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Electronic vapor product use and suicidal behavior in adolescents

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INTRODUCTION

The global burden of suicide is substantial, claiming the lives of over 800,000 people each year.¹ In the United States, suicide is the second leading cause of death among individuals ages 10 to 34; additional suicidal behaviors, including suicidal ideation and attempted suicide, contribute to significant morbidity in this demographic.^{2,3} The risk of developing a suicide plan or making a suicide attempt is markedly elevated immediately following the onset of ideation, with a greater than 100-fold increase in the odds of plan or attempt in the first 12 months.³

There has been considerable effort to identify youth at risk of suicidal behavior in order to appropriately target life-saving interventions. Tobacco use is of particular concern, as smokers have an 80% greater risk of death by suicide than non-smokers.¹ Furthermore, early-onset tobacco use and daily consumption of cigarettes in adolescence are associated with subsequent self-injurious behavior and suicidal ideation in young adulthood.⁴

Electronic vapor products (EVPs) and their component parts are included in the definition of “tobacco product” by the U.S. Food and Drug Administration.⁵ EVPs are now the most commonly used tobacco product by American adolescents, with more than 3.5 million middle and high school students reporting current use of such devices.⁵

Recent research indicates that adolescents underestimate the health risks associated with EVP use.⁶ EVPs expose the user to nicotine, which alters brain development and may contribute to the onset of mood disorders and impulsivity.⁷ Evidence suggests that conditions such as

depression and anxiety are associated with EVP use⁷, though a substantial gap remains in the literature regarding the relationship between EVPs and suicidal behavior.

The primary objective of this research was to determine whether an association exists between EVP use and suicidal behavior in adolescents in a Northeastern US State. Specifically, we tested the hypothesis that EVP use is associated with creation of a suicide plan and/or suicide attempts in adolescents.

METHODS

Data were obtained from the 2017 Vermont Youth Risk Behavior Survey (VT YRBS). The survey is administered biannually to youth in grades 6 through 12. Parental consent was obtained, and participation was anonymous and voluntary. The specific methodology of the YRBS is discussed elsewhere.⁸ This research meets exemption criteria outlined by the University of Vermont Committee on Human Research.

Study Participants

Participants included middle school students grades 6th-8th (N=13,887) and high school students grades 9th-12th (N=20,653). Demographics are reported in Table 1.

Exposure

EVP use was assessed using one survey question. Respondents who answered “Yes” to “Have you ever used an electronic vapor product?” were classified as ever users of EVP. Those who answered “No” were classified as never users.

Outcome

Suicidal behavior was assessed using three survey questions for middle school students and two survey questions for high school students. Respondents who answered “Yes” to any/all question(s) were considered to display suicidal behavior. Those who answered “No” were classified with no outcome. Questions differed between the two surveys as follows:

Middle School:

- Question #14: “Have you ever seriously thought about killing yourself?”
- Question #15: “Have you ever made a plan about how you would kill yourself?”
- Question #16: “Have you ever tried to kill yourself?”

High School:

- Question #27: “During the past 12 months, did you make a plan about how you would attempt suicide?”
- Question #28 “During the past 12 months, how many times did you actually attempt suicide?”

Statistical Analysis

All statistical analyses were performed using SPSS v.25. Descriptive statistics and distributions were examined for all covariates. EVP use status and suicidal behavior were classified as dichotomous variables. Demographic variables and potential confounders were selected based on review of the literature. Two multivariable logistic regression models were constructed using stepwise selection of variables. Age, sex, and hunger status were included in both models, consistent with the literature. Other variables accounted for in both models include feeling sad or hopeless, ever use of alcohol, marijuana, or other illicit substances, as well as being bullied or bullying someone else. Predictors unique to each model are as follows:

High school model: An interaction term for alcohol use and EVP use.

Middle school model: Ever use of tobacco, screen time duration, and interaction terms for age and EVP use and sex and EVP use.

RESULTS

Across all participants (middle and high school students), females were 22.7% less likely to report EVP use than males; however, they were 11.7% more likely to report suicidal ideation and/or attempted suicide. Significant predictors of suicidal behavior in middle and high school students are included in Table 1.

Middle School

EVP ever users were 6.84 (95% CI = 2.66, 17.63) times more likely to report suicidal behavior than never users, which was highly significant ($p < 0.001$; Table 1).

High School

EVP ever users were 0.315 (95% CI = 0.46, 1.01) times less likely to report suicidal behavior than never users (Table 1). This relationship approaches significance ($p = 0.056$). Respondents who reported ever feeling sad or hopeless were 10.5 (95% CI= 9.35, 11.75) times more likely to report suicidal behavior than those who did not (Table 1).

Table 1: Descriptive and Multilevel Logistic Regression Analysis for Suicidal Behaviors								
Demographic Covariates			Middle School Students (N= 13,887)			High School Students (N= 20,653)		
			Total N	%	Adjusted OR (95% CI)	Total N	%	Adjusted OR (95% CI)
Age	≤ 12		13,824	40.5	1.31	20,477	0.3	1.12***
	13 - 17			59.4	(.914, 1.87)		87.4	(1.07, 1.17)
	≥ 18						12.3	
Sex	Male		13,717	51.3	4.34***	20,319	50.9	1.29***
	Female			48.7	(2.25, 8.35)		49.1	(1.16, 1.44)
Hunger status	Yes		13,887		1.54**	20,653		1.57***
			306	2.2	(1.11, 2.14)	588	2.9	(1.25, 1.99)
Risk Factors								
EVP use	Yes		13,724		6.84***	20,498		0.685
			1,207	8.8	(2.66, 17.63)	6,882	33.6	(0.46, 1.01)
Feeling sad/hopeless	Yes		13,887		8.65**	20,653		10.5***
			2,536	18.8	(7.6, 9.71)	5,199	25.3	(9.35, 11.75)
≥3 hr. screen time/day	Yes		13,887		1.40**	20,653		
			6,261	45.8	(1.81, 2.27)	10,638	52.6	
Alcohol use	Yes		13,887		1.97***	20,653		0.645
			2,559	18.4	(1.71, 2.27)	11,502	57	(0.36, 1.17)
Marijuana use	Yes		13,887		1.42**	20,653		1.32***
			950	6.8	(1.13, 1.8)	7,525	36.8	(1.15, 1.51)
Been bullied/bullied others	Yes		13,887		2.58***	20,653		2.02***
			7,336	53	(2.28, 2.91)	5,644	27.3	(1.82, 2.25)
Substance use	Yes		13,887		2.03***	20,653		2.22***
			844	6.1	(1.65, 2.51)	2,911	14.2	(1.96, 2.51)
Tobacco use	Yes		13,887		1.42***	20,653		
			1,190	8.6	(1.51, 1.75)	2,854	13.9	
Interaction Terms								
Alcohol use·EVP use								1.41*
								(1.03, 1.94)
Age·EVP Use					0.823*			
					(0.683, 0.993)			
Sex·EVP Use					0.561***			
					(0.398, 0.789)			
For each variable, the number of students for whom data were available is given as the total number. Due to rounding, not all percentages total 100. A Chi-square test was performed for all dichotomous and ordinal variables and a two-sample z-test was performed for continuous variables. OR: odds ratio, CI: 95% confidence interval.								
* p ≤ 0.05 ** p ≤ 0.01 *** p ≤ 0.001								

DISCUSSION

These data suggest that EVP use is strongly associated with the formation of a suicide plan and/or attempted suicide among middle school students (OR 6.48; CI 2.655, 17.626).

To our knowledge, this is the first investigation of the association between EVP use and adolescent suicidal behavior in the United States, though a recent study of South Korean students yielded similar results.⁹

Despite a greater proportion of high school students reporting use of EVPs, an association between use and suicidal behavior was not observed in this study. The transition to early adolescence is often accompanied by elevated emotional stress and an increased number of behavioral problems. Research suggests that there is a developmental lag between the onset of these emotional changes and the development of coping skills associated with cognitive maturation and cortical development of late adolescence.¹⁰ This gap may represent an important window for the onset of suicidal behaviors in vulnerable middle school students. While suicidal ideation peaks during middle school, the rate of suicide attempts and death is higher among high school students.¹¹ Because our main outcome of interest includes both suicidal ideation and suicide attempts, further analysis is necessary to clarify the influence of EVP use on individual outcome variables.

There are some important limitations to this study. All data were derived from survey responses, which are self-reported and therefore subject to recall bias. However, previous surveys designed by the CDC have demonstrated robust test-retest reliability, reducing concern for misreporting.⁸ This methodology is also prone to selection bias, as home-schooled and absent students are inherently excluded from the sample. It should be noted that truancy has been associated with a higher likelihood of tobacco, drug, and alcohol use¹²; therefore, it is possible that this data set underestimates students' use of EVPs.

PUBLIC HEALTH IMPLICATIONS

This research identified a significant association between EVP use and suicidal ideation in middle school-aged children. In light of the significant increase in completed suicide among children ages 10 through 14 between 1999 and 2017², this report underscores the need for targeted suicide prevention strategies and smoking cessation initiatives.

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