

# Youth Vaping Associated with Co-occurring Risk Factors: Results from National Representative Data

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**ABSTRACT:** Vaping among youth remains a significant public health concern, with limited effective cessation interventions available. Data from the Youth Risk Behavior Survey (YRBS) were analyzed to investigate the association between vaping and high-risk behaviors. Odds ratios were calculated for subgroups. Odds ratio is a measure of association that measures the odds of an event happening in one group compared to the odds of the same event happening in another group. Analysis of YRBS data from 2015 to 2023 revealed strong associations between current use of electronic vapor products and other high-risk behaviors, including current marijuana use, binge drinking, suicidal ideation, and feelings of sadness or hopelessness. Findings indicate alarming trends across all survey years. The likelihood of current vapers also being current marijuana users increased dramatically, from 7 to 27 times higher. Notably, Asian youth consistently exhibited the highest risk odds ratios, 17 to 81, of vaping among those who reported current marijuana use across all five survey periods. For youth who binge drank in the past, the odds of currently using vapor products ranged from 9 to 18 times greater than those who do not currently use vapor products. American Indian/Alaska Native youth who reported current vaping had an odds ratio of 6.4 for planning how they would attempt suicide in 2021. These findings highlight the critical public health implications of the association between vaping and other risk behaviors, emphasizing the urgent need for targeted interventions aimed at high-risk populations.

**KEYWORDS:** Behavioral and Social Sciences, Sociology and Social Psychology, Vaping, Mental Health, Marijuana, Binge Drinking.

## ■ Introduction

The use of electronic vapor products has surged significantly among youth over the past decade in countries worldwide.<sup>1</sup> Electronic vapor products are devices that heat a liquid in a cartridge or reservoir to produce an aerosol or vapor which the user inhales through a mouthpiece.<sup>2</sup> Vaping liquids come in a variety of flavors and typically contain nicotine, a highly addictive chemical that can affect brain development.<sup>3</sup> Electronic vapor products include e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods, such as JUUL, SMOK, Suorin, Vuse, and blu. Recent entrance into the marketplace of electronic vapor products has increased the availability of vapor products to youth.

Youth vaping raises the risk of nicotine addiction and exposure to harmful substances, plus a potential association with cannabis and alcohol.<sup>4</sup> Electronic vapor products are rarely used in isolation; instead, they are often combined with other substances, which may amplify the risks. This combined use can complicate intervention efforts, enhance the effects of other substances, and increase the physiological toll on youth. In addition to the harmful effects of vaping itself, nicotine vaping is frequently associated with the use of cannabis, alcohol, and various other substances.<sup>5-7</sup>

This study aims to identify associations between vaping, cannabis use, binge drinking, and mental health in a large, nationally representative youth sample. This information is necessary to establish resource allocation priorities for prevention and treatment.<sup>8-11</sup>

## ■ Methods

The YRBS, conducted by the Centers for Disease Control and Prevention, monitors the prevalence of health-risk behaviors among U.S. high school students in grades 9 through 12. This study examined youth from YRBS in 2015 (n = 15713), 2017 (n = 14956), 2019 (n = 13677), 2021 (n = 17508), and 2023 (n = 20103). Data were collected every two years through self-administered student surveys, generating nationally representative samples via a combination of national, state, and local surveys, with the national survey providing representative data for high school students across the U.S.

Vaping and marijuana use were assessed based on at least one day of use in the 30 days prior to the survey. Binge drinking was evaluated by consuming 10 or more drinks in a row in the past 30 days. To assess feelings of sadness and hopelessness, participants were asked if they ever felt so sad or hopeless almost every day for two weeks or more in a row that they stopped doing some usual activities. For suicide, participants were asked if, during the past 12 months, they had made a plan for how they would attempt suicide.

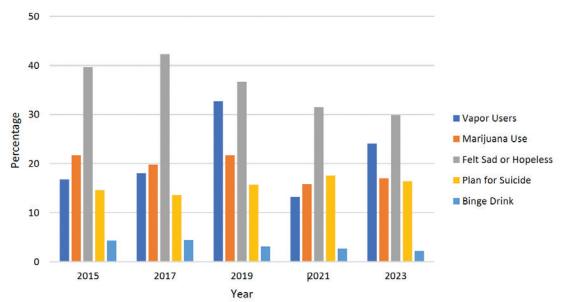
Statistical analysis was performed on YRBS data imported into Epi Info 7 using procedures that accommodate the weighted sampling design of YRBS.<sup>12</sup> Odds ratios were calculated for subgroups by race and sex. Odds ratio is a measure of association that measures the odds of an event happening in one group compared to the odds of the same event happening in another group.

## Result and Discussion

Based on a representative sampling of high school students from the YRBS, the analysis revealed significant trends in various risk behaviors among youth between 2015 and 2023.<sup>11</sup> Table 1 shows that while the use of electronic vapor products and marijuana fluctuated and binge drinking consistently declined, a troubling trend emerged: feelings of sadness or hopelessness and suicide planning steadily increased. This reflects growing mental health concerns among youth over the study period. Figure 1 illustrates these same behavioral trends over time, highlighting the steady increase in reported sadness or hopelessness and suicide planning, especially after 2017. Vaping peaked in 2021 before slightly declining, while marijuana use remained consistently elevated. These visual representations are essential for comprehending the evolving behavioral patterns among youth over the past decade.

**Table 1:** Shows trends in selected behavioral health indicators among study participants from 2015 to 2023. Data represent the percentage of individuals reporting each behavior, with corresponding 95% confidence intervals. Feelings of sadness or hopelessness increased over time, while binge drinking declined.

	Year				
	2015	2017	2019	2021	2023
Percentage [95% Confidence Interval]					
Currently Used Electronic Vapor Products	24.1 [22.1 – 26.2]	13.2 [11.4 – 15.2]	32.7 [30.7 – 34.8]	18.0 [16.3 – 19.8]	16.8 [15.4 – 18.2]
Binge Drinking	4.3 [3.6 – 5.1]	4.4 [3.6 – 5.3]	3.1 [2.5 – 3.8]	2.7 [2.3 – 3.2]	2.2 [1.6 – 2.9]
Currently Used Marijuana	21.7 [19.3 – 24.2]	19.8 [18.4 – 21.6]	21.7 [19.9 – 23.7]	15.8 [14.3 – 17.6]	17.0 [15.4 – 18.7]
Felt Sad or Hopeless	29.9 [28.0 – 31.8]	31.5 [29.6 – 33.4]	36.7 [35.1 – 38.3]	42.3 [41.0 – 43.7]	39.7 [37.7 – 41.7]
Making a Suicide Plan	14.6 [13.4 – 15.8]	13.6 [12.4 – 14.8]	15.7 [14.6 – 16.9]	17.6 [16.4 – 16.9]	16.4 [14.4 – 18.6]



**Figure 1:** Youth Risk Behaviors Reported from 2015 to 2023. The figure illustrates trends in vaping, marijuana use, binge drinking, sadness/hopelessness, and suicide planning. Feelings of sadness or hopelessness were the most frequently reported behaviors.

### Binge Drinking:

A significant association between binge drinking and current vaping was observed across sex and racial groups from 2015 to 2023, as shown in Table 2 and Figure 2. Among female youth, odds ratios rose steadily throughout the period, with the highest value observed in 2023. In contrast, male youth showed increasing odds ratios from 2015 through 2021, followed by a decline in 2023 (Figure 2a). Table 2 and Figure 2b also show notable racial differences in 2021. Among Asian youth, the odds of current vaping among those who reported binge drinking were 133 times higher than among those who did not report vaping. For Black youth, the odds were 44 times

higher in the same year. These data reflect the highest subgroup-specific associations observed during the study period.

**Table 2:** Odds ratios for the association between current use of vapor products and binge drinking among youth from 2015 to 2023. Data are stratified by year, sex, and race. The odds of current vaping were significantly higher among binge drinkers, especially among females and Asian youth, peaking in 2021.

	Odds Ratios by Year				
	2015	2017	2019	2021	2023
Youth	9.3	17.5	16.3	28.1	18.0
Male	8.8	17.0	17.1	33.6	17.5
Female	9.2	15.2	18.7	27.7	44.6
Race					
White	8.1	14.2	15.2	26.3	21.3
Black/AA*	12.3	49.9	19.4	44.3	13.9
Hispanic/Latino	10.1	15.9	24.3	25.6	16.8
Asian	33.4	91.2	24.5	133.9	58.6
AI/AN**	5.3 <sup>§</sup>	59.5	10.7 <sup>§</sup>	21.8	13.3
NH/OPI***	7.2	4.8 <sup>§</sup>	1.6 <sup>§</sup>	23.2 <sup>§</sup>	9.0 <sup>§</sup>
MNH****	7.0	9.0	9.5	17.9	11.19

\* African American

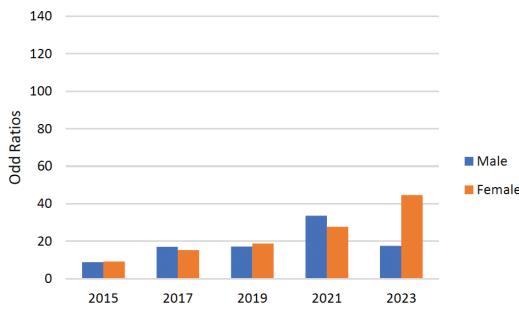
\*\* American Indian/Alaska Native

\*\*\* Native Hawaiian/Other Pacific Islander

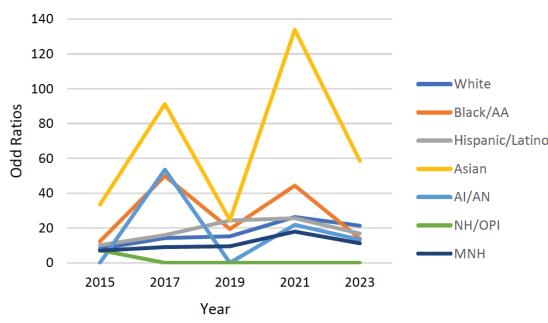
\*\*\*\* Multi-race Non-Hispanic

<sup>§</sup>Odds ratios were not statistically significant.

(a) Odds Ratios for Binge Drinking among Current Vapers by Sex



(b) Odds Ratios for Binge Drinking among Current Vapers by Race



**Figure 2:** (a) This figure shows an eight-year trend analysis of odds ratios for binge drinking among current vapers by sex. (b) This figure shows an eight-year trend analysis of odds ratios for binge drinking among current vapers by race. Female youth showed a steady increase in vaping risk associated with binge drinking; Asian youth showed extremely elevated odds ratios in 2021.

### Marijuana:

Marijuana use showed a robust association with current vaping. As shown in Table 3, current vapor users were up to 24 times more likely to be current marijuana users than youth who did not currently vape and reaching 30.0 among male youth in 2023. Marijuana is a risk factor for current vaping. Both male and female youth demonstrated increasing odds ratios for marijuana use among vapers from 2015 to 2023. Asian youth consistently reported the highest marijuana-associated vaping odds across all survey years. Figure 3a provides an eight-year trend analysis of odds ratios for marijuana use among current

vapers by sex, while Figure 3b shows the same analysis by race. In 2021, Asian marijuana users had over 45 times the odds of vaping, with odds reaching 91.2 in 2017, depicted in Figure 3b. Between 2019 and 2021, the odds of marijuana use among vapers increased for nearly all subgroups, followed by a decline from 2021 to 2023, except for Asian youth, whose odds remained elevated. Among male youth who use marijuana, their odds of currently using vapor products are nearly 30 times greater than male youth who do not currently use vapor products (Figure 3a). In other words, among male youth who are current marijuana users, male youth odds of current vaping are 30 times greater than the odds of vaping for those who do not currently use marijuana.

**Table 3:** Odds ratios for the association between current use of vapor products and marijuana use among youth from 2015 to 2023. Results are stratified by year, sex, and race. Current marijuana users were up to 30 times more likely to vape; Asian youth consistently had the highest odds.

Odds Ratios by Year					
	2015	2017	2019	2021	2023
Youth	7.5	10.8	13.4	24.7	24.1
Male	7.2	10.3	15.8	28.3	30
Female	7.5	11.7	11.4	19.2	24.8
Race					
White	9.8	13.7	19.0	29.1	29.4
Black/AA*	5.1	8.6	8.2	18.4	27.2
Hispanic/Latino	6.4	12.3	14.2	23.3	23.9
Asian	17.4	60.7	34.1	45.7	81.2
AI/AN**	10.1	5.8	20.2	26.4	18.6
NH/OPI***	7.0	2.4 <sup>†</sup>	8.2	27.5	13
MNH****	7.6	10.0	11.4	27.4	23.0

\* African American

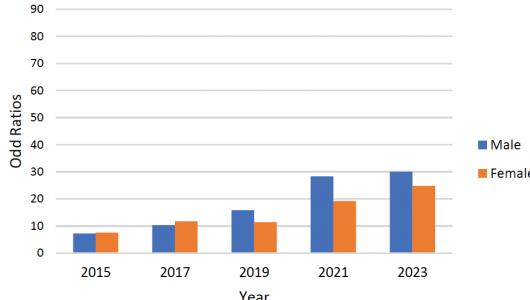
\*\* American Indian/Alaska Native

\*\*\* Native Hawaiian/Other Pacific Islander

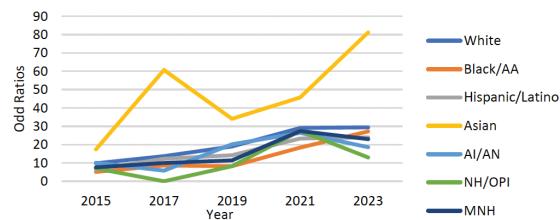
\*\*\*\* Multi-race Non-Hispanic

<sup>†</sup>Except for 2017 Native Hawaiian/ other Pacific Islander data, all odds ratios were statistically significant.

(a) Odds Ratios for Marijuana Use among Current Vapers by Sex



(b) Odds Ratios for Marijuana Use among Current Vapers by Race



**Figure 3:** (a) This figure shows an eight-year trend analysis of odds ratios for marijuana use among current vapers by sex. (b) This figure shows an eight-year trend analysis of odds ratios for marijuana use among current vapers by race. Odds ratios increased for both sexes from 2015 to 2021, with Asian youth reporting the highest vaping risk among marijuana users.

#### Feeling of Sadness or Hopelessness:

As shown in Table 4 and Figure 4, there is a strong and consistent association between feelings of sadness or hopelessness

and current use of vapor products among youth from 2015 to 2023. The overall odds of current vaping among youth who reported feeling sad or hopeless increased from 1.9 in 2015 to 3.65 in 2021. This association was particularly pronounced among female youth, who exhibited a near doubling in odds over time, with Figure 4a showing a steady upward trend from 2015 to 2021. Among racial groups, American Indian/Alaska Native (AI/AN) youth reported the highest odds of sadness or hopelessness among current vapers across all study years. In 2021, this subgroup experienced the most extreme disparity, with more than eightfold greater odds of sadness or hopelessness among current vapers compared to their non-vaping counterparts, as shown in Figure 4b. Across all demographic groups, odds ratios peaked in 2021, likely reflecting the compounded effects of the COVID-19 pandemic on adolescent mental health. Although a slight decline in odds was observed in 2023 for most subgroups, Hispanic/Latino youth were an exception, reporting a continued, albeit modest, increase.

**Table 4:** Odds ratios for the association between current use of vapor products and reported feelings of sadness or hopelessness among youth from 2015 to 2023. Results are stratified by year, sex, and race. The odds of vaping were significantly higher among youth who felt sad or hopeless, particularly among females and American Indian/Alaska Native youth.

Odds Ratios by Year					
	2015	2017	2019	2021	2023
Youth	1.92	1.81	2.02	3.65	3.54
Male	3.71	1.86	1.78	3.02	2.95
Female	2.49	2.22	2.39	4.18	4.03
Race					
White	1.97	1.81	1.94	3.88	3.64
Black/AA*	1.70	1.39	1.79	3.26	2.78
Hispanic/Latino	1.90	2.08	2.38	3.06	3.31
Asian	2.04	1.74	2.61	4.03	3.45
AI/AN**	2.11	2.58	3.17	8.20	3.86
NH/OPI***	1.88	1.79	1.33	4.45	1.74
MNH****	1.77	1.59	1.84	4.07	3.40

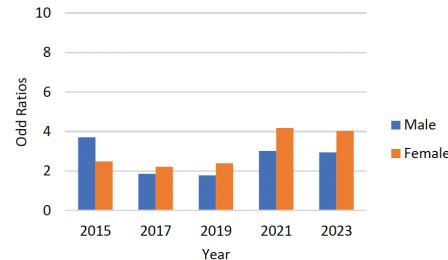
\* African American

\*\* American Indian/Alaska Native

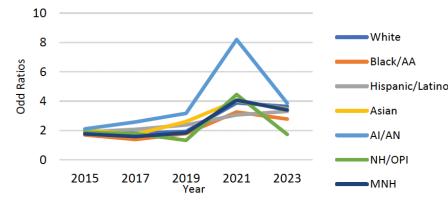
\*\*\* Native Hawaiian/Other Pacific Islander

\*\*\*\* Multi-race Non-Hispanic

(a) Odds Ratios for Risk of Feeling Sad or Helpless among Current Vapers by Sex



(b) Odds Ratios for Risk of Feeling Sad or Helpless among Current Vapers by Race



**Figure 4:** (a) This figure shows an eight-year trend analysis of odds ratios for the risk of feeling sad or helpless among current vapers by sex. (b) This figure shows an eight-year trend analysis of odds ratios for the risk of feeling sad or helpless among current vapers by race. Peak odds occurred in 2021, with American Indian/Alaska Native youth reporting the highest risk association.

### Plan for Suicide:

A similar trend was observed in the relationship between current vaping and the likelihood of having made a suicide plan among youth from 2015 to 2023. As shown in Table 5, youth who currently used vapor products consistently exhibited elevated odds of reporting a suicide plan compared to non-vapers, with odds ratios ranging from 2.0 to 3.8 over the study period. This association was evident across both sexes and racial subgroups. Among female youth, the odds of having made a suicide plan steadily increased from 2015 and reached a peak in 2023 at 3.81, while for male youth, the peak occurred in 2021 at 3.59, followed by a slight decline.

Racial subgroup analysis revealed particularly elevated risks among Asian and American Indian/Alaska Native (AI/AN) youth. In 2023, Asian youth who had made a suicide plan had 5.68 times greater odds of currently using vapor products compared to their non-vaping peers, the highest observed in 2023. Similarly, in 2021, AI/AN youth who reported suicide planning had odds of vaping that were 6.43 times greater than AI/AN youth who had not made a suicide plan, marking the highest risk observed across all years and subgroups. Additionally, all racial groups showed a notable increase in odds ratios between 2019 and 2021, suggesting a widespread escalation of suicide planning among youth who vape during that time period.

These findings, as shown in Figure 5, reinforce the significant comorbidity between mental health distress and vapor product use among youth. They underscore the urgent need for integrated mental health and substance use prevention strategies, particularly for high-risk populations such as Asian, American Indian/Alaska Native (AI/AN), and female youth.

**Table 5:** Odds ratios for the association between current use of vapor products and reported plans for suicide among youth from 2015 to 2023. Results are stratified by year, sex, and race. Youth who made a suicide plan had 2-5 times greater odds of vaping; the highest risks were reported among Asian and American Indian/Alaska Native (AI/AN) youth.

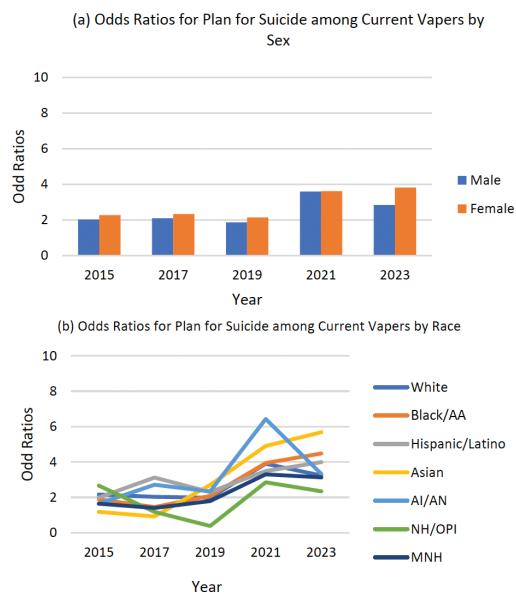
Odds Ratios by Year					
	2015	2017	2019	2021	2023
Youth	2.02	2.10	2.02	3.76	3.56
Male	2.02	2.09	1.86	3.59	2.83
Female	2.27	2.33	2.13	3.61	3.81
Race					
White	2.16	2.03	1.98	3.90	3.23
Black/AA*	1.88	1.45	2.08	3.94	4.48
Hispanic/Latino	1.99	3.12	2.30	3.49	3.99
Asian	1.18	0.92	2.7	4.90	5.68
AI/AN**	1.64	2.71	2.33	6.43	3.32
NH/OPI***	2.66	1.18	0.38	2.85	2.34
MNH****	1.64	1.40	1.79	3.30	3.13

\* African American

\*\* American Indian/Alaska Native

\*\*\* Native Hawaiian/Other Pacific Islander

\*\*\*\* Multi-race Non-Hispanic



**Figure 5:** (a) This figure shows an eight-year trend analysis of odds ratios for the plan for suicide among current vapers by sex. (b) This figure shows an eight-year trend analysis of odds ratios for the plan for suicide among current vapers by race. Odds increased for all groups over time, with 2021 showing peak risks for most subgroups, especially among females and minority youth.

This study analyzed recent YRBS data spanning from 2015 to 2023. The findings revealed that youth who reported current use of electronic vapor products were more likely to engage in multiple high-risk behaviors, including marijuana use, binge drinking, suicidal ideation, and feelings of sadness or hopelessness. Youth who vaped exhibited statistically significantly higher odds ratios for these risk behaviors compared to those who did not use vapor products.

Notably, the odds ratios for risk behaviors in 2021 showed an increase across all behaviors assessed in this study. Specifically, the association between current vapor use and feeling sad or hopeless was particularly strong. Youth who reported using vapor products ranged from a low of 13% in 2017 to a high of 33% in 2019. In contrast, 30% to 42% of youth reported feeling sad or hopeless at least some of the time, specifically experiencing these feelings for two or more weeks in a row to the extent that it interfered with their usual activities in the year prior to the survey. Differences by sex were also observed, with females showing stronger associations between current vaping and feelings of sadness or hopelessness compared to males across all survey years from 2017 to 2023. Additionally, the odds ratios for vapor use increased for most racial groups over the five survey years, highlighting a growing trend among youth of various backgrounds.

These findings on feeling sad or hopeless are consistent with previous research. "Approximately one in every four to five youth in the U.S. meets criteria for a mental disorder with severe impairment across their lifetime. The likelihood that common mental disorders in adults first emerge in childhood and adolescence highlights the need for a transition from the common focus on treatment of U.S. youth to that of prevention and early intervention."<sup>12</sup> This study's findings also align with other research indicating that females in this population

exhibit a significantly greater risk for mental health issues than males, consistent with national-level data.<sup>13</sup>

In addition to mental health concerns, the data suggest an increased risk for suicide ideation among youth who use vapor products. This aligns with previous studies that report e-cigarette use is linked to various negative physical and mental health outcomes, including depression and suicidal ideation. Compared to non-users, e-cigarette users tend to exhibit more significant mental health issues, though they generally report fewer problems than conventional cigarette users.<sup>14</sup> Similar trends were observed for marijuana use, with an increase in odds ratios from 2015 to 2023 among youth who currently vape. "Our findings indicate that sociodemographic characteristics, tobacco product use, and frequency of e-cigarette use are important factors associated with vaping marijuana. Tobacco control campaigns targeted at curbing the use of e-cigarettes and other vaping devices among youth in the US should be extended to address vaping substances other than nicotine, such as marijuana."<sup>15</sup>

The study also identified particularly high odds ratios for current vapor use among Asian youth who reported binge drinking. In 2021, the odds of vaping among Asian youth who engaged in binge drinking were 133 times greater than those who did not vape. Similarly, among Black youth who reported binge drinking, the odds of vaping were 44 times greater in 2021 than for those who did not use vapor products. These results are consistent with prior research, which found that youth who use e-cigarettes are at higher risk for alcohol use and binge drinking.<sup>16</sup> The findings show that interventions to decrease electronic vapor product use should be combined with interventions to reduce alcohol use in adolescents.<sup>17</sup>

The findings in this study are consistent with previous research. "Mental health problems are associated with increased risk for initiating e-cigarette, combustible cigarette, and dual-product use in adolescence... Addressing mental health could be a promising target for preventing initiation of nicotine- and/or tobacco-product use by adolescents."<sup>18</sup> Minority-tailored interventions may be warranted to prevent tobacco product initiation. These findings point to the need for improved school-based services in the area of mental health and vaping cessation, with a priority need for focus on minority youth. Researchers recommend that health services should be accessible to adolescents to address their needs to prevent any adverse mental health outcomes.<sup>19, 20</sup> Ensuring access to comprehensive health services for adolescents could help prevent adverse mental health outcomes and reduce the initiation of harmful behaviors, including vaping and substance use.

## ■ Conclusion

Electronic vapor products are now the most widely used tobacco product among US youth, with over four million high school students reported vaping in the past 30 days.<sup>18, 21</sup> Studies have linked the electronic vapor products to long-term health risks, highlighting the urgent need to understand disparities in electronic vapor product use among different populations.<sup>10, 22</sup> The findings of this study reveal differences in the risk of current vapor use by sex and race, particularly when examining

other risk factors such as feelings of sadness or hopelessness, suicide planning, marijuana use, and binge drinking.

Youth who reported feeling sad or hopeless exhibited a two- to fourfold higher risk of current vaping. Similarly, the risk of current vaping among youth who were planning suicide was also 2 to 4 times higher. For marijuana users, the risk of current vaping was even more pronounced, with odds ranging from 7 to 25 times higher. The risk for youth who engaged in binge drinking was particularly concerning, with the odds of current vaping ranging from 9 to 28 times higher compared to non-users.

When considering racial and ethnic disparities, American Indian/Alaska Native youth were at higher risk for current vaping, particularly among those who reported feelings of sadness or hopelessness and those planning suicide. Asian youth were at higher risk for current vaping among marijuana users and binge drinkers. Black youth had the second-highest risk of current vaping among binge drinkers.

These findings align with previous research showing a high co-occurrence of substance use and mental health issues among youth tobacco users, especially those who use multiple tobacco products.<sup>11</sup> This underscores the importance of addressing these comorbidities in prevention and treatment efforts for high-risk youth. The findings also reinforce previous studies highlighting persistent disparities in substance use among minority youth populations.<sup>11</sup>

Given these disparities, there is a pressing need for improved school-based services focused on mental health. As one study suggests, targeted programming and direct services for minority adolescents are crucial for addressing their unique needs.<sup>18</sup> Schools should consider routine mental health assessments for youth and provide mental health services or referral systems to community-based resources. "Child and adolescent psychiatry treatment programs may be a good setting for prevention efforts and treatment, which should focus on both nicotine dependence and psychiatric disorders."<sup>23</sup>

Further research is needed to better understand these trends and develop effective prevention strategies. Such efforts should include improving data collection on electronic vaping product rates, perceptions, and disease risk among minority youth to ensure data-driven interventions. Additionally, research should focus on identifying effective methods to reduce electronic vapor product use in minority communities, ensuring greater access to cessation services, and reducing barriers to care. Cessation and outreach programs should be tailored to the unique challenges and experiences of minority youth. Increasing access to mental health resources is also critical to addressing the stressors faced by minority youth, and vaping control policies should be evaluated for their effectiveness in reducing vaping rates in these communities.<sup>23</sup> Given the strong associations between vapor product use and co-occurring risk factors, there is a clear need for sustained interventions, advertising and promotion restrictions, and national public education campaigns aimed at reducing vaping among adolescents.

### Limitation:

Study measures are self-reported, resulting in social desirability bias from study participants. Furthermore, the data come from a school-based survey and may not be generalizable to youth not attending schools. Another limitation of the study, relatively small sample cell sizes for American Indian/Native Alaskan and Native Hawaiian/Pacific Islanders when calculating odds ratios.

### Acknowledgments

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