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Trends in Use of Electronic Nicotine Delivery Systems by Adolescents

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Abstract

Electronic Nicotine Delivery Systems (ENDS) have been gaining in popularity. The few prevalence studies in adults have found that most ENDS users are current or former smokers. The objectives of this study were to estimate the prevalence of ENDS usage in adolescents, and examine the correlates of use. Self-administered written surveys assessing tobacco use behaviors were conducted in multiple waves as part of a larger intervention study in two large suburban high schools. The prevalence of past-30 day ENDS use increased from 0.9% in February 2010 to 2.3% in June 2011 ($p = 0.009$). Current cigarette smokers had increased odds of past-30 day ENDS use in all study waves. When adjusted for school, grade, sex, race and smoking status, students in October 2010 (Adjusted OR 2.12; 95% Confidence Interval (CI): 1.12–4.02) and June 2011 (Adjusted OR 2.51; 95% CI: 1.17–4.71) had increased odds past-30 days ENDS use compared to February 2010. The prevalence of ENDS use doubled in this sample of high school students, and current cigarette smoking is the strongest predictor of current use. Continued monitoring of ENDS is needed to determine whether it increases the likelihood of cigarette smoking initiation and maintenance in youth.

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Keywords

Tobacco; epidemiology; adolescent

1. Introduction

Electronic Nicotine Delivery Systems (ENDS) are marketed as harm reducing alternatives to cigarette smoking and have been gaining in availability and popularity recently (Ayers, Ribisl, & Brownstein, 2011). Proponents of ENDS maintain that they are a safer alternative to smoking, exposing the user to fewer chemicals and that they could aid in cessation or smoking reduction (Cahn & Siegel, 2011). Although ENDS have not been thoroughly evaluated by the Food and Drug Administration, preliminary testing has found low levels of tobacco toxicants, such as tobacco specific nitrosamines (Westenberger, 2009), however early studies have also demonstrated that electronic cigarettes have significantly less cytotoxic effects compared to traditional cigarettes (Romagna et. al, 2013). As of this time, the FDA Center for Tobacco Products (CTP) has reported intention to regulate ENDS, although has not exerted its authority as of yet (FDA, 2009).

Since the introduction of ENDS to the market in 2007 (Pauly, Li, & Barry, 2007), many concerns have arisen regarding their safety for adolescent populations as a whole. It is unknown if the availability of ENDS serves to alter use of cigarettes among current smokers or leads to increased initiation among non-using youth. Nevertheless, there is concern that ENDS use may undermine social norms about tobacco (Mejia, Ling, & Glantz, 2010), serve as a starter product for cigarettes among youth, or delay smoking cessation among current adolescent smokers.

Given these concerns, it is important to understand the patterns of ENDS use among adolescents. Existing data in adolescents are lacking, although few studies have begun to explore the prevalence and correlates of ENDS use in adults. (Pearson et al, 2012; Regan et al, 2013). For example, a 2010 nationally representative online survey of adults (Pearson et al, 2012) found that the prevalence of ever use of ENDS in the adult general public was 3.4%, with an 11.4% usage rate among adult smokers and 2.0% in former smokers. Only one study to our knowledge has assessed trends in ENDS use over time. A consumer-based mail-in survey of over 10,000 US adults found that ever ENDS use increased from 0.6% to 2.7% between 2009 and 2010. Furthermore, this same study showed that awareness of ENDS doubled from 16.4% to 32.2% in the same timer period. Given the unanswered questions about the safety of ENDS in youth, and the preliminary trends of usage among adults, it is essential to understand these same trends in youth.

The purpose of this study is to describe the trends of ENDS usage in two high schools in Connecticut and New York over a 16-month period in 2010 and 2011 and examine the correlates of use. The findings from this study will help determine which youth use ENDS, and whether use of ENDS increased over time.

2. Materials and Methods

This is a data analysis of three self-administered written surveys assessing tobacco use behaviors conducted in two suburban high schools in Connecticut and New York between 2010 and 2011. The anonymous surveys were conducted as part of an evaluation of a tobacco use prevention program and also contained questions assessing interest in tobacco cessation services (data not included). The students in grades 9–12 were surveyed in February 2010/Wave 1 (n=1719; response rate = 76.2%), October 2010/Wave 2 (n=1702; response rate = 76.4%), and June 2011/Wave 3 (n=1345; response rate = 56.7%).

Information about the surveys was mailed home to parents and they were asked to inform the school or the researchers if they did not want their child to participate. Surveys were conducted in an assembly setting. On the day of the survey, research staff informed students about the confidentiality and voluntary and anonymous nature of the survey. These procedures were approved by the Institutional Review Boards of Yale University and Roswell Park Cancer Institue and by the local school boards.

The survey included questions on past-30 day use of ENDS. Correlates examined included grade, gender, race, survey year, and any cigarette use in the 30 days prior to the survey (see Table 1). Past-30 day use of ENDS was measured by the response to the question '*In the PAST 30 DAYS, have you used any of the following tobacco products?*' by selecting the option "*E-cigarettes (An electronic cigarette that is filled with liquid nicotine)*".

Descriptive statistics by study wave on prevalence of past-30 day use of ENDS were conducted using chi square tests. Multivariate logistic regression was conducted to assess trends and correlates of past-30 day use of ENDS. The dependent variable was current ENDS use (yes/no), and the categorical predictor variables were study wave (February 2010 as the reference), school (Connecticut or New York), grade, race (white vs. non-white), and cigarette smoking status (current smoker vs. non-smoker)

3. Results

Table 1 demonstrates that the prevalence of past-30 day ENDS use increased from 0.9% in February 2010 to 2.3% in June 2011 ($p = 0.009$). The prevalence of current (past-30 day) cigarette smoking ranged from 11.6% in February 2010, 10.8% in October 2010 to 13.6% in June 2011 ($p=0.05$). The prevalence of dual cigarette and ENDS use increased from February 2010 (0.8%) to June 2011 (1.9%) ($p=0.03$) and the majority of ENDS users also used cigarettes (n=14/16 (87.5%) in wave 1; n= 24/29 (82.8%) in wave 2; n=26/31(83.9%) in wave 3). The study waves had similar gender and race distributions, although a larger proportion of respondents in June 2011 were in 9th grade (27.8% February 2010 vs. 26.2% October 2010 vs. 19.6% June 2011; $p<0.001$). Table 2 demonstrates the adjusted odds of past-30 day ENDS use by study wave. When adjusted for all variables included in the unadjusted models (school, grade, sex, race and smoking status), students in Fall 2010 (Adjusted OR (AOR) 2.12; 95% Confidence Interval (CI) 1.12–4.02) and Spring 2011 (AOR 2.51; 95% CI 1.17–4.71) had increased odds of past-30 day ENDS use compared to Spring 2010. Current cigarette smokers had increased adjusted odds of past-30 day ENDS use in all study waves. Additionally, white students had an increased AOR of past 30-day ENDS use in wave 1 (AOR 3.92; 95% CI 1.30–11.78) but similar odds of use in waves 2 and 3 (Table 2).

4. Discussion

This study provides one of the first reports of increasing prevalence of ENDS use among adolescents. We found that past-30 day ENDS use had more than doubled over a recent 16-month period. Furthermore, similar to findings in adults, we found that current cigarette use strongly predicts ENDS use in adolescents, and that a majority of ENDS users concurrently use cigarettes. Although the overall prevalence of ENDS use was low (0.9% to 2.3%), the increasing trend of use is concerning given the unknown health effects of ENDS.

These findings are similar to studies in adults, which demonstrate increasing prevalence of ENDS use, especially among smokers (Pearson et al, 2012). Among adults, dual use of ENDS and combustible tobacco products is the most common pattern of use (Pearson et. al, 2012). A recent study of a sample of male adolescents found that cigarettes smokers were more willing to try an electronic cigarette than non-smokers, and non-smokers had more

negative beliefs about ENDS (Pepper et al. 2013), suggesting that the same factors that promote cigarette use may promote ENDS use in youth. For example, high levels of sensation-seeking among cigarette- smoking adolescents (Sargent, 2010) may increase their likelihood of trying ENDS. Alternatively, adolescent smokers may use ENDS in an effort to quit smoking. Future studies in adolescents are needed to determine the etiology of dual use in this population. Additionally, we found an increased odds of ENDS use among white students in wave 1 only, suggesting that the product was initially used among white youth, but is now used among non-white youth as well. Future studies are needed to more thoroughly examine the demographic correlates of trends in ENDS use.

The increasing prevalence of ENDS use in general may be due to its increasing promotion in convenience stores (Herzog, Metrano & Gerberi, 2012) and youth-dominated media outlets such as social networking and internet advertising (Ayers 2011). Furthermore, as prevalence increases among adults, youth may be exposed to ENDS products through older family members. Lastly, youth may increasingly use ENDS in place of traditional cigarettes due to the perception that they are a healthier product.

This study has several limitations. It is possible that our low response rates (76.2% in wave 1 to 56.7% during wave 3) may have biased the trend results in that ENDS user may have been more likely to respond during wave 3. Given the small sample size of ENDS users, the estimates for use among cigarette smokers have wide confidence intervals and larger studies are needed to validate these results. Data are self-reported, which may result in underreporting in the school setting (Patrick et al., 1994). We found that less than 15% of the sample reported current smoking, which is less than that reported in other school-based surveys such as the Youth Risk Behavior Surveillance Survey (Centers for Disease Control and Prevention, 2012), although similar to the 2010 and 2011 Monitoring the Future estimates (Johnston, O'Malley, Bachman, & Schulenberg, 2013). ENDS prevalence between the second and third surveys may have been due to the aging of the sample within the school year, which may have naturally resulted in increased experimentation with ENDS, as experimentation increases with age (Messer & Pierce, 2010). However, the prevalence also increased across school years. Future studies are needed to examine the effect of age on ENDS experimentation, as well as other potential important correlates of use, such as sensation- seeking and sensitivity to existing advertising. Furthermore, the generalizability of the findings may be limited by the inclusion of two suburban schools from the northeast United States.

4.1 Conclusions

In summary, this study demonstrates that ENDS use increased over a 16 month period in 2010–2011 in a sample of high school students. Current cigarette use is the strongest predictor of ENDS use in adolescents, indicating the need for future research about dual use of these products. Overall, prospective data are needed to understand these critical potential consequences of youth ENDS use when trying to estimate the net population health impact of these products.

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Highlights

- We examined trends in current electronic nicotine delivery system use in high school students in 2 high schools in Connecticut and New York.
- The prevalence of electronic nicotine delivery system use doubled between 2010 and 2011.
- Current cigarette smoking is the strongest predictor of electronic nicotine delivery system use in high school students.

Table 1

Demographics by Study Wave

	February 2010 n=1719		October 2010 n=1702		June 2011 n=1345		p-value
	n	(%)	n	(%)	n	(%)	
School A/CT	848	49.3	855	50.2	612	45.5	0.03
School B/NY	871	50.7	847	49.8	733	54.5	
9th	478	27.8	446	26.2	264	19.6	<0.001
10th	469	27.3	459	27.0	385	28.6	
11th	397	23.1	444	26.1	370	27.5	
12th	368	21.4	347	20.4	322	23.9	
Male	784	45.6	774	45.5	603	44.8	0.8
Female	903	52.5	903	53.1	723	53.8	
Non-white	470	34.9	500	37.2	410	30.5	0.14
White	1249	72.7	1202	70.6	935	69.5	
Cigarette Smokers	200	11.6	183	10.8	183	13.6	0.05
ENDS users	16	0.9	29	1.7	31	2.3	0.009
Cigarette and ENDS users	14	0.8	24	1.4	26	1.9	0.03

ENDS=Electronic Nicotine Delivery System

Table 2

Predictors of Past-30 day ENDS Use by Study Wave

	February 2010				October 2010				June 2011			
	Crude OR	**(95% CI)**	**Adj. OR**	**(95% CI)**	**Crude OR**	**(95% CI)**	**Adj. OR**	**(95% CI)**	**Crude OR**	**(95% CI)**	**Adj.OR**	**(95% CI)**
School A/NY	Ref		Ref		Ref		Ref		Ref		Ref	
School B/CT	0.76	(0.28–2.04)	1.16	(0.40–3.43)	0.52	(0.24–1.12)	0.48	(0.21–1.10)	1.01	(0.48–2.02)	1.14	(0.51–2.55)
9th	Ref		Ref		Ref		Ref		Ref		Ref	
10th	1.71	(0.41–7.18)	1.24	(0.27–5.61)	0.06	(0.36–2.61)	0.73	(0.24–2.18)	0.82	(0.30–2.20)	0.34	(0.10–1.10)
11th	0.40	(0.04–3.90)	0.21	(0.02–2.16)	1.13	(0.43–2.96)	0.59	(0.20–1.68)	0.71	(0.26–1.91)	0.28	(0.08–0.95)
12th	3.07	(0.8–12.0)	2.44	(0.57–10.4)	0.64	(0.19–2.14)	**0.28**	**(0.08–0.99)**	0.82	(0.30–2.20)	0.39	(0.12–1.24)
Male	Ref		Ref		Ref		Ref		Ref		Ref	
Female	0.70	(0.26–1.89)	1.01	(0.34–2.96)	0.80	(0.38–1.66)	0.93	(0.42–2.07)	0.67	(0.32–1.41)	0.76	(0.34–1.69)
Non-white	Ref		Ref		Ref		Ref		Ref		Ref	
White	**4.56**	**(1.65–12.62)**	**3.92**	**(1.30–11.78)**	1.28	(0.59–2.78)	0.89	(0.38–2.06)	1.92	(0.94–3.94)	1.25	(0.55–2.81)
Non-smoker	Ref		Ref		Ref		Ref		Ref		Ref	
Smokers	**57.17**	**(12.9–253.2)**	**55.63**	**(12.58–254.9)**	**45.52**	**(17.13–121.0)**	**54.89**	**(20.04–150.03)**	**38.47**	**(14.56–101.6)**	**54.50**	**(17.93–165.9)**