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Sources of electronic cigarette acquisition among adolescents in Connecticut

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Abstract

Objectives—We examined sources of e-cigarette acquisition among youth, and changes in these sources, between 2014 and 2015. We also assessed whether youth were ever refused the sale of e-cigarettes.

Methods—Anonymous, cross-sectional surveys conducted in five high schools in 2014 and 2015 in Connecticut assessed demographics, e-cigarette and cigarette use, and e-cigarette acquisition sources (friends/boyfriends/girlfriends, tobacco shops, siblings, online, parents/adult family members, other). We restricted analyses to adolescents younger than 18 years old who had used e-cigarettes in the past month (2014: N = 400, 2015: N = 390).

Results—Top sources of e-cigarette acquisition were friends (2014: 50.2%, 2015: 45.4%), tobacco shops (2014: 17.5%, 2015: 12.6%), and online shops (2014: 9.8%, 2015: 10.5%). A multilevel model, controlling for sex, age, and cigarette smoking status, while clustering by schools showed a decrease in the proportion of youth obtaining e-cigarettes from friends (AOR = .84) between 2014 and 2015. In 2015, 69.8% and 85.8% purchased e-cigarettes from a physical store and an online store, respectively.

Conclusions—Peers were the most popular source of e-cigarette acquisition. Many adolescents were able to purchase e-cigarettes from commercial sources. Future studies should continue to conduct surveillance of where adolescents obtain e-cigarettes to inform prevention strategies.

Human Subjects Statement

The Yale IRB and the participating schools approved all study procedures (Yale HIC protocol# 1207010580).

Conflict of Interest Statement

All authors of this article declare they have no conflicts of interest.

Keywords

electronic cigarettes; adolescents; youth; regulation; policy; prevention

INTRODUCTION

Electronic cigarette (e-cigarette) use among youth is high.¹ For the first time in history, the prevalence of past month e-cigarette use among U.S. adolescents has surpassed cigarette smoking.^{1,2} Among U.S. 12th graders, 17% report past-30-day use of e-cigarettes, while only 14% report cigarette smoking.² E-cigarettes are popular even among youth who have never tried combustible tobacco products.^{3,4} Between 2011 and 2013, e-cigarette use among youth who had never smoked a cigarette increased three-fold from 79,000 to 263,000.⁴ Moreover, a recent study showed that initiating with e-cigarettes encouraged youth to initiate use of combustible tobacco products.⁵

There is considerable public health debate surrounding e-cigarettes. Some public health experts believe that e-cigarettes could undermine the advances made in tobacco control by promoting initiation of tobacco use among youth and nicotine addiction.^{6,7} This is concerning because nicotine is addictive and has deleterious effects on the adolescent brain.⁸ However, others believe that e-cigarettes are a safer alternative to combustible tobacco products.⁹ Despite these differing views, concerted effort is needed to prevent youth from exposure to nicotine and addiction through the use of e-cigarettes.

The FDA issued a new federal rule in May 2016 banning the sale of e-cigarettes to minors under 18 years old. This rule goes into effect on August 8, 2016.¹⁰ Prior to this rule, many states and local municipalities have passed laws that prohibit the sale of e-cigarettes to minors starting from 2010. By December 2015, the sale of e-cigarettes to minors was prohibited in 48 states and 2 territories.¹¹ In spite of these laws, rates of e-cigarette use remain high, suggesting that examination of where youth are obtaining e-cigarettes is warranted. However, no published studies to our knowledge have examined enforcement of these laws or where underage minors obtain e-cigarettes. Similar to cigarettes, minors could be obtaining e-cigarettes from non-commercial sources (ie, social sources), such as their peers or relatives,^{12,13} or they could be purchasing e-cigarettes from local or online stores (ie, commercial sources).¹⁴ A better understanding of youth e-cigarette acquisition sources is critical to inform regulatory efforts to limit youth access to e-cigarettes.

This study examined the rates of obtaining e-cigarettes from commercial sources (eg, tobacco shops, online shops) and social sources (eg, friends, parents, siblings) among underage e-cigarette users. Importantly, our evidence was collected before and after the law prohibiting the sale of e-cigarettes to minors was passed in Connecticut on October 1, 2014.^{11,15} This allowed us to examine if the presence of the law changed where underage minors were obtaining e-cigarettes. In 2015 (after the law was passed), we also examined whether adolescents who tried to purchase e-cigarettes from physical or online stores were refused sale of these products.

We hypothesized that there would be an increase in the proportion of e-cigarette users obtaining e-cigarettes from social sources (eg, peers, family members) and a decrease in the proportion of users obtaining e-cigarettes from commercial sources (eg, tobacco shops, online shops) after the law prohibiting the sale of e-cigarettes to minors was enacted in Connecticut. When examining changes in e-cigarette acquisition sources, we included sex, past-30-day cigarette smoking, and age as covariates. We examined sex differences based on evidence that girls are more likely to obtain cigarettes from social sources,¹² and therefore, they also may be more likely to obtain e-cigarettes from social sources. We examined past-30-day cigarette smoking because adolescent smokers who are able to purchase cigarettes illegally also may be more successful at bypassing the law prohibiting the sale of e-cigarettes to minors. Finally, we examined age because students who appear old enough to purchase the products legally may have more success in bypassing underage e-cigarette sale restrictions.

METHODS

Procedures/Participants

The data for this study were derived from a larger study of anonymous school-based surveys to assess e-cigarette use and perceptions among adolescents. In the current study, we examined survey data collected from five high schools (HSs) in southeastern Connecticut in 2014 (N = 4014) and in 2015 (N = 5595) to assess whether sources of e-cigarette acquisition changed over time.

We restricted the sample to students who were younger than 18 years old (2014 N = 3430, 2015 N = 3399). See Table 1 for the demographic and cigarette and e-cigarette use status of the analytic sample.

The Institutional Review Board of Yale University, the local school administrators, and the participating schools approved all study procedures. Upon obtaining passive parental permission, we administered paper-and-pencil surveys during advisories/homerooms. Survey response rates based on attendance on the days of survey administration were 79.2% in 2014 and 83.8% in 2015. Teachers distributed the surveys and informed the students that participation was voluntary and anonymous. This information also was included on the first page of the surveys. Research staff was available at each school during the survey administration to answer questions.

Measures

We assessed demographic information, e-cigarette and cigarette use, and sources of e-cigarette acquisition in 2014 and 2015. We assessed cigarette smoking by asking the question, "During the past 30 days, how many did you smoke a cigarette?" and e-cigarette use by asking the question, "How many days out of the past 30 days did you use an e-cigarette?" Participants were classified as past-30-day e-cigarette and/or cigarette users if they endorsed using e-cigarettes and/or cigarettes at least 1 out of the past 30 days, respectively.

Sources of e-cigarette acquisition were assessed with the following question: “Where do you usually get an e-cigarette?” Participants were told to select as many options as were applicable from the following options: “friends,” “boyfriends/girlfriends,” “parents, adult family members,” “brother/sister/cousin,” “online shops,” “tobacco shops,” and “other.” In the 2015 survey, we added “vape shops” as a response option.

We assessed if youth were refused sale of e-cigarettes from a physical store or an online store, in 2015 only, using two separate questions: “Did anyone ever refuse to sell you an e-cigarette from a store (eg, gas station)?” and “Did anyone ever refuse to sell you an e-cigarette from an online store (eg, an e-cigarette website)?” The response options for each question were “yes,” “no,” and “I did not try to buy an e-cigarette from a store/an online store.”

Data Analyses

To assess whether sources of e-cigarette acquisition changed between 2014 and 2015, we ran multilevel models using Mplus 7.0,¹⁶ with each source of e-cigarettes as a separate dependent variable (ie, friends, boyfriends/girlfriends, parents/adult family members, brothers/sisters/cousins, online shops, tobacco shops, other), school as a cluster variable, and year (2014 vs. 2015), sex, age, and past-30-day cigarette smoking as independent variables. We applied a Bonferroni correction for multiple comparisons and considered $p < .008$ statistically significant.

RESULTS

Table 1 presents demographic information as well as past-30-day e-cigarette and cigarette use rates in 2014 and in 2015. Overall, past-30-day e-cigarette users were 45.4% girls, 9.2% 14 years old, 28.0% 15 years old, 31.1% 16 years old, 31.6% 17 years old, and 35.3% past-30-day cigarette smokers. We did not observe any differences in e-cigarette use rates by sex ($X^2(1, 783) = .05, p = .88$), age ($X^2(1, 790) = 2.34, p = .51$), or past-30-day smoking ($X^2(1, 790) = .73, p = .39$), between 2014 and 2015.

Among past-30-day e-cigarette users (2014: $N = 400$; 2015: $N = 390$), the top three sources of e-cigarette acquisition in both years were friends/boyfriends/girlfriends (2014: 50.2%, 2015: 45.4%), tobacco shops (2014: 12.7%, 2015: 9.4%), and online stores (2014: 6.4%, 2015: 8.0%). See Figure 1 for the rates of endorsement of all e-cigarette sources.

When examining changes in sources between 2014 and 2015, we observed a significant difference only in rates of acquiring e-cigarettes from friends/boyfriends/girlfriends ($AOR = .84$); specifically, adolescents were less likely to endorse obtaining e-cigarettes from friends/boyfriends/girlfriends in 2015 than in 2014 (See Figure 1 for rates). When examining sex differences, girls were more likely to obtain e-cigarettes from friends ($AOR = 2.59$) and less likely to obtain e-cigarettes online ($AOR = .45$) or from other sources ($AOR = .32$), when compared with boys. When examining age and cigarette smoking differences, older adolescents were more likely to obtain e-cigarettes from tobacco shops ($AOR = 1.66$), and past month cigarette smokers were more likely to obtain e-cigarettes from parent/adult family members ($AOR = 3.21$), online ($AOR = 3.13$), tobacco shops ($AOR = 2.48$) and other

sources (AOR = 2.37). See Table 2 for the adjusted odds ratios and 95% confidence intervals of predictors for each sources of e-cigarette acquisition.

Among adolescents who used an e-cigarette in the past 30 days, 38.7% (N = 151) reported that they tried to purchase an e-cigarette from a physical store and only 30.5% of these adolescents were refused sale of e-cigarettes. Among the 29% (N = 113) of adolescents who tried to purchase an e-cigarette from an online store, only 14.2% were refused sale. We conducted exploratory analyses to examine sources of e-cigarette acquisition among e-cigarette users reported that they had never tried to purchase an e-cigarette from either a physical or online store (N = 182), and observed that 56.6% obtained e-cigarettes from their friends/boyfriends/girlfriends, 11.5% from siblings/cousins, 6.6% from family members, 3.8% from vape shops, 2.7% from “other” sources, and 1.6% from tobacco shops.

DISCUSSION

To the best of our knowledge, this is the first study to examine the sources of e-cigarette acquisition among underage high-school adolescent e-cigarette users over a one-year period (2014–2015). We also assessed whether adolescents were ever refused sale of an e-cigarette from online or physical stores. Of note, we examined e-cigarette acquisition behaviors before and after the passing of a law prohibiting the sale of e-cigarettes to minors in Connecticut on October 1, 2014.

Contrary to our hypothesis, the rates of e-cigarette acquisition from commercial sources did not decrease between 2014 and 2015. In fact, we did not detect any changes in the sources of e-cigarette acquisition, with the exception of fewer adolescents reporting that they obtained e-cigarettes from their peers in 2015 when compared with 2014. The lack of change in e-cigarette acquisition from commercial sources may suggest that compliance with the sales restriction law may be limited. This conclusion is supported further by the finding that a large portion of underage adolescent e-cigarette users reported that they were not refused sale of e-cigarettes from physical (approximately 70%) or online stores (approximately 86%). However, these findings should be interpreted with caution because we did not specifically query adolescents on whether their purchase behaviors were influenced by the passing of the law. Nevertheless, our results are consistent with findings from North Carolina that showed that 93.7% of minors who tried to purchase an e-cigarette online were successful.¹⁷

The finding that very few adolescents were refused the sale of e-cigarettes online is concerning because of the growing presence of online domestic and international e-cigarette vendors.¹⁸ The use of online shops may become even more popular for minors as states begin to enforce compliance with underage access restriction laws. An evaluation of the current online age verification system used by e-cigarette vendors suggests bypassing this system is easy; 61.4% of online e-cigarettes vendors had a simple age verification process that required users to click a pop-up indicating that they are 18 years old or older while 35% of online e-cigarette vendors did not have any age verification system.¹⁸ Furthermore, 70% of online e-cigarette vendors used social networking services to market and promote e-cigarettes,¹⁸ which could target many adolescents who use online social networking.¹⁹ In

our study, the third highest source of e-cigarette acquisition was online stores, and about 10% of adolescent e-cigarette users reported that online stores are where they usually obtain their e-cigarettes.

Our data also indicate that cigarette-smoking youth were more likely to obtain e-cigarettes from commercial sources like online and tobacco shops than were non-smoking youth. Perhaps cigarette-smoking youth are more knowledgeable about how to bypass underage restrictions of sale of all tobacco products, including e-cigarettes. Given that we do not know the health consequences of e-cigarettes or the utility of e-cigarettes for smoking cessation/harm reduction, more effective methods of restricting the sale of e-cigarettes to even cigarette smoking minors are needed.

While enforcement of the law restricting youth access to e-cigarettes via commercial sources is needed, non-commercial sources of e-cigarette acquisitions also need to be better understood. Our data showed that peers were the most commonly reported source of e-cigarette acquisition in both 2014 and 2015. This finding is not surprising given the strong empirical evidence demonstrating the importance of peers in adolescent tobacco use behaviors.^{20,21} We also found that girls were more likely to obtain e-cigarettes from social sources, such as peers, similar to cigarette obtainment.¹² Overall, our evidence suggests that the influence of peers may be equally important in e-cigarette and cigarette use among youth. However, we could not determine how peers are influencing e-cigarette use behavior. For instance, it is unclear whether adolescents are experimenting with a friend's e-cigarette because they do not have their own or whether they are regularly sharing their e-cigarettes with their peers. Underage youth also may be asking their older peers to purchase e-cigarettes for them (like with cigarettes).²²

Of note, we detected a decrease in reports of obtaining e-cigarettes from peers between 2014 and 2015. While we do not have an explanation for this finding, it is possible that youth may be unwilling to share e-cigarette with their peers over time because of cost. Future studies should continue to monitor the role of peers in e-cigarette acquisition and sharing to inform how best to develop targeted prevention efforts.

Interestingly, we observed that cigarette-smoking youth were more likely to obtain e-cigarettes from their parents/adult family members. Parents/adult family could be providing youth with e-cigarettes because of the belief that e-cigarettes are healthier alternatives to cigarettes, and may also be an important target for future education efforts. The role of social sources in obtaining e-cigarettes may become even more prominent as the enforcement of laws restricting the sale of e-cigarettes to youth in commercial venues become stronger.

The study findings should be interpreted in light of limitations. First, we surveyed adolescents in Connecticut, so our findings may not generalize to other regions. However, e-cigarette use rates among adolescents in Connecticut are comparable to rates reported in national samples, so e-cigarette acquisition behaviors also may also be similar.²³ Second, the data were self-reported and we could not confirm the exact sources of e-cigarette acquisition. Third, the data were cross-sectional, and therefore, causal associations could not be determined. Fourth, we did not assess the enforcement of, or compliance with, the law in

Connecticut. Fifth, we did not take into consideration other factors that could influence adolescent acquisition of e-cigarettes, like the marketing of products or the cost of e-cigarettes, which could influence youth use behaviors. Sixth, we did not assess vape shops as a source of e-cigarette acquisition until 2015, and were therefore unable to examine if rates of obtaining e-cigarettes from vape shops changed from 2014 to 2015. While only a small portion (5%) of youth reported obtaining their e-cigarettes from vape shops in 2015, role of vape shops in e-cigarette use behaviors and perceptions among youth needs close monitoring. Vape shops provide a social milieu where e-cigarette use is acceptable and “cool” and therefore may be highly appealing to youth.²⁴ Finally, adolescents could be obtaining e-cigarettes from other sources not assessed in this study, such as convenience stores. We also did not explicitly define “tobacco shops” in our survey as physical stores that primarily sell tobacco and tobacco paraphernalia, so adolescents may have interpreted “tobacco shops” as representing a broader range of stores. However, this concern is mitigated by the fact that tobacco shops are common in Connecticut and they are known for selling tobacco products at cheaper prices than other retailers. Future studies need to include more comprehensive assessments of commercial sources.

Despite these limitations, a significant strength of this study is the availability of the data on sources of e-cigarette acquisition before and after the passing of the Connecticut law restricting e-cigarette sales of minors. Our findings suggest that merely setting restrictions on e-cigarette sales to minors without effective enforcement of the law is ineffective, similar to what has been observed when cigarette underage restriction laws are not adequately enforced.^{13,25} Future studies should continue to assess the sources of e-cigarette acquisition to evaluate potentially evolving trends in other geographic regions.

In conclusion, our findings highlight the importance of effectively implementing and enforcing the prohibition of sale of e-cigarettes to minors in person and online. Our findings also suggest that enforcement efforts need to be extended to online sources and that e-cigarette prevention efforts need to be extended to peers, older friends and family members. Continual monitoring of sources of e-cigarette acquisition is important as policies, social norms, use behaviors, and public attitudes surrounding e-cigarettes change.

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IMPLICATIONS FOR TOBACCO REGULATION

The results of this study have implications for policymakers at the federal, state, and local levels to enforce youth access restrictions of e-cigarettes. After the law banning the sale of e-cigarettes to minors was passed in Connecticut, we observed no changes in the proportion of adolescents who reported obtaining e-cigarettes from commercial venues. Many adolescents were able to purchase e-cigarettes in 2015, highlighting the need for stricter enforcement of the law prohibiting e-cigarette sale to minors. Top sources of e-cigarette acquisition in both years were peers, tobacco shops, and online shops, which suggest that regulatory considerations also should include non-commercial sources and online sources.

Figure 1.

Sources of E-cigarette Acquisition among Past-30-Day E-cigarette Users in 2014 and 2015.

Note: Vape shop was only assessed in 2015. Participants were asked to select all of the response options as applicable to indicate their usual source of e-cigarette acquisition, so the percentages do not add to 100%.

Table 1

Characteristics of Participants Younger than 18 Years Old in 2014 and 2015

	Spring 2014 (N = 3430)	Spring 2015 (N = 3399)
	%	
Girls	51.9	51.7
Age		
14 years old	12.7	13.4
15 years old	30.9	29.8
16 years old	29.7	30.0
17 years old	26.7	26.8
Past-30-Day Cigarette Smoking	8.0	6.8
Past-30-Day E-cigarette Use	11.7	11.5

Table 2

Predictors of Sources of E-cigarette Acquisition between 2014 and 2015 using Multilevel Modeling

	Parents/Adult Family	Friends	Siblings	Online	Tobacco	Other
	AOR (95% CI)					
Sex (boys [ref] vs. girls)	1.31 (1.05, 1.63)	2.59 (1.75, 3.83)	2.11 (.96, 4.64)	.45 (.34, .59)	.69 (.40, 1.20)	.32 (.20, .49)
Wave (2014 [ref] vs. 2015)	1.40 (.76, 2.57)	.84 (.74, .94)	1.37 (.97, 1.95)	1.12 (.41, 3.05)	.66 (.37, 1.18)	1.13 (.68, 1.90)
Age	.77 (.63, .95)	.89 (.77, 1.02)	.85 (.59, 1.21)	.87 (.72, 1.04)	1.66 (1.53, 1.80)	.79 (.52, 1.19)
Past-30-Day Cig Smoking (non-smoker [ref] vs. smoker)	3.21 (2.31, 4.48)	.74 (.54, 1.00)	1.27 (.79, 2.04)	3.13 (2.34, 4.17)	2.48 (1.78, 3.45)	2.37 (1.28, 4.40)

Note: AOR = adjusted odds ratio, 95% CI = 95% confidence intervals. Each source of e-cigarette acquisition was modeled as a separate dependent variable, with age sex, wave, age, and past-30-day smoking included as independent variables, accounting for school clustering effects. We applied a Bonferroni correction for multiple comparisons and considered $p < .008$ statistically significant (indicated by bold font).