

Multilevel Risk and Protective Factors for Frequent and Nonfrequent Past-30-Day Marijuana Use: Findings From a Representative Sample of High School Youth

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ABSTRACT. Objective: Research has identified many factors associated with past-30-day (P30D) marijuana use among youth but has not assessed factors that may differentiate youth who use frequently from youth who do not. We took a multilevel approach to identify and compare risk and protective factors associated with frequent and nonfrequent P30D marijuana use among high school students. **Method:** Individual-level data were obtained from the 2019 Nevada Youth Risk Behavior Survey (completed by 4,980 high school youth from 99 schools); school-level data were obtained from the state's Department of Education. A multinomial, multilevel model was used to estimate the association between risk and protective factors at the individual and school levels and a three-level frequency of use outcome: no P30D use (0 times), nonfrequent P30D use (1–19 times), and frequent P30D use

(≥20 times). **Results:** At the individual level, other P30D substance use, exposure to adverse childhood experiences (ACEs), perceived ease of access, and perceived risk were associated with both frequent and nonfrequent use, but the relationships were generally stronger for frequent use. P30D nonprescription drug use and school connectedness were associated with frequent use only. At the school level, number of students with individualized education programs, number of incidents involving possession of controlled substances, and school type were associated with frequent use only. **Conclusions:** Individual and school-based interventions designed to address the factors uniquely or strongly associated with frequent marijuana use may prevent escalation from occasional use to more frequent use among high school youth. (*J. Stud. Alcohol Drugs*, 84, 508–519, 2023)

FOR THE PAST DECADE, U.S. adolescents' use of most drugs had declined, but past-30-day (P30D) marijuana remained relatively stable; in the years leading up to the COVID-19 pandemic, the proportion of 8th, 10th, and 12th graders who used marijuana 20 or more times in the past 30 days (subsequently called "P30D frequent use") began to increase (Miech et al., 2023). Research investigating the prevalence and patterns of adolescent marijuana use during the COVID-19 pandemic is complicated by stay-at-home orders and methodological challenges but suggests a post-pandemic decline in P30D and P30D frequent marijuana use (Monitoring the Future, 2023). However, as schools remain consistently open and students resume their normal social lives, it is possible that prior frequent marijuana users may resume prior frequent use patterns, elevating their risk for

poor physical and emotional health outcomes (Hadland & Harris, 2014).

Although there is growing evidence that occasional marijuana use in adolescence may be associated with negative outcomes in later life (Hammond, 2022; Hammond et al., 2020), daily or near-daily marijuana use is uniquely associated with reduced cognitive functioning (Scott et al., 2018) and other drug use in adolescence (Thrul et al., 2021) and is prospectively associated with increased risk of cannabis use disorder, anxiety, depression, and suicidal behaviors later in life (Forman-Hoffman et al., 2017; Hadland & Harris, 2014; Moore et al., 2007). Given its distinct health risks, reducing frequent marijuana use in adolescence may be an important secondary prevention goal, especially as more states legalize adult-use marijuana and pro-marijuana norms continue to increase (Carliner et al., 2017; Napper et al., 2016; Roditis et al., 2016; Wong et al., 2020; Wu et al., 2015). Public health efforts to date have primarily focused on preventing the initiation of marijuana use in adolescence. For example, a summary of 46 systematic reviews of adolescent substance use prevention programs included only one article that presented results by marijuana use frequency (Carney et al., 2016; Das et al., 2016). Similarly, research investigating risk and protective factors for marijuana use has largely focused on lifetime, past-year, and P30D marijuana use. Salient risk factors for nonfrequent marijuana use include use of other substances (Halladay et al., 2020), exposure to violence and victimization (Afifi et al., 2020; Lambe & Craig, 2017), depressive symptoms (Hayatbakhsh et al., 2007), and ease of access to marijuana (Roditis et al., 2016). Protective factors

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include positive family relationships (Dubowitz et al., 2019), parental monitoring (Rusby et al., 2018), school connectedness (Weatherson et al., 2018), prosocial involvement (Lisha et al., 2014), and risk perceptions (Wu et al., 2015).

A smaller body of literature has examined factors associated with different frequencies of marijuana use, identifying associations between risk perceptions (Fleming et al., 2016), perceived ease of access (Fleming et al., 2016), other substance use (Barnes et al., 2005; Fleming et al., 2016), aggression (Barnes et al., 2005; Farhat et al., 2011), academic performance (Farhat et al., 2011), parental substance use (Graves et al., 2005), and parental knowledge of behaviors and behavioral control (Farhat et al., 2011; Graves et al., 2005) and frequent use. However, these studies used relatively low levels of marijuana use as a threshold for frequent use (e.g., three or more times in P30D, or once or more per week) and thus may not be able to identify factors associated with the most problematic patterns of use.

Two studies have examined risk and protective factors for different levels of marijuana use using more nuanced measures. One study using a more sensitive differentiation of P30D marijuana use (0–9 times, 10–39 times, and ≥ 40 times) found that males and older adolescents were more likely to use marijuana 40 or more times and that the frequency of use increased as perceived harm decreased, ease of access increased, and peer influence increased (Chen et al., 2018). In addition, deviant behaviors (e.g., gang fighting and selling drugs) were strongly associated with use of marijuana 40 or more times (Chen et al., 2018). Another study examined factors associated with different levels of lifetime marijuana use, including experimental use (1 time), episodic use (2–19 times), and frequent use (≥ 20 times). Male sex, low socioeconomic status, truancy at school, and not reading for enjoyment were associated with frequent use (Gerra et al., 2020). However, this study focused on lifetime use and not P30D use. Further, neither of these studies included school-level factors and used separate, non-mutually exclusive outcome measures for each level of marijuana use, which does not allow for the identification of factors that may differentiate occasional from more frequent users.

Prevention of any adolescent marijuana use is a worthy primary prevention goal; however, among adolescents who have already initiated marijuana use, preventing escalation (a concept termed “preescalation”) is an important secondary prevention goal, as frequent use in adolescence is associated with negative social, mental, and physical health outcomes in later in life (Forman-Hoffman et al., 2017; Moore et al., 2007; Power et al., 2021; Scott et al., 2018; Thrul et al., 2021; Villanti et al., 2019). Given possible differences in the personal characteristics, marijuana use motivations, and means of obtaining marijuana between occasional users and frequent users, it is possible that interventions meant to prevent initiation or reduce occasional use may not reduce risk

for transition to frequent use (Wardell et al., 2021; Windle & Wiesner, 2004). Understanding which factors are associated with frequent P30D marijuana use and how they differ from factors associated with nonfrequent P30D use will help identify adolescents who may benefit most from a preescalation approach before they transition to adulthood (Villanti et al., 2019). To address gaps in recent literature and identify possible modifiable factors, we took a multilevel approach to identify and compare individual- and school-level factors associated with frequent (≥ 20 times) and nonfrequent (0–19 times) P30D marijuana use among high school students in Nevada.

Method

Participants and procedures

The Youth Risk Behavior Survey (YRBS) is a national, school-based surveillance system established by the Centers for Disease Control and Prevention (CDC) to monitor risk behaviors among high school students (grades 9–12) in the United States (Kann et al., 2018). Data for this study were obtained from the 2019 Nevada High School YRBS. The Nevada High School YRBS used a two-stage sampling design to generate sampling weights and randomly sample classrooms of students from regular public, charter, and alternative high schools. At the first sampling stage, all high schools were grouped into eight regions based on the state’s substance use prevention coalition structure. At the second sampling stage, a random sample of second period or required English classes from each school were selected for participation. The study was approved by the university’s institutional review board and by local school district institutional review boards when required.

Before participation, active (41% of school districts) and passive (59% of school districts) parental consent was obtained in compliance with individual school district policy. After we obtained parental consent, the survey was administered to eligible students in randomly sampled classrooms. Students were given the entire class period to complete the survey and could opt out of participation at any point.

A total of 4,980 high school students from 99 schools completed the 2019 Nevada YRBS. The school response rate was 98% and the student response rate was 68.6%, yielding a combined response rate of 67.3%. Students from participating and nonparticipating schools had similar sociodemographic characteristics.

Measures

Outcome: Frequency of P30D marijuana use. Frequency of P30D marijuana use was assessed using a standardized item from the core CDC YRBS survey: “During the past 30 days, how many times did you use marijuana?” Responses

included 0 times, 1 or 2 times, 3–9 times, 10–19 times, 20–39 times, and 40 or more times (CDC, 2021b). We created a three-level, mutually exclusive outcome, as follows: (a) no P30D use; (b) nonfrequent P30D use (use between 1 and 19 times in P30D); and (c) frequent P30D use (use ≥ 20 times in P30D). This frequent P30D use definition is consistent with definitions used by the Monitoring the Future survey (Johnston et al., 2019; Terry-McElrath et al., 2019).

Individual-level factors. All individual factors—including sociodemographic characteristics, other substance use, depressive symptoms, exposure to violence and victimization, perceptions about marijuana, sports team participation, family communication, and school connectedness—were included based on previous literature and associations with marijuana use in other studies (Afifi et al., 2020; Fleming et al., 2016; Hayatbakhsh et al., 2007; Nawi et al., 2021; Roditis et al., 2016; Scheier et al., 2021; Substance Abuse and Mental Health Services Administration, 2021; Weatherson et al., 2018; Wu et al., 2015).

(A) *SOCIODEMOGRAPHIC CHARACTERISTICS:* Sociodemographic characteristics included sex (male or female), school grade (9–12), free or reduced-price lunch eligibility (yes or no), and family active-duty military involvement (yes or no), race/ethnicity (Hispanic, non-Hispanic Black, non-Hispanic multiple/other, and non-Hispanic White), and sexual and gender minority (yes or no).

(B) *OTHER SUBSTANCE USE (P30D):* We used standardized measures from the YRBS core survey for P30D alcohol, cigarette, and electronic vapor product (EVP) use, as well as a state-added P30D prescription drug use measure. Responses were dichotomized as any versus no P30D use.

(C) *DEPRESSIVE SYMPTOMS (PAST 12 MONTHS):* Depressive symptoms in the past 12 months were measured using an item from the YRBS core survey: “During the past 12 months, did you ever feel so sad or hopeless almost every day for two weeks or more in a row that you stopped doing some usual activities?” Responses included “yes” and “no.”

(D) *BULLYING VICTIMIZATION: AT SCHOOL OR ONLINE (PAST 12 MONTHS):* Using two core YRBS measures, students reported whether they had been bullied electronically (including texting, Instagram, Facebook, or other social media) or on school property in the past 12 months. Students who answered “yes” to either question were coded as having experienced bullying.

(E) *ADVERSE CHILDHOOD EXPERIENCES (ACEs):* In addition to lifetime sexual abuse, the following five state-added ACE measures were included (CDC, n.d.; Clements-Nolle et al., 2018): (a) witnessing domestic violence, (b) physical abuse, (c) verbal abuse, (d) living with someone who had a mental health problem, and (e) living with someone who had problems with alcohol or other substances. Consistent with coding of the ACE variables from the Behavioral Risk Factor Surveillance System (BRFSS), responses were dichotomized as “yes” versus “no” for all items, except verbal abuse,

which was coded as “yes” if it occurred sometimes, most of the time, or always (CDC, 2021a). The six ACE questions were summed to create a score ranging from 0 to 6. The complete BRFSS ACE module measures eight ACEs and is usually categorized as 0, 1, 2, 3, and ≥ 4 ACEs (Merrick et al., 2018); we used 3 or more ACEs as the high exposure category because we only measured 6 ACEs (Clements-Nolle et al., 2018, 2021).

(F) *PERCEIVED RISK OF MARIJUANA USE:* Perceived risk of marijuana use was measured using a standardized measure from the Drug Free Communities Core Instrument: “How much do you think people risk harming themselves physically or in other ways if they smoke marijuana once or twice a week?” (ICF, 2021). Responses were dichotomized as *no risk/slight risk* and *moderate risk/great risk* (Harpin et al., 2018).

(G) *PERCEIVED EASE OF ACCESS TO MARIJUANA:* Students reported their perceived ease of access to marijuana with the item: “How difficult do you think it would be for you to get marijuana, if you wanted some?” Response options included *very difficult*, *fairly difficult*, *fairly easy*, *very easy*, and *not sure* and were dichotomized as *fairly difficult/very difficult/not sure* and *fairly easy/very easy* (Harpin et al., 2018).

(H) *SPORTS TEAM PARTICIPATION (PAST 12 MONTHS):* Sports team participation (an indicator of prosocial involvement) was measured using a core YRBS item in which students reported the number of sports teams they played on in the past 12 months. Responses were dichotomized as “yes” (*any teams*) and “no” (*0 teams*).

(I) *FAMILY COMMUNICATION:* Family communication was measured using three items adapted from the Youth Asset Survey (YAS; Oman et al., 2010): (a) “How often do you talk to your parents or other adults in your home about your problems?”; (b) “How often do you talk to your parents about what is right and wrong?”; and (c) “How often do you feel comfortable talking to your parents about personal matters?” Responses included *never* (0), *rarely* (1), *sometimes* (2), *most of the time* (3), and *always* (4). For youth answering at least one out of the three items, responses were summed and then divided by the number of items answered to create a family communication score, with higher scores reflecting higher family communication (range: 0–4) (Lensch et al., 2021).

(J) *SCHOOL CONNECTEDNESS:* School connectedness was measured using three items adapted from the YAS (Oman et al., 2010): (a) “How often do you feel close to people at your school,” (b) “how often are you happy to be at your school,” and (c) “how often do the teachers at your school treat students fairly?” Responses were summed and scored using the same methods described for family communication.

School-level factors. School factors were included based on evidence of associations with marijuana use in other studies (Nawi et al., 2021). Data for all school-level factors were obtained from the Nevada Department of Education’s Data Portal (Nevada Department of Education, n.d.).

(A) *STUDENT BODY PERCENT NON-HISPANIC WHITE*: The percentage of students who are White within each school was treated as a continuous variable in all analyses.

(B) *NUMBER OF STUDENTS ELIGIBLE FOR FREE AND REDUCED-PRICE LUNCH (PER 100 STUDENTS)*: The number of students eligible for free or reduced-price lunch at a school was divided by the total student enrollment at that school and then multiplied by 100 to obtain a number per 100 students.

(C) *NUMBER OF STUDENTS ON AN INDIVIDUALIZED EDUCATION PROGRAM (PER 100 STUDENTS)*: Individualized Education Programs (IEPs) allow principals, schools, teachers, and parents to develop targeted educational goals for youth and are required for children attending public schools who receive special education or related resources (Office of Special Education and Rehabilitative Services, 2000). The number of students with IEPs at a school was divided by the total student enrollment at that school and multiplied by 100 to obtain a number per 100 students.

(D) *NUMBER OF VIOLENT INCIDENTS BETWEEN STUDENTS (PER 100 STUDENTS)*: The number of violent incidents between students at a school was divided by the total student enrollment at that school and multiplied by 100 to obtain a number per 100 students.

(E) *NUMBER OF REPORTED BULLYING INCIDENTS BETWEEN STUDENTS (PER 100 STUDENTS)*: The number of bullying incidents at a school was divided by the total student enrollment at that school and multiplied by 100 to obtain a number per 100 students.

(F) *SCHOOL TYPE*: Each school was coded as a regular public, charter, or alternative high school based on official classifications from the Nevada Department of Education (2017).

(G) *TITLE I CLASSIFICATION*: Using official federal classification, schools were classified as Title I and non-Title I schools. Title I schools can use federal funds to implement school-wide programs to support students and families if 40% or more of the total school enrollment comprises students from low-income families (U.S. Department of Education, 2018).

Statistical analysis

Given the potential for multicollinearity among study variables, we first evaluated variance inflation factor (VIF) and tolerance estimates. The VIF (1.07 to 1.51) and tolerance (0.66 to 0.93) range estimates suggest that multicollinearity was acceptable. We then used unadjusted multilevel logistic regression models to estimate the association between each individual-level and school-level factor and the three-level frequency of marijuana use outcome. Odds ratios (ORs) and corresponding 95% confidence intervals (CIs) were reported for the following: (a) nonfrequent users versus non-users; (b) frequent users versus non-users; and (c) frequent users versus nonfrequent users (Table 2). The final model

included all individual- and school-level factors that were significantly associated with the outcome in the unadjusted models. Again, adjusted ORs and 95% CIs were reported for (a) nonfrequent versus frequent users, (b) frequent users versus nonfrequent users, and (c) frequent users versus nonfrequent users (Table 3). Because students were nested within classrooms and schools, two random intercepts were included in all models to account for the nested structure of the data. We used SAS Version 9.4 for all analyses (SAS Institute Inc., Cary, NC).

Results

Sample characteristics are presented in Table 1. About half of the participants were female (52.7%), with similar proportions of participants reporting Hispanic (40.9%) and non-Hispanic White (39.2%) races/ethnicities. One third of participants were from rural counties (34.0%), 37.2% qualified for free or reduced-price lunch, and 18.9% self-reported sexual or gender minority identity. The prevalence of individual- and school-level risk and protective factors are also listed in Table 1. Most students (80.3%) reported no P30D marijuana use, 14.6% reported nonfrequent P30D use, and 5.1% reported frequent P30D use.

Unadjusted associations between individual and school factors and frequency of marijuana use are presented in Table 2. All sociodemographic characteristics were significantly associated with both nonfrequent and frequent P30D marijuana use, except family active-duty military involvement. Compared with females, males had lower odds of nonfrequent P30D use, but higher odds of frequent P30D use. All individual factors were significantly associated with both nonfrequent and frequent P30D use, with the exception of sports team participation, which was not significantly associated with nonfrequent P30D use. School factors significantly associated with both nonfrequent and frequent P30D marijuana use included the number of students with an IEP, the number of incidents involving possession of controlled substances, and school type.

Adjusted associations between individual- and school-level factors and frequency of marijuana use are presented in Table 3. First, we compared factors that differentiated nonfrequent and frequent P30D marijuana users from no P30D marijuana users. Sex was not associated with nonfrequent P30D marijuana use, but males had more than twice the odds of frequent P30D use compared with females. Compared with no P30D use, non-Hispanic Black students had 2.6 times higher odds of nonfrequent P30D marijuana use than non-Hispanic White students, and non-Hispanic students of "other" or mixed race had lower odds of frequent P30D use compared with non-Hispanic White students. There was no relationship between grade and nonfrequent versus no P30D use, but the odds of frequent versus no P30D use were higher for 11th and 12th graders compared with 9th graders.

TABLE 1. Prevalence of participant characteristics: Nevada High School Youth Risk Behavior Survey, 2019 ($n = 4,980$)

Variable	<i>n</i>	%	[95% CI]
Total	4,980	100.0%	–
Sociodemographics			
Sex			
Male	2,341	47.3%	[45.9, 48.7]
Female	2,607	52.7%	[51.3, 54.1]
Race/ethnicity			
Hispanic	1,986	40.9%	[39.5, 42.3]
Non-Hispanic Black	238	4.9%	[4.3, 5.5]
Non-Hispanic multiple/other race	727	15.0%	[14.0, 16.0]
Non-Hispanic White	1,904	39.2%	[37.8, 40.6]
Grade			
9th grade	1,317	26.7%	[25.4, 27.9]
10th grade	1,341	27.1%	[25.9, 28.4]
11th grade	1,263	25.6%	[24.3, 26.8]
12th grade	1,019	20.6%	[19.5, 21.8]
Location of residence			
Rural	1,692	34.0%	[32.7, 35.9]
Urban	3,288	66.0%	[64.7, 67.3]
Free or reduced-price lunch			
Yes	1,832	37.2%	[35.9, 38.6]
No	3,087	62.8%	[61.4, 64.1]
Family military involvement, active duty			
Yes	245	5.0%	[4.4, 5.6]
No	4,682	95.0%	[94.4, 95.6]
Sexual or gender minority			
Yes	885	18.9%	[17.8, 20.1]
No	3,786	81.1%	[79.9, 82.2]
Individual-level factors			
Cigarette use, past 30 days			
Yes	269	5.5%	[4.9, 6.2]
No	4,594	94.5%	[93.8, 95.1]
Electronic vapor product use, past 30 days			
Yes	1,262	27.6%	[26.3, 28.9]
No	3,316	72.4%	[71.1, 73.7]
Alcohol use, past 30 days			
Yes	1,203	25.9%	[24.7, 27.2]
No	3,436	74.1%	[72.8, 75.3]
Prescription drug use, past 30 days			
Yes	390	8.1%	[7.4, 8.9]
No	4,397	91.9%	[91.1, 92.6]
Depressive symptoms, past 12 months			
Yes	1,971	40.3%	[38.9, 41.7]
No	2,919	59.7%	[58.3, 61.1]
Bullying victimization, past 12 months			
Yes	1,054	21.6%	[20.4, 22.7]
No	3,831	78.4%	[77.3, 79.6]
Adverse childhood experiences (ACEs)			
0 ACEs	1,774	35.8%	[34.4, 37.1]
1 ACE	1,244	25.1%	[23.9, 26.3]
2 ACEs	859	17.3%	[16.3, 18.4]
≥ 3 ACEs	1,083	21.8%	[20.7, 23.0]

Table continued

Students who qualified for free or reduced-price lunch had increased odds of both nonfrequent and frequent versus no P30D marijuana use.

Nearly all individual-level factors were associated with both nonfrequent and frequent P30D marijuana use compared with no P30D use. P30D use of cigarettes, EVPs, and prescription drugs, as well as exposure to a higher number of ACEs, were associated with both nonfrequent and frequent P30D marijuana use; however, the size of the associations was generally larger for frequent P30D marijuana use. Belief

that marijuana was difficult to access or moderately/greatly risky was inversely associated with both nonfrequent and frequent P30D marijuana use. Although family communication and school connectedness scores were protective in unadjusted analyses, only school connectedness endured as a protective factor after adjustment. None of the school factors were significantly associated with nonfrequent P30D marijuana use when compared with no P30D marijuana use (Table 3).

We also compared factors that differentiated frequent

TABLE 1. *Continued*

Variable	<i>n</i>	%	[95% CI]
Perceived ease of access to marijuana			
Difficult/very difficult/not sure	1,528	31.6%	[30.2, 32.9]
Easy/very easy	3,315	68.4%	[67.1, 69.8]
Perceived risk of marijuana use			
Moderate/great risk	2,816	60.4%	[59.0, 61.8]
Slight/no risk	1,844	39.6%	[38.2, 41.0]
Sports team participation, past 12 months			
Yes	2,338	49.5%	[48.0, 50.9]
No	2,388	50.5%	[49.1, 52.0]
Family communication, <i>M (SD)</i>	1.8 (1.1)	–	–
School connectedness, <i>M (SD)</i>	2.2 (0.9)	–	–
School-level factors (<i>n</i> = 99 schools)			
Student body percentage non-Hispanic White, <i>M (SD)</i>	43.2 (22.4)	–	–
No. of students with an individualized education program, per 100 students, <i>M (SD)</i>	11.1 (3.9)	–	–
No. of violent incidents between students, per 100 students, <i>M (SD)</i>	1.7 (1.6)	–	–
No. of incidents involving possession of controlled substances, per 100 students, <i>M (SD)</i>	1.6 (1.4)	–	–
No. of bullying incidents between students, per 100 students, <i>M (SD)</i>	1.3 (1.4)	–	–
School type			
Alternative	3	3.0%	–
Charter	8	8.1%	–
Regular public	88	88.9%	–
Title I school			
Yes	42	42.4%	–
No	57	57.6%	–
Outcome: Frequency of use			
Frequency of P30D marijuana use			
No P30D use, 0 times	3,846	80.3%	[79.2, 81.4]
Nonfrequent P30D use, 1–19 times	700	14.6%	[13.6, 15.6]
1–2 times	349		
3–9 times	215		
10–19 times	136		
Frequent P30D use, ≥20 times	243	5.1%	[4.5, 5.7]
20–39 times	96		
≥40 times	147		

Notes: CI = confidence interval; no. = number; P30D = past-30-day.

from nonfrequent P30D marijuana users. Males and 11th and 12th grade students had higher odds of frequent P30D use compared with females and 9th grade students, respectively. Although P30D alcohol use did not differentiate frequent from nonfrequent P30D marijuana users, P30D cigarette, EVP, and prescription drug use were all associated with frequent versus nonfrequent P30D marijuana use. Lifetime exposure to three or more ACEs also elevated the odds of frequent versus nonfrequent P30D marijuana use. Unlike prior comparisons to students who had not used marijuana in the P30D, perceived ease of access to or perceived risk of marijuana use did not differentiate nonfrequent from frequent P30D users. As was the case with frequent versus no P30D use, school connectedness was associated with reduced odds of frequent versus nonfrequent P30D use. At the school level, a one-unit increase in the number of incidents involving possession of controlled substances (per 100 students) was associated with higher odds of frequent P30D marijuana use; and students who attended alternative schools

had significantly higher odds of frequent P30D marijuana use compared with students from regular public schools (Table 3).

Discussion

The purpose of this study was to identify individual- and school-level risk and protective factors that differentiate frequent P30D marijuana use from nonfrequent use patterns to identify targets for intervention that could reduce the physical and mental health risks of sustained frequent marijuana use. When compared with non-users, cigarette, EVP, prescription drug, and alcohol use were associated with and frequent and nonfrequent P30D marijuana use compared with no P30D use; however, even compared with nonfrequent P30D users, frequent P30D users had elevated odds of cigarette, EVP, and prescription drug use. These findings comport with the common liability model, which explains that co-occurring substance use behaviors are likely driven

TABLE 2. Unadjusted association between individual-level and school-level characteristics and nonfrequent and frequent past-30-day (P30D) marijuana use: Nevada High School Youth Risk Behavior Survey, 2019 ($n = 4,980$)

Variable	Nonfrequent P30D marijuana use vs. no P30D use OR [95% CI]	Frequent P30D marijuana use vs. no P30D use OR [95% CI]	Frequent P30D marijuana use vs. nonfrequent P30D marijuana use OR [95% CI]
Sociodemographics			
Sex			
Male	1.45 [1.10, 1.93]	0.77 [0.65, 0.92]	1.96 [1.43, 2.69]
Female	ref.	ref.	ref.
Race/ethnicity			
Hispanic	0.88 [0.64, 1.21]	1.26 [1.03, 1.54]	0.72 [0.51, 1.02]
Non-Hispanic Black	1.15 [0.59, 2.25]	1.96 [1.35, 2.84]	0.52 [0.26, 1.05]
Non-Hispanic multiple/other race	0.51 [0.31, 0.84]	0.93 [0.71, 1.23]	0.54 [0.31, 0.94]
Non-Hispanic White	ref.	ref.	ref.
Grade			
9th grade	ref.	ref.	ref.
10th grade	1.66 [1.00, 2.75]	0.79 [0.60, 1.04]	1.96 [1.15, 3.32]
11th grade	2.82 [1.74, 4.56]	1.17 [0.89, 1.54]	2.28 [1.39, 3.75]
12th grade	3.74 [2.26, 6.20]	1.54 [1.14, 2.02]	2.32 [1.40, 3.85]
Location of school			
Rural	0.99 [0.62, 1.58]	0.90 [0.68, 1.20]	1.12 [0.75, 1.66]
Urban	ref.	ref.	ref.
Free or reduced lunch			
Yes	1.64 [1.16, 2.11]	1.41 [1.18, 1.69]	1.14 [0.83, 1.57]
No	ref.	ref.	ref.
Family military involvement, active duty			
Yes	1.22 [0.69, 2.16]	0.96 [0.65, 1.43]	1.19 [0.60, 2.36]
No	ref.	ref.	ref.
Sexual or gender minority			
Yes	1.84 [1.33, 2.54]	1.64 [1.33, 2.01]	1.16 [0.81, 1.67]
No	ref.	ref.	ref.
Individual-level factors			
Cigarette use, past 30 days			
Yes	15.34 [10.02, 23.47]	8.29 [6.00, 11.45]	1.84 [1.24, 2.75]
No	ref.	ref.	ref.
Electronic vapor product use, past 30 days			
Yes	22.24 [15.45, 32.03]	12.24 [9.94, 15.07]	2.10 [1.38, 3.18]
No	ref.	ref.	ref.
Alcohol use, past 30 days			
Yes	8.93 [6.54, 12.20]	8.83 [7.27, 10.72]	1.00 [0.71, 1.40]
No	ref.	ref.	ref.
Prescription drug use, past 30 days			
Yes	6.94 [4.81, 10.02]	3.53 [2.69, 4.63]	1.95 [1.32, 2.87]
No	ref.	ref.	ref.
Depressive symptoms, past 12 months			
Yes	2.94 [2.22, 3.90]	2.65 [2.23, 3.14]	1.11 [0.81, 1.53]
No	ref.	ref.	ref.
Bullying victimization, past 12 months			
Yes	1.46 [1.06, 2.01]	1.99 [1.64, 2.40]	0.73 [0.51, 1.04]
No	ref.	ref.	ref.
Adverse childhood experiences (ACEs)			
0 ACEs	ref.	ref.	ref.
1 ACE	1.96 [1.22, 3.15]	2.03 [1.59, 2.60]	0.93 [0.54, 1.59]
2 ACE	3.50 [2.20, 5.58]	2.61 [2.01, 3.38]	1.33 [0.79, 2.26]
≥3 ACEs	9.04 [6.00, 13.60]	4.31 [3.40, 5.36]	2.06 [1.30, 3.27]
Perceived ease of access to marijuana			
Difficult/very difficult	0.17 [0.11, 0.27]	0.20 [0.15, 0.26]	0.81 [0.47, 1.39]
Easy/very easy	ref.	ref.	ref.
Perceived risk of marijuana use			
Moderate/great risk	0.16 [0.10, 0.24]	0.25 [0.20, 0.31]	0.60 [0.37, 0.98]
Slight/no risk	ref.	ref.	ref.
Sports team participation, past 12 months			
Yes	0.67 [0.50, 0.90]	1.05 [0.88, 1.25]	0.64 [0.46, 0.88]
No	ref.	ref.	ref.
Family communication, continuous score	0.74 [0.65, 0.85]	0.78 [0.72, 0.84]	0.94 [0.81, 1.10]
School connectedness, continuous score	0.48 [0.41, 0.57]	0.65 [0.58, 0.72]	0.67 [0.55, 0.81]

Table continued

TABLE 2. *Continued*

Variable	Nonfrequent P30D marijuana use vs. no P30D use OR [95% CI]	Frequent P30D marijuana use vs. no P30D use OR [95% CI]	Frequent P30D marijuana use vs. nonfrequent P30D marijuana use OR [95% CI]
School-level factors			
Student body percentage non-Hispanic White	1.01 [1.00, 1.02]	1.00 [0.99, 1.00]	1.01 [1.00, 1.02]
No. of students with an individualized education Program, per 100 students	1.05 [1.00, 1.11]	1.06 [1.02, 1.09]	1.00 [0.96, 1.05]
No. of violent incidents between students, per 100 students	1.01 [0.89, 1.15]	1.04 [0.96, 1.13]	0.97 [0.87, 1.09]
No. of incidents involving possession of controlled substances, per 100 students	1.15 [1.01, 1.32]	1.15 [1.06, 1.25]	1.02 [0.91, 1.14]
No. of bullying incidents between students, per 100 students	1.00 [0.88, 1.13]	1.00 [0.92, 1.08]	0.99 [0.88, 1.12]
School type			
Alternative	17.03 [5.73, 50.61]	3.42 [1.33, 8.80]	4.32 [1.71, 10.94]
Charter	1.05 [0.39, 2.85]	0.55 [0.26, 1.17]	1.93 [0.65, 5.70]
Regular public	ref.	ref.	ref.
Title 1 school			
Yes	1.18 [0.75, 1.85]	1.07 [0.81, 1.42]	1.12 [0.76, 1.65]
No	ref.	ref.	ref.

Notes: OR = odds ratio; CI = confidence interval; ref. = reference; no. = number.

by a common genetic, biochemical, psychological, and/or environmental underlying cause (Vanyukov et al., 2003); addressing this cause could reduce risk for multiple types of substance use concurrently. It is also worth noting that youth who reported P30D EVP use had significantly higher odds of engaging in frequent P30D marijuana use compared with both nonfrequent and no P30D use. Although we did not assess what substance students were vaping, it is possible that vaping nicotine fluid facilitates vaping cannabis concentrate or vice versa, as some devices/device components can be used for vaping either substance. Youth who use marijuana frequently may also use EVPs more often, as it is easier to conceal than smoking marijuana (Ramamurthi et al., 2019).

Numerous studies have found that adolescents with high exposure to ACEs have higher rates of early initiation, P30D, and daily use of marijuana (Chatterjee et al., 2018; Clements-Nolle et al., 2022; Duke, 2018). We extend these findings and demonstrate that high ACE exposure also differentiates youth who use marijuana frequently from those who do not. It is possible that youth with high levels of exposure to trauma may be a particularly high risk for using marijuana frequently, possibly as a coping mechanism (Kato, 2020). These results suggest that interventions that address experiences of trauma and increase resiliency may be particularly useful for decreasing risk for transition to frequent P30D marijuana use.

As has been identified in prior studies (Chen et al., 2018; Fleming et al., 2016), we found that perceived risk of marijuana use and ease of access to marijuana were strongly associated with both frequent and nonfrequent use compared with no use; however, we found that these measures did not distinguish frequent from nonfrequent P30D marijuana use-

ers. Conceptually, this makes sense: P30D marijuana users have demonstrated their ability to access marijuana regardless of how frequently they use. Given the strong correlation between these perceptions and both frequencies of marijuana use, community policies that eliminate underage marijuana access and interventions that communicate the particular risks of marijuana use in adolescence may reduce risk for both frequencies of use.

Several factors related to the school environment—namely school connectedness, number of IEPs per 100 students, number of incidents involving possession of controlled substances per 100 students, and alternative school attendance—were associated with frequent P30D marijuana use compared with non-use and nonfrequent use. Previous research shows that school connectedness is associated with P30D marijuana use in general, but we found that school connectedness was uniquely protective for frequent use. Interventions designed to foster school connectedness, particularly those that are co-developed by school administrators, teachers, and students, may have a protective influence on escalation to more frequent use (Chapman et al., 2013). IEPs are generally recognized as a foundation of quality education and increase positive outcomes for students with special needs, including students with emotional or behavioral challenges (Blackwell & Rossetti, 2014) who may be at risk for escalating to frequent marijuana use. Finally, these findings also provide support for tailored secondary preescalation marijuana prevention efforts at schools with high-risk environments such as those with more incidents involving possession of a controlled substance and at alternative schools, which commonly serve students who engage in high-risk behaviors and are at risk for dropping out (U.S. Department of Education, n.d.).

TABLE 3. Multilevel associations between individual-level and school-level characteristics and nonfrequent and frequent past-30-day (P30D) marijuana use: Nevada High School Youth Risk Behavior Survey, 2019 ($n = 4,980$)

Variable	Nonfrequent P30D marijuana use vs. no P30D use AOR [95% CI]	Frequent P30D marijuana use vs. no P30D use AOR [95% CI]	Frequent P30D marijuana use vs. nonfrequent P30D marijuana use AOR [95% CI]
Sociodemographics			
Sex			
Male	0.96 [0.74, 1.24]	2.48 [1.56, 3.94]	2.43 [1.52, 3.88]
Female	ref.	ref.	ref.
Race/ethnicity			
Hispanic	1.22 [0.92, 1.63]	0.73 [0.44, 1.21]	0.68 [0.42, 1.10]
Non-Hispanic Black	2.55 [1.49, 4.35]	1.38 [0.46, 4.12]	0.49 [0.18, 1.36]
Non-Hispanic multiple/other race	0.84 [0.57, 1.23]	0.27 [0.12, 0.61]	0.41 [0.19, 0.92]
Non-Hispanic White	ref.	ref.	ref.
Grade			
9th grade	ref.	ref.	ref.
10th grade	0.76 [0.53, 1.10]	1.09 [0.51, 2.36]	1.46 [0.69, 3.07]
11th grade	0.86 [0.60, 1.24]	1.80 [0.87, 3.71]	2.47 [1.25, 4.91]
12th grade	1.00 [0.68, 1.46]	1.98 [0.93, 4.22]	2.91 [1.42, 5.95]
Free or reduced lunch			
Yes	1.33 [1.02, 1.72]	1.74 [1.09, 2.77]	1.27 [0.81, 2.00]
No	ref.	ref.	ref.
Sexual or gender minority			
Yes	1.07 [0.79, 1.46]	1.13 [0.84, 1.52]	1.17 [0.69, 2.00]
No	ref.	ref.	ref.
Individual-level factors			
Cigarette use, past 30 days			
Yes	1.81 [1.12, 2.91]	2.76 [1.43, 5.34]	1.83 [1.04, 3.21]
No	ref.	ref.	ref.
Electronic vapor product use, past 30 days			
Yes	5.59 [4.31, 7.26]	9.96 [5.95, 16.68]	1.77 [1.02, 3.05]
No	ref.	ref.	ref.
Alcohol use, past 30 days			
Yes	3.08 [2.38, 3.98]	2.69 [1.67, 4.32]	0.74 [0.46, 1.19]
No	ref.	ref.	ref.
Prescription drug use, past 30 days			
Yes	1.56 [1.02, 2.39]	2.89 [1.51, 5.52]	2.65 [1.46, 4.82]
No	ref.	ref.	ref.
Depressive symptoms, past 12 months			
Yes	1.31 [1.00, 1.70]	1.14 [0.71, 1.84]	0.93 [0.58, 1.48]
No	ref.	ref.	ref.
Bullying victimization, past 12 months			
Yes	1.08 [0.81, 1.44]	0.62 [0.35, 1.09]	0.55 [0.33, 0.92]
No	ref.	ref.	ref.
Adverse childhood experiences (ACEs)			
0 ACEs	ref.	ref.	ref.
1 ACE	1.29 [0.91, 1.82]	1.48 [0.74, 2.94]	1.01 [0.49, 2.09]
2 ACEs	1.57 [1.08, 2.27]	1.75 [0.86, 3.56]	1.54 [0.73, 3.23]
≥3 ACEs	1.58 [1.10, 2.28]	2.89 [1.49, 5.60]	2.12 [1.07, 4.19]
Perceived ease of access to marijuana			
Difficult/very difficult	0.25 [0.17, 0.36]	0.34 [0.17, 0.66]	1.20 [0.56, 2.58]
Easy/very easy	ref.	ref.	ref.
Perceived risk of marijuana use			
Moderate/great risk	0.36 [0.27, 0.47]	0.18 [0.09, 0.36]	0.61 [0.30, 1.23]
Slight/no risk	ref.	ref.	ref.
Sports team participation, past 12 months			
Yes	1.19 [0.93, 1.52]	1.06 [0.67, 1.66]	0.92 [0.59, 1.45]
No	ref.	ref.	ref.
Family Communication	0.95 [0.84, 1.07]	1.12 [0.90, 1.38]	1.15 [0.94, 1.24]
School Connectedness	0.86 [0.74, 1.01]	0.72 [0.55, 0.94]	0.73 [0.56, 0.96]
School-level factors			
No. of students with an individualized education program, per 100 students	1.01 [0.97, 1.06]	0.91 [0.84, 0.99]	0.93 [0.85, 1.01]
No. of incidents involving possession of controlled substances, per 100 students	1.01 [0.90, 1.14]	1.39 [1.12, 1.72]	1.31 [1.06, 1.61]
School type			
Alternative	0.68 [0.18, 2.51]	17.24 [3.76, 78.94]	11.00 [2.63, 45.98]
Charter	0.46 [0.16, 1.38]	0.25 [0.04, 1.66]	0.67 [0.10, 4.67]
Regular public	ref.	ref.	ref.

Notes: AOR = adjusted odds ratio; CI = confidence interval; ref. = reference; no. = number.

This study had several limitations. First, there is potential for underreporting because sensitive information such as substance use, emotional well-being, and childhood trauma, was self-reported by students. However, no personal identifying information was collected and students were given materials to cover their answers during survey administration. Second, there is potential for dependent error (i.e., error in one study variable being correlated with error in another) since the youth self-reported exposure and outcome variables on the same survey. Third, given the cross-sectional study design, there is potential for reverse causality with certain indicators (e.g., P30D substance use). Fourth, the family communication measure did not account for differential communication across parents. Finally, the results of this study may only be generalizable to high school students living in Nevada—a state where the sale of recreational marijuana has been legal since 2017—or more broadly to high school students living in states with recreationally legal sales. Our sample contained a significant proportion of Hispanic youth (40%), which may not be representative of racial and ethnic distributions in other states.

Conclusions

Adolescents who are frequent marijuana users are at particularly high risk for reduced cognitive functioning (Scott et al., 2018), other substance use problems (Thrul et al., 2021), and mental health problems in adulthood (Forman-Hoffman et al., 2017; Hadland & Harris, 2014; Moore et al., 2007). Although many individual- and school-level factors were independently associated with both frequent and nonfrequent P30D marijuana use, substance use, exposure to ACEs, and factors associated with the school environment had stronger or unique relationships with frequent use. Taking a pre-escalation perspective, our findings can be used to identify potential targets for secondary prevention interventions to reduce transition from occasional to frequent marijuana use as a supplement to primary prevention efforts preventing initiation of any marijuana use.

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