Journal of Child & Adolescent Substance Use

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/wcas21

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To cite this article: Heather K. Barr, Kristen Clements-Nolle, Taylor Lensch & Wei Yang (2025) Risk and Protective Factors for Driving Under the Influence of Alcohol, Marijuana, and Both Substances in a Population-Based Sample of High School Students, Journal of Child & Adolescent Substance Use, 30:1, 2-12, DOI: 10.1080/1067828X.2024.2391127

To link to this article: https://doi.org/10.1080/1067828X.2024.2391127

Published online: 26 Aug 2024.

JOURNAL OF CHILD & ADOLESCENT SUBSTANCE USE
2025, VOL. 30, NO. 1, 2–12
https://doi.org/10.1080/1067828X.2024.2391127

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Risk and Protective Factors for Driving Under the Influence of Alcohol, Marijuana, and Both Substances in a Population-Based Sample of High School Students

Heather K. Barr, Kristen Clements-Nolle, Taylor Lensch and Wei Yang

School of Public Health, University of Nevada Reno, Reno, NV, USA

ABSTRACT

Using results from the 2017 Nevada Youth Risk Behavior Survey, this research aims to understand factors associated with driving under the influence of alcohol (DUIA), marijuana (DUIM), and both alcohol and marijuana (DUIB) among students who reported they drove and used alcohol and/or marijuana recently. DUIM was the most prevalent behavior (16.4%), followed by DUIB (9.3%) and DUIA (4.9%). Weighted multinomial logistic regression analysis showed more risk and protective factors were associated with DUIB than DUIM and DUIA. To decrease motor vehicle crashes among adolescents, interventions should address modifiable factors for driving under the influence of both alcohol and marijuana.

KEYWORDS

Marijuana; cannabis; alcohol; adolescents; driving

Introduction

Unintentional injuries have been the leading cause of death among teenagers aged 14–19 since 1999, with motor vehicle crashes accounting for nearly two thirds of these deaths (Centers for Disease Control & Prevention, National Center for Health Statistics, 2024). One of the strongest risk factors for motor vehicle crashes among teens is driving under the influence of alcohol and other substances. Driving under the influence of substances can impair the driver's abilities in a number of ways. Slower reaction times, varying speeds, swerving within lanes, and crossing lane boundaries have been documented among those who drove impaired by alcohol (Marczinski et al., 2008; Ronen et al., 2010). Marijuana, in particular, has been shown to decrease a driver's speed and reaction times and increase the risk of fatal accidents (Anderson et al., 2010; Martin et al., 2017; Miller et al., 2020). In addition to the independent effects of driving under the influence of alcohol or marijuana, there are severe synergistic effects of driving under the influence of both substances (Fares et al., 2022; Li et al., 2017; Ronen et al., 2010). Many adolescents initiate substance use during high school making this a critical period to reduce potential harms associated with substance use, such as driving under the influence. Understanding the risk and protective factors that differentiate youth who drive under the influence of alcohol, marijuana, and both substances is essential to guide efforts to prevent motor vehicle crashes.

Alcohol remains the most commonly used substance among adolescents (Hoots et al., 2023) and numerous studies have investigated factors associated with driving under the influence of alcohol (DUIA). Risk factors for DUIA included being male (O'Malley & Johnston, 2013; Yellman et al., 2020), living in a single family home (O'Malley & Johnston, 2013), living in a non-metro area (Yockey & Barroso, 2023), initiating alcohol at an early age (Buckley et al., 2017; Gruber et al., 1996), binge drinking (Delcher et al., 2013; Evans-Polce et al., 2017), using marijuana or other illicit drugs (Buckley et al., 2017; Yockey & Barroso, 2023), consuming alcohol or marijuana on school grounds (Dudovitz et al., 2015), riding with someone who drove under the

CONTACT Kristen Clements-Nolle, PhD, MPH clements@unr.edu Epidemiology, University of Nevada, Reno, School of Public Health, Mailstop 275, Reno, NV 89557, USA.

influence of alcohol (Leadbeater et al., 2008; Yellman et al., 2020), and poor academic performance (Yellman et al., 2020; O'Malley & Johnson, 2013). Few studies have focused on protective factors, but higher parental monitoring and school connectedness were associated with lower prevalence of DUIA in one study (Haegerich et al., 2016).

With continuing legalization of recreational marijuana use in many states there is growing concern about teens driving under the influence of marijuana (DUIM) (Ladegard et al., 2020). The 2017 national Youth Risk Behavior Survey found that recent alcohol use was more prevalent than recent marijuana use (29.8% versus 19.8%), but among students who recently drove, 13% reported DUIM compared to just 5.5% who reported DUIA (Kann et al., 2018; Li et al., 2020).

Despite the higher rates of DUIM compared to DUIA, less is known about adolescents who engage in DUIM. O'Malley and Johnston (2013) found similar risk factors associated with DUIM as with DUIA (male, single-parent household, low religiosity, poor academic performance, spending evenings out, working outside of school, and driving a greater number of miles). Similarly, Leadbeater and colleagues found that as was observed for DUIA, students with friends or parents who drove after using marijuana were more likely to do it themselves (Leadbeater et al., 2008). More recently, studies have shown that DUIM is more common among youth who live in rural areas (Carpino et al., 2020), initiated marijuana use at an early age and engage in DUIA (Hammig et al., 2021; Li et al., 2020), frequently use marijuana (Hammig et al., 2021), currently use alcohol and illicit drugs, and report major depressive symptoms (Yockey & Barroso, 2023). Carpino et al. (2020) also found that teen drivers with higher perception of risk were less likely to report DUIM.

To our knowledge, only one study has assessed factors associated with DUIA, DUIM, and DUIB. Salas-Wright et al. (2023) found that youth and young adults who reported criminal justice involvement, cannabis- and alcohol-related disorders, early initiation of substance use, and use of illicit drugs had higher odds of DUIA, DUIM, and DUIB while greater perceived risk was protective against all three behaviors. However, the analytic sample for these analyses combined young adults (18–20 year olds) and adolescents (16–17 year olds) making it difficult to extrapolate findings to high school adolescents. The study also included all youth irrespective of whether they were current substance users when assessing risk factors, so the findings may be more reflective of factors associated with substance use rather than the driving under the influence behavior itself. To guide early prevention efforts during the time when many adolescents are experimenting with substance use and starting to drive, there is a need to assess a wider range of risk and protective factors for DUIA, DUIM, as well as DUIB among high school students who currently use alcohol and/or marijuana.

To address these limitations, this study aimed to identify risk and protective factors associated with DUIA, DUIM, and DUIB in a population-based sample of substance using high school students who participated in the 2017 Nevada Youth Risk Behavior Survey. Data were collected immediately preceding legal sale of recreational marijuana in Nevada, which provided an opportunity to examine marijuana use behaviors as a baseline before it becomes more accessible and socially accepted through the legalization process. We focused on available risk and protective factors that are supported by the literature and may be amenable to intervention such as early initiation of substance use (Buckley et al., 2017; Gruber et al., 1996; Hammig et al., 2021; Li et al., 2020; Salas-Wright et al., 2023), riding with an impaired driver—which likely reflects the choice to drive under the influence made by parents and friends (Leadbeater et al., 2008; Li et al., 2020; Yellman et al., 2020), poor mental health (Yockey & Barroso, 2023), academic performance (O'Malley & Johnston, 2013, Yellman et al., 2020), parental monitoring (Haegerich et al., 2016), and sports team participation (Boyes et al., 2017).

Materials and methods

Participants and procedures

The Centers for Disease Control and Prevention (CDC) established the Youth Risk Behavior Survey (YRBS) in 1990 to monitor health risk

behaviors among U.S. adolescents (Youth Risk Behavior Risk Factor Surveillance System (YRBSS) Overview, 2023). The CDC funds states, territories, and tribal nations to collect data from randomly selected public, charter, and alternative schools. In addition to the schools randomly selected by the CDC to participate in the YRBS, Nevada samples all additional high schools across the state using the same methodology developed by the CDC.

Our research team conducted the 2017 Nevada high school YRBS from February through May using a random cluster sampling design. All high schools ($N = 101$) were invited to participate and only 3 schools (3%) declined. First, the state's seventeen school districts were grouped into eight regions that reflect the prevention coalition structure in the state. Next, either 2nd period or required English classes at each school were randomly sampled to reach the sample size requirement per region. Either active or passive parental permission was obtained, depending on school district policy. Students in randomly selected classes completed the survey during one class session; the survey was anonymous and voluntary and students had the option to skip any questions or refuse participation. An overall response rate of 65.7% (a combination of school and student responses) resulted in a total sample of 5,336 students from 98 high schools representing a weighted frequency of 134,083 high school students.

The Internal Review Board (IRB) at the University of Nevada, Reno and local school districts (when required) approved the study.

Measures

Substance use

Two standard YRBS survey measures were used to select our study population of students who had used alcohol, marijuana, or both substances in the past 30 days. (1) "During the past 30 days, on how many days did you have at least one drink of alcohol?" and (2) "During the past 30 days, how many times did you use marijuana?" Students who indicated "one or more" on either question were placed into their representative group: Alcohol only, marijuana only, or both substances (a positive response to both questions).

Driving under the influence

The national YRBS includes a standard driving under the influence of alcohol question: "During the past 30 days, how many times did you drive a car or other vehicle when you had been drinking alcohol?" Few states assess driving under the influence of marijuana, but in 2017 Nevada included a state-added variable: "During the past 30 days, how many times did you drive a car or other vehicle when you had been using marijuana (also called grass, pot, or weed)?" The two separate measures were used to create the four-level outcome. Participants were categorized as DUIA (students reported driving under the influence of alcohol, but not marijuana), DUIM (students reported driving under the influence of marijuana, but not alcohol), DUIB (students reported driving under the influence of alcohol and marijuana at some point in the past 30 days, but not necessarily concurrently) or neither (students did not report driving under the influence of alcohol or marijuana).

Demographics

Demographic measures included sex, race/ethnicity (Hispanic, Non-Hispanic white, and Non-Hispanic other), and qualification for free or reduced priced lunch. Students who selected "Hispanic" were classified as Hispanic; those who select "Non-Hispanic" were further divided into "White" and "Other." Schools were classified as urban or rural using the US Census Bureau's definition; the Census Bureau does not use a suburban classification (US Census Bureau, 2021).

Risk factors

Early age of initiation of alcohol and marijuana—Two standard YRBS questions assessed age of initiation: (1) "How old were you when you had your first drink of alcohol other than a few sips?" and (2) "How old were you when you tried marijuana for the first time?" Students who responded that they were under the age of 13 when they first used alcohol or marijuana were classified as

early initiators, consistent with the CDC's definition of early initiation (Kann et al., 2018).

Riding with a driver who had been using alcohol or marijuana—Students responded to two separate questions about the number of times during the past 30 days they had ridden in a car driven by an individual who had been using alcohol (YRBS standard question) or marijuana (state-added question). These responses were dichotomized into "yes" versus "no."

Depressive symptoms—One standard YRBS question was used to assess depressive symptoms: "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 were dichotomized into "yes" versus "no."

Protective factors

Parental monitoring –One state-added question assessed parental monitoring: "How often do your parents or other adults in your family ask where you are going or with whom you will be?" Responses were categorized as "high" (most of the time or always) versus "low" (never, rarely, or sometimes).

Grades—One state-added question assessed how students would describe their grades in school during the past 12 months. Responses were dichotomized as "mostly A's and B's" versus "mostly C's to F's."

Sports team participation—Students were asked: "During the past 12 months, on how many sports teams did you play?" Responses were dichotomized as "0 teams" versus "1 or more teams."

Analyses

To ensure that we assessed factors associated with driving under the influence rather than overall use alcohol or marijuana, the analytic sample was restricted to students who used alcohol or marijuana is the past 30 days and drove a vehicle in the past 30 days ($N = 1{,}023$). All analyses were conducted using SAS version 9.4 (SAS Institute, Cary, NC) and accounted for the complex survey design of the YRBS. Data were weighted based on sex, grade, and race/ethnicity among youth within each of the eight regions and accounted for regional/classroom clustering using methodology recommended by the CDC.

We calculated the weighted prevalence of demographics, all potential exposures, and the 4-level driving under the influence outcome, as well as the distribution of driving behaviors by substance use. To assess differences in sociodemographics and risk and protective factors between each of the driving groups, weighted chi-square tests were used and we applied the Bonferroni correction for multiple comparisons. Finally, we conducted weighted multinomial regression controlling for demographics to evaluate the association between risk and protective factors and the driving under the influence outcome, producing adjusted odds ratios (AOR) and corresponding 95% CIs (students who did not drive when they had been using alcohol or marijuana were the referent group). We used multinomial logistic regression because the outcome was nominal, but not ordered and had mutually exclusive and exhaustive categories. Adding another choice would not change the odds of DUIA, DUIM, or DUIB. We tested collinearity between exposure variables by calculating the variance inflation factor (VIF) for each variable; most were very close to 1 and the highest was 1.20 demonstrating that multicollinearity was not a concern.

Results

Table 1 shows the descriptive characteristics of the 1,023 high school students who currently used alcohol and/or marijuana and reported driving in the past 30 days. The majority were either Hispanic (41.9%) or non-Hispanic white (38.4%) which is consistent with Nevada adolescent population. Over a third of the sample (36.7%) qualified for free or reduced priced lunch, and a greater proportion of students were from urban cities (85.7%). A greater proportion of students reported early initiation of alcohol (30.6%) than marijuana (19.9%), but more had ridden with a driver who had used marijuana (44.6%) than a driver who had used alcohol (26.8%). Forty percent of students reported having depressive symptoms, 77.2% had high levels of parental monitoring, 69.6% mostly had A's or B's, and

Table 1. Characteristics of 1,023 high school students[a], Nevada 2017.

	N (%)
	1,023 (100.0)
Sociodemographics	
Sex	
Female	525 (49.4)
Male	491 (50.6)
Race/Ethnicity	
Non-Hispanic white	435 (38.4)
Hispanic	419 (41.9)
Non-Hispanic other	153 (19.6)
Free or reduced lunch	
Yes	338 (36.7)
No	674 (63.3)
Location	
Rural	438 (14.3)
Urban	585 (85.7)
Risk factors	
Early initiation of alcohol	
Yes	307 (30.6)
No	652 (69.4)
Early initiation of marijuana	
Yes	203 (19.9)
No	803 (80.1)
Rode with a driver who had been using alcohol	
Yes	280 (26.8)
No	738 (73.2)
Rode with a driver who had been using marijuana	
Yes	440 (44.6)
No	566 (55.4)
Depressive symptoms	
Yes	441 (40.9)
No	569 (59.1)
Protective factors	
Parental monitoring	
High	751 (77.2)
Low	247 (22.8)
Grades	
A's and B's	663 (69.6)
C's–F's	332 (30.4)
Sport team participation	
Yes	564 (52.1)
No	424 (47.9)
Past 30-day substance use	
Alcohol only	395 (41.8)
Marijuana only	126 (17.4)
Both alcohol and marijuana	361 (40.7)
Driving after using	
Alcohol (DUIA)	62 (4.9)
Marijuana (DUIM)	159 (16.4)
Both substances (DUIB)	86 (9.3)
Neither substance	716 (69.4)

[a]Students who used alcohol and/or marijuana during the past 30 days and who had driven during the past 30 days.

52.1% participated on a sports team in the past 12 months (52.1%). About 42% of the sample used alcohol only, 17.4% used marijuana only, and 40.7% used both alcohol and marijuana in the past 30 days. DUIM (16.4%) and DUIB (9.3%) were more common than DUIA (4.9%).

Table 2 shows the distribution of driving behaviors by substance use in the past 30 days. Most students who only used alcohol did not drive under the influence of any substance (93.5%) and 6.5% reported DUIA. Among students who only used marijuana, 78.7% did not drive under the influence, but 21.3% reported DUIM. Among youth who used both substances, 42.4% did not drive under the influence, 2.8% reported DUIA, 29% reported DUIM, and 25.5% reported DUIB.

Table 2. Distribution of driving behaviors by substance use in the past 30 days among 1,023 high school students[a], Nevada 2017.

	None *N* (%)	DUIA *N* (%)	DUIM *N* (%)	DUIB *N* (%)
Past 30 day substance use				
Alcohol only	357 (93.5)	38 (6.5)	0 (0.0)	0 (0.0)
Marijuana only	96 (78.7)	0 (0.0)	30 (21.3)	0 (0.0)
Both alcohol and marijuana	171 (42.4)	12 (2.8)	100 (29.3)	78 (25.5)

[a]Students who had used alcohol and/or marijuana during the past 30 days and who had driven during the past 30 days.

As shown in Table 3, there were no sociodemographic differences between students who drove under the influence and those who did not, except students who reported DUIA were more likely to live in rural areas compared to those who did not drive under the influence. Students who reported DUIA, DUIM and DUIB were more likely to initiate alcohol early, initiate marijuana early, and ride with a driver who had been using alcohol compared to students who did not drive under the influence. Students who reported DUIM and DUIB were more likely to report riding with a driver who had been using marijuana compared to youth who did not drive under the influence and youth who reported DUIB were more likely to have depressive symptoms compared to those who did not drive under the influence. In terms of protective factors, youth who reported DUIB were less likely to have high parental monitoring and report getting mostly A's and B's in school compared to youth who did not drive under the influence.

Students who reported DUIA, DUIM, and DUIB were similar to each other in terms of sociodemographics and most risk and protective factors. However, students who reported DUIA and DUIB were more likely to ride with a driver who had been using alcohol compared to those who reported DUIM. Similarly, students who reported DUIB were more likely to ride with a

Table 3. Differences in risk, protective, and demographic factors associated with driving under the influence of alcohol, marijuana, and both substances among 1,023 high school students[a], Nevada 2017.

	None N (%)	DUIA N (%)	DUIM N (%)	DUIB N (%)	*p*-Value**
Demographics					
Sex					
Male	386 (53.0)	28 (39.2)	80 (47.4)	31 (31.3)	
Female	328 (47.0)	33 (60.8)	79 (52.6)	51 (68.7)	
Race					
Non-Hispanic white	320 (40.1)	28 (42.2)	61 (34.2)	26 (31.6)	
Hispanic	292 (42.0)	21 (30.3)	64 (40.4)	42 (50.4)	
Non-Hispanic other	92 (17.9)	12 (27.5)	17 (25.4)	32 (18.1)	
Free or reduced lunch					
Yes	32 (36.1)	14 (31.8)	57 (38.3)	35 (41.0)	
No	476 (63.9)	47 (68.2)	102 (61.7)	49 (59.0)	
Location					A
Rural	293 (13.7)	40 (24.8)	66 (13.7)	39 (14.0)	
Urban	423 (86.3)	22 (75.2)	93 (86.3)	47 (86.0)	
Risk factors					
Early initiation alcohol					A,B,C
Yes	182 (26.2)	27 (47.6)	53 (33.5)	45 (48.5)	
No	487 (73.8)	34 (52.4)	91 (66.5)	40 (51.5)	
Early initiation marijuana					A,B,C
Yes	117 (15.9)	9 (25.7)	43 (27.7)	34 (32.9)	
No	591 (84.1)	47 (74.3)	113 (72.3)	52 (67.1)	
Rode with driver who had been using alcohol					A,B,C,D,F
Yes	138 (18.8)	34 (63.3)	53 (29.9)	55 (63.5)	
No	578 (71.2)	27 (36.7)	105 (70.1)	28 (36.5)	
Rode with driver who had been using marijuana					B,C,E
Yes	243 (34.1)	21 (40.3)	112 (69.9)	64 (87.6)	
No	473 (65.9)	41 (59.7)	42 (30.1)	10 (12.4)	
Depressive symptoms					C
Yes	304 (40.3)	20 (28.1)	75 (39.8)	42 (53.7)	
No	406 (59.7)	40 (71.9)	82 (61.2)	41 (46.3)	
Protective factors					
Parental monitoring					C
High	548 (79.4)	44 (68.2)	113 (78.4)	46 (62.5)	
Low	151 (20.6)	16 (31.8)	43 (21.6)	37 (37.5)	
Grades					C
A's and B's	492 (74.4)	40 (66.1)	90 (61.5)	41 (49.2)	
C's–F's	208 (25.6)	20 (33.9)	61 (38.5)	43 (50.8)	
Sports team participation					
Yes	407 (53.3)	39 (72.2)	76 (45.6)	42 (44.7)	
No	289 (46.7)	20 (27.8)	77 (54.4)	38 (55.3)	

[a]Students who had used alcohol and/or marijuana during the past 30 days and who had driven during the past 30 days. ***Note*: Bonefferoni correction for multiple comparisons is $p < 0.0011$. A: None vs DUIA. B: None vs DUIM. C: None vs DUIB. D: DUIA vs DUIM. E: DUIA vs DUIB. F: DUIM vs DUIB.

driver who had been using marijuana compared to those who reported DUIA.

The weighted multinomial regression results assessing the relationship between risk and protective factors and driving under the influence are shown in Table 4. Only two risk factors were associated with DUIA: early initiation of alcohol [AOR = 2.3, 95% CI (1.0–5.3)] and riding with a driver who had been using alcohol [AOR = 7.2, 95% CI (3.3–15.7)]. Additionally, while investigated as a potential protective factor, sports team participation was associated with greater odds of DUIA [AOR = 2.3, 95% CI (1.0–5.4)].

Three risk factors and one protective factor were associated with DUIM. The risk factors were: early initiation of marijuana [AOR = 1.9, 95% CI (1.1–3.5)], riding with a driver who had used alcohol [AOR = 1.8, 95% CI (1.0–3.1)], riding with a driver who had used marijuana [AOR = 4.4, 95% CI (2.5–7.8)]. Students earning mostly A's and B's were seen to have a protective relationship against DUIM [AOR = 0.5, 95% CI (0.3–1.0)].

All risk factors and two of three protective factors were associated with DUIB: early initiation of alcohol and marijuana [AOR = 2.2, 95% CI (1.2–4.0); AOR = 2.3, 95% CI (1.2–4.3), respectively], riding with a driver who had used alcohol [AOR = 7.0, 95% CI (3.8–12.8)] and marijuana [AOR = 14.0, 95% CI (5.7–34.3)], and depressive symptoms [AOR = 2.2, 95% CI (1.1–4.2)]. Protective factors associated with DUIB included: high parental monitoring [AOR = 0.5, 95% CI (0.2–0.9)] and earning mostly A's and B's [AOR = 0.4, 95% CI (0.2–0.7)].

Table 4. Risk and protective factors associated with driving under the influence of alcohol, marijuana, and both substances among 1,023 high school students[a], Nevada 2017.

	DUIA		DUIM		DUIB	
	AOR	95%CI	AOR	95%CI	AOR	95%CI
Risk factors						
Early initiation of alcohol						
Yes	**2.3**	**(1.0–5.3)***	1.4	(0.8–2.4)	**2.2**	**(1.2–4.0)****
No	1	–	1	–	1	–
Early initiation of marijuana						
Yes	1.8	(0.6–5.0)	**1.9**	**(1.1–3.5)***	**2.3**	**(1.2–4.3)***
No	1	–	1	–	1	–
Rode with a driver who had been using alcohol						
Yes	**7.2**	**(3.3–15.7)*****	**1.8**	**(1.0–3.1)***	**7.0**	**(3.8–12.8)*****
No	1	–	1	–	1	–
Rode with a driver who had been using marijuana						
Yes	1.3	(0.6–3.1)	**4.4**	**(2.5–7.8)*****	**14.0**	**(5.7–34.3)*****
No	1	–	1	–	1	–
Depressive symptoms						
Yes	0.6	(0.3–1.3)	1.0	(0.6–1.7)	**2.2**	**(1.1–4.2)***
No	1	–	1	–	1	–
Protective factors						
Parental monitoring						
High	0.7	(0.3–1.6)	1.0	(0.6–1.8)	**0.5**	**(0.2–0.9)***
Low	1	–	1	–	1	–
Grades						
A's and B's	0.7	(0.3–1.7)	**0.5**	**(0.3–1.0)***	**0.4**	**(0.2–0.7)****
C's–F's	1	–	1	–	1	–
Sport team participation						
Yes	**2.3**	**(1.0–5.4)***	0.7	(0.4–1.2)	0.7	(0.4–1.2)
No	1	–	1	–	1	–

[a]Students who had used alcohol and/or marijuana during the past 30 days and who had driven during the past 30 days. All models controlled for sex, location, race, qualification for free or reduced lunch). *p<.05.**p<.01.***p<.001.

Discussion

The purpose of this study was to identify risk and protective factors associated with DUIA, DUIM, and DUIB in a population-based sample of high school students. To date, most research and public health interventions have focused on driving under the influence of alcohol, through more studies are beginning to address youth DUIM behaviors (Carpino et al., 2020; Hammig et al., 2021; Li et al., 2020). Our results are timely in demonstrating the importance of addressing driving under the influence of marijuana at the cusp of legalization. Supporting previous research on DUIM (Kann et al., 2018; Li et al., 2020; O'Malley & Johnston, 2013; Salas-Wright et al., 2023), we found that DUIM and DUIB were much more common behaviors than DUIA. Furthermore, most students who only used alcohol did not report driving under the influence, compared to 78.7% of students who only used marijuana and 42.4% who used both substances. Previous research has shown that adolescents perceive DUIM as less risky than DUIA (Donnan et al., 2022) which may contribute to the higher prevalence of DUIM among adolescent marijuana users (Hammig et al., 2021). These findings have important implications for primary prevention of substance use as well as secondary prevention of driving under the influence of substances.

Students who reported DUIA, DUIM, and DUIB were similar to each other in terms of sociodemographics and most risk and protective factors. However, all risk factors and two of the three protective factors assessed were associated with DUIB compared to only two risk factors for DUIA and four risk factors for DUIB.

Building on previous research that has shown that early initiation of alcohol use is a risk factor for DUIA (Gruber et al., 1996) and early initiation of marijuana is associated with DUIM (Li et al., 2020), we found that early initiation

drinking was also associated with DUIB and early initiation of marijuana use was associated with DUIM and DUIB. This supports a recent study that found that early initiation of both substances was associated with DUIA, DUIM, and DUIB in a sample of youth and young adults, age 16–20 (Salas-Wright et al., 2023). Interventions aimed at delaying substance use among youth may decrease driving under the influence of alcohol, marijuana, and both substances.

The bi-directional relationship between substance use and poor mental health is well established (Esmaeelzadeh et al., 2018) and we found that youth with depressive symptoms had higher odds of DUIB. While Salas-Wright et al. (2023) did not find an association with DUIB, they did find that youth with depressive episodes were more likely to report DUIM. Future adolescent studies should continue to investigate the associations with mental health and marijuana-associated driving behaviors and assess whether alcohol and cannabis self-medication may be contributing to driving under the influence. Over one quarter of the students in our sample reported riding with a driver who had been using alcohol and almost half rode with a driver who used marijuana. In addition to direct harm that may result from riding with impaired drivers, experiences as a passenger (riding in the car with a driver who had drank alcohol or smoked marijuana) were associated with youth's own driving behaviors. Riding with a driver who had been using alcohol was associated with all driving under the influence outcomes and riding with a driver who had been using marijuana was associated with DUIM and DUIB. While we did not assess who the student was riding with, previous research demonstrates that riding with adults and peers who are under the influence of either substance has an effect on the youth's own driving behaviors (Leadbeater et al., 2008; Li et al., 2020; Yellman et al., 2020). Future research should explore whether education campaigns and interventions aimed at changing the social norms regarding the perceived safety of driving under the of influence marijuana can reduce riding and driving behaviors (Berg et al., 2018).

Unlike previous research (Haegerich et al., 2016), we did not find that parental monitoring protected youth from DUIA, but it was protective for DUIB. Another study found that early parental monitoring was prospectively associated with driving under the influence of alcohol or other illegal drugs, but adolescent impaired driving behaviors did not increase parental monitoring knowledge suggesting that parents may not be fully aware of their child's substance use and driving behaviors (Li, Simons-Morton, Vaca, & Hingson, 2015). These results highlight the need to support continual parental involvement in adolescents' lives.

We found that students with higher grades were less likely to report DUIM and DUIB. While substance use may be related to lower grades, it is also possible that higher grades are a marker for school connectedness, which has been shown to be very protective against driving under the influence of alcohol (Haegerich et al., 2016). Future longitudinal studies should explore a wider range of school-level protective factors on driving under the influence.

Finally, while we chose to evaluate sports team participation as a protective factor, research has shown that its influence on substance use varies by substance (Boyes et al., 2017). We did not find that sports team participation had a protective relationship with DUIM or DUIB and it was actually a risk factor for DUIA. Other studies have found a positive relationship between general sport team participation and alcohol use (Boyes et al., 2017; Kwan et al., 2014; Parent et al., 2016) and this may influence their driving behaviors. Furthermore, sports participation could function as a risk or protective factor depending on the sport. For example, Veliz et al. (2015) found that youth who participated in high-contact sports were more likely to engage in substance use behaviors (alcohol, marijuana, and cigarettes) compared to those who participated in low- to no-contact sports. Future research should distinguish the type of sport participation to better understand how this exposure affects driving under the influence.

A few limitations should be acknowledged when interpreting these results. The YRBS is a cross-sectional national surveillance system so temporality is difficult to assess, and we were limited in the number of risk and protective

factors we could evaluate. Furthermore, because the analyses were restricted to students who drove and used alcohol and/or marijuana in the past 30 days, our findings do not represent all students surveyed. Compared to the full sample, the analytic sample had a higher proportion of students who were non-Hispanic black, lived in urban areas, and qualified for free or reduced lunch (Lensch et al., 2018). Another limitation is that we were unable to determine if students had used both alcohol and marijuana simultaneously before driving as two separate measures were combined to create the category of students who reported driving when they had been using alcohol or marijuana prior to driving. Additionally, the survey measures did not establish degree of impairment. Students are asked if they had driven when they had been using alcohol or marijuana, but not the quantity or duration before driving. Further, adolescents are being asked to self-report illegal behaviors, including under-aged substance use and driving after use. Since both exposures and outcomes are self-reported, this study is also vulnerable to dependent error. Future studies could look at the outcome using more objective measures such as highway or crash data in tandem with survey data. Because the YRBS is a surveillance system, single questions are used to assess prevalence rather than validated scales and inventories. This may have limited the self-report of complex issues such as depressive symptoms. Finally, while this study provides insights to modifiable factors associated with DUIA, DUIM, and DUIB behaviors immediately preceding recreational marijuana sales in Nevada, the data were collected in 2017 and ongoing research is needed to study evolving trends in substance use and associated behaviors.

Despite the limitations, our analyses highlight the importance of studying a range of risk and protective factors for youth who report driving under the influence of alcohol, marijuana, and both substances. While public health interventions have traditionally targeted teens driving under the influence of alcohol, our findings highlight a need to broaden the scope to include teens driving under the influence of marijuana. Not only was DUIM the most prevalent behavior, but more modifiable risk and protective factors were associated with DUIM and DUIB. This highlights multiple opportunities for public health interventions among youth who have driven after use of marijuana or both alcohol and marijuana which is more dangerous than using either substance alone (Fares et al., 2022; Li et al., 2017; Ronen et al., 2010). With increased legalization of recreational cannabis across the United States, it will be critical to monitor whether an increase in availability will impact teen driving behaviors.

Acknowledgments

We would like to acknowledge those who assisted with the 2017 Nevada High School Youth Risk Behavior Survey (YRBS) Report including the Nevada Department of Education; school district superintendents; school principals, teachers and staff; and members of the Nevada Statewide Coalition Partnership.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This publication was supported by CDC-PS13-1308, funded by the Centers for Disease Control and Prevention. Its contents are solely the responsibility of the authors and do not necessarily represent the official views of the Centers for Disease Control and Prevention or the Department of Health and Human Services. Supplemental funding was also provided by the Nevada Division of Public and Behavioral Health.

References:

Anderson, B. M., Rizzo, M., Block, R. I., Pearlson, G. D., & O'Leary, D. S. (2010). Sex differences in the effects of marijuana on simulated driving performance. *Journal of Psychoactive Drugs*, *42*(1), 19–30. https://doi.org/10.1080/02791072.2010.10399782

Berg, C. J., Daniel, C. N., Vu, M., Li, J., Martin, K., & Le, L. (2018). Marijuana use and driving under the influence among young adults: A sociological perspective on risk factors. *Substance Use & Misuse*, *53*(3), 370–380. https://doi.org/10.1080/10826084.2017.1327979

Boyes, R., O'Sullivan, D. E., Linden, B., McIsaac, M., & Pickett, W. (2017). Gender-specific associations between involvement in team sport culture and Canadian adolescents' substance-use behavior. *SSM - Population Health*, *3*, 663–673. https://doi.org/10.1016/j.ssmph.2017.08.006

Buckley, L., Bonar, E. E., Walton, M. A., Carter, P. M., Voloshyna, D., Ehrlich, P. F., & Cunningham, R. M. (2017).

Marijuana and other substance use among male and female underage drinkers who drive after drinking and ride with those who drive after drinking. *Addictive Behaviors*, *71*, 7–11. https://doi.org/10.1016/j.addbeh.2017.02.016

Carpino, M., Langille, D., Ilie, G., & Asbridge, M. (2020). Cannabis-related driving and passenger behaviours among high school students: A cross-sectional study using survey data. *CMAJ Open*, *8*(4), E754–E761. https://doi.org/10.9778/cmajo.20200081

Centers for Disease Control and Prevention, National Center for Health Statistics. (2024). *National Vital Statistics System, Mortality 1999-2020 on CDC WONDER Online Database, released in 2021. Data are from the Multiple Cause of Death Files, 1999-2020, as compiled from data provided by the 57 vital statistics jurisdictions through the Vital Statistics Cooperative Program*. http://wonder.cdc.gov/ucd-icd10.html

Delcher, C., Johnson, R., & Maldonado-Molina, M. (2013). Driving after drinking among young adults of different race/ethnicities in the United States: Unique risk factors in early adolescence? *The Journal of Adolescent Health*, *52*(5), 584–591. https://doi.org/10.1016/j.jadohealth.2012.10.274

Donnan, J. R., Drakes, D. H., Rowe, E. C., Najafizada, M., & Bishop, L. D. (2022). Driving under the influence of cannabis: Perceptions from Canadian youth. *BMC Public Health*, *22*(1), 2384. https://doi.org/10.1186/s12889-022-14658-9

Dudovitz, R. N., McCoy, K., & Chung, P. J. (2015). At-school substance use as a marker for serious health risks. *Academic Pediatrics*, *15*(1), 41–46. https://doi.org/10.1016/j.acap.2014.06.022

Esmaeelzadeh, S., Moraros, J., Thorpe, L., & Bird, Y. (2018). Examining the association and directionality between mental health disorders and substance use among adolescents and young adults in the U.S. and Canada—A systematic review and meta-analysis. *Journal of Clinical Medicine*, *7*(12), 543. https://doi.org/10.3390/jcm7120543

Evans-Polce, R. J., Patrick, M. E., & O'Malley, P. M. (2017). Prospective associations of 12th-grade drinking intensity and age 19/20 driving-related consequences. *The Journal of Adolescent Health*, *61*(3), 389–391. https://doi.org/10.1016/j.jadohealth.2017.04.016

Fares, A., Wickens, C. M., Mann, R. E., Di Ciano, P., Wright, M., Matheson, J., Hasan, O. S. M., Rehm, J., George, T. P., Samokhvalov, A. V., Shuper, P. A., Huestis, M. A., Stoduto, G., Brown, T., Stefan, C., Rubin-Kahana, D. S., Le Foll, B., & Brands, B. (2022). Combined effect of alcohol and cannabis on simulated driving. *Psychopharmacology*, *239*(5), 1263–1277. https://doi.org/10.1007/s00213-021-05773-3

Gruber, E., DiClemente, R., Anderson, M., & Lodico, M. (1996). Early drinking onset and its association with alcohol use and problem behavior in adolescence. *Preventive Medicine*, *25*(3), 293–300. https://doi.org/10.1006/pmed.1996.0059

Haegerich, T., Shults, R., Oman, R., & Vesely, S. (2016). The predictive influence of youth assets on drinking and driving behaviors in adolescence and young adulthood. *The Journal of Primary Prevention*, *37*(3), 231–245. https://doi.org/10.1007/s10935-016-0418-7

Hammig, B., Davis, R., & Jones, C. (2021). Driving after marijuana use among U.S. adolescents: Prevalence profiles and related behaviors. *Traffic Injury Prevention*, *22*(5), 361–365. https://doi.org/10.1080/15389588.2021.1906870

Hoots, B. E., Li, J., Hertz, M. F., Esser, M. B., Rico, A., Zavala, E. Y., & Jones, C. M. (2023). Alcohol and other substance use before and during the COVID-19 pandemic among high school students—Youth risk behavior survey, United States, 2021. *MMWR Supplements*, *72*(1), 84–92. https://doi.org/10.15585/mmwr.su7201a10

Kann, L., McManus, T., Harris, W. A., Shanklin, S. L., Flint, K. H., Queen, B., Lowry, R., Chyen, D., Whittle, L., Thornton, J., Lim, C., Bradford, D., Yamakawa, Y., Leon, M., Brener, N., & Ethier, K. A. (2018). Youth risk behavior surveillance - United States, 2017. *Morbidity and Mortality Weekly Report. Surveillance Summaries*, *67*(8), 1–114. https://doi.org/10.15585/mmwr.ss6708a1

Kwan, M., Bobko, S., Faulkner, G., Donnelly, P., & Cairney, J. (2014). Sport participation and alcohol and illicit drug use in adolescnets and young adults: A systematic review of longitudinal studies. *Addictive Behaviors*, *39*(3), 497–506. https://doi.org/10.1016/j.addbeh.2013.11.006

Ladegard, K., Thurstone, C., & Rylander, M. (2020). Marijuana legalization and youth. *Pediatrics*, *145*(Suppl 2), S165–S174. https://doi.org/10.1542/peds.2019-2056D

Leadbeater, B., Foran, K., & Grove-White, A. (2008). How much can you drink before driving? The influence of riding with impaired adults and peers on the driving behaviors of urban and rural youth. *Addiction*, *103*(4), 629–637. https://doi.org/10.1111/j.1360-0443.2008.02139.x

Lensch, T., Martin, H. K., Zhang, F., Parrish, B., Clements-Nolle, K., Yang, W. (2018). *2017 Nevada High School Youth Risk Behavior Survey (YRBS) report*. https://scholarworks.unr.edu/handle/11714/5007

Li, G., Chihuri, S., & Brady, J. (2017). Role of alcohol and marijuana use in the initiation of fatal two-vehicle crashes. *Annals of Epidemiology*, *27*(5), 342–347.e1. https://doi.org/10.1016/j.annepidem.2017.05.003

Li, K., Simons-Morton, B. G., Vaca, F. E., & Hingson, R. (2015). Reciprocal associations between parental monitoring knowledge and impaired driving in adolescent novice drivers. *Traffic Injury Prevention*, *16*(7), 645–651. https://doi.org/10.1080/15389588.2014.996215

Li, L., Hu, G., Schwebel, D. C., & Zhu, M. (2020). Analysis of US teen driving after using Marijuana, 2017. *JAMA Network Open*, *3*(12), e2030473. https://doi.org/10.1001/jamanetworkopen.2020.30473

Marczinski, C., Harrison, E., & Fillmore, M. (2008). Effects of alcohol on simulated driving and perceived driving impairment in binge drinkers. *Alcoholism, Clinical and Experimental Research*, *32*(7), 1329–1337. https://doi.org/10.1111/j.1530-0277.2008.00701.x

Martin, J.-L., Gadegbeku, B., Wu, D., Viallon, V., & Laumon, B. (2017). Cannabis, alcohol and fatal road accidents. *PLoS One*, *12*(11), e0187320. https://doi.org/10.1371/journal.pone.0187320

Miller, R. E., Brown, T. L., Lee, S., Tibrewal, I., Gaffney, G. G., Milavetz, G., Hartman, R. L., Gorelick, D. A., Compton, R., & Huestis, M. A. (2020). Impact of cannabis and low alcohol concentration on divided attention tasks during driving. *Traffic Injury Prevention*, *21*(sup1), S123–S129. https://doi.org/10.1080/15389588.2020.1814956

O'Malley, P. M., & Johnston, L. D. (2013). Driving after drug or alcohol use by US high school seniors, 2001-2011. *American Journal of Public Health*, *103*(11), 2027–2034. https://doi.org/10.2105/AJPH.2013.301246

Parent, M., Bradstreet, T., Piper, M., Brace, T., & Parkman, T. (2016). Racial disparities in substance use by sport participation among high school students. *Journal of Studies on Alcohol and Drugs*, *77*(6), 980–985. https://doi.org/10.15288/jsad.2016.77.980

Ronen, A., Chassidim, H. S., Gershon, P., Parmet, Y., Rabinovich, A., Bar-Hamburger, R., Cassuto, Y., & Shinar, D. (2010). The effect of alcohol, THC and their combination on perceived effects, willingness to drive and performance of driving and non-driving tasks. *Accident; Analysis and Prevention*, *42*(6), 1855–1865. https://doi.org/10.1016/j.aap.2010.05.006

Salas-Wright, C. P., Hai, A. H., Vaughn, M. G., Hodges, J. C., & Goings, T. C. (2023). Driving under the influence of cannabis and alcohol: Evidence from a national sample of young drivers. *Addictive Behaviors*, *147*, 107816. https://doi.org/10.1016/j.addbeh.2023.107816

US Census Bureau. (2021). *Urban and rural*. https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html

Veliz, P. T., Boyd, C. J., & McCabe, S. E. (2015). Competitive sport involvement and substance use among adolescents: A nationwide study. *Substance Use & Misuse*, *50*(2), 156–165. https://doi.org/10.3109/10826084.2014.962049

Yellman, M. A., Bryan, L., Sauber-Schatz, E. K., & Brener, N. (2020). Transportation risk behaviors among high school students—Youth risk behavior survey, United States, 2019. *MMWR Supplements*, *69*(1), 77–83. https://doi.org/10.15585/mmwr.su6901a9

Yockey, A. R., & Barroso, C. S. (2023). Drugged driving among U.S. adolescents, 2016–2019, USA. *Journal of Safety Research*, *84*, 1–6. https://doi.org/10.1016/j.jsr.2022.10.002

Youth Risk Behavior Risk Factor Surveillance System (YRBSS) Overview. (2023). *Center for Disease Control and Prevention, adolescent and school health*. https://www.cdc.gov/healthyyouth/data/yrbs/overview.htm