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E-cigarette Use among Texas Youth: Results from the 2014 Texas Youth Tobacco Survey

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Abstract

Introduction—Several characteristics of electronic cigarettes (e-cigarettes), such as candy flavorings, are worrisome for attracting youth. The current cross-sectional study uses data on e-cigarette use from the 2014 Texas Youth Tobacco Survey (TYTS), a representative statewide sample of Texas middle school and high school students. This study's aims are to determine the prevalence of e-cigarette use, including rates of concurrent use with other tobacco products among Texas youth and to describe the demographic and tobacco use differences between e-cigarette users and non-users.

Methods—Participants were 13,602 6th through 12th grade students in Texas. Descriptive statistics were generated to determine the prevalence of current and lifetime e-cigarette use and to determine the prevalence of demographic characteristics across e-cigarette usage groups. Logistic regression analyses were conducted to examine differences in demographic characteristics, cigarette use in the home, and tobacco use behaviors for e-cigarette users versus non-users.

Results—Almost one quarter of all middle and high school students reported lifetime e-cigarette use and 14.0% were past 30-day users of these products. Current e-cigarette users were more likely to be high school students, white and male than non-current users. Both current and lifetime e-cigarette users were also more likely than their peers to use other tobacco products, although 24.2% of current e-cigarette users had never smoked conventional cigarettes, and 7.3% had never used any other type of tobacco product besides an e-cigarette.

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Contributors

All authors contributed to the study's concept and design. MC conducted literature searches and provided summaries of previous research studies. KC conducted the statistical analysis. MC and KC wrote the first draft of the manuscript and all authors contributed to and have approved the final manuscript.

Conflict of Interest

None of the authors has any competing interests.

Conclusions—Findings highlight the urgency to regulate e-cigarettes as well as to include these products in tobacco prevention programs.

Keywords

alternative tobacco products; adolescents; tobacco use; electronic cigarettes

1. Introduction

Electronic cigarettes (e-cigarettes) are novel nicotine delivery devices for which awareness and use are rapidly rising among all age groups.¹⁻³ These new and emerging tobacco products, currently unregulated by the United States (U.S.) Food and Drug Administration (FDA), have neither been determined as safe in general nor as effective for smoking cessation.⁴ Nevertheless, they are frequently marketed as both.^{5,6} Marketing and promotional campaigns feature cartoons, celebrity spokespersonship and sexual appeal, presenting a concern for increasing youth initiation. Other e-cigarette characteristics such as flavorings like grape and piña colada are also worrisome for attracting youth. Of particular concern is the concept of e-cigarettes as “starter products” that pave the way for conventional tobacco product use.⁷

Two national surveys have documented a rising trend in e-cigarette use among youth. The National Youth Tobacco Survey (NYTS) found that rates of ever use and current use have increased significantly between 2011 to 2014 among 6th through 12th graders, with the most dramatic increase occurring between 2013 to 2014.⁸ In fact, in 2014, according to NYTS, e-cigarettes became the most commonly used tobacco product among middle (3.9%) and high (13.4%) school students.⁸ The Monitoring the Future study estimated that, in 2014, 8.7% of 8th graders, 16.2% of 10th graders and 17.1% of 12th graders had used e-cigarettes in the past 30 days.⁹ National data are important for understanding general trends in e-cigarette use. But, differences across states in population demographics and in state-specific laws require examination of e-cigarette use within states, particularly those that do not have laws regarding youth e-cigarette use, such as Texas.

Texas represents a unique backdrop to understand tobacco product use among youth. Children under the age of 18 in Texas represent 9.5% of all U.S. children.¹⁰ The state is highly diverse as Hispanic children outnumber children of all other racial and ethnic groups.¹⁰ Additionally, Texas is not among the 40 U.S. states that, as of November 2014, have enacted statewide laws to prohibit e-cigarettes sales to minors.¹¹ The current cross-sectional study uses data on e-cigarette use from the 2014 Texas Youth Tobacco Survey (TYTS), a representative statewide sample of Texas middle school and high school students. This study offers a portrait of youth e-cigarette users, including concurrent use with other tobacco products. This study's aims are to 1) determine the prevalence of e-cigarette use, including rates of concurrent use with other tobacco products among Texas youth and 2) describe the demographic and tobacco use differences between e-cigarette current users and non-users. Based on previous research examining the correlates of e-cigarette use in youth,^{12,13} we hypothesize that e-cigarette use will be higher among students who are in high school, white, male and have a family member who smokes conventional cigarettes.

Given that approximately half of adolescents who use tobacco are dual or multiple product users,¹⁴ we also hypothesize that students who used e-cigarettes in the past 30 days or in their lifetime will be more likely than those who have not used e-cigarettes to have used other tobacco products.

2. Methods

2.1 Participants

Participants were 13,602 6th through 12th grade students attending 69 public schools in 27 counties in Texas; 49.9% were female; 43.9% were non-Hispanic white, 5.8% were African-American, 41.1% were Hispanic, and 9.2% reported another ethnicity. The age range of the participants was 11 to 18, with a mean age of 14.49 (sd=1.98). Among all students, 36.9% reported that someone in their home currently smokes conventional cigarettes.

2.2 Procedure

Data were drawn from the 2014 TYTS, which sampled students from public school districts across the state. Recruitment of schools occurred in one of two ways: 1) school districts in 12 “coalition” counties involved in a state-funded tobacco prevention and control project were recruited to participate in the study; of the 65 school districts in these counties, 23 participated ($n=52$ schools); and 2) proportional probability sampling, whereby recruitment probability is proportionate to size of the school, was used to recruit an additional 17 schools from 15 additional counties. Of the participating counties, 44% were rural and 56% were urban. The overall school response rate was 25%, while student participation rate was 87%. In spring 2014, 13,602 students voluntarily completed the 38-item anonymous survey, either via paper- pencil ($n=59$ schools) or online ($n=10$ schools), in their classrooms during class time.

2.3 Measures

Gender, school level, and race/ethnicity served as demographic variables in the analyses. Dummy variables were created for gender (0=female, 1=male) and school level (0=middle school, 1= high school). To examine differences in the racial/ethnic characteristics of current e-cigarette users versus non-users, four dummy variables were created corresponding to the four different race/ethnic categories: white (0=non-white, 1=white), black (0=non-black, 1=black), Hispanic (0=non-Hispanic, 1=Hispanic), and other race (0=non-other race, 1=other race). In addition, cigarette use in the home was also included as a variable in the analyses; cigarette use in the home was measured using the item, “Besides yourself, does anyone who lives in your home smoke cigarettes now?” A dummy variable for home cigarette use was created (0=no, 1=yes).

The item regarding current e-cigarette use asked, “During the past 30 days, on how many days did you use electronic cigarettes or e-cigarettes, such as Ruyan or NJOY?” Current e-cigarette use was operationalized using a dummy variable; students reporting at least one day of e-cigarette use in the past 30 days were classified as current users, while those reporting zero days of e-cigarette use in the past 30 days were classified as non-current users (0=non-current users, 1=current e-cigarette users). Non-current users were individuals who

had not used e-cigarettes in the past 30 days and included students who had ever tried e-cigarettes. The item regarding lifetime e-cigarette use asked, “Have you ever tried using electronic cigarettes or e-cigarettes, such as Ruyan or NJOY?” Lifetime e-cigarette use was also operationalized using a dummy variable; participants who responded “yes” were classified as lifetime users, while those responding “no” were classified as non-users (0=non-users, 1=lifetime user).

Current and lifetime use of other tobacco products including conventional cigarettes, chew, snus, hookah, flavored tobacco, and any tobacco products were also analyzed. For each of the tobacco products, students reporting at least one day of other tobacco product use in the past 30 days were classified as current users, and those who reported ever using a tobacco product were classified as lifetime users. For any tobacco use, participants who reported past 30-day use of one or more tobacco products, excluding e-cigarettes, were considered current users of any tobacco product. Similarly, participants who reported ever use of one or more tobacco products, excluding e-cigarettes, were considered lifetime users of any tobacco product. Similar to the procedures described above, dummy variables were created for each tobacco product for both current and lifetime use.

2.4 Data Analysis

STATA 13.1 (College Station, TX) was used for all analyses. First, descriptive statistics using the STATA tabulate command were conducted to examine the prevalence of current and lifetime e-cigarette use, as well as the prevalence of demographic characteristics for the total sample, current e-cigarette users, and non-current e-cigarette users. Logistic regression models were conducted to examine differences in demographic characteristics for current e-cigarette versus non-current users, with demographic characteristics serving as the dependent variables and current e-cigarette use as the independent variable. Separate models were conducted for each dependent variable. Next, to examine differences in the home cigarette use and tobacco use characteristics of current e-cigarette users versus non-users, multivariable logistic regression analyses were conducted, adjusting for sex, school level, and race/ethnicity. Separate models were conducted for each of the different tobacco use behaviors, as well as for home cigarette use; since the dependent variables were dichotomized using dummy variables, the regression estimates approximate the prevalence of the characteristics among current e-cigarette users as compared to non-current users (see Table 1). This procedure was repeated to examine differences in home cigarette use and tobacco use characteristics of lifetime e-cigarette users versus non-users (see Table 2). State sampling weights were used in all of the models, and school level clustering was accounted for by including schools as the cluster variable in the logistic regression models. While the overall sample size was 13,602, the sample sizes varied for each model due to missing data, which ranged from 0.8% to 2.3% for the included variables.

3. Results

Overall, 14.0% of middle school and high school students reported current use of e-cigarettes, and 23.6% reported lifetime use. Sample characteristics and differences in demographic characteristics and tobacco use behaviors between current and non-current

users are presented in Table 1. A higher prevalence of current e-cigarette use was observed in students who were male, non-Hispanic white, in high school and had someone in their home who currently smoked conventional cigarettes. Seventy-four percent of current e-cigarette users were high school students, compared to 51.3% of non-current e-cigarette users. Current e-cigarette users were significantly more likely than non-current users to report current and lifetime use of conventional cigarettes, chew, snus, hookah, flavored tobacco, as well as any tobacco products ($p<.001$ for all analyses). Among current e-cigarette users, 48.9% reported current cigarette use, compared to 4.7% of non-current e-cigarette users. Ninety-three percent of current e-cigarette users reported lifetime use of any tobacco product, compared to 22.5% of non-current e-cigarette users. Table 2 displays differences in tobacco use behaviors between lifetime e-cigarette users and non-users. Lifetime e-cigarette users were also significantly more likely than non-users to report current and lifetime use of conventional cigarettes, chew, snus, hookah, flavored tobacco, and any tobacco products ($p<.001$ for all analyses).

4. Discussion

This study contributes to the limited evidence indicating that e-cigarette use is increasing among adolescents, and varying statewide restrictions on e-cigarettes may contribute to differences across states. Results from the 2014 TYTS indicate that almost one quarter of all middle and high school students reported lifetime e-cigarette use and 14.0% were past 30-day users of these products. Current e-cigarette users were more likely to be white, male and older than non-current users. While the majority of e-cigarette users were in high school, approximately one quarter were in middle school. In addition, current e-cigarette users were also more likely than their peers to use other tobacco products, although 24.2% of current e-cigarette users had never smoked conventional cigarettes, and 7.3% had never used any other type of tobacco product besides an e-cigarette. Findings provide evidence for the changing landscape of tobacco product use among adolescents and underscore the need for additional research examining predictors of use.

Prior studies indicate that rates of dual and poly tobacco product use are on the rise for youth.² The current study is consistent with previous evidence and demonstrates that current e-cigarette users were significantly more likely to be current users of other tobacco products, though the rate of dual use among current e-cigarette users with conventional cigarettes (48.9%) was lower than estimates from the NYTS (76.3%).³ E-cigarette users were also significantly more likely to be current users of tobacco products other than conventional cigarettes as compared to non-current users. Twenty nine percent of users were also current users of chew, 24.5% were current users of snus, and 50.3% were current users of hookah. Results reported from the 2012 NYTS showed similar patterns: e-cigarette use was much higher among users of both conventional and non-conventional tobacco products.² These patterns of dual use warrant attention as previous research suggests an additive and perhaps synergistic effect of using more than one tobacco product. One study demonstrated that concomitant use of cigarettes and smokeless tobacco exposed users to higher levels of nicotine, and dual users were less likely to stop using tobacco than users of single products.¹⁵

Importantly, this study documents the highest prevalence of current e-cigarette use among adolescents compared to previously reported estimates in other states—Hawaii, Connecticut and Minnesota—in 2013 and 2014.^{16, 17, 12} In fact, 2014 Texas estimates (19.1% for high school students and 7.9% for middle school students) are higher than nationwide estimates from Monitoring the Future and NYTS.^{8, 9} These higher than expected rates may be in part due to the fact that Texas receives the highest amount of tobacco industry marketing funds than any other state,¹⁸ and ranks 40th among all states for its funding of tobacco control activities.¹⁹

It is particularly noteworthy that current e-cigarette use in the TYTS was higher than current conventional cigarette use (11.7%), a finding that is consistent with three other surveys conducted in 2014.^{17, 8, 9} Trends in e-cigarette use are rising in parallel with nationwide e-cigarette marketing efforts. In the U.S., youth exposure to television e-cigarette advertisements increased 256% from 2011 to 2013,²⁰ and spending for advertisements in magazines, television, newspapers and the internet has increased almost three-fold between 2011 to 2012.²¹

This study is the first to demonstrate that trying flavored tobacco products is linked to current e-cigarette use. Sixty-two percent of current e-cigarette users indicated that they had ever tried flavored tobacco products as compared to only 9.3% of non-current users. This finding extends previous research showing similar patterns between flavored products and conventional cigarette use. A recent study of adolescents in New York city found an association between trying a flavored tobacco product and current cigarette smoking.²²

Another notable finding of the present study is that almost one quarter of current e-cigarette users had never smoked a conventional cigarette. As such, in 2014 an estimated 293,206 middle school and high school students in Texas had used an e-cigarette in the past 30 days but had never smoked a cigarette. Recent research indicates that e-cigarettes may not be harmless as their vapor contains toxins such as carbonyl compounds, volatile organic compounds, and nitrosamines, albeit at lower levels than conventional cigarettes.^{23, 24} Other research has demonstrated that nicotine alone may have deleterious effects on the developing brain.²⁵ Thus, there is an emerging consensus that the healthiest option, especially for youth, is abstaining from all tobacco and nicotine products.²⁶⁻²⁸

This study has several limitations. First, the sample was limited to Texas students and may not necessarily be generalizable to other populations. Second, the study's design is cross-sectional, which prohibits making causal inferences or understanding the directionality of relationships. Finally, the question on flavored tobacco products does not make a distinction between type of product. Therefore, it is unclear whether respondents consider e-cigarettes to be a tobacco product.

4.1 Conclusions

Notwithstanding the limitations, this study has implications for prevention, for regulation of e-cigarettes by the FDA, and for future research. First, findings from this study emphasize the need to include e-cigarettes in tobacco prevention programs for adolescents, including early intervention efforts given that one quarter of current users were in middle school. In

addition, findings highlight the urgency to implement regulations restricting sales to minors, some of whom are being introduced to nicotine through e-cigarettes. The findings also underscore the importance of regulating the advertising and promotion of e-cigarettes, which often include cartoons, celebrity spokespersonship, and other features that are appealing to youth. Additional research is needed to understand the link between flavored products on tobacco product initiation in this population.

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Highlights

- We analyze current e-cigarette use in the 2014 Texas Youth Tobacco Survey.
- Texas does not have a statewide law prohibiting e-cigarette sales to minors.
- We document the highest prevalence of e-cigarette use among youth to date.
- We found that 20.7% of current e-cigarette users had never smoked cigarettes.
- Almost 7% of e-cigarette users never used any other type of tobacco product.

Sample Characteristics and Differences between Current E-cigarette Users and Non-Current Users - 2014 Texas Youth Tobacco Youth Survey

Table 1

	Total Sample (<i>n</i> = 13602)	Current E-cigarette Users (<i>n</i> = 1402)		Non-current Users ^{<i>a</i>} (<i>n</i> =11923)		<i>p</i> [†]
	Percentage (95% CI)	Percentage (95% CI)		Percentage (95% CI)		
Sex						
% Male	49.92 (46.45, 53.38)	61.17 (51.51, 70.02)		48.32 (44.56, 52.10)		<.001
% Female	50.08 (46.62, 53.55)	38.83 (29.98, 48.49)		51.68 (47.90, 55.44)		<.001
Grade						
% Middle School	45.75 (42.51, 49.02)	25.60 (19.66, 32.62)		48.73 (45.05, 52.43)		<.001
% High School	54.25 (50.98, 57.49)	74.40 (67.38, 80.34)		51.27 (47.57, 54.95)		<.001
Race/Ethnicity						
% White	43.91 (40.49, 47.4)	53.17 (43.74, 62.37)		42.36 (38.64, 46.16)		<.001
% Black	5.81 (4.28, 7.84)	2.10 (1.16, 3.79)		6.53 (4.74, 8.93)		>.05
% Hispanic	41.12 (37.83, 44.5)	30.81 (23.32, 39.47)		42.65 (39.01, 46.47)		<.01
% Other	9.16 (7.27, 11.46)	13.91 (7.73, 23.77)		8.47 (6.6, 10.81)		>.05
Cigarette use in the home [‡]						
% Yes	36.92 (33.52, 40.46)	48.92 (36.53, 61.31)		34.91 (31.46, 38.37)		<.001
% No	63.08 (59.54, 66.48)	51.08 (38.68, 63.46)		65.08 (61.62, 68.53)		<.001
Tobacco Use Behaviors [‡]						
Current Use						
% E-cigarette	13.98 (11.72, 16.60)	---		---		<.001
% Cigarette	11.7 (9.65, 14.12)	48.89 (41.86, 55.91)		4.72 (3.79, 5.64)		<.001
% Chew	8.55 (6.73, 10.81)	28.84 (24.70, 32.99)		3.98 (3.31, 4.66)		<.001
% Snus	5.17 (3.73, 7.12)	24.50 (17.86, 31.14)		1.14 (0.71, 1.57)		<.001
% Hookah	9.17 (7.25, 11.53)	50.33 (40.84, 59.82)		2.54 (1.73, 3.34)		<.001
% Flavored tobacco ^{<i>b</i>}	10.08 (8.13, 12.43)	50.49 (46.26, 54.73)		3.32 (2.70, 3.94)		<.001
% Any tobacco	21.17 (18.5, 24.13)	77.25 (72.22, 82.29)		8.48 (7.63, 9.34)		<.001

	Total Sample (<i>n</i> = 13602)	Current E-cigarette Users (<i>n</i> = 1402)	Non-current Users ^a (<i>n</i> =11923)	<i>p</i> [†]
	Percentage (95% CI)	Percentage (95% CI)	Percentage (95% CI)	
Lifetime Use				
% E-cigarette	23.62 (20.73, 26.77)	---	---	<.001
% Cigarette	25.51 (22.71, 28.52)	75.81 (66.99, 84.63)	16.62 (14.44, 18.80)	<.001
% Chew	14.37 (12.12, 16.96)	36.64 (31.48, 41.79)	9.35 (8.18, 10.52)	<.001
% Snus	8.98 (7.15, 11.22)	31.09 (24.95, 37.23)	4.25 (3.13, 5.37)	<.001
% Hookah	14.04 (11.71, 16.75)	54.48 (46.51, 62.44)	6.72 (5.39, 8.04)	<.001
% Flavored tobacco ^c	17.22 (14.73, 20.04)	61.92 (57.98, 65.85)	9.32 (8.70, 9.94)	<.001
% Any tobacco	33.87 (30.72, 37.16)	92.70 (89.47, 95.93)	22.47 (19.44, 25.49)	<.001

[†] P-value corresponds to differences between current e-cigarette users and non-current users

[‡] Current e-cigarette and non-current percentage adjusted for sex, grade, race/ethnicity

^d Non-current users includes users who have ever tried e-cigarettes

^b Current flavored tobacco product use was defined as using a tobacco product that was flavored on any day in the past 30 days

^c Lifetime flavored tobacco product use was defined as ever trying a tobacco product that was flavored

Table 2

Difference between E-cigarette Lifetime Users and Non- Users, by Tobacco Use Behaviors, Adjusting for Gender, Grade Level, and Race/Ethnicity – 2014 Texas Youth Tobacco Survey

	E-cigarette Lifetime Users ^a (n = 2519)	Non-Users (n = 10806)	p
	Percentage (95% CI)	Percentage (95% CI)	
Tobacco Use Behavior			
Current Use			
% Cigarette	38.82 (33.54, 44.11)	2.38 (1.80, 2.95)	<.001
% Chew	25.09 (20.63, 29.56)	1.59 (0.79, 2.39)	<.001
% Snus	15.72 (11.93, 19.51)	0.85 (0.56, 1.15)	<.001
% Hookah	31.59 (25.99, 37.19)	2.11 (1.36, 2.86)	<.001
% Flavored ^b	34.27 (29.64, 38.90)	2.38 (1.47, 3.28)	<.001
% Any tobacco	60.99 (55.18, 66.80)	4.70 (3.59, 5.81)	<.001
Lifetime Use			
% Cigarette	74.74 (70.47, 79.02)	9.57 (7.03, 12.10)	<.001
% Chew	38.08 (32.91, 43.25)	4.84 (3.45, 6.24)	<.001
% Snus	28.08 (24.45, 31.72)	1.46 (0.88, 2.04)	<.001
% Hookah	45.28 (39.45, 51.11)	3.36 (2.60, 4.12)	<.001
% Flavored ^c	56.98 (52.19, 61.77)	4.15 (3.35, 4.96)	<.001
% Any tobacco	93.04 (89.66, 96.42)	13.54 (9.83, 17.26)	<.001

^a Lifetime users included individuals who were current e-cigarette users

^b Current flavored tobacco product use was defined as using a tobacco product that was flavored on any day in the past 30 days

^c Lifetime flavored tobacco product use was defined as ever trying a tobacco product that was flavored