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Association between Sexual Violence Victimization and Electronic Vaping Product Use among Adolescents: Findings from a Population-based Study

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Abstract

Background: Although studies have investigated the association between sexual violence (SV) victimization and substance use, few studies have examined the association between SV victimization and electronic vaping product (EVP) use among adolescents in the United States. The objective of this study was to examine the cross-sectional association between SV victimization and EVP use among adolescents.

Methods: Data were pooled from the 2017 and 2019 Youth Risk Behavior Survey. An analytic sample of 28,135 adolescents (51.2% female) was analyzed using binary logistic regression. The outcome variable investigated was EVP use, and the main explanatory variable was SV victimization.

Results: Of the 28,135 adolescents, the prevalence of past 30-day EVP use and SV victimization was 22.7% and 10.8%, respectively. Controlling for other factors, adolescents who experienced SV had 1.52 times higher odds of being EVP users when compared to their counterparts who did not experience SV (*AOR* = 1.52, $p < .001$, 95% CI = 1.27–1.82). Other factors associated with EVP use included cyberbullying victimization, symptoms of depression, and current use of cigarettes, alcohol, and marijuana.

Conclusions: Experiencing SV was associated with EVP use. Future studies that employ longitudinal designs may offer more insight into the mechanisms underlying the association

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Declaration of interest

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between SV victimization and EVP use. In addition, school-based interventions that focus on sexual violence prevention and reducing substance use among adolescents are warranted.

Keywords

Sexual violence victimization; electronic vaping products; substance use; adolescents

1. Introduction

Sexual violence (SV) victimization remains a significant public health issue in the United States (U.S.), affecting millions of individuals (Basile, Clayton, Rostad, et al., 2020; Black et al., 2014; Ybarra & Mitchell, 2013). Available data suggest that about one in five women and about one in twenty men will experience SV at some point in their life (Smith et al., 2018). Data from the 2019 national Youth Risk Behavior Survey (YRBS) also showed that one in ten adolescents (16.6% of females and 5.2% of males) experienced SV victimization in the past year (Basile, Clayton, DeGue, et al., 2020).

The extant literature has found that individuals who experience SV are at increased risk of experiencing mental health problems later in life even after adjusting for demographic and mental health factors (Casanovas et al., 2022; Clarke et al., 2021; Davis et al., 2022; Meadows et al., 2022; Oshodi et al., 2020; Stewart et al., 2015; Verelst et al., 2014; Zeglin et al., 2020). For example, Maniglio (2010, 2013) conducted systematic reviews and found that adolescents who experienced SV were at significant risk of feeling anxious or depressed, irrespective of the victimization severity. Another body of research suggests that adolescents who experience SV are at elevated risk of misusing substances (Nelon et al., 2019; Ngo et al., 2018). Most of these studies have found a strong association between SV victimization and alcohol use (Anne Lown et al., 2011), combustible cigarette smoking (Charak et al., 2015; Huffhines et al., 2014; Lin et al., 2011), cannabis use (Hébert et al., 2021; Sartor et al., 2013), and illicit drug use (Hébert et al., 2019). However, one area of research that has received relatively little empirical attention is the association between SV victimization and the use of electronic vaping products (EVPs).

EVPs are electronic devices that are normally shaped in the form of a cigarette or cigar and contain a nicotine-based fluid that is vaporized and inhaled. EVPs usually come in different flavors (e.g., fruit, mint, or chocolate) and contain nicotine, a component to produce the aerosol (Centers for Disease Control and Prevention (CDC), 2022). EVPs usually include e-cigarettes, e-cigars, e-hookahs, and vape pens. E-cigarettes are battery-powered devices that offer doses of nicotine and other additives to the user in an aerosol (Cobb et al., 2010). EVP use among adolescents in the U.S. has been identified as a growing public health problem, since such devices may promote increased use of nicotine and other non-disclosed, and often unregulated substances (Miech et al., 2016, 2019). Whereas combustible cigarette smoking among adolescents in the U.S. has declined over the past two decades (Meza et al., 2020), EVP use has increased over the same period, although not in a linear fashion (Chen-Sankey et al., 2019; Collins et al., 2019; Cullen et al., 2019; Miech et al., 2016, 2019; Park et al., 2019; Struik et al., 2020; Tsai et al., 2018). This increase in EVP use has led the U.S. Surgeon General and the Food and Drug Administration (FDA) Commissioner

to declare EVP use among adolescents a national epidemic (US Department of Health & Human Services, 2018; US FDA, 2018).

Whereas some adults may use EVPs in an attempt to quit combustible cigarette smoking (Caraballo et al., 2017), the concern with EVP use among adolescents is unique to their age group. EVPs are addictive (Gorukanti et al., 2017; Wagoner et al., 2021), and given that the adolescent brain is still under development (Dahl, 2004), EVP use among adolescents could potentially influence other substance use behaviors. For instance, research indicates that the prefrontal cortex part of the brain which is responsible for the adjustment of behavioral strategies (Peters et al., 2008), is not fully developed until early adulthood (Dahl, 2004; Siegel, 2012). As a result, adolescents exhibit less impulse control than adults (Arnett, 1995; Dahl, 2004), increasing their susceptibility to substance use (Baiden et al., 2021; Meeus et al., 2021). Moreover, EVPs have been found to contain harmful chemicals (Heide et al., 2021; Pepper et al., 2017; Schier et al., 2019; Wagener et al., 2012), meaning the vaporization process can be harmful regardless of the type of substance being vaped. For instance, Mills et al. (2022) recently found that EVP use and combustible cigarettes produce the same risk for vascular disease. EVP use has also been found to have short- and long-term adverse health effects on individuals, including injury to the pulmonary and respiratory system (Lappas et al., 2018; Lozier et al., 2019; Vardavas et al., 2012) and damage to the bronchial epithelial cells (Pinkston et al., 2020).

Prevalence estimates of EVP use among adolescents in the U.S. vary between 12% and 28% (Cullen et al., 2019; Miech et al., 2016, 2019). Gentzke et al. (2022) examined data from the 2021 National Youth and Tobacco Survey and found that 34% of adolescent high school students reported ever using a tobacco product (i.e., electronic cigarettes, cigarettes, cigars, smokeless tobacco, hookahs, pipe tobacco, heated tobacco products, nicotine pouches, and bidis), with electronic cigarettes being the most commonly used tobacco product, cited by 11.3% of adolescents. Moreover, available research suggests sex differences in EVP use (Wong & Fan, 2018; Yimsaard et al., 2021). For instance, some scholars have found that whereas males are more likely to use EVPs to help cut down on smoking, females are more likely to use EVPs to deal with stress (Piñeiro et al., 2016). In addition, EVP use is known to co-occur with other substances (Miech et al., 2016; Osibogun et al., 2018; Richter et al., 2017; Villanti et al., 2017). Some reasons cited for the increasing prevalence of EVP use among adolescents in the U.S. include the perception that EVPs are less harmful than combustible cigarettes (Park et al., 2019; Tsai et al., 2018), different flavors (Tsai et al., 2018), and desire for social experimentation and entertainment purposes (Chen-Sankey et al., 2019; Patrick et al., 2016). The rise in EVP use among adolescents has been commonly attributed in part to one of the first popular pod style devices, JUUL devices (CDC, 2022; Huang et al., 2019). JUUL remains a leading e-cigarette brand in the U.S., representing more than 70% of the e-cigarette market share (LaVito, 2018). However, the landscape of EVP devices is everchanging, with devices like disposable vapes (e.g., small devices that are recharged and prefilled with e-liquid) becoming increasingly popular among adolescents (Ali et al., 2020). Regardless of EVP type, however, these devices remain attractive to adolescents partly because they come in different flavors, including fruit, mint, menthol, candy, and dessert flavors (Hammond et al., 2022). The use of fruit and other exotic flavors

has been found to be associated with long-term use of EVP among adolescents (Gravely et al., 2020; Leventhal et al., 2019).

This study is guided by the self-medication theory (SMT; Khantzian, 1997). SMT posits that substance use may be part of an individual's response to emotional or psychological distress, or an individual's decision to use a particular substance is based on the substance's effect on the subjective affect regulation mechanism (Khantzian, 1997). Applying SMT to the present study, EVP use may be viewed as a response to the emotional or psychological distress arising out of the experience of SV. This line of reasoning is supported by past research, which suggests that adolescents who have been victimized are at increased risk of experiencing emotional distress, feelings of loneliness, sadness, and hopelessness (Idsoe et al., 2012; Lardier Jr et al., 2016; Reed et al., 2015; Sulkowski & Simmons, 2018), all of which have been found to be associated with substance use (Baiden & Tadeo, 2019; Ingram et al., 2020). Various studies have found SMT as a viable theoretical perspective in understanding substance use behaviors among adolescents with a history of child abuse and neglect (Gomez et al., 2015; Vilhena-Churchill & Goldstein, 2014) or who experienced school bullying and cyberbullying (Maniglio, 2015, 2017; Tharp-Taylor et al., 2009).

1.1. Current study

Although studies have examined the association between SV victimization and substance use behaviors among adolescents (Anne Lown et al., 2011; Charak et al., 2015; Hébert et al., 2019, 2021; Huffhines et al., 2014; Lin et al., 2011; Nelon et al., 2019; Ngo et al., 2018; Sartor et al., 2013), there is a dearth of studies examining the association between SV victimization and EVP use among adolescents. Given the long-term adverse effects of SV victimization on substance use, and the increasing rates of EVP use among adolescents, examining the association between SV victimization and EVP use would allow for early identification of adolescents with a history of SV victimization who might be at risk of using EVPs. Thus, drawing on a large nationally representative sample of adolescents from the U.S., the objective of this cross-sectional study was to investigate the association between SV victimization and EVP use among adolescents. We hypothesized that there would be an association between SV victimization and EVP use. Given the co-occurrence of EVP use with other substances (Miech et al., 2016; Osibogun et al., 2018; Richter et al., 2017; Villanti et al., 2017), we also hypothesized that cigarette smoking, alcohol use, and marijuana use would be associated with EVP use.

2. Methods

2.1. Data source and participants

Data for this study came from the 2017 and 2019 YRBS. The YRBS is a cross-sectional national study conducted biennially by the CDC to understand health-risk behaviors among students in grades 9–12 from public and private schools in the U.S. Detailed information about the YRBS, including the objectives, methodology, and sampling procedure, has been described elsewhere (Brener et al., 2013; Kann et al., 2018; Underwood et al., 2020) and in other publications by the authors (Baiden, Tadeo, Graaf, et al., 2019; Baiden, Graaf, et al., 2019; Baiden et al., 2023; Baiden et al., 2022; Mukherjee et al., 2022; Ziminski et

al., 2022). In brief, the YRBS utilized a three-stage cluster sample design to recruit 9th to 12th graders from public and private schools to complete self-administered surveys. A nationally representative sample of schools and a random sample of classes within those schools were selected to participate in the 2017 and 2019 YRBS. First, schools were selected systematically with probability proportional to enrollment in grades 9 through 12 using a random start from primary sampling units (PSUs), made up of entire counties, groups of smaller adjacent counties, or parts of larger counties. PSUs were categorized into different strata based on their metropolitan statistical area status (e.g., urban or rural) and the percentages of non-Hispanic Black (Black) and Hispanic students in each PSU. For the second-stage sampling, secondary sampling units were sampled with probability proportional to school enrollment size. The third and final stage of sampling comprised of a random sampling of one or two classrooms in each of grades 9 through 12 from either a required subject (e.g., English or social studies) or a required period (e.g., homeroom or second period). All students in sampled classes were eligible to participate. Schools, classes, and students who refused to participate were not replaced in the sampling design. The YRBS has been used in several studies, and the measures have been found to have strong psychometric properties (Baiden & Tadeo, 2019; Brener et al., 2013; Mantey et al., 2021; Pontes et al., 2021; Poteat et al., 2020). The study protocol for conducting the YRBS was approved by the CDC's Institutional Review Board (IRB), and the publicly available data has been de-identified (Brener et al., 2013). We followed Strengthening the Reporting of Observational Studies in Epidemiology (STROBE) guidelines in the conduct of this study (Von Elm et al., 2007).

2.2. Sample

Data from the 2017 and 2019 national YRBS were combined to examine the association between SV victimization and EVP use. The sample used in this study has been described elsewhere (removed for review purposes). The initial sample size for the 2017 and 2019 national YRBS was 14,765 and 13,677, respectively, and the combined sample was 28,442 adolescents. Several studies have combined the national YRBS to obtain larger sample sizes and increase coverage across years (see, for example, Jackman et al., 2020; Kreski et al., 2022; Mantey et al., 2021; Pontes et al., 2021; Poteat et al., 2020). The analytic sample included adolescents aged 13 to 18 years (n = 28,135). Missing data were handled using Multiple Imputation Chained Equations (MICE). The majority of respondents were female (51.2%). About 85% of the adolescents self-identified as straight/heterosexual, 2.7% as lesbian/gay, 8.4% as bisexual, and 4.3% indicated they were unsure about their sexual identity. About half (46.8%) of the respondents self-identified as non-Hispanic White, 17.5% as non-Hispanic Black, 24.1% as Hispanic, and 11.6% as other.

2.3. Variables

2.3.1. Outcome variable—The outcome variable examined in this study was current EVP use and was measured as a binary variable. Adolescents were asked, "During the past 30 days, on how many days did you use an electronic vapor product?" with response options ranging from 0 days to all 30 days. In 2017, the questions on EVP use were preceded by the statement, "the next three questions ask about electronic vapor products, such as blu, NJOY, Vuse, MarkTen, Logic, Vapin Plus, eGo, and Halo. Electronic vapor products include

e-cigarettes, e-cigars, e-pipes, vape pipes, vaping pens, e-hookahs, and hookah pens." In 2019, the questions on EVP use were preceded by the statement, "the next three questions ask about electronic vapor products, such as JUUL, Vuse, MarkTen, and blu. Electronic vapor products include e-cigarettes, vapes, vape pens, e-cigars, e-hookahs, hookah pens, and mods." For the purposes of this study, adolescents who reported EVP use at least once during the past 30 days were coded as 1 (users), whereas those who reported no EVP use during the past 30 days were coded as 0 (nonusers).

2.3.2. Explanatory variable—The main explanatory variable examined in this study was SV victimization, and it was measured based on response to the question, "During the past 12 months, how many times did anyone force you to do sexual things that you did not want to do?" (Count such things as kissing, touching, or being physically forced to have sexual intercourse) with response options ranging from zero times to six or more times. Adolescents who experienced SV at least once during the past 12 months were recoded as 1 (yes) whereas adolescents who did not experience SV during the past 12 months were coded as 0 (no).

2.3.3. Demographic and covariates—Demographic variables included survey year, age, sex, sexual identity, and race/ethnicity. Covariates examined included bullying victimization, symptoms of depression, cigarette smoking, current use of alcohol, and current use of marijuana. Bullying was measured based on two questions. The YRBS defined the term bullying to mean, "Bullying is when one or more students tease, threaten, spread rumors about, hit, shove, or hurt another student over and over again. It is not bullying when two students of about the same strength or power argue or fight or tease each other in a friendly way." School bullying victimization was measured based on response to the question, "During the past 12 months, have you ever been bullied on school property?" Cyberbullying victimization was measured based on response to the question, "During the past 12 months, have you ever been electronically bullied? (Count being bullied through texting, Instagram, Facebook, or other social media)." In both instances, adolescents who answered "yes" were coded as 1, and those who answered "no" were coded as 0.

Symptoms of depression were measured based on response to the question, "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?" Adolescents who answered "yes" were coded as 1, whereas those who answered "no" were coded as 0. Also, adolescents who endorsed using cigarettes, alcohol, and marijuana during the past 30 days were coded as 1 (users). Adolescents who indicated no past 30-day use were coded as 0 (non-users).

2.4. Statistical analysis

First, missing data analyses were conducted to assess whether respondents with observed data on one variable were significantly different from respondents with missing data on another variable. The percent of missing data ranged from less than 1% to 14%, with sexual identity, cigarette smoking, alcohol use, and SV victimization having the highest proportion of missing data. We found that data were missing completely at random (MCAR), that is, the probability of missingness on one variable is not dependent on any observed data

(van Ginkel et al., 2020). Given that data were MCAR, Multiple Imputation using Chained Equations (MICE) was chosen as the most appropriate technique to impute complete data (Van Buuren, 2018). Multiple imputation is a simulation-based approach for analyzing missing data that replaces missing values with multiple sets of simulated values to complete the dataset and adjust for missing data uncertainty (Rubin, 1996). We followed the four steps recommended by Azur et al. (2011) in imputing missing data. Given the amount of missing data present in the current study, we followed the recommendation of Graham et al. (2007) and generated 20 imputed datasets. This number is generally considered sufficient to improve the model's statistical power (Azur et al., 2011; Graham et al., 2007). The authors have used a similar approach in handling missing data (Baiden, Tadeo, Peters, 2019; Baiden, Tadeo, Tonui, et al., 2020; Baiden, Findley, Onyeaka, 2022; Baiden, LaBrenz, et al., 2020; Baiden, Tadeo, Graaf, et al., 2019; Baiden, Szlyk, et al., 2022).

Second, descriptive, bivariate, and multivariable analytic techniques were employed to analyze the data. The general distribution of all the variables included in the analysis was examined using percentages. We checked for multicollinearity by running a series of bivariate associations among the explanatory variables. We found a moderate association between school bullying and cyberbullying and a moderate association among the substance use variables. However, none of the associations rise to the level to pose a problem of multicollinearity. The main analysis involves using binary logistic regression to examine the association between SV victimization and EVP use while controlling for the effects of demographic factors and other covariates. Unadjusted and adjusted logistic regression models were fitted. In the unadjusted models, we examined the bivariate association between the study variables and EVP use. In the fully adjusted model, we examined the association between SV victimization and EVP use while simultaneously controlling for the effects of demographic factors, bullying, symptoms of depression, and current substance use. Unadjusted and adjusted odds ratios (AORs) are reported with their 95% Confidence Intervals (C.I.). Variables were considered statistically significant if the *p*-value was less than .05. Stata's "svyset" command was used to account for the weighting and complexity of the sampling design employed by the YRBS. All analyses were performed using Stata version 15.

3. Results

3.1. Sample characteristics

Table 1 shows the general distribution of the study variables. Of the 28,135 adolescents, 22.7% used EVPs at least once within 30 days preceding the survey date. A little over one in ten adolescents (10.8%) were victims of SV. About one in three adolescents (34.2%) reported feeling sad or hopeless almost every day for two weeks or more in a row, 19.1% were victims of school bullying, and 15.1% were victims of cyberbullying. About 7% of adolescents reported smoking cigarettes, 29.5% reported drinking alcohol, and 21.2% reported using marijuana during the past 30 days.

3.2. Distribution of cigarette smoking and use of EVP by survey year

Table 2 shows the proportion of adolescents who smoked cigarettes or used EVPs in 2017 and 2019. We found a decrease in the proportion of adolescents who smoked cigarettes from 2017 to 2019. In 2017, 8.9% of adolescents smoked cigarettes during the past 30 days compared to 6.1% of adolescents in 2019 (OR = 0.65, $p = .002$, 95% C.I. = 0.50–0.86). However, we found that the rate of EVP use increased from 2017 to 2019. In 2017, 13.9% of adolescents used EVPs during the past 30 days compared to 32.9% of adolescents who used EVPs during the past 30 days. The odds of EVP use in 2019 were more than threefold when compared to 2017 (OR = 3.03, $p < .001$, 95% C.I. = 2.54–3.62).

3.3. Logistic regression examining the association between SV victimization and EVP use

Table 3 shows the unadjusted and adjusted binary logistic regression results examining the association between SV victimization and EVP use. In the unadjusted model, only sex of respondents failed to reach statistical significance. In the unadjusted model, adolescents who experienced SV had almost threefold higher odds of EVP use when compared to adolescents who did not experience SV (*OR* = 2.91, $p < .001$, 95% CI = 2.58–3.27). This significant effect persisted after adjusting for demographic and other covariates. In the adjusted model, adolescents who experienced SV had 1.52 times higher odds of EVP use when compared to their counterparts who did not experience SV (*AOR* = 1.52, $p < .001$, 95% CI = 1.27–1.82).

Controlling for the effects of other factors, EVP use was more than sixfold higher in 2019 when compared to 2017 (*AOR* = 6.77, $p < .001$, 95% CI = 5.53–8.28). Each additional increase in age increased the odds of EVP use by 5% (*AOR* = 1.05, $p = .036$, 95% CI = 1.01–1.09). Adolescent females had 26% lower odds of EVP use when compared to their male counterparts (*AOR* = 0.74, $p < .001$, 95% CI = 0.64–0.85). Compared to adolescents who self-identified as straight/heterosexual, the odds of EVP use were significantly lower among adolescents who self-identified as lesbian/gay (*AOR* = 0.63, $p = .023$, 95% CI = 0.43–0.94), bisexual (*AOR* = 0.66, $p = .001$, 95% CI = 0.52–0.84), or not sure about their sexual identity (*AOR* = 0.58, $p = .002$, 95% CI = 0.42–0.80). Compared to adolescents who self-identified as non-Hispanic Black, the odds of EVP use were 2.14 times higher for adolescents who self-identified as non-Hispanic White (*AOR* = 2.14, $p < .001$, 95% CI = 1.69–2.70) and 1.45 times higher for adolescents who self-identified as Hispanic (*AOR* = 1.45, $p < .001$, 95% CI = 1.13–1.86). Adolescents who experienced cyberbullying had 1.45 times higher odds of EVP use when compared to their counterparts who did not experience cyberbullying (*AOR* = 1.45, $p < .001$, 95% CI = 1.25–1.69). The association between school bullying victimization and EVP use was not statistically significant. Adolescents with symptoms of depression had 1.28 times higher odds of EVP use when compared to their counterparts with no symptoms of depression (*AOR* = 1.28, $p < .001$, 95% CI = 1.13–1.45). Additionally, adolescents were more likely to use EVPs if they endorsed current cigarette smoking (*AOR* = 6.10, $p < .001$, 95% CI = 4.64–8.02), current alcohol drinking (*AOR* = 6.39, $p < .001$, 95% CI = 5.64–7.24), or current marijuana use (*AOR* = 5.61, $p < .001$, 95% CI = 4.71–6.69).

4. Discussion

This study examined the association between SV victimization and EVP use among a nationally representative sample of U.S. adolescents. We found that 22.7% of adolescents used EVPs (13.9% in 2017 and 32.9% in 2019), and 10.8% were victims of SV. The proportion of adolescents who endorsed current EVP use is consistent with some past research (Cullen et al., 2019). Consistent with past research (Hébert et al., 2021), we found that about one in ten adolescents were victims of SV. A systematic review and meta-analysis of published studies found that between 8% to 31% of adolescent females and 3% to 17% of adolescent males experienced SV by age 18 (Barth et al., 2013). It is important to note that the prevalence of SV victimization reported in this study may be confounded by underreporting due partly to the social stigma that comes with disclosing SV victimization, particularly among adolescent males (Baiden et al., 2017).

Overall, the prevalence of reported EVP use among U.S. adolescents increased from 12% in 2017 to 31.5% in 2019, and the odds of EVP use were three-fold higher among adolescents in 2019 compared to 2017. This large and dramatic uptake of EVP use among adolescents mirrors similar observations reported in Canada (Cole et al., 2021; Hammond et al., 2019). Although the exact reasons for the increasing EVP use are unknown, we propose several possibilities that may partly explain our findings. First, evidence suggests that aggressive and targeted marketing of adolescents through social media may play a role in the uptake of EVP use among adolescents (Laestadius et al., 2019). Another potential reason is that the 2019 YRBS data marked the first time JUUL was included in the definition of EVP use. Since its introduction to the market in 2015, JUUL has remained the leading EVP brand in the U.S. (Huang et al., 2019; Tan et al., 2020). Also, emerging data indicate that EVP sales with higher nicotine concentrations and delivery are increasing (Romberg et al., 2019). It is possible that such higher-content nicotine EVPs may encourage the initiation of nicotine use among adolescents.

We found support for our hypothesis that there would be an association between SV victimization and EVP use, similar to the link observed between SV victimization and the use of other substances (Martin et al., 1999; Mintz et al., 2022; Mulla et al., 2020; Temple & Freeman Jr, 2011). Within the context of the SMT, we can speculate that SV victimization increases the likelihood of using EVPs as a coping mechanism to relieve or change painful affect states associated with the traumatic event (Khantzian, 1997). Overall, our findings add to the literature that victims of SV may seek out EVPs to self-soothe.

Additionally, while several scholars have found sex differences in the prevalence of EVP use at a bivariate level (Levy et al., 2017; Pepper et al., 2017; Rigsby et al., 2019), our study corroborates that of Kim (2021) who also found evidence for increased odds of EVP use among males (compared to females) after adjusting for other demographic and health risk behavior factors. The finding that adolescent males are more likely to use EVPs is of significant public health concern and has policy, school, and clinical implications. It is important that school administrators consider tailoring health promotion messaging about the safety of EVPs differently for male and female students. For instance, past research has found sex differences in types of reasons for EVP use, with adolescent males being

more likely to report more positive expectancies (e.g., desirable taste, social facilitation, increased energy as a result of use) for EVP use than females (Kim, 2021). Other scholars have found that whereas females prefer sweet and fruit-flavored EVPs or those that have a non-tobacco flavor (Bunch et al., 2018), males prefer tobacco-flavored EVPs (Piñeiro et al., 2016). While there were no measures of types of EVPs in the YRBS, we believe that future studies should consider examining sex differences in types of EVP use among adolescents using a nationally representative data. Moreover, using this finding as an example, it would be important for school professionals to identify unique prevention strategies for adolescent males who may be enthusiastic about initiating EVP use to cut down on combustible cigarette smoking instead of primarily using it to cope with past trauma. Our finding also highlights the importance of expanding provider screening services to include questions about EVP use to promote early identification of at-risk male adolescents in clinical settings (Benyo et al., 2021).

The associations found between cigarettes, alcohol, marijuana, and EVP use corroborate trend analysis of adolescent substance use behaviors that indicate engaging in one problem behavior increases the likelihood of engaging in other problem behaviors (Miech et al., 2016; Osibogun et al., 2018; Richter et al., 2017; Villanti et al., 2017). These findings are of significant public health concern and signal the need for comprehensive prevention efforts that target polysubstance use among adolescents (Matson et al., 2022; Vuolo et al., 2022). Consistent with epidemiological trends in vaping among adolescents, our finding that EVP use was more than seven times higher in 2019 than in 2017 demonstrates a drastic increase in EVP use among adolescents over the past decade. This finding also highlights the need for improved education on the significant health risks vaping products pose to adolescents, especially since some data have linked EVP use to risky sexual behaviors, poor dietary and physical activity practices, violence, and suicide attempts among adolescents (Demissie et al., 2017).

In the present study, being a victim of cyberbullying but not school bullying was significantly associated with EVP use after adjusting for other factors. A burgeoning number of research suggests that cyberbullying may produce more lasting adverse emotional effects on adolescents than school bullying (Dooley et al., 2009; Kowalski & Limber, 2007; Mishna et al., 2011). Although cyberbullying shares similar features with school bullying, including imbalance of power, intentional harm doing, and repeated acts carried out over time, cyberbullying also has unique characteristics (Olweus, 2012, 2013). Cyberbullying can occur 24 hours a day, seven days a week, and be perpetrated by individuals or groups masked by anonymity (Baiden & Tadeo, 2020; Mishna et al., 2011). The nature of cyberbullying allows perpetrators to increase the frequency, duration, and severity of bullying behaviors (i.e., humiliation experienced in the school setting is expanded to online publications) which has the potential of reaching wide-ranging audiences (e.g., YouTube videos), evoking fear of public humiliation beyond the school setting (Dooley et al., 2009; Menesini et al., 2012). Therefore, adolescent victims of cyberbullying may feel a greater need to self-medicate through EVP use. When asking adolescents about exposure to bullying, school staff, counselors, and clinicians should inquire about possible experiences that happen online.

4.1. Limitations

First, the findings of this study may not be generalizable to all adolescents in the U.S., as the data apply only to adolescents who attended school. The use of a school-based sample also suggests that estimates of EVP use reported in this study may be underestimated as research has shown that substance use tends to be higher among adolescents who drop out of school (Bachman et al., 2008). Second, the cross-sectional nature of the data does not allow causal inferences. It is possible that some adolescents may have used EVPs before experiencing SV. Hence, only an association can be inferred. Third, the use of secondary data limits our analysis to variables present in the dataset. Fourth, differences in the definition of EVPs from 2017 to 2019 may affect the prevalence estimate of EVP use reported in this study. It is important to note that the inclusion of JUUL in the 2019 brand exemplars may have led to increased rates of endorsement of EVP use in 2019. While our reported estimates may indicate a real increase in EVP use, this could also be a limitation wherein adolescents did not indicate EVP use in 2017 due to the lack of the inclusion of popular brands in the description. Fifth, data on SV victimization and health risk behaviors are self-reported and may be subject to recall bias or confounded by underreporting due partly to the social stigma that comes with disclosing SV victimization, particularly among adolescent males (Baiden et al., 2017). However, the YRBS questions have been found to have good test-retest reliabilities (Brener et al., 2013).

4.2. Conclusions

The study contributes to the needed literature on the association between SV victimization and EVP use among adolescents. We report a positive association between SV victimization exposure and current EVP use, and males in our study were at greater odds of using EVPs when compared to females. Additionally, victimization of cyberbullying but not school bullying was significantly associated with EVP use.

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Table 1.

Sample characteristics (N = 28,135).

Variables	Frequency (Weighted %)
Outcome variable	
Current use of electronic vaping products	
No	21,741 (77.3)
Yes	6,394 (22.7)
Main explanatory variable	
Experienced sexual violence	
No	25,099 (89.2)
Yes	3,036 (10.8)
Demographic variables	
Survey year	
2017	14,624 (52.0)
2019	13,511 (48.0)
Age in years	
13 years	146 (0.5)
14 years	3,591 (12.8)
15 years	7,020 (24.9)
16 years	7,289 (25.9)
17 years	6,693 (23.8)
18 years	3,396 (12.1)
Sex	
Male	13,733 (48.8)
Female	14,402 (51.2)
Sexual identity	
Straight/Heterosexual	23,811 (84.6)
Lesbian/gay	749 (2.7)
Bisexual	2,350 (8.4)
Not sure	1,225 (4.3)
Race/ethnicity	
Non-Hispanic Black	4,912 (17.5)
Non-Hispanic White	13,183 (46.8)
Hispanic	6,769 (24.1)
Other	3,271 (11.6)
Covariates	
Experienced school bullying	
No	22,755 (80.9)
Yes	5,380 (19.1)
Experienced cyberbullying	
No	23,902 (84.9)
Yes	4,233 (15.1)

Variables	Frequency (Weighted %)
Has symptoms of depression	
No	18,518 (65.8)
Yes	9,617 (34.2)
Currently smoke cigarette	
No	26,066 (92.7)
Yes	2,069 (7.3)
Currently drinks alcohol	
No	19,826 (70.5)
Yes	8,309 (29.5)
Current use of marijuana	
No	22,158 (78.8)
Yes	5,977 (21.2)

Table 2.

Association between survey year, cigarette smoking, and electronic vaping products.

	Survey year			
Variables	**2017**	**2019**	**OR**	***p*-value**
Current cigarette use			0.66 (0.50–0.86)	.002
No	91.0	93.9		
Yes	8.9	6.1		
Current use of electronic vaping products			3.03 (2.54–3.62)	< .001
No	86.1	67.1		
Yes	13.9	32.9		

Table 3.

Multivariate logistic regression results examining current use of electronic vaping products (N = 28,135).

	Unadjusted Model		Adjusted Model	
Variables	**OR (95% C.I.)**	***p*-value**	**AOR (95% C.I.)**	***p*-value**
Experienced sexual violence (No)				
Yes	2.91 (2.58–3.27)	<.001	1.52 (1.27–1.82)	< .001
Survey year (2017)				
2019	3.03 (2.54–3.62)	< .001	6.77 (5.53–8.28)	< .001
Age in years	1.23 (1.18–1.28)	< .001	1.05 (1.01–1.09)	.036
Sex (Male)				
Female	0.90 (0.81–1.00)	.057	0.74 (0.64–0.85)	< .001
Sexual orientation (Straight/Heterosexual)				
Lesbian/gay	1.13 (0.86–1.49)	.365	0.63 (0.43–0.94)	.023
Bisexual	1.24 (1.06–1.46)	.007	0.66 (0.52–0.84)	.001
Not sure	0.75 (0.60–0.94)	013	0.58 (0.42–0.80)	.002
Race/ethnicity (Non-Hispanic Black)				
non-Hispanic White	2.25 (1.85–2.74)	< .001	2.14 (1.69–2.70)	< .001
Hispanic	1.74 (1.41–2.16)	<.001	1.45 (1.13–1.86)	< .001
Other	1.31 (1.05–1.64)	.019	1.33 (0.99–1.79)	.058
Victim of school bullying (No)				
Yes	1.67 (1.50–1.87)	< .001	1.12 (0.96–1.30)	.150
Victim of cyberbullying (No)				
Yes	2.23 (1.99–2.48)	< .001	1.45 (1.25–1.69)	< .001
Has symptoms of depression (No)				
Yes	2.17 (1.98–2.37)	< .001	1.28 (1.13–1.45)	< .001
Current cigarette use (No)				
Yes	14.24 (11.59–17.51)	< .001	6.10 (4.64–8.02)	< .001
currently drinks alcohol (No)				
Yes	10.74 (9.64–11.96)	< .001	6.39 (5.64–7.24)	< .001
Current use of marijuana (No)				

Variables	Unadjusted Model		Adjusted Model	
	OR (95% C.I.)	*p*-value	AOR (95% C.I.)	*p*-value
Yes	10.45 (9.10–11.99)	< .001	5.61 (4.71–6.69)	< .001

Note: Reference category is indicated in parenthesis.

OR indicates odds ratio.

AOR indicates adjusted odds ratio.