alcohol is the most commonly abused drug in the United States, including among middle- and high-school students (Substance Abuse and Mental Health Service Administration, 2011). However, studies of alcohol's effect on academic aspirations and students' grades are often conflicting. This may be due to the normative use of alcohol by students both of low- and high-academic performance. For example, one study using a twelve-year longitudinal study of 13 to 17 year old youth found that alcohol use was *not* related to a decrease in academic motivation (Andrews & Duncan, 1997). Although alcohol use may not diminish academic aspirations, it may have an effect on students' academic performance. Studies of alcohol's effect on students' grades have produced ambiguous results. One set of analyses, for example, found that binge drinkers had lower grades than non-binge drinkers, yet a logistic regression revealed that binge drinking was not significantly related to lower academic performance after introducing controlling factors, such as gender, race, and grade-level (Cox et al., 2007).

The results of studies that examined the effect of alcohol use on standardized test scores are similarly conflicting. Research using longitudinal student data found that early use of cigarettes and alcohol predicted lower standardized test scores (Flemming et al., 2005). Similarly, data from the National Education Longitudinal Survey for 1992 have led to findings that being under the influence of alcohol at school was negatively related to a student's standardized math and reading scores (Jeynes, 2002). The finding that being under the influence of alcohol at school would have an effect on a student's academic performance is predictable, however, and alcohol use in general has not shown the same effect on students standardized test scores. For example, a study of Kansas schools found that past month alcohol use was not associated with standardized math and reading scores (Arthur et al., 2006). Another study found similar results in a study of psychiatrically hospitalized adolescents with substance and conduct disorders when compared to a control group of students without substance abuse and conduct disorders (Braggio, Plshkln, Gameros, & Brooks, 1993). The results indicated that substance abuse did *not* affect students' scores on the Wide Range Achievement Test (WRAT) reading, spelling, and arithmetic subsets (Braggio et al., 1993). However, the data did show that students who have a familial history of alcoholism have lower Peabody Individual Achievement Test (PIAT) test scores than students without a family history of alcoholism, suggesting that alcohol use can create an environment that negatively influences learning (Braggio et al., 1993).

Marijuana

Studies of marijuana's effect on educational motivation and attainment consistently show that marijuana has a negative effect on educational outcomes (Lynskey & Hall, 2002). For example, marijuana use is negatively related to academic motivation in the form of perceptions of importance to perform well on tests and getting good grades to go to college (Andrews & Duncan, 1997). However, the decline in academic motivation is mediated by a student's general deviance, thus suggesting that a student's general deviance leads to increases in marijuana use and subsequently lower academic motivation, or vice versa (Andrews & Duncan, 1997).

Empirical evidence has also indicated that marijuana use has a negative impact on educational attainment. One investigation into that effect indicates that marijuana use is positively related to dropping out of high school and students who have initiated marijuana use are more than twice as likely to drop out of school as those who have not (Bray et al., 2000). The researchers also suggest that regular use of marijuana could have an even greater effect on dropping out of school, as their study included students who had smoked marijuana once, but did not include regular users (Bray et al., 2000). This suggestion is supported by a longitudinal study of a birth cohort of 1,265 New Zealand students, which found that students who smoked marijuana 100 times or more were more than five times as likely to drop out of school in comparison to those who had never smoked marijuana, and were also three times less likely to enter college and over four times less likely to obtain a college degree (Fergusson et al., 2003). Additional research indicates that the earlier a student initiates marijuana use, the greater its effects on educational achievement. Early regular marijuana use (weekly use at age 15), for instance, is associated with an increased risk of leaving school early and this effect diminishes with age (Lynskey et al., 2003). This effect purportedly operates through the context in which the drug was used and not necessarily due to the pharmacological effects of the drug (Lynskey et al., 2003). The negative effect of marijuana use holds true for black and Puerto Rican students who use marijuana in early adolescents, as they are at increased risk of not graduating from college (Brooks-Gunn, Klebanov, & Duncan, 2000). Marijuana use has also been shown to have a negative effect on academic performance via lower grades (Cox et al., 2007) and lower math and reading scores on standardized tests (Arthur et al., 2006). Additionally, it has also been suggested that the use of marijuana by students before going to school or at school creates an environment that promotes marijuana use even among students that do not associate with marijuana users (Kuntsche & Jordan, 2006).

Studies of marijuana's effect on academic performance, however, should not be taken as a blanket statement that marijuana use will produce low academic performance. For example, one study found that marijuana's effect on performance varies by gender, with 19 percent of male marijuana users being high performers on the Texas Assessment of Academic Skills (TAAS) compared to 10 percent of female marijuana users (Codina, Yin, Katims, & Zapata, 1998). Being under the influence of marijuana while at school would naturally affect academic performance, though studies of the long term effects of marijuana use have produced mixed results and suggest that marijuana's effects on learning may not be as straight forward. In other words, studies have not consistently shown that long-term marijuana use causes permanent cognitive impairment (Iverson, 2005). For example, a comparison of nine long-term marijuana users' performance on auditory selective attention tasks to nine non-users indicated that marijuana users performed significantly worse on the tasks (Solowij, Michie, & Fox, 1991). However, these were among current users and the results could be due to the buildup of tetrahydrocannabinol (THC) in the respondents system, so it could be speculated that their functioning could return to normal if they ceased using marijuana. This theory is supported by a study comparing respondents' IQ at the age of 9-12 to their IQ at the age of 17-20. The results showed that heavy marijuana use (smoking five or more joints per week) was significantly related to decreases in IQ (a decrease of 4.1 points). Current light users (less than five joints a week), former users, and non-users, however, all had IQ gains of 5.8, 3.5, and 2.6 respectively (Fried, Watkinson, James, & Gray, 2002). This supports the theory that heavy use may result in a buildup of THC that causes impairment and that light use does not hinder cognitive functioning. Other studies (e.g., Lyketsos, Garrett, Liang, & Anthony, 1999) have found that there is no significant difference in cognitive decline between heavy, light, and non-marijuana users as they age.

Prescription Drug Use

The non-prescription use of prescription drugs has increased in prevalence among high-school students and is reported to be the most abused drug besides alcohol and marijuana use (Ford, 2009). According to a 2005 web-based survey of 1,086 secondary school students in grades seven through twelve, 17.5 percent of students reported medical and non-medical use of prescription drugs and 3.3 percent of students reported only using non-prescribed prescription drugs (McCabe, Boyd, & Young, 2007). The rates of non-medical use of prescription drugs varies by the type of drug. One study reported that twelve percent of students used opioid pain medications, three percent non-medically used sleeping medication, two percent used sedatives/anxiolytic agents, and two percent used stimulants in the past year (Boyd, McCabe, Cranford, & Young, 2006). Students who non-medically use prescription drugs are also more likely than non-users to report illicit drug use (McCabe et al., 2007), particularly with opioid analgesics (Boyd et al., 2006).

Non-medical use of prescription drugs covers a wide array of prescription medication, which each have different pharmacological effects and are used for various reasons. High-school students used prescription drugs non-medically for multiple reasons, which varied by the type of drug used, with the most common motivation listed among students was "to help with concentration or alertness" (Boyd et al., 2006). This makes high school students similar to college undergraduates, who reportedly have 8.1 percent lifetime and 5.4 percent past-year usage rates for illicit prescription stimulants and whose motives for use are often to help with concentration, increase alertness, and get high, but mainly to enhance academic performance (Teter et al., 2005). Although a number of students non-medically use prescription medication for their intended purposes, 11 percent of students list their reason for using prescription medication as getting high (Boyd et al., 2006).

Many students who use prescription stimulants claim that their motives for use are to help with concentration, yet research suggests that these students are not performing better than non-users. A study of the illicit use of methylphenidate (ADHD medication) using Monitoring the Future data found that grade point average was significantly related to illicit use of methylphenidate, with students who have C grades and D grades being more likely to use than students who better grades (McCabe et al., 2004). This may be true of prescription stimulants as well, but additional research has yet to be conducted examining how various categories of prescription drugs could differently affect educational outcomes.

Although there is limited research regarding how the non-prescription use of prescription drugs affects the academic achievement of secondary school students, research on college students suggests that non-prescription use of prescription drugs is quite prevalent among college students and could negatively affect academic success. One study found that lifetime and past-year prevalence rates for non-prescription use of prescription stimulants or analgesics are 19.6 and 15.6 percent among college students at a large university (Arria et al., 2008). Students who use these drugs have significantly lower high-school grade point averages (GPA) than non-users and non-prescription use of stimulants and analgesics continues to have a negative effect on these students' academic performance in college, with non-prescription drug users skipping 21 percent of their college classes compared to 9 percent of non-users (Arria et al., 2008). When controlling for high-school GPA and other factors, past-year use of stimulants and analgesics predicted lower college GPA by the end of the first year of college.

These studies tend to suggest that nonmedical use of prescription drugs has a negative effect on students' academic performance. However, students may be using these drugs to make up for procrastinating their studies, thus poorly-performing students may be attempting to rectify their deficiencies through using academic performance enhancing drugs. The manner in which these drugs affect an individual under normal circumstances is less clear. In an attempt to answer this question, Smith (2011) reviewed the literature of nonmedical use of prescription stimulants to enhance cognition and concluded that evidence suggests that use can improve declarative memory, with some evidence that it can enhance the consolidation of memory. The evidence of prescription stimulants' effect on executive functions and working memory, however, is less clear.

Other Illegal Drugs

Other illegal drugs, such as cocaine and ecstasy, though perhaps not as frequently used as alcohol, marijuana, and prescription drugs, have also been found to have a negative effect on students' academic achievement. Event history analysis of the National Longitudinal Survey has revealed that using cocaine or other illegal drugs (excluding marijuana) at any age increases the propensity of students to drop out of school (Mensch & Kandel, 1998). Similarly, results from a study using the 2002-2005 National Survey on Drug Use and Health and weighted logistic regression found that ecstasy users, similar to marijuana and alcohol users, had lower grades compared to non-drug users and were four and twelve times more likely to report moderate grades (C average) and low grades (D or lower), respectively, than non-drug users, who were more likely to report good grades (B or A averages) (Martins & Alexandre, 2009).

Other illegal drugs seem to have a similar negative effect on students' standardized test scores, including cocaine users having lower standardized test scores (Jeynes, 2002) and other drug use (besides marijuana and alcohol) being correlated with lower standardized test scores (Arthur et al., 2006). The use of other illegal drugs has also been shown to affect memory functions, which may have an effect on student learning, grades, and standardized test scores. For example, a study comparing ecstasy users with a concomitant use of marijuana with a control group of marijuana users and non-drug users found that the ecstasy users scored lower than one or both control groups on tests of attention, in memory and learning tasks, and in tests of general intelligence (Gouzoulis-Mayfrank et al., 2000). The researchers concluded that even recreational doses of ecstasy are sufficient to cause neurotoxicity in humans.

Socioeconomic Status

Besides drug use, other factors have been shown to affect students' academic achievement and performance. One of these factors is a student's socioeconomic status (SES). Because students are often unaware of their SES, surveys rarely ask youth directly about affluence. Instead, asking whether or not the student receives free or reduced lunches is frequently used as a proxy for SES in studies of school children. For example, one study found that student not participating in reduced-price lunch program reported higher grades than students participating in such lunch programs (Bowen & Bowen, 1999). Studies show that a student's socioeconomic status may also affect students standardized test scores. Low poverty (more affluent) schools are 22 times more likely to be high-performing on standardized tests than high poverty (poor) schools (Harris, 2007) and the percentage of students in a school receiving free or reduced lunch in a school is negatively correlated with math and reading standardized test scores, explaining between 17 percent and 31 percent of the variance in scores for 7th and 11th grader students (Arthur et al., 2006).

Poverty in the United States is closely related to race, with a disproportionate number of minorities living below the poverty line. The discrepancies between low- and high-poverty schools become even more staggering when factoring in race, as high-poverty, high-minority schools are 89 times less likely to be high performing schools than low-poverty, low-minority schools (Harris, 2007). In a review of students' standardized test scores, one study found that black and Hispanic students under-performed on standardized reading and math test compared to white and Asian students (Horn, 2003). These differences in standardized test scores should not be contributed solely to race, however, as they may be also related to economic factors. For example, racial differences in learning have also been found to be influenced by poverty. Based on the Wechsler Preschool and Primary Scale of

Intelligence, analyses indicate that black five-year-old children have IQ scores that are one standard deviation below those of white five-year-old children (Brooks-Gunn et al., 1996). After adjusting for economic and social differences between black and white children, however, the differences in IQ scores between the two groups disappear.

There are a number of reasons that minority students and students living in poverty perform lower on standardized tests. One reason is the performance anxiety caused by stereotype threat. Research suggests, however, that the stereotype threat that affects female, minority, and low-income adolescents can be overcome by encouraging individuals in these categories to view intelligence as malleable or attribute academic difficulties to the transition into the seventh grade (Good, Aronson, & Inzlicht, 2003). Students who were mentored to view intelligence in this manner had significantly higher reading standardized test scores than students in the control group.

The Present Study

Prior literature suggests that substance use can influence academic performance through a number of effects. This study contributes to the literature on substance use and academic performance in two ways. First, this study offers a more comprehensive list of substance use than the aforementioned studies, providing measures for alcohol, marijuana, prescription drugs, and other illegal drug use instead of focusing on only one or two substances. By using a more comprehensive measure of substance use and standardized test scores (instead of letter grades or self-reported measures of academic performance), the current study provides a more complete assessment of the effect of substance use on student performance while also allowing for each type of substance use to act as a control on the others' effects. Second, the increasing popularity of non-medical prescription drug use among school-aged children warrants increased study of the effect of prescription drug use on students. By including a measure for prescription drug use, this study provides new evidence in an area of growing concern and contributing to our understanding on how non-medical use of prescription drugs effects students' academic performance. Finally, this study also incorporates other school-level variables – including indicators relating to socioeconomic status, such as race and poverty – to examine whether effects from substance use remain significant after including additional controls.

Hypothesis 1: The greater proportion of students using a given substance, the lower their school's average test score is.

Hypothesis 2: The greater proportion of students using a given substance, the lower their school's average test score is, even after controlling for demographic characteristics.

Methods

The data used in the present study are derived from two sources. These include data directly collected from students through the Delaware School Survey and data collected about schools by the Delaware Department of Education.

Delaware Department of Education

The Delaware Department of Education (DDOE) collects various statistics about each public and public-charter school in the state of Delaware. These statistics are publicly available on the DDOE's website (DDOE, n.d.). For the present study, four variables are used from the DDOE data. Three of these serve as the dependent variables and originate from the Delaware Student Testing Program (DSTP), which is an annual standardized test of students in select grades. The three used here are annual averages (mean) DSTP scores in for reading, math, and writing for each of the schools in this sample.[1] The reading and math scores are based on objective questions, whereas the writing scores are based on student performance in writing response essays. For reading and math, data used includes years 2006 through 2010, while the writing data includes 2006 through 2009. All three categories are based on average scores in the 8th and 10th grades. Although DSTP scores have a wide range of outcomes at the student-level, school averages naturally have a distribution closer to the mean, and range from 460 to 593 for reading/math and 6.9 to 10.8 for writing.

In addition to the dependent variables, the DDOE data also provide one independent variable: the percentage of students receiving free or reduced-price lunches. Because there are no available direct measures of social class or income, this indicator will serve as a proxy for social class, approximately measuring the percent of students from poverty-affected families. The descriptive statistics for these and the other variables are presented in Table 1.

Table 1. *Descriptive Statistics (School-Level Data)*

	Mean	SD	Min	Max
8th Grade:				
Mean Reading Score	526.7	16.5	479.2	593.3
Mean Math Score	510.2	20.5	460.2	570.8
Mean Writing Score	8.4	0.6	6.9	10.8
% of Students Used Alcohol in Past Month	20.6	6.7	3.2	40.0
% of Students Used Marijuana in Past Month	10.1	5.4	0.0	27.4
% of Students Used Other Illegal Drugs in Past Month	10.7	3.7	2.9	28.2
% of Students Used Rx Drugs in Past Month	10.2	4.4	0.0	23.1
% of Students Female	52.0	7.2	31.7	84.1
% of Students Black	26.6	16.9	0.0	90.9
% of Students Hispanic	11.6	8.4	0.0	47.2
% of Students Other Race/Ethnicity	10.5	4.1	0.0	26.8
% of Students Receiving Free/Reduced Lunch	39.4	20.2	0.0	90.3
10th/11th Grade:				
Mean Reading Score	518.5	14.9	466.5	577.6
Mean Math Score	535.5	17.8	492.8	620.4
Mean Writing Score	8.4	0.6	7.2	10.6
% of Students Used Alcohol in Past Month	38.7	8.8	14.3	66.4
% of Students Used Marijuana in Past Month	23.2	7.2	5.7	44.8
% of Students Used Other Illegal Drugs in Past Month	14.5	4.8	3.6	28.6
% of Students Used Rx Drugs in Past Month	20.5	6.0	6.6	42.1
% of Students Female	51.6	7.2	30.0	78.4
% of Students Black	25.9	13.2	2.6	87.1
% of Students Hispanic	10.3	6.4	1.3	39.7
% of Students Other Race/Ethnicity	9.4	4.5	0.0	28.7
% of Students Receiving Free/Reduced Lunch	31.7	14.4	0.0	89.5

1 In addition, these models were also estimated using science scores and social study scores. To conserve space, these models are not shown or discussed in this study. However, the findings drawn from those models are quite similar to those of the presented models and result in the same conclusions.

Delaware School Survey

The Delaware School Survey (DSS) is an annual census of students in the 5th, 8th, and 11th grades administered by the University of Delaware Center for Drug and Health Studies. Classes in public and public-charter schools in Delaware are selected based on subject matter so that all students of those grades will be enrolled in a corresponding class. Some classes are randomly selected to receive a survey from the Centers for Disease Control and Prevention (CDC) instead (the Youth Risk Behavior Survey or the Youth Tobacco Survey in alternating years), but otherwise the survey attempts for a census of students in the three grades. Of students present on the dates of administration, approximately 98% chose to participate (with the remainder either unwilling to participate, or having been asked to not participate by a parent). The present study uses data collected over several years. For 8th grade, this includes the annual data from 2006 through 2010 and totals 33,324 participants. For the 11th grade, this includes annual data from 2007 through 2011 (the one-year difference is for a lag effect that is explained in the analytic strategy subsection) and totals 26,885 participants.

Because the dependent variables are at the school-level rather than the student-level, the DSS data are aggregated to the school-level for these analyses as well, and each DSS measure represents the percentage of students in that school in that year who responded affirmatively to the associated question. Substance use is measured with four variables.[2] First, alcohol use and marijuana use are each the percent of students who report having used that substance in the past month. A past month time frame was used for these indicators rather than past year or lifetime use so that these measures more closely approximate regular use instead of experimental use. Prescription drugs and other illegal drugs were both measured using lists of drugs. These lists correspond to substances typically associated with prescription drug use (OxyContin, Vicodin, other painkillers, Ritalin, and various others) and illegal drug use (hallucinogens, heroin, crack cocaine, powder cocaine, etc.), and use a past year time frame. For prescription drugs, all questions include an exception for situations in which the drugs were actually prescribed to the student, thus capturing only non-prescribed prescription drug use. As with alcohol and marijuana, both of these variables reflect the percentage of students using the associated drug(s). Additional variables from the DSS include the percentage of students in each school/year who are female, black, non-white Hispanic, and other non-white race/ethnicity (thus making male and non-Hispanic white the two reference categories).

Analytic Strategy

After combining the school-level data by year from the DSS and the DDOE, the 8th grade data include 46 schools at up to 5 time points for a total of 200 cases.[3] The high

2 These measures are composites of multiple questions. For example, each substance used for the other illegal drug measure was a separate question on the questionnaire. To conserve space, the full questions are not presented here, but are available at the survey project's website (Center for Drug and Health Studies, n.d.).

3 Some schools have fewer than five time points. The reasons for this vary, but generally are either because data were unavailable for the year (e.g., the school had not yet opened) or because the DSS sample size was too small for the estimates to be reliable. Any school with fewer than 20 participants is excluded for that year in the present study.

school data include 35 schools at up to 5 time points for a total of 164 cases. Because the DDOE high school data are from 10th grade students and the DSS data are from 11th grade students, a one-year lag is used for these data to ensure the data are gathered from the same cohort of students. Because students may fail a grade, drop out or transfer schools, these cohorts might not necessarily be identical, but using such a lag is preferable than using entirely mismatched cohorts. This also presents a time-order violation, but most of the independent variables are time-invariant (e.g., race and gender) or unlikely to be affected by test scores, and therefore this issue, while not irrelevant, is unlikely to present a major concern.

Because the cases used in these analyses are not independent of one another (i.e., data from the same schools are used at multiple time points), a traditional approach to regression would violate the assumption of autocorrelation. To correct for this, multilevel modeling is used to ensure that the estimates are not biased by this effect. Specifically, models are estimated using the SAS mixed-level (PROC MIXED) procedure. In order to estimate the effect of substance use, models are first estimated using only these variables as predictors. Then, a second model is estimated that includes the controls for gender, race/ethnicity, and poverty.

Results

The results for models predicting reading DSTP scores are presented in Table 2. The first 8th grade model indicates that only marijuana use is significantly predictive of reading scores ($\beta = -.129$). Specifically, each percentage increase in marijuana users in a school results in a decrease in reading scores. Alcohol use, drug use, and prescription drug use are not significant predictors of reading scores. The first model at the high school level indicates a similar story, with only marijuana use being predictive of a decline in reading scores ($\beta = -.256$) and the other substance-related indicators being non-significant. Based on the decline in unexplained variance between these models and null models, these models explain 12 to 16 percent of the variance in school reading score averages.

In contrast to models with only substance use predictors, the full models are able to explain much more of the variance in reading scores. Among 8th grades, the percent of students who are black ($\beta = -.341$) or Hispanic ($\beta = -.157$) affects reading scores, with schools with higher minority populations averaging lower reading scores. Additionally,

Table 2. *Multilevel Linear Regression Predicting School Average Reading Scores*

	8th Grade						10th/11th Grade					
	Model 1			Model 2			Model 1			Model 2		
	b	*SE***	*β*	*b*	*SE***	*β*	*b*	*SE***	*β*	*b*	*SE***	*β*
% of Students Used Alcohol	-.064	.134	-.026	-.040	.125	-.016	.100	.092	.059	-.114	.070	-.068
% of Students Used Marijuana	-.394	.162	-.129*	-.145	.158	-.047	-.533	.110	-.256**	-.098	.087	-.047
% of Students Used Other Illegal Drugs	.361	.189	.082	.098	.184	.022	-.018	.020	-.059	-.018	.014	-.060
% of Students Used Rx Drugs	-.009	.136	-.003	.074	.135	.020	.016	.015	.066	.010	.019	.044
% of Students Female	---	---	---	-.039	.090	-.017	---	---	---	.013	.068	.007
% of Students Black	---	---	---	-.332	.068	-.341**	---	---	---	-.148	.065	-.131*
% of Students Hispanic	---	---	---	-.308	.120	-.157**	---	---	---	.086	.095	.037
% of Students Other Race/Ethnicity	---	---	---	-.057	.147	-.014	---	---	---	.100	.123	.030
% Receiving Free/Reduced Lunch	---	---	---	-.287	.072	-.353**	---	---	---	-.565	.045	-.038**
Intercept	527.0			553.3			525.8			544.6		
Variance Explained			.123			.754			.162			.593

* $p < .05$
** $p < .01$

schools with more impoverished students also tend to receive lower scores (β = −.353). Among high school students, the effects from black (β = −.131) and poverty (β = −.038) are significant, though the effect from Hispanic is not. In both models, marijuana use is *not* significant after controlling for these demographic characteristics (β = −.047 and −.047), and the other substance-related variables remain non-significant. These models explain 75 and 59 percent of the variance in reading scores respectively, marking a notable increase from the previous substance use variables-only models.

The results for models predicting average school math scores are presented in Table 3. At the 8th grade, both alcohol use (β = −.121) and prescription drug use (β = .129) are predictive of math scores. Schools with more alcohol-involved students generally receive lower math scores, and this effect is statistically significant. However, schools with higher percentages of students using prescription drugs receive *higher* DSTP math scores. It is possible that this relationship is coincidental or correlated with some other variable/effect not considered, though it is also possible that this effect is related to the use of prescription drugs as a study-aid, and very plausibly could be a causal relationship. Introducing controls into the model does not affect either of these relationships (β = −.117 and .123, respectively). Among the controls, schools with a higher proportion of black students (β = −.438) and schools with a higher proportion of impoverished students (β = −.221) generally received lower average math scores. As before, introducing these demographic variables explained more variance (64 percent compared to 6 percent).

Among the 10th/11th grade students, the models were quite different from those of the younger grade. In the reduced model, only marijuana use indicated a significant effect, with more marijuana users relating to lower math scores (β = −.108). After introducing the controls, however, this effect reversed and was no longer significant (β = .028). The effect of other illegal drugs is significant after introducing controls into the model. Specifically, schools with a higher proportion of drug-involved students tend to receive lower math scores (β = −.100). Based on demographic characteristics, schools with impoverished students also tend to receive lower scores (β = −.024). Among the race variables, only the other race category was significant, with school with more students fitting this category receiving higher math scores (β = .086). Introducing these demographic variables increased the explained variance from 8 percent to 52 percent.

The results for models predicting writing scores are presented in Table 4. Among

Table 3. *Multilevel Linear Regression Predicting School Average Math Scores*

	8th Grade						10th/11th Grade					
	Model 1			Model 2			Model 1			Model 2		
	b	*SE***	*β*	*b*	*SE***	*β*	*b*	*SE***	*β*	*b*	*SE***	*β*
% of Students Used Alcohol	-.372	.131	-.121**	-.361	.121	-.117**	.036	.083	.018	-.101	.078	-.051
% of Students Used Marijuana	-.136	.158	-.036	.052	.152	.014	-.268	.101	-.108**	.070	.098	.028
% of Students Used Other Illegal Drugs	-.085	.184	-.016	-.194	.178	-.035	-.336	.178	-.092	-.366	.158	-.100*
% of Students Used Rx Drugs	.606	.132	.129**	.578	.130	.123**	.171	.135	.061	.112	.120	.040
% of Students Female	---	---	---	-.023	.090	-.008	---	---	---	.014	.077	.006
% of Students Black	---	---	---	-.531	.074	-.438**	---	---	---	-.145	.077	-.108
% of Students Hispanic	---	---	---	-.151	.125	-.062	---	---	---	-.060	.107	-.022
% of Students Other Race/Ethnicity	---	---	---	-.266	.144	-.054	---	---	---	.337	.139	.086*
% Receiving Free/Reduced Lunch	---	---	---	-.225	.079	-.221**	---	---	---	-.416	.051	-.024**
Intercept	512.5			541.7	_		540.9	__		554.1		
Variance Explained			.059			.644			.081			.515

** p < .05*
*** p < .01*

Table 4. *Multilevel Linear Regression Predicting School Average Writing Scores*

	8th Grade						10th/11th Grade					
	Model 1			Model 2			Model 1			Model 2		
	b	*SE***	*β*	*b*	*SE***	*β*	*b*	*SE***	*β*	*b*	*SE***	*β*
% of Students Used Alcohol	-.006	.007	-.061	-.006	.007	-.066	-.017	.006	-.250**	-.018	.007	-.294*
% of Students Used Marijuana	.003	.008	.023	.007	.008	.058	.013	.008	.160	.018	.009	.220*
% of Students Used Other Illegal Drugs	-.007	.009	-.043	-.011	.010	-.069	.017	.013	.134	.018	.014	.142
% of Students Used Rx Drugs	.012	.006	.082	.011	.007	.077	-.010	.009	-.111	-.017	.010	-.164
% of Students Female	---	---	---	.003	.005	.034	---	---	---	.006	.006	.076
% of Students Black	---	---	---	-.011	.004	-.293**	---	---	---	-.016	.004	-.346**
% of Students Hispanic	---	---	---	-.005	.006	-.067	---	---	---	.009	.008	.089
% of Students Other Race/Ethnicity	---	---	---	.005	.008	.030	---	---	---	.025	.011	.190*
% Receiving Free/Reduced Lunch	---	---	---	-.010	.004	-.319*	---	---	---	-.013	.004	-.028**
Intercept	8.41			8.99			8.66	_		8.96	_	
Variance Explained			.031			.588			.160			.797

$*p < .05$
$**p < .01$

the 8th grade schools, substance use had no significant effect on writing scores with or without the controls included. Schools with a higher percentage of black (β = −.293) or impoverished students (β = −.319), however, tended to do worse on the writing assessment. At the high school level, alcohol use was related to lower scores, both with and without the demographic controls (β = −.250 and −.294, respectively). Marijuana use, however, was significantly predictive of *better* writing scores (β = .220). Among demographic variables, black (β = −.346) and impoverished students (β = −.028) are predictive of lower writing scores, while the other race category predicts higher writing scores (β = .190). As with models predicting other types of DSTP scores, adding demographic variables substantially increases the variance explained by the model (3 to 58 percent and 16 to 80 percent). Notably, the 10th/11th grade model for writing scores is the only model using these data in which the substance use variables remained powerful after controlling for demographic variables. Specifically, alcohol use had a powerful negative impact on writing, yet marijuana use had an almost as powerful *positive* impact on the same performance.

Discussion

Improving education in the United States is important for a number of reasons beyond simply giving our children the best life chances. Improving education, for example, could strengthen the economy and our workforce. One way of improving education is by identifying factors that hinder positive educational outcomes and rectifying them. Some prior research has identified one possible factor as substance use and its potential impact on standardized test scores (Arthur, Brown, & Briney, 2006; Flemming et al., 2005; Jeynes, 2002). However, such studies often examine only one substance and lack additional controls. This study furthers this line of research through examining how substance use may affect a school's standardized test score averages after controlling for other substances and demographic factors. Given the possible cultural bias of these tests (Grodsky, Warren, & Felts, 2008), controlling for these other factors is vital in understanding this relationship. The hypotheses predicting a negative relationships between substance use and standardized test scores received only minimal and mixed support from this study.

The results indicated that, though substance use is somewhat predictive of testing scores, the relationships are not consistent. Specifically, they are often very weak in strength, and sometimes actually have a positive effect on performance. Among the full models, alcohol use significantly lowered scores only in two of six full models, while other illegal drug use significantly lowered scores in only one of the six. Each of these significant relationships is compatible with previously identified relationships (e.g., Flemming et al., 2005; Jeynes, 2002). In these same models, however, marijuana and non-prescription drug use both raised scores in one model each, which runs contrary to the expected relationships based on prior research (e.g., Arria et al., 2008; Arthur et al., 2006; Cox et al., 2007). It is unclear why these results differ, though the use of statistical controls and examining the data at the school-level are both possible explanations. In total, the models identified three negative effects, two positive effects, and nineteen non-significant effects. Together with the low variance explained in substance use-only models, these results can be described more as supportive of the null hypothesis than the expected relationship between substance use and test scores.

In sharp contrast, the effects from demographic variables are quite clear. In the six models including demographic variables, being black was significant in five models and poverty (as measured with free/reduced lunch) was significant in all models. Other demographic influences by race/ethnicity varied, but the effects from the percent of students who are black and impoverished were fairly consistent across the models. Moreover, the introduction of these variables substantially increased the amount of variance explained over both the null and reduced models. Given the well-established correlation between socioeconomic status and academic performance, this is hardly surprising. However, what it noteworthy is the impact that these variables had on other effects. Specifically, the introduction of these controls substantially reduced both the significance and the effect size of many of the relationships between substance use and standardized test averages, suggesting that at least part of a correlation between substance use and performance at the school-level may be spurious. Whether the connection between test scores and demographic characteristics is reflective of bias in the tests (Grodsky, Warren, & Felts, 2008) or inequality in general is beyond the scope of these data and this study, but it is clear that examining test scores without also examining race and class can result in misleading findings.

Naturally, there are some limitations to the present research. First, substance use variables were captured using self-report data. Consequentially, though reported prevalence rates are high enough to suggest that lying was not a pervasive problem, there is no guarantee that it did not occur. Second, as noted in the analytic strategy, a lag effect was necessary to match cohorts for the 10th/11th grade data. This may partially bias the sample, and raises questions about the time-order of substance use effects. Third, the measure of prescription drug use conflates various types of prescription drugs that have different pharmacological effects that could affect learning in various ways. As prescription drug use is increasing in popularity and given the positive results in one of the models, future research should study this with further detail to disentangle the effects of various types of prescription drugs on learning. Because the results for high school grades were substantively similar to those of the younger grade, however, such concerns are likely trivial. Finally, while standardized testing is generally similar enough to generalize between states/tests, there is no guarantee that these exact results would be found using other approaches to standardized testing.

Based on the findings of this study, future research in this area should take care to include adequate controls for socioeconomic factors when examining the possible effect of substance use on academic performance, as the evidence presented here suggests that including such controls can lead to quite different conclusions. This study, of course, used school-level data, so future research should also explore whether these findings hold true at the individual-level.

The results of this study ultimately do not support a general negative impact from substance use on standardized test scores at the school-level. However, what is clear from the findings is that schools that have a high percentage of students living in poverty and high percentage of minority students tend to have lower averages on standardized tests. Therefore, policies implemented to discourage drug use, while potentially beneficial in other areas, may have no or only have marginal effects on improving students standardized test scores.

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