JMCH Journal of Maternal and Child Health (2022), 07(02): 214-221
Masters Program in Public Health, Universitas Sebelas Maret

Research

Examining the Relationship between Vaping and Smoking among Texas High School Students

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ABSTRACT

Background: Over the last decade, e-cigarettes have grown in popularity, surpassing cigarettes as the most widely used tobacco product among adolescents. Current evidence suggests that using e-cigarettes (vaping) is less harmful than smoking cigarettes; however, vaping has been linked to severe health consequences and an increased likelihood of transitioning to cigarettes. The upward trend of vaping is infrequently studied in concert with the prevalence of cigarette smoking. The objective of this study is to explore the prevalence of e-cigarette use and to assess potential associations with cigarette smoking among Texas adolescents.
Subjects and Method: This study analyzed data on the prevalence of vaping and cigarette smoking among high school students from the 2019 Texas Youth Risk Behavior Survey (YRBS), a cross-sectional survey with a sample size of 2032. Participating schools were selected using a multi-level cluster sampling technique and variables of interest were measured using a standardized self-administered questionnaire. The t-test and chi-square tests were used to determine significance of associations between estimates.
Results: Almost one in five respondents (18.7%) reported vaping. Non-Hispanic White students ($p < 0.001$), bisexual students ($p < 0.001$) and students in the higher grades were more likely to report e-cigarette use. Overall, cigarette smoking appeared to be on the decline in contrast to e-cigarette use and there was a positive association between cigarette smoking and vaping ($p < 0.001$).
Conclusion: The high prevalence of vaping among Texas high school students is a call to action. Halting the upward trend of e-cigarette use is a priority as these products predispose adolescents to significant morbidity.

Keywords: Vaping, e-cigarettes, smoking, Texas.

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Cite this as:
Odeyemi J (2022). Examining the Relationship between Vaping and Smoking among Texas High School Students. J Matern Child Health. 07(02): 214-221. https://doi.org/10.26911/thejmch.2022.07.02.10.

BACKGROUND

Cigarettes were introduced into the United States market in the early 19th century (Centers for Disease Control and Prevention [CDC], 2015). However, it was not until the second half of the 1800s that smoking cigarettes achieved significant popularity (CDC, 2015). On the other hand, Electronic Vapor Products or E-Cigarettes were only invented in 2003, and within 20 years, e-cigarettes have achieved significant popularity despite campaigns by health organizations and anti-smoking messages (Consumer Advocates for Smoke-free Alternatives Association [CASAA], 2021). E-cigarettes are currently the second most used tobacco product in the United States and the most widely used tobacco product among ado-

lescents (Cornelius et al., 2020; Park-Lee et al., 2021). This alarming rise in the popularity of e-cigarette use, also called vaping, has been attributed to several factors (Miller, 2019). These include the rapid changes in the chemistry of the devices over the last two decades (Miller, 2019). Flavored e-cigarettes have been introduced; furthermore, one cartridge of some e-cigarettes contains as much nicotine as a pack of 20 traditional cigarettes (Miller, 2019; CDC, 2021). Also, e-cigarettes have been marketed as a safe, healthy alternative to cigarettes that helps smokers quit (Miller, 2019). Lastly, the e-cigarette designs appeal to young people, who are vulnerable to the intense marketing of these devices through social media and celebrity endorsements (Miller, 2019).

In addition to nicotine, the addictive psychoactive agent, the smoke of traditional cigarettes contains thousands of cancer-causing chemicals, including polycyclic aromatic hydrocarbons and benzene (American Cancer Society, 2021). While e-cigarettes do not produce smoke, the aerosols that these devices produce also contain numerous toxic chemicals which have been linked to lung disease and cancer (CDC, 2021). Also, while some studies have suggested that vaping may be less harmful than smoking cigarettes, emerging data have revealed possible links of vaping to chronic lung and cardiovascular diseases, similar to traditional cigarettes (American Cancer Society, 2021; MacDonald and Middlekauff, 2019). Furthermore, since e-cigarettes also contain nicotine, they are just as addictive as traditional cigarettes (Blaha, 2021). Consequently, evidence has shown that young people who use e-cigarettes are likely to smoke cigarettes, exposing them to increased risk of morbidity (CDC, 2021). In addition, as e-cigarettes are relatively new, the long term health consequences are still being studied (CDC, 2021).

The Office of Disease Prevention and Health Promotion (ODPHP, 2020a) recognizes the rising rates of e-cigarette use among adolescents and the public health consequences of this behavior. Consequently, one of the Healthy People 2030 objectives directly addresses e-cigarette use with a second objective targeting the use of flavored tobacco products by adolescents (ODPHP, 2020b; ODPHP, 2020c). Healthy People 2030 adopted the data reported by the 2018 National Youth Tobacco Survey as baseline values (ODPHP, 2020b; ODPHP, 2020c). According to the survey, 13.8% of high school and middle school students use e-cigarettes; this informed a Health People 2030 target of 10.5% (ODPHP, 2020b). In addition, 64.1% of tobacco users in middle and high school used flavored tobacco products; this informed a Health People 2030 target of 59.2% (ODPHP, 2020c).

This study has two purposes: (a) to explore the prevalence of e-cigarette use among Texas high schoolers and to understand the socio-demographic factors that influence this behavior and (b) to examine the trend for e-cigarette use among this population and assess possible associations with the use of traditional cigarettes. Guided by this statement of purpose, this paper intends to understand how the current e-cigarette trends affect the prevalence of cigarette smoking among Texas high school students.

SUBJECTS AND METHOD

1. Study Design

This study utilized data from the Youth Risk Behavior Surveillance System (YRBSS). The Youth Risk Behavior Survey (YRBS) is a biennial cross-sectional survey that monitors various health behaviors including tobacco use among adolescents nationwide (Underwood et al., 2020). This study

will focus on data from the 2019 Texas high school YRBS for prevalence reports but will reference previous Texas YRBS data to study relevant trends.

2. Population and Sample

All Texas high school students form the source population for the YRBS survey. A multi-level cluster sampling technique was employed to select participating schools ensuring a representative sample of Texas high school students (Underwood et al., 2020; CDC, 2020a). The sample size for the 2019 survey in Texas was 2032 (CDC, 2020a).

3. Study Variables

The variables of interest include the independent variable, current electronic vapor product use and the dependent variable, current cigarette smoking.

4. Operational Definition of Variables

Current electronic vapor product use refers to the use of e-cigarette products on at least one day during the 30 days before the survey while current cigarette smoking refers to cigarette smoking on at least one day during the 30 days before the survey. Other reported variables include frequent electronic vapor product use, which refers to vaping on 20 or more days during the 30 days before the survey, used to assess the frequency of e-cigarette use. The variables of interest were included in the survey instrument as questions requiring yes or no answers. The number of respondents who answered yes to these questions was divided by the total number of respondents who answered the questions to determine the percentage prevalence.

5. Study Instruments

The study instrument was a standardized self-administered questionnaire. The Texas 2019 YRBS questionnaire contained 99 questions measuring risky behaviors among high school students in the state. Questions were reviewed for formatting and clarity and the questionnaire has been shown to be valid and reliable by several methodological studies (Underwood et al., 2020). Respondents completed the survey in an average of 35 minutes (Texas Health and Human Services [HHS], 2019).

6. Data analysis

Analysis was conducted using the YRBSS online interactive data tool. This tool utilized SAS (version 9.4) and SUDAAN (version 11.0.1) software (Underwood et al., 2020). The pairwise T-test was used to determine the statistical significance of differences in prevalence estimates between two groups (Underwood et al., 2020). The current use of electronic vapor products and current cigarette smoking were cross tabulated and the Wald Chi-Square Test was used to determine the presence of significant association. All differences were considered statistically significant if the p-value for the statistical test was less than 0.05 ($p < 0.05$).

7. Research Ethics

Informed consent was obtained from all participants before taking the survey. Furthermore, respondents could choose not to answer any questions they were not comfortable with. Also, parental permission procedures were followed with active or passive consent obtained from parents depending on the school district (Texas Health and Human Services [HHS], 2019). Lastly, confidentiality was ensured during the research process (HHS, 2019).

RESULTS

Based on Table 1 showed that there was no statistically significant difference in current use of electronic vapor products by sex. However, non-Hispanic White high school students were significantly more likely to report current use of electronic vapor products than Hispanic and non-Hispanic Black adolescents ($p < 0.001$). Hispanic

students were also more likely to report current use of electronic vapor products than non-Hispanic Black students (p= 0.030). The likelihood of reporting electronic vapor product use appeared to increase with high school grades, with 9th graders less likely to report current use than 10th, 11th, and 12th graders. Lastly, bisexual high school students were significantly more likely to report current use of electronic vapor products than heterosexual (straight) students (p= 0.030).

Table 1. Demographic characteristics with survey weighted percentages of high school students that used electronic vapor products on at least one day during the 30 days before the survey, from the high school Youth Risk Behavior Survey, Texas, 2019 (N= 2032).

Variables		Currently use electronic vapor products		p			
		Sample size	Survey-weighted % (95% CI)	0 vs I	I vs II	0 vs II	0 vs III
Sex	Female (0)	878	17.9 (14.4 to 22.2)	0.460			
	Male (I)	792	19.4 (15.3 to 24.2)				
Race/Ethnicity	NH - Black (0)	225	9.8 (6.7 to 14.2)	0.030	<0.001	<0.001	
	Hispanic (I)	924	14.5 (11.4 to 18.5)				
	NH - White (II)	363	30.9 (24.5 to 38.1)				
	Other	119	14.3 (8.2 to 23.7)				
Grade	9th (0)	471	12.9 (9.9 to 16.6)	0.030	0.340	0.030	0.020
	10th (I)	458	19.0 (15.1 to 23.6)				
	11th (II)	356	22.0 (15.6 to 30.2)				
	12th (III)	369	22.1 (15.6 to 30.3)				
Sexual Identity	Heterosexual (0)	1374	17.4 (13.6 to 21.9)	0.240	0.720	0.030	0.360
	Gay or Lesbian (I)	50	26.6 (15.2 to 42.3)				
	Bisexual (II)	140	29.3 (19.5 to 41.5)				
	Not sure (III)	52	12.9 (6.0 to 25.5)				

Note: Non-Hispanic

Based on Table 2 showed that almost one in five respondents reported using electronic vapor products during the 30 days before the survey. This was much higher than the 4.9% of respondents who reported smoking cigarettes during the same time period. In addition, about 6.5% of survey respondents reported using electronic vapor products on 20 or more days during the 30 days before the survey.

Table 2. Survey weighted percentages of high school students that currently and frequently used two types of tobacco products, from the high school Youth Risk Behavior Survey, Texas, 2019 (N= 2032).

Variables	Sample size	Survey-weighted % (95% CI)
Respondents that **currently** use electronic vapor products[a]	1673	18.7 (15.3 to 22.6)
Respondents that **currently** smoke cigarettes[b]	1948	4.9 (3.8 to 6.3)
Respondents that **frequently** use electronic vapor products[b]	1673	6.5 (4.4 to 9.5)
Respondents that **frequently** smoke cigarettes[c]	1948	0.7 (0.3 to 1.4)

[a] Used these products on at least one day during the 30days before the survey
[b] Used this product on 20 or more days during the 30 days before the survey

Bsed on Table 3 showed that there was a gradual decline in the proportion of high school students that reported cigarette smoking between 2011 and 2019. On the other hand, the use of electronic vapor products appears to be increasing.

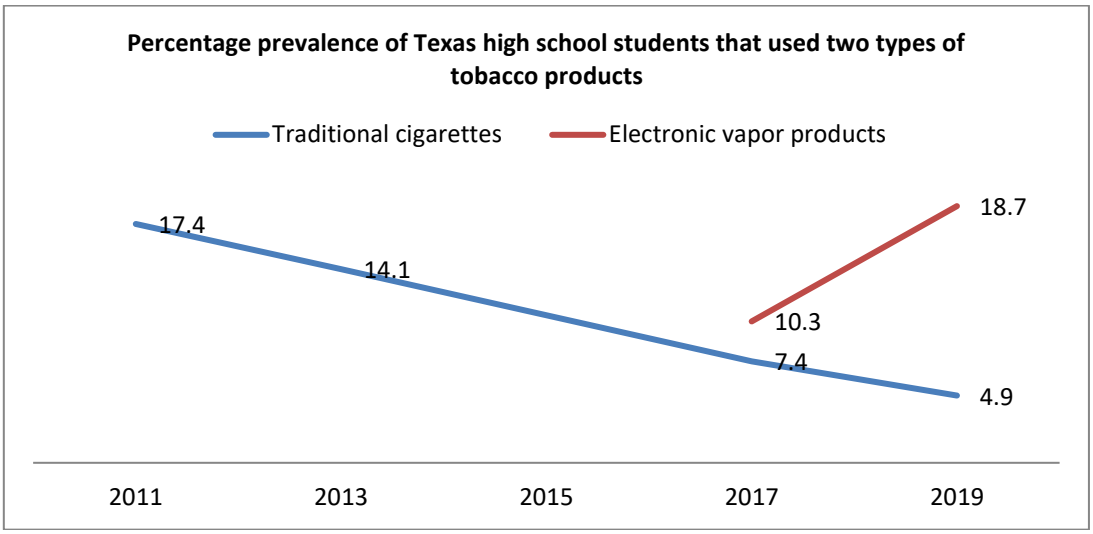

Figure 1. Chart comparing the prevalence of Texas high school students that used two types of tobacco products over time.

Based on Table 3 showed that over 80% of high school students who reported cigarette smoking also used electronic vapor products. Likewise, about one-quarter of students who used electronic vapor products reported cigarette smoking. This association between the use of electronic vapor products and cigarette smoking was statistically significant (OR= 38.87; p < 0.001).

Table 3. Cross Tabulation of 'currently smoke cigarettes' by 'currently use electronic vapor products', from the high school Youth Risk Behavior Survey, Texas, 2019 (N=2032).

		Currently use electronic vapor products[a]		Total
		Yes	No	
Currently smoke cigarettes[a]				
Yes	n	72	12	84
	Row %	N/A	N/A	N/A
	Column %	N/A	N/A	N/A
	% of Total[b]	N/A	N/A	N/A
No	n	207	1341	1548
	Row %	14.3	85.7	100.0
	Column %	73.9	99.1	94.5
	% of Total[b]	13.5	81.0	94.5
Total	n	279	1353	1632
	Row %	18.3	81.7	
	Column %	100.0	100.0	
	% of Total[b]	18.3	81.7	

[a] Used these products on at least one day during the 30 days before the survey
[b] Total percentage (Weighted)
Records excluded – 400
N/A: Less than 100 respondents for the subgroup

Table 4. Bivariate Analysis

Wald Chi Square Statistic	Degrees of Freedom	p
39.15	1	<0.001

DISCUSSION

Cigarette smoking among American high school students has reduced steadily over the last 20 years (CDC, 2020b). Public health initiatives including increased taxing of tobacco companies and the subsequent higher costs of tobacco products, anti-smoking campaigns, community and school-based programs, and increasing the minimum age for procurement of tobacco products have all contributed to this decline (CDC, 2020b). In contrast, the popularity of electronic vapor products has continued to increase, surpassing cigarettes as the most common tobacco products among adolescents (CDC, 2020b). Reporting this association will facilitate conversations about this public health issue and lead to targeted programs and interventions.

The prevalence of electronic vapor product use among Texas high school students according to the 2019 Youth Risk Behavior Survey (YRBS) was almost one in five. This is similar to the figure reported by the Texas Youth Tobacco survey in 2018 (Texas Health and Human Services [HHS], 2021). Alarmingly, national data shows that about one-third of high school students nation-wide use electronic vapor products (CDC, 2019a). It is not clear why Texas reports a much lower prevalence as Texas anti-vaping laws are not more restrictive than other US states (Public Health Law Center, 2021). The trend data from this study aligns with other reports that have documented the increasing popularity of electronic vapor products and reducing cigarette smoking prevalence among high school students (CDC, 2020b). However, YRBS data on electronic vapor product use for Texas is only available for 2017 and 2019; consequently, only two sets of data are available for trend assessment (CDC, 2019b). This is important, as the trend of electronic vapor product use in the United States according to the YRBS recorded a remarkable decline between 2015 and 2017, before increasing significantly between 2017 and 2019 (CDC, 2019c). Data from the 2014 Texas Youth Tobacco survey reported that 14% of high school students were current users of electronic vapor products (Cooper et al., 2015). This suggests that the Texas trend for electronic cigarette use might be similar to that reported for the United States. It is therefore important to investigate the potential causes of the decline in electronic vapor product use between 2015 and 2017, as this might inform future public health interventions.

This study also reported a positive association between the use of electronic vapor products and cigarette smoking. However, the direction of causality is difficult to determine in this analysis of cross-sectional data. This study is also vulnerable to other weaknesses of cross-sectional surveys. Consequently, it is also difficult to make inferences about the relationship between the declining prevalence of cigarette smoking and the rising popularity of electronic vapor products among high school students. Furthermore, parental permission is obtained before administration of the survey (HHS, 2019). The consent collection procedure varies, depending on the school or district and consent may be passive or active (HHS, 2019).

As a result, it is not clear if the high school students were aware of this process as parental involvement may affect disclosure of socially undesirable behaviors, like tobacco use (Tokic & Pecnik, 2011). This is a potential threat to the validity of this data. Also, studies have shown that students who skip school frequently may be more likely to smoke cigarettes or use electronic vapor products (Perelman et al., 2019). Selection bias could have been introduced by the potential exclusion of

these groups of students. The Texas YRBS also excludes private high schools, another potential source of selection bias (HHS, 2019). Lastly, the overall response rate for the 2019 Texas survey was 54%, less than the CDC minimum requirement of 60% (CDC, 2020a). Thus, non-response bias is another potential limitation of this data.

The high prevalence of vaping among Texas high school students is a call to action. Halting the upward trend of e-cigarette use is a priority as these products predispose adolescents to significant morbidity.

AUTHOR CONTRIBUTION

JO conceptualized the paper, analyzed and interpreted the data, and also drafted and revised the article.

FUNDING AND SPONSORSHIP

None.

CONFLICT OF INTEREST

There are no conflicts of interests.

ACKBOWLEDGMENT

The author would like to thank the thousands of Texas adolescents who participate in the YRBS survey process biennially for the unique insight that they provide.

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