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Article

Marijuana Use and Associated Risk Behavior Factors among High School Students in Mississippi: Youth Risk Behavior Surveillance System 2021

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Abstract: Marijuana is the most used illicit drug among youths in the United States. The objectives of the study were to identify the association between marijuana use and other risk behaviors including suicidality among high school students. The 2021 Mississippi Youth Risk Behavior Survey data sets were combined for this study. Crude odds ratio (OR) and adjusted odds ratio (AOR) with a 95% confidence interval were generated using the survey packages in R to account for weights and the complex sampling design of YRBS data. Tobacco products and alcohol use were significantly associated with marijuana use. Students who responded “Yes” to questions “currently used an electronic vapor product?”, “currently smoked cigarettes or cigars?” or “currently drank alcohol?” were more likely to use marijuana compared to students who responded “No”, after adjusting for other risk factors. Marijuana use is also significantly associated with students who had sex, compared to those who never had sex. The adjusted odds ratio is nearly doubled in those who had sex with the same sex or both sexes, compared to those who had heterosexual sex only. After adjusting for other health risk factors, the association between current marijuana use and attempted suicide was not statistically significant. The impact of students’ not sleeping in their parent’s or guardian’s home on current marijuana use was not significant after adjusting for other risk factors. Marijuana use is evenly burdened between males and females and between all race categories among Mississippi high school students. The identified associations seem to indicate that electronic vapor, tobacco products, and alcohol use could be the forerunners for drug use and should be treated accordingly in drug use prevention programs.

Keywords: marijuana; risk behavior; drug use; suicidality; CDC; YRBS

1. Introduction

Marijuana is one of the most widely used substances among youths and adolescents in the United States. According to the National Center for Drug Abuse Statistics, 2.08 million of 12- to 17-year-olds nationwide reported using drugs in the last month; of them, about 84% reported using marijuana [1]. The use of marijuana has been associated with short-term and long-term side effects such as increased heart rates, mood changes, difficulty with thinking and problem-solving, and impaired memory [2]. People who started smoking marijuana heavily in their teens had long-term disfunction of the brain (notable IQ declines), and mental disorders, including anxiety, depression, and suicidal thoughts among teens [2]. One of the brain areas, called the prefrontal cortex, enables the brain to assess situations, make sound decisions, and keep our emotions under control. In adolescents and children, this part of the brain continues to grow into adulthood and undergoes dramatic changes during adolescence [3]. Introducing drugs during this critical period of brain

development can cause profound and long-lasting effects on brain function. Studies show that drug use can exacerbate existing mental health issues, resulting in them being two to four times more likely to develop full-blown psychiatric disorders [3,4]. Teens who use marijuana are not only more likely to experience major mental health problems (anxiety and depression) but also, they are at risk of developing psychosis if genetically predisposed. They also risk developing diagnosable substance use disorders (SUDs) which can complicate chronic health conditions and result in negative social and economic consequences [3,5].

In our recently published report, although the burden of drug use in adolescents is showing a declining trend in the United States, Mississippi's drug use trend has been increasing in the last 20 years from 2001 to 2021 [6]. This calls for exploring the root causes of the higher trend in Mississippi.

Research indicates a link between the use of various substances and continued marijuana use. While cigarette smoking rates have dropped from 28.3% in 1996 to 2.3% in 2022 [7], nicotine vaping has risen. In 2023, 11.4% of 8th graders, 17.6% of 10th graders, and 23.2% of 12th graders reported vaping nicotine. Adolescents who vape are at higher risk of progressing to marijuana and alcohol use [8]. For instance, current users of electronic vapor products are 9.3 times more likely to use marijuana [9]. Alcohol use and abuse remain prevalent among adolescents and is often used with marijuana [10]. In 2023, 30.6% of 10th graders and 45.7% of 12th graders reported using alcohol in the past year, with 35% currently using it [8].

Despite the existing wealth of national data, the demographics of Mississippi make it unique because of a higher poverty rate and a higher rate of racial and ethnic minorities, compared to the national average [11]. To understand the relationship between the demographic factors and other risky behaviors of youth with substance use in Mississippi, there has been a dearth of information in the existing literature. This study aims to fill up the literature gap to identify the association of youth risk behaviors and suicidality with increased marijuana use in Mississippi by analyzing the CDC data from the Youth Risk Behavior Survey (YRBS).

2. Material and Methods

2.1. Data Source

The Youth Risk Behavior Survey (YRBS) is a cross-sectional survey that monitors health risk behaviors in high school students. The Centers for Disease Control and Prevention (CDC) developed YRBS for the national and state levels. As a complex sampling survey, YRBS used a multistage probability design to ensure a nationally representative sample. The primary sampling unit (PSU) is at the county level. The secondary sampling unit (SSU) is defined at the school level. PSUs and SSUs are sampled with probability proportional to overall school enrollment size. The third stage is a random sampling, having one or two classrooms in each grade 9-12 of the selected schools [12,13]. Mississippi YRBS is conducted by the Mississippi Departments of Health and Education every other year. Mississippi YRBS 2021 data was obtained from the CDC public domain [14].

2.2. Measurements

This study's data point of interest was current marijuana use among Mississippi high school students. The self-reported question "During the past 30 days, how many times did you use marijuana?" captured six possible responses (0 times; 1 or 2 times; 3 to 9 times; 10 to 19 times; 20 to 39 times, and 40 or more times). These responses were recoded into a binary variable for analysis. We examined the associations between current marijuana use and other health risk behaviors that contributed to the leading causes of death, disability and social problems, including Current use of vapor products (Yes, No); Currently smoked cigarettes or cigars (Yes, No); Currently drank alcohol (Yes, No); Attempted suicide (Yes, No); Sex of sex contact(s) (Never had sex, Opposite sex only, Same-sex only or both sexes); and Usually did not sleep in their parent's or guardian's home (Yes, No). These were all binary variables recoded from responses to self-reported questions.

Data points used in this study also included gender (male, female), and race/ethnicity (Non-Hispanic American Indian or Alaska Native, Non-Hispanic Asian, Non-Hispanic Black, Hispanic,

Non-Hispanic Native Hawaiian or Other Pacific Islander, Non-Hispanic White and Non-Hispanic Multiple races). Due to the small Mississippi YRBS data sample size, Race was recoded to have three values for analysis: White (Non-Hispanic White), Black (Non-Hispanic Black), and Other. "Other" race categories included Hispanic, Asian, American Indian/Alaskan Native, Native Hawaiian/other Pacific Islander, and multiple races [15,16].

2.3. Statistical Analysis

First, a crude odds ratio (OR) with a 95% confidence interval (95% CI) was generated by univariate logistic regression models between current marijuana use, each of the health risk behavior factors, and demographic variables. Then, an adjusted odds ratio (AOR) with 95% CI was obtained by applying multivariate logistic regression models that account for confounding and effect modification. When the 95% CI contained 1 but the p -value was less than 0.05, we reported the difference as statistically significant [17,18].

R software version 4.4.0 was used for sample characteristic statistics, summary statistics, and logistic regression models. The CDC identifies the survey packages in R as appropriate tools capable of accounting for the complex sampling design of YRBS data [19].

2.4. Multivariate Analysis

As mentioned earlier, a multivariate logistic regression model was used to calculate an adjusted odds ratio for each risk behavior factor. The formula:

$$\text{Log} [p(X) / (1-p(X))] = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \dots + \beta_n X_n$$

Here, β_0 is the intercept term.

$\beta_1, \beta_2, \dots, \beta_n$ are the coefficients of the risk behavior factors X_1, X_2, \dots, X_n

3.1. Sample Characteristics

The Mississippi 2021 YRBS sample size was 1747. Female and male students were approximately equally represented: valid percent being 49.9% and 50.1% between female and male, respectively. There were 35.4% White, 49.2% Black, and 15.4% Other races. The valid percentages for students were: 36.6% for 9th grade, 23.1% for 10th grade, 22.6% for 11th grade, and 17.7% for 12th grade.

Table 1 shows that the overall prevalence of current marijuana use was 13.4%. There was no significant difference in current marijuana use between female and male students (PD = -1.8, PR = 1.14, $p = 0.32$). Compared to White students, no significant difference was observed in current marijuana use for Black students (PD = 3.1, PR = 1.27, $p = 0.09$) or students in the other race subgroup (PD = 4.5, PR = 1.39, $p = 0.06$). Compared to the 9th graders, no statistically significant difference was observed in current marijuana use for students in other grade categories.

Table 1. Current marijuana use prevalence of Mississippi high school students by demographic characteristics, Mississippi YRBS 2021.

Characteristic	Prevalence (%)	PD* (%)	PR* (95% CI)	p -value
Total	13.4 (11.8, 15.1)	NA	NA	NA
By Gender				
Female	14.3 (11.8, 16.9)	Ref*	Ref	
Male	12.5 (10.2, 14.9)	-1.8	1.14 (0.88, 1.48)	0.32
By Race				
White	11.7 (9.3, 14.0)	Ref	Ref	
Black	14.8 (12.1, 17.5)	3.1	1.27 (0.96, 1.69)	0.09
Other	16.2 (11.2, 21.1)	4.5	1.39 (1.00, 1.94)	0.06

By Grade

Grade 9	11.6 (8.6, 14.6)	Ref	Ref	
Grade 10	14.0 (9.5, 18.4)	2.4	1.20 (0.77, 1.87)	0.42
Grade 11	13.2 (10.2, 16.2)	1.6	1.13 (0.75, 1.70)	0.55
Grade 12	15.0 (10.8, 19.1)	3.4	1.29 (0.87, 1.90)	0.21

*PD - Prevalence difference; PR - Prevalence ratio; Ref - Reference group; NA – not applicable.

3.2. Associated Factors for Marijuana Use

Table 2 presents the evaluation of the association between current marijuana use and six health risk behavior factors in terms of crude *OR* and *AOR*.

Table 2. Behavior risk factors associated with current marijuana use, Mississippi YRBS 2021.

Variables	Univariate Analysis		Multivariate Analysis	
	<i>OR</i> (95% <i>CI</i>)	<i>P</i> -value	<i>AOR</i> (95% <i>CI</i>)	<i>p</i> -value
Currently used an electronic vapor product				
No	Ref		Ref	
Yes	24.0 (15.8, 36.3)	<0.001	8.1 (4.8, 13.6)	<0.01
Currently smoked cigarettes or cigars				
No	Ref		Ref	
Yes	18.4 (13.0, 26.1)	<0.001	3.4 (1.5, 7.4)	<0.05
Currently drank alcohol				
No	Ref		Ref	
Yes	11.2 (7.8, 16.0)	<0.001	2.6 (1.5, 4.5)	<0.01
Attempt suicide				
No	Ref		Ref	
Yes	3.6 (2.1, 6.4)	<0.001	1.3 (0.6, 2.7)	0.53
Sex or sex contact(s)				
Never had sex	Ref		Ref	
Opposite sex only	10.6 (5.5, 20.5)	<0.001	2.2 (1.1, 4.4)	<0.05
Same-sex or both sexes	19.0 (8.7, 41.5)	<0.001	3.7 (1.8, 7.8)	<0.01
Usually slept in their parent's or guardian's home				
Yes	Ref		Ref	
No	4.0 (2.8, 5.9)	<0.001	2.9 (0.8, 10.3)	0.13

* *OR* - Odds ratio; *AOR* - Adjusted odds ratio; Ref - Reference group.

Univariate analysis identified six health risk behavior factors that were significantly associated with current marijuana use. Students who currently used an electronic vapor product were 24 times more likely to be current marijuana users ($p < 0.001$), compared to students who did not currently use an electronic vapor product. Students who currently smoked cigarettes or cigars were 18.4 times more likely to be current marijuana users ($p < 0.001$) compared to students who did not currently smoke cigarettes or cigars. Students who presently drink alcohol were 11.2 times more likely to be current marijuana users ($p < 0.001$) compared to students who did not currently drink alcohol. Students who attempted suicide were 3.6 times more likely to be current marijuana users ($p < 0.001$) compared to students who did not attempt suicide. Students who had the opposite sex only were 10.6 times more likely to be current marijuana users ($p < 0.001$), compared to students who never had sex; those who had same sex only or both sexes were 19 times more likely to be current marijuana users ($p < 0.001$), compared to those who never had sex. Similarly, students who did not sleep in their parent's or guardian's house were 4 times more likely to be current marijuana users ($p < 0.001$) compared to students who slept in their parent's or guardian's home.

In Table 2, the AORs considered confounding and effect modifications and showed the strength of association between a risk factor and current marijuana use after adjusting for the other risk factors. AOR for "attempted suicide" and "Usually did not sleep in their parent's or guardian's home" was no longer statistically significant. After adjusting for other risk factors, students who currently used an electronic vapor product, smoked cigarettes or cigars, or currently drank alcohol were still more likely to be current marijuana users compared to those who did not, with AOR being 8.1 ($p < 0.01$), 3.4 ($p < 0.05$) and 2.6 ($p < 0.01$), respectively. Compared to students who never had sex, those who had opposite sex only or those who had same-sex only or both sexes were more likely to be current marijuana users, with AOR being 2.2 ($p < 0.05$) and 3.7 ($p < 0.01$), respectively.

4. Discussions

In this study, the prevalence of current marijuana usage among high-school students was 13.4%, which is lower than the national average of 27.8% [20]. Although the rate of girls using marijuana outnumbered boys in the nation (30.9% *vs.* 24.8% between girls and boys, respectively), there was no statistical difference based on gender in our study in Mississippi.

Marijuana usage also varied significantly based on grade level in the national sample. In contrast, there was no significant difference in the use rate based on grade level in Mississippi, although the rates increased among seniors compared to other high school students. The use prevalence rates of marijuana in the nation are disproportionately higher among seniors – about 1 in 16 high school seniors use marijuana every day [21]. About 21% of 12th graders and 10% of 10th graders reported smoking marijuana in the last 30 days of the survey [21], whereas in Mississippi, the rates are about the same between 10th graders and 12th graders. The observed differences between the national and Mississippi rates could be attributable to demographic differences between the two populations.

Associations of six behavioral risk factors were analyzed in our study. They played a significant role in marijuana usage in Mississippi. In univariate analysis, all the risk factors studied, including current use of electronic vape products, current smoking cigarettes or cigars, current drinking, attempted suicide, sex with the opposite sex only or same sex or both sexes and not staying at parents or guardian's home were significantly associated with current marijuana use ($p < 0.001$ for all). In multivariate logistic regression analysis, all the factors except attempted suicide and staying in parental house remained statistically significant factors for marijuana use.

A review article examined 95 published papers that found a concurrent use pattern of alcohol and cannabis [22]. The authors analyzed the data using substitution versus complementary theories of use. Substitution theory posits that persons might use one substance in place of another due to similarities in the drug's effect [23]. Complementary theory, on the other hand, posits that persons may use drugs in combination to enhance their outcomes [24]. Interestingly, both theories held for the concurrent use of alcohol and cannabis. Data also suggest that the coadministration of alcohol

and cannabis (marijuana) results in increased impairment of brain function, compared to single use of either substance [25].

In another study of 2034 college students using both alcohol and marijuana [26] were assessed to determine whether protective behavioral strategies (PBS) were helpful for both substances among concurrent users. Common PBS strategies include 1) setting limits on the number of drinks or the number of drugs used in a given time frame; 2) drinking slowly and spacing out drinks over time to avoid intoxication; 3) alternating alcoholic and non-alcoholic drinks; 4) avoid mixing substances with alcohol; 5) choose safe environments when drinking or using and making a plan for getting home safely; 6) carefully attend to how intoxicated one feels and adjust accordingly, and 7) always use a designated driver [26]. Not only can these programs educate students on the risks associated with alcohol and drug use, but they can also provide them with tools to manage their behavior effectively as they move into college settings and adulthood. In the study mentioned here, PBS had mediator effects on alcohol and marijuana outcomes, suggesting that strategies such as PBS seem to be an important intervention target for alcohol/marijuana concurrent users.

Our study concurred with a nationally representative cohort study, Population Assessment of Tobacco and Health (PATH), in which 9828 adolescents' data were analyzed [27]. The PATH study found a strong association between e-cigarette use and subsequent cannabis use in 1 year. In this study, those who had ever used e-cigarettes had a 2.57 times greater risk (adjusted relative risk) of cannabis use in the subsequent 12 months (95% CI, 2.04-3.09), after adjusting for sociodemographic characteristics [27].

Like our study, other studies demonstrated an association between suicidality (or a suicidal attempt) with marijuana use [28,29]. However, a causal association could not be established in most studies because it was not certain which came first – whether the suicide attempt was a result of a mental disorder (such as depression) or whether depression was a result of substance use. However, in a systematic review and meta-analysis of 11 studies and 23 317 individuals, adolescent cannabis consumption was associated with an increased risk of developing depression and suicidal behavior later in life [29].

4.1. Limitations

Our cross-sectional study had several limitations: although several risk factors were significantly associated with marijuana use, a causal association was undermined, as mentioned earlier. Other potential limitations of a cross-sectional study are reporting bias (either under-reporting or over-reporting) of self-reported events of marijuana use and the behavioral risk factors.

However, the CDC's YRBS data are robust as they use a multistage stratified sampling design with a large representative sample of the nation. Also, so far, this is the only study that reported the association of multiple demographic and behavioral risk factors with marijuana use in the high school population in Mississippi.

5. Conclusions

This study revealed significant associations between various behavioral risk factors, such as cigarette smoking, the use of electronic vapor products, alcohol consumption, and sexual activity with concurrent marijuana use among high school students in Mississippi. Implementing intervention strategies like PBS and targeted risk reduction programs for at-risk groups could play a crucial role in addressing the increasing prevalence of substance abuse and its negative impacts on youth. School-based initiatives and preventive measures, such as academic enrichment, promoting socially competent behaviors, providing social skills training, and fostering school-family-community partnerships, are essential strategies for reducing behavioral risks among school children.

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