Original Investigation

Electronic Cigarettes and Conventional Cigarette Use Among US Adolescents
A Cross-sectional Study

Lauren M. Dutra, ScD; Stanton A. Glantz, PhD

IMPORTANCE Electronic cigarette (e-cigarette) use is increasing rapidly among adolescents, and e-cigarettes are currently unregulated.

OBJECTIVE To examine e-cigarette use and conventional cigarette smoking.

DESIGN, SETTING, AND PARTICIPANTS Cross-sectional analyses of survey data from a representative sample of US middle and high school students in 2011 (n = 17 353) and 2012 (n = 22 529) who completed the 2011 and 2012 National Youth Tobacco Survey.

EXPOSURES Ever and current e-cigarette use.

MAIN OUTCOMES AND MEASURES Experimentation with, ever, and current smoking, and smoking abstinence.

RESULTS Among cigarette experimenters (≥1 puff), ever e-cigarette use was associated with higher odds of ever smoking cigarettes (≥100 cigarettes; odds ratio [OR] = 6.31; 95% CI, 5.39-7.39) and current cigarette smoking (OR = 5.96; 95% CI, 5.67-6.27). Current e-cigarette use was positively associated with ever smoking cigarettes (OR = 7.42; 95% CI, 5.63-9.79) and current cigarette smoking (OR = 7.88; 95% CI, 6.01-10.32). In 2011, current cigarette smokers who had ever used e-cigarettes were more likely to intend to quit smoking within the next year (OR = 1.53; 95% CI, 1.03-2.28). Among experimenters with conventional cigarettes, ever use of e-cigarettes was associated with lower 30-day (OR = 0.24; 95% CI, 0.21-0.28), 6-month (OR = 0.24; 95% CI, 0.21-0.28), and 1-year (OR = 0.25; 95% CI, 0.21-0.30) abstinence from cigarettes. Current e-cigarette use was also associated with lower 30-day (OR = 0.11; 95% CI, 0.08-0.15), 6-month (OR = 0.11; 95% CI, 0.08-0.15), and 1-year (OR = 0.12; 95% CI, 0.07-0.18) abstinence. Among ever smokers of cigarettes (≥100 cigarettes), ever e-cigarette use was negatively associated with 30-day (OR = 0.61; 95% CI, 0.42-0.89), 6-month (OR = 0.53; 95% CI, 0.33-0.83), and 1-year (OR = 0.32; 95% CI, 0.18-0.56) abstinence from conventional cigarettes. Current e-cigarette use was also negatively associated with 30-day (OR = 0.35; 95% CI, 0.18-0.69), 6-month (OR = 0.30; 95% CI, 0.13-0.68), and 1-year (OR = 0.34; 95% CI, 0.13-0.87) abstinence.

CONCLUSIONS AND RELEVANCE Use of e-cigarettes was associated with higher odds of ever or current cigarette smoking, higher odds of established smoking, higher odds of planning to quit smoking among current smokers, and, among experimenters, lower odds of abstinence from conventional cigarettes. Use of e-cigarettes does not discourage, and may encourage, conventional cigarette use among US adolescents.

Editorial

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Author Affiliations: Center for Tobacco Research and Education, University of California, San Francisco.

Corresponding Author: Stanton A. Glantz, PhD, Center for Tobacco Research and Education, University of California, San Francisco, 530 Parnassus Ave, Ste 366, San Francisco, CA 94143 (glantz@medicine.ucsf.edu).

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Electronic cigarettes (e-cigarettes) are devices that deliver a heated aerosol of nicotine in a fashion that mimics conventional cigarettes while delivering lower levels of toxins than a conventional combusted cigarette.[1-4] They are being aggressively marketed using the same messages and media channels (plus the Internet) that cigarette companies used to market conventional cigarettes in the 1950s and 1960s,[5] including on television and radio where cigarette advertising has been prohibited for more than 40 years.

In addition to these traditional media, e-cigarettes have established a strong advertising presence on the Internet, and e-cigarette companies heavily advertise their products through electronic communication. Studies have demonstrated for decades that youth exposure to cigarette advertising causes youth smoking.[6] Electronic cigarettes are also sold using characterizing flavors (eg, strawberry, licorice, chocolate) that are banned in cigarettes in the United States because they appeal to youths. The 2011 and 2012 National Youth Tobacco Survey (NYTS) revealed that e-cigarette use among youths in grades 6 through 12 doubled between 2011 and 2012, from 3.3% to 6.8%.[7] As with adults,[7-10] concurrent dual use of e-cigarettes and conventional cigarettes was also high, with 76.3% of current e-cigarette users reporting concurrent use of conventional cigarettes in 2012.[7] Likewise, e-cigarettes were introduced to Korea in 2007 using marketing techniques similar to those used in the United States, and use among adolescents rapidly increased: in 2011, 4.7% of Korean adolescents were using e-cigarettes, 76.7% of whom were dual users.[3]

The prevalence of e-cigarette use is also rising among adults in the United States. In a web-based survey,[11] 3.3% of adults in 2010 and 6.2% in 2011 had ever used an e-cigarette. In addition, awareness of these products among adults increased from 40.9% in 2010 to 57.9% in 2011. Current cigarette smokers had significantly higher levels of ever e-cigarette use than former and never cigarette smokers in both years.

Electronic cigarettes are marketed as smoking cessation aids[5,12-14] and many adult e-cigarette users cite the desire to stop smoking conventional cigarettes as their reason for using them.[8,15-17] However, the value of e-cigarettes as a cigarette substitute has been questioned because of high levels of dual use with conventional cigarettes.[3,8,9,11,18-20] In addition, 2 longitudinal population studies of adult smokers contradict claims that e-cigarettes are effective cessation aids: one (in the United States, United Kingdom, Canada, and Australia) found that e-cigarette use is not associated with quitting conventional cigarettes[21] and the other (in the United States) found significantly less quitting.[17] (A randomized clinical trial[22] found that e-cigarettes were not superior to nicotine patches for smoking cessation, but both interventions showed low quit rates and there was no control group of spontaneous quitters.) A cross-sectional US study[23] also found that unsuccessful cigarette quitters were significantly more likely to have ever tried e-cigarettes in comparison with individuals who had never tried to quit. Likewise, a cross-sectional study of Korean adolescents[3] found that they were using e-cigarettes as smoking cessation aids (odds ratio [OR] = 1.58; 95% CI, 1.39-1.79 for e-cigarette use among students who had made a quit attempt compared with those who had not) but were less likely to have quit smoking (OR = 0.10; 95% CI, 0.09-0.12).

To further understand the relationship between e-cigarette use with conventional cigarette use and quitting, this study used data from the 2011 and 2012 NYTS to examine the relationship between e-cigarette use and both conventional cigarette smoking and smoking cessation among US adolescents.

Methods

Data Source

The NYTS is a nationally representative cross-sectional sample of students from US middle and high schools (grades 6-12) located in all 50 states and the District of Columbia that was developed to inform national and state tobacco prevention and control programs.[24] The 2011 sample included 18 866 students (88.0% response rate) from 178 schools (83.2% response rate), and the 2012 sample included 24 658 students (91.7% response rate) from 228 schools (80.3% response rate). The NYTS is an anonymous, self-administered, 81-item, pencil-and-paper questionnaire that includes indicators of tobacco use (including cigarettes, cigars, smokeless tobacco, kreteks, pipes, and emerging tobacco products), tobacco-related beliefs, attitudes about tobacco products, smoking cessation, exposure to secondhand smoke, ability to purchase tobacco products, and exposure to protobacco and antitobacco influences.[25] It uses a 3-stage clustered probability sampling design without replacement to select primary sampling units (county, several small counties, portion of large county), schools within each primary sampling unit, and students within each school. Non-Hispanic black and Hispanic students are oversampled. Written permission to participate is obtained from parents or legal guardians.[24] Institutional review board approval was waived because we used data from a deidentified public-use data set.

Variables

Conventional cigarette experimenters were defined as adolescents who responded yes to the question "Have you ever tried cigarette smoking, even 1 or 2 puffs?" Ever smokers of conventional cigarettes were defined as those who replied "100 or more cigarettes (5 or more packs)" to the question "About how many cigarettes have you smoked in your entire life?" Current smokers of conventional cigarettes were those who had smoked at least 100 cigarettes and smoked in the past 30 days.

In 2011, intention to quit smoking within the next year was measured among current cigarette smokers using the question "I plan to stop smoking cigarettes for good within the next… ." Respondents who chose any time within the next year (7 days, 30 days, 6 months, or 1 year) were classified as intending to quit; those who responded "I do not plan to stop smoking cigarettes within the next year" were classified as not intending to quit. This question was not asked in 2012. We measured quit attempts with the question "During the past 12 months, how many times did you stop smoking for 1 day or longer because you were trying to quit smoking cigarettes for good?" Those who responded 1 or more times were consid-

Table 1. Sociodemographic Characteristics of Respondents in the 2011 and 2012 National Youth Tobacco Survey by Ever and Current Use of Electronic Cigarettes in 2011 and 2012[a]

Characteristic	2011 (n = 17 353)			2012 (n = 22 529)		
		E-cigarette Use[c]			E-cigarette Use[c]	
	All[b]	Ever	Current	All[b]	Ever	Current
Respondents, No. (%)		511 (3.1)	174 (1.1)		1450 (6.5)	462 (2.0)
Age, mean (SD), y	14.7 (0.1)	15.8 (0.1)[d]	15.3 (0.2)[d]	14.6 (0.1)	15.9 (0.1)[d]	15.7 (0.1)[d]
Gender, No. (%)						
Male	8544 (50.6)	296 (3.9)[d]	114 (1.6)[d]	11 093 (50.1)	863 (7.7)[d]	305 (2.7)[d]
Female	8809 (49.4)	215 (2.4)	60 (0.6)	11 436 (49.9)	587 (5.3)	157 (1.4)
Race, No. (%)						
Non-Hispanic white	6731 (56.6)	274 (3.8)[d]	81 (1.2)[e]	11 311 (54.7)	878 (7.8)[d]	257 (2.2)[d]
Non-Hispanic black	3102 (13.9)	28 (1.2)	12 (0.6)	2886 (13.5)	79 (2.8)	28 (1.1)
Other	7520 (29.5)	209 (2.8)	80 (1.0)	8332 (31.8)	493 (5.7)	177 (2.1)
Ever cigarette smoking, No. (%)[f]						
Ever	860 (5.6)	234 (30.8)[d]	80 (10.3)[d]	972 (4.5)	562 (57.1)[d]	237 (23.5)[d]
Never	16 493 (94.4)	277 (1.5)	94 (0.5)	21 557 (95.5)	888 (4.1)	225 (1.0)
Dual ever use[g]	232 (1.7)			562 (2.6)		
Current cigarette smoking, No. (%)[h]						
Smoker	778 (5.0)	219 (31.9)[d]	76 (10.6)[d]	869 (4.0)	505 (57.2)[d]	230 (25.7)[d]
Nonsmoker	16 575 (95.0)	292 (1.6)	98 (0.6)	21 660 (96.0)	945 (4.4)	232 (1.1)
Dual current use[i]	75 (0.5)			230 (1.0)		

Abbreviation: e-cigarette, electronic cigarette.

[a] Respondents with missing values for e-cigarette use, cigarette smoking, and covariates are excluded.

[b] Percentages are by column.

[c] Percentages are by row. Ever e-cigarette use indicates having ever tried an e-cigarette, and current e-cigarette use indicates having used an e-cigarette in the past 30 days.

[d] $P < .01$.

[e] $P < .05$.

[f] Smoked at least 100 cigarettes in lifetime.

[g] Percentages are of the entire sample who have ever used e-cigarettes and ever smoked conventional cigarettes.

[h] Smoked at least 100 cigarettes in lifetime and at least a puff of a cigarette in the past 30 days.

[i] Percentages are of the entire sample who are currently using e-cigarettes and conventional cigarettes.

ered having made an attempt; those who responded "I did not try to quit during the past 12 months" were considered not having made a quit attempt.

Abstinence from conventional cigarettes for 30 days, 6 months, and 1 year was based on responses to the question "When was the last time you smoked a cigarette, even 1 or 2 puffs?" "Not in the past 30 days but in the past 6 months" was coded as 30-day abstinence, "not in the past 6 months but in the past year" as 6-month abstinence, and "1 to 4 years ago" or "5 or more years ago" as 1-year abstinence.

Ever e-cigarette users were defined as adolescents who responded "electronic cigarettes or e-cigarettes, such as Ruyan or NJOY," to the question "Which of the following tobacco products have you ever tried, even just 1 time?" Current e-cigarette users were those who responded "e-cigarettes" to the question "During the past 30 days, which of the following tobacco products did you use on at least 1 day?"

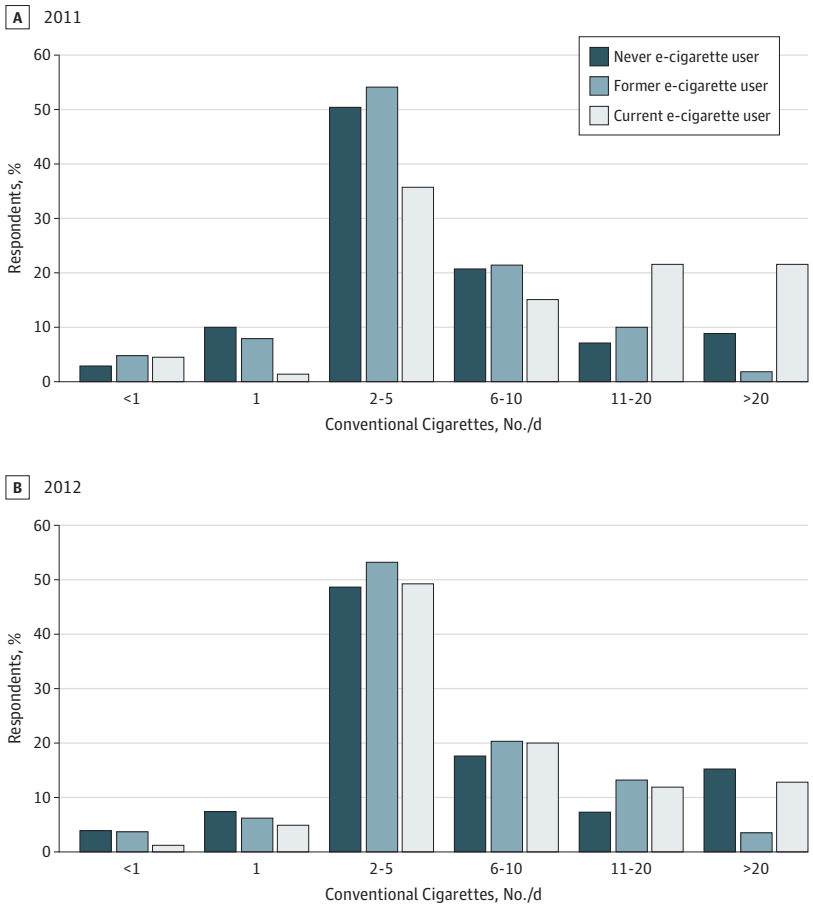
Covariates included race, gender, and age (in years, continuous). Race and ethnicity were coded based on answers to the questions "Are you Hispanic or Latino?" and "What race or races do you consider yourself to be?" (white, black, Asian, American Indian/Alaskan Native, or Native Hawaiian/Pacific Islander). Responses were collapsed into non-Hispanic white, non-Hispanic black, and other to obtain at least 20 ever e-cigarette users in each category.

Statistical Analysis

The 92.0% of respondents (17 353 of 18 866) in 2011 and 91.4% of respondents (22 529 of 24 658) in 2012 with complete data on conventional cigarette use, e-cigarette use, and covariates were included in this analysis using SAS-callable SUDAAN (SAS version 9.3, SAS Institute, Inc; SUDAAN version 11.0.0, RTI International), which accounted for the stratified clustered sampling design of the NYTS, and Stata version 12.1 (StataCorp LP), which was used to pool the data from both years. Sampling weights were used in all analyses to adjust for nonresponse and the probability of selection and to match the sample's sociodemographic characteristics with those of US middle and high school students in 2011.[24,25]

The PROC CROSSTAB procedure was used for χ^2 analyses of categorical demographic variables by e-cigarette use. The PROC DESCRIPT and PROC REGRESS (generalized linear model) procedures provided means and *P* values for bivariate analyses of continuous and ordinal variables. All descriptive statistics and ORs were adjusted for stratification variables and weights. The PROC RLOGIST procedure was used to obtain ORs and 95% confidence intervals from multivariable logistic regression models of e-cigarette use and cigarette smoking, intention to quit, quit attempts, and abstinence from cigarettes, adjusting for demographic covariates. Because the NYTS study designs in 2011 and 2012 were essentially identical, we pooled

Figure. Electronic Cigarette Use and Conventional Cigarette Smoking in 2011 and 2012



Current e-cigarette use in 2011 (A) and 2012 (B) was associated (P = .003 in 2011; P = .001 in 2012) with heavier smoking among conventional smokers (≥100 cigarettes in lifetime, having smoked in past 30 days). Participants were a representative sample of US middle and high school students who responded to the National Youth Tobacco Survey. Current e-cigarette users had used e-cigarettes in the past 30 days. Former e-cigarette users had tried e-cigarettes but had not used e-cigarettes in the past 30 days. Never e-cigarette users had never tried an e-cigarette. The numbers of conventional cigarettes smoked per day are on the days cigarettes were smoked during the past 30 days.

adjusted ORs for e-cigarette use in 2011 and 2012 using a fixed-effects meta-analysis with the Stata metan command. As expected, there was no evidence of heterogeneity between the 2 years (median P value for heterogeneity = .32; range, .09-.98).

Results

In 2011, 3.1% of the study sample had ever tried e-cigarettes (1.7% dual ever use, 1.5% only e-cigarettes) and 1.1% were current e-cigarette users (0.5% dual use, 0.6% only e-cigarettes). In 2012, 6.5% of the sample had tried e-cigarettes (2.6% dual use, 4.1% only e-cigarettes) and 2.0% were current e-cigarette users (1.0% dual use, 1.1% only e-cigarettes). Ever and current e-cigarette use varied significantly by sociodemographic characteristics (**Table 1**). Ever e-cigarette users were significantly more likely to be male (P < .01), white (P < .01), and older (P < .01). Ever conventional cigarette smokers (≥100 cigarettes in lifetime) were significantly more likely than never smokers to have tried e-cigarettes (P < .01) and to be current e-cigarette users (P < .01). Compared with nonsmokers (never and former smokers), current cigarette smokers were significantly more likely to have used e-cigarettes (P < .01) and to be current e-cigarette users (P < .01). In 2011, 45.4% of ever e-cigarette users had never been established smokers of conventional cigarettes and 49.7% of current e-cigarette users were current smokers of conventional cigarettes. In 2012, 61.2% of ever e-cigarette users had never been established smokers and 49.8% of current e-cigarette users were current cigarette smokers.

Reflecting high levels of dual use, ever and current e-cigarette use was associated with very high odds of experimentation with cigarettes, ever cigarette smoking, and current cigarette smoking (eTable 1 and eTable 2 in Supplement).

Among current smokers, current e-cigarette use was associated with higher levels of cigarette smoking (P = .003 for 2011; P = .001 for 2012) (**Figure**).

In pooled analyses, among experimenters (ever smoked a puff), ever e-cigarette use was positively associated with being an established smoker (≥100 cigarettes; OR = 6.31; 95% CI, 5.39-7.39) and current cigarette smoking (≥100 cigarettes and smoked in past 30 days; OR = 5.96; 95% CI, 5.67-6.27). Current e-cigarette use was also associated with ever cigarette smoking (OR = 7.42; 95% CI, 5.63-9.79) and current cigarette smoking (OR = 7.88; 95% CI, 6.01-10.32) (**Table 2**). **Table 3** shows separate analyses by year.

Use of e-cigarettes was also associated with lower odds of abstinence. Among experimenters, ever e-cigarette use associated with lower odds of 30-day (OR = 0.24; 95% CI, 0.21-

Table 2. Pooled Analysis of Ever and Current Electronic Cigarette Use and Cigarette Smoking in the 2011 and 2012 National Youth Tobacco Survey[a]

	OR (95% CI)				
	Cigarette Smoking Status[b]		Abstinence From Cigarettes[c]		
Dependent Variable	Ever	Current	30 d[d]	6 mo[e]	1 y[f]
Cigarette experimenters (n = 10 850)[g]					
Ever e-cigarette use[h]	6.31 (5.39-7.39)	5.96 (5.67-6.27)	0.24 (0.21-0.28)	0.24 (0.21-0.28)	0.25 (0.21-0.30)
Current e-cigarette use[i]	7.42 (5.63-9.79)	7.88 (6.01-10.32)	0.11 (0.08-0.15)	0.11 (0.08-0.15)	0.12 (0.07-0.18)
Ever cigarette smokers (n = 1832)[a]					
Ever e-cigarette use[h]	...	...	0.61 (0.42-0.89)	0.53 (0.33-0.83)	0.32 (0.18-0.56)
Current e-cigarette use[i]	...	...	0.35 (0.18-0.69)	0.30 (0.13-0.68)	0.34 (0.13-0.87)

Abbreviations: e-cigarette, electronic cigarette; OR, odds ratio; ellipses, not applicable.

[a] Excludes respondents with missing values for e-cigarette use, cigarette smoking, and covariates.

[b] Ever cigarette smoking indicates having smoked at least 100 cigarettes in lifetime, and current cigarette smoking indicates having smoked at least 100 cigarettes in lifetime and at least a puff of a cigarette in the past 30 days.

[c] Based on answers to "When was the last time you smoked a cigarette, even 1 or 2 puffs?"

[d] Responded "not in the past 30 days but in the past 6 months" to the abstinence question.

[e] Responded "not in the past 6 months but in the past year" to the abstinence question.

[f] Responded "1 to 4 years ago" or "5 or more years ago" to the abstinence question.

[g] Smoked at least 1 puff of a cigarette.

[h] Ever tried an e-cigarette.

[i] Used an e-cigarette in the past 30 days.

Table 3. Association of Electronic Cigarette Use With Ever and Current Smoking Among Adolescents Reporting Experimentation With Conventional Cigarettes in the 2011 National Youth Tobacco Survey[a]

	Smoking, OR (95% CI)			
	2011 (n = 5169)		2012 (n = 5681)	
Dependent Variable	Ever[b]	Current[c]	Ever[b]	Current[c]
Ever e-cigarette use[d]				
Adjusted	7.66 (5.44-10.79)	7.43 (5.39-10.22)	5.99 (5.02-7.16)	5.61 (4.66-6.76)
Age, y	1.33 (1.23-1.44)	1.30 (1.20-1.41)	1.24 (1.17-1.33)	1.25 (1.16-1.35)
Race				
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	0.37 (0.23-0.57)	0.43 (0.28-0.67)	0.44 (0.29-0.69)	0.47 (0.31-0.72)
Non-Hispanic other	0.72 (0.54-0.97)	0.76 (0.57-1.01)	0.73 (0.58-0.92)	0.77 (0.60-0.99)
Male	1.39 (1.13-1.70)	1.44 (1.16-1.78)	1.53 (1.26-1.86)	1.44 (1.18-1.74)
Unadjusted	8.52 (6.06-11.98)	8.31 (6.02-11.46)	6.97 (5.76-8.44)	6.52 (5.37-7.93)
Current e-cigarette use[e]				
Adjusted	7.46 (4.12-13.49)	6.84 (3.95-11.84)	7.41 (5.41-10.14)	8.24 (6.04-11.23)
Age, y	1.35 (1.25-1.46)	1.32 (1.23-1.43)	1.29 (1.22-1.37)	1.30 (1.22-1.39)
Race				
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	0.31 (0.20-0.47)	0.36 (0.24-0.55)	0.32 (0.21-0.50)	0.35 (0.23-0.53)
Non-Hispanic other	0.67 (0.50-0.89)	0.69 (0.52-0.92)	0.61 (0.48-0.77)	0.64 (0.49-0.84)
Male	1.38 (1.13-1.70)	1.44 (1.16-1.77)	1.55 (1.27-1.90)	1.45 (1.19-1.77)
Unadjusted	6.84 (4.01-11.67)	6.49 (3.92-10.76)	7.52 (5.69-9.93)	8.31 (6.28-11.00)

Abbreviations: e-cigarette, electronic cigarette; OR, odds ratio.

[a] Excludes respondents with missing values for e-cigarette use, cigarette smoking, and covariates. Experimentation indicates ever tried smoking cigarettes, even 1 or 2 puffs.

[b] Smoked at least 100 cigarettes in lifetime.

[c] Smoked at least 100 cigarettes in lifetime and at least a puff of a cigarette in the past 30 days.

[d] Ever tried an e-cigarette (in 2011, n = 468 [9.1% of experimenters]; in 2012, n = 1313 [23.1% of experimenters]).

[e] Used an e-cigarette in the past 30 days (in 2011, n = 154 [3.0% of experimenters]; in 2012, n = 423 [7.4% of experimenters]).

0.28), 6-month (OR = 0.24; 95% CI, 0.21-0.28), and 1-year (OR = 0.25; 95% CI, 0.21-0.30) abstinence from conventional cigarettes. Current e-cigarette use was also associated with lower odds of 30-day (OR = 0.11; 95% CI, 0.08-0.15), 6-month (OR = 0.11; 95% CI, 0.08-0.15), and 1-year (OR = 0.12; 95% CI, 0.07-0.18) abstinence from conventional cigarettes. **Table 4** shows analyses by year.

Among ever cigarette smokers (≥100 cigarettes), ever e-cigarette use was negatively associated with 30-day (OR = 0.61; 95% CI, 0.42-0.89), 6-month (OR = 0.53; 95% CI, 0.33-0.83), and 1-year (OR = 0.32; 95% CI, 0.18-0.56) abstinence from conventional cigarettes. Current e-cigarette use was also negatively associated with 30-day (OR = 0.35; 95% CI, 0.18-0.69), 6-month (OR = 0.30; 95% CI, 0.13-0.68), and 1-year (OR = 0.34; 95% CI, 0.13-0.87) abstinence from conventional cigarettes. **Table 5** shows analyses by year.

In adjusted analyses for 2011, among current smokers, ever e-cigarette use was associated with planning to stop smoking within the next year (OR = 1.53; 95% CI, 1.03-2.28), but current e-cigarette use was not (OR = 1.34; 95% CI, 0.62-2.90). In

Table 4. Ever and Current Electronic Cigarette Use by Abstinence From Smoking Conventional Cigarettes Among Adolescents Reporting Experimentation With Conventional Cigarettes in the 2011 National Youth Tobacco Survey[a]

	Abstinence, OR (95% CI)[b]					
	2011 (n = 5169)			2012 (n = 5681)		
Dependent Variable	30 d[c]	6 mo[d]	1 y[e]	30 d[c]	6 mo[d]	1 y[e]
Ever e-cigarette use[f]						
Adjusted	0.22 (0.16-0.29)	0.21 (0.16-0.28)	0.21 (0.15-0.31)	0.25 (0.21-0.29)	0.25 (0.21-0.30)	0.27 (0.22-0.33)
Age, y	0.91 (0.86-0.95)	0.94 (0.90-0.98)	0.98 (0.94-1.02)	0.91 (0.87-0.96)	0.94 (0.89-0.99)	0.95 (0.91-1.00)
Race						
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	1.43 (1.04-1.96)	1.91 (1.51-2.41)	2.18 (1.72-2.75)	1.33 (1.06-1.68)	1.98 (1.54-2.54)	2.07 (1.65-2.60)
Non-Hispanic other	1.20 (0.99-1.46)	1.40 (1.21-1.61)	1.53 (1.33-1.77)	1.09 (0.94-1.26)	1.25 (1.06-1.48)	1.36 (1.13-1.65)
Male	0.91 (0.78-1.07)	0.90 (0.76-1.06)	0.82 (0.67-1.00)	0.83 (0.73-0.93)	0.87 (0.76-1.00)	0.90 (0.77-1.05)
Unadjusted	0.20 (0.15-0.27)	0.19 (0.15-0.25)	0.19 (0.13-0.28)	0.23 (0.20-0.26)	0.22 (0.19-0.27)	0.24 (0.19-0.29)
Current e-cigarette use[g]						
Adjusted	0.15 (0.08-0.27)	0.15 (0.07-0.32)	0.17 (0.07-0.38)	0.10 (0.07-0.14)	0.10 (0.06-0.16)	0.10 (0.06-0.17)
Age, y	0.89 (0.85-0.93)	0.93 (0.89-0.97)	0.97 (0.93-1.01)	0.88 (0.84-0.93)	0.92 (0.87-0.96)	0.93 (0.89-0.98)
Race						
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	1.57 (1.16-2.12)	2.05 (1.63-2.57)	2.32 (1.84-2.92)	1.62 (1.27-2.06)	2.33 (1.79-3.03)	2.39 (1.88-3.03)
Non-Hispanic other	1.26 (1.04-1.51)	1.45 (1.27-1.66)	1.58 (1.38-1.82)	1.23 (1.05-1.44)	1.38 (1.17-1.64)	1.49 (1.22-1.81)
Male	0.91 (0.78-1.06)	0.89 (0.76-1.06)	0.81 (0.67-0.99)	0.83 (0.74-0.93)	0.87 (0.76-0.99)	0.90 (0.78-1.03)
Unadjusted	0.15 (0.08-0.27)	0.14 (0.06-0.32)	0.15 (0.07-0.35)	0.09 (0.06-0.14)	0.09 (0.06-0.15)	0.10 (0.06-0.16)

Abbreviations: e-cigarette, electronic cigarette; OR, odds ratio.

[a] Excludes respondents with missing values for e-cigarette use, cigarette smoking, and covariates. Experimentation indicates ever tried smoking cigarettes, even 1 or 2 puffs.

[b] Based on answers to "When was the last time you smoked a cigarette, even 1 or 2 puffs?"

[c] Responded "not in the past 30 days but in the past 6 months" to the abstinence question.

[d] Responded "not in the past 6 months but in the past year" to the abstinence question.

[e] Responded "1 to 4 years ago" or "5 or more years ago" to the abstinence question.

[f] Ever tried an e-cigarette (in 2011, n = 468 [9.1% of experimenters]; in 2012, n = 1313 [23.1% of experimenters]).

[g] Used an e-cigarette in the past 30 days (in 2011, n = 154 [3.0% of experimenters]; in 2012, n = 423 [7.4% of experimenters]).

contrast, in pooled analyses, neither ever e-cigarette use (OR = 1.01; 95% CI, 0.77-1.34) nor current e-cigarette use (OR = 0.89; 95% CI, 0.61-1.30) was significantly associated with having made a quit attempt in the past 12 months after adjusting for covariates.

We also ran all analyses unadjusted by demographic variables, with little impact on the effects of e-cigarette use, indicating that the results were not due to confounding by demographic variables (Tables 3, 4, and 5).

Discussion

As with adults,[8-10] dual use of e-cigarettes and conventional cigarettes is high among adolescents and increasing rapidly. Adolescents who had ever experimented with cigarettes (smoked at least a puff) and used e-cigarettes were more likely to report having smoked at least 100 cigarettes and to be current smokers than adolescents who never used e-cigarettes. Thus, in combination with the observations that e-cigarette users are heavier smokers and less likely to have stopped smoking cigarettes, these results suggest that e-cigarette use is aggravating rather than ameliorating the tobacco epidemic among youths. These results call into question claims[15,26,27] that e-cigarettes are effective as smoking cessation aids.

Our US results are consistent with those for Korean youths,[3] with high levels of dual use in both populations. Current e-cigarette users (past 30 days) were much less likely to have abstained from smoking cigarettes in the past 30 days in both populations (≥1 puff but not in past 30 days: OR = 0.10; 95% CI, 0.09-0.12 in Korean youths vs OR = 0.15; 95% CI, 0.08-0.28 for experimenters with cigarettes in US youths). Among current cigarette-smoking youths in Korea, there was a significant association between current e-cigarette use and attempting to quit smoking in the past 12 months (OR = 1.67; 95% CI, 1.48-1.90), but there was not a significant association for US youths (OR = 1.20; 95% CI, 0.65-2.23). This difference may reflect behavioral differences between the 2 countries but may also reflect the lower power in our study. The Korean sample was much larger than ours (75 643 vs 17 320 individuals, respectively) with higher prevalence of current (12.1% vs 5.0%)

Table 5. Ever and Current Electronic Cigarette Use by Abstinence From Smoking Conventional Cigarettes Among Ever Smokers in the 2011 National Youth Tobacco Survey[a]

	Abstinence, OR (95% CI)[b]					
	2011 (n = 860)			2012 (n = 972)		
Dependent Variable	30 d[c]	6 mo[d]	1 y[e]	30 d[c]	6 mo[d]	1 y[e]
Ever e-cigarette use[f]						
Adjusted	0.57 (0.31-1.04)	0.48 (0.18-1.23)	0.40 (0.10-1.53)	0.64 (0.40-1.03)	0.54 (0.32-0.90)	0.30 (0.16-0.56)
Age, y	1.09 (0.98-1.22)	1.08 (0.93-1.26)	0.99 (0.85-1.15)	0.94 (0.80-1.10)	0.94 (0.80-1.10)	0.93 (0.77-1.12)
Race						
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	0.81 (0.22-3.01)	1.65 (0.38-7.07)	2.55 (0.44-14.80)	0.40 (0.16-0.99)	0.52 (0.14-1.87)	0.48 (0.10-2.23)
Non-Hispanic other	1.12 (0.72-1.74)	1.30 (0.66-2.55)	1.59 (0.60-4.19)	1.08 (0.65-1.79)	1.23 (0.62-2.45)	1.22 (0.61-2.41)
Male	0.87 (0.53-1.42)	1.49 (0.67-3.34)	1.97 (0.72-5.40)	1.53 (0.98-2.38)	1.55 (0.85-2.80)	1.74 (0.82-3.69)
Unadjusted	0.56 (0.31-1.02)	0.47 (0.19-1.18)	0.38 (0.10-1.48)	0.69 (0.44-1.09)	0.57 (0.35-0.92)	0.31 (0.17-0.58)
Current e-cigarette use[g]						
Adjusted	0.61 (0.23-1.64)	0.73 (0.20-2.71)	0.79 (0.14-4.42)	0.22 (0.09-0.56)	0.17 (0.06-0.49)	0.24 (0.08-0.75)
Age, y	1.08 (0.97-1.21)	1.07 (0.92-1.25)	0.99 (0.85-1.15)	0.92 (0.78-1.07)	0.91 (0.78-1.08)	0.90 (0.74-1.09)
Race						
Non-Hispanic white	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]	1 [Reference]
Non-Hispanic black	0.91 (0.25-3.38)	1.89 (0.46-7.84)	2.96 (0.52-16.73)	0.40 (0.17-0.94)	0.56 (0.17-1.81)	0.65 (0.16-2.58)
Non-Hispanic other	1.19 (0.77-1.85)	1.40 (0.72-2.73)	1.74 (0.65-4.65)	1.16 (0.69-1.98)	1.35 (0.67-2.73)	1.38 (0.68-2.78)
Male	0.85 (0.52-1.39)	1.44 (0.65-3.15)	1.86 (0.68-5.09)	1.61 (1.04-2.49)	1.60 (0.90-2.84)	1.71 (0.82-3.57)
Unadjusted	0.56 (0.22-1.47)	0.75 (0.20-2.83)	0.89 (0.16-4.95)	0.25 (0.10-0.61)	0.20 (0.07-0.53)	0.27 (0.09-0.81)

Abbreviations: e-cigarette, electronic cigarette; OR, odds ratio.

[a] Excludes respondents with missing values for e-cigarette use, cigarette smoking, and covariates. Ever smokers are those who have smoked at least 100 cigarettes in lifetime.

[b] Based on answers to "When was the last time you smoked a cigarette, even 1 or 2 puffs?"

[c] Responded "not in the past 30 days but in the past 6 months" to the abstinence question.

[d] Responded "not in the past 6 months but in the past year" to the abstinence question.

[e] Responded "1 to 4 years ago" or "5 or more years ago" to the abstinence question.

[f] Ever tried an e-cigarette (in 2011, n = 234 [27.2% of ever cigarette smokers]; in 2012, n = 562 [57.8% of ever smokers]).

[g] Used an e-cigarette in the past 30 days (in 2011, n = 80 [9.3% of ever cigarette smokers]; in 2012, 237 [24.4% of ever smokers]).

and ever (26.3% vs 5.6%) cigarette smoking and current (4.7% vs 1.1%) and ever (9.4% vs 3.1%) e-cigarette use.

Although e-cigarettes deliver many fewer toxins and at much lower levels than conventional cigarettes,[28-30] they contain nicotine, a highly addictive substance,[31] in doses designed to mimic cigarettes. Animal models suggest that, through its effect on cholinergic pathways, nicotine may have permanent effects on the brain and behavior[32,33] such as dysregulation of the limbic system, which can lead to long-term difficulties with behavioral regulation, attention, memory, and motivation, among other functions.[33,34] The adolescent human brain may be particularly vulnerable to the effects of nicotine because it is still developing.[35-37]

This is a cross-sectional study, which only allows us to identify associations, not causal relationships. Our results are also limited by the lack of information about motivation for using e-cigarettes (eg, popularity, trendy, smoking cessation) and the fact that they only apply to middle and high school students, not all US youths.

In comparison with the 8.0% and 8.6% of respondents who had missing data in 2011 and 2012, respectively, and were dropped, our analytical sample had slightly more girls (2011: 42.9% vs 49.4%, $P = .007$; 2012: 38.3% vs 49.9%, $P < .001$) and more white respondents (2011: 39.5% vs 56.6%, $P < .001$; 2012: 39.8% vs 54.7%, $P < .001$) (eTable 3 in Supplement). In 2012 only, our sample compared with students with missing data also had a lower prevalence of e-cigarette use (6.5% vs 10.2%; $P = .002$) and was slightly younger (mean age, 14.6 vs 14.2 years; $P < .001$). There were no significant differences by any of the other demographic, e-cigarette use, or cigarette smoking variables.

Conclusions

While the cross-sectional nature of our study does not allow us to identify whether most youths are initiating smoking with conventional cigarettes and then moving on to (usually dual use of) e-cigarettes or vice versa, our results suggest that e-cigarettes are not discouraging use of conventional cigarettes. Among experimenters with conventional cigarettes, e-cigarette use is associated with established cigarette smoking and lower rates of abstinence from conventional cigarettes. The debate over

e-cigarettes[2,28,31,38-40] has centered on whether e-cigarettes could be useful as a harm-reduction strategy in established adult cigarette smokers. The results of our study together with those from the study in Korea[3] suggest that e-cigarettes may contribute to nicotine addiction and are unlikely to discourage conventional cigarette smoking among youths.

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Study concept and design: Dutra, Glantz.
Analysis and interpretation of data: Dutra, Glantz.
Drafting of the manuscript: Dutra, Glantz.
Critical revision of the manuscript for important intellectual content: Dutra, Glantz.
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REFERENCES

1. WHO Study Group on Tobacco Product Regulation, World Health Organization. *Report on the Scientific Basis of Tobacco Product Regulation: Third Report of a WHO Study Group*. Geneva, Switzerland: World Health Organization; 2009.

2. Cobb NK, Byron MJ, Abrams DB, Shields PG. Novel nicotine delivery systems and public health: the rise of the "e-cigarette." *Am J Public Health*. 2010;100(12):2340-2342.

3. Lee S, Grana RA, Glantz SA. Electronic cigarette use among Korean adolescents: a cross-sectional study of market penetration, dual use, and relationship to quit attempts and former smoking [published online November 22, 2013]. *J Adolesc Health*. doi:10.1016/j.jadohealth.2013.11.003.

4. Cobb NK, Abrams DB. E-cigarette or drug-delivery device? regulating novel nicotine products. *N Engl J Med*. 2011;365(3):193-195.

5. Grana R, Ling P. Smoking revolution? a content analysis of electronic cigarette retail websites. *Am J Prev Med*. In press.

6. US Department of Health and Human Services. *Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General*. Atlanta, GA: US Dept of Health & Human Services, Centers for Disease Control & Prevention, National Center for Chronic Disease Prevention & Health Promotion, Office on Smoking & Health; 2012.

7. Corey C, Wang B, Johnson SE, et al; Centers for Disease Control and Prevention. Notes from the field: electronic cigarette use among middle and high school students: United States, 2011-2012. *MMWR Morb Mortal Wkly Rep*. 2013;62(35):729-730.

8. Pearson JL, Richardson A, Niaura RS, Vallone DM, Abrams DB. E-cigarette awareness, use, and harm perceptions in US adults. *Am J Public Health*. 2012;102(9):1758-1766.

9. Regan AK, Promoff G, Dube SR, Arrazola R. Electronic nicotine delivery systems: adult use and awareness of the "e-cigarette" in the USA. *Tob Control*. 2013;22(1):19-23.

10. Rath JM, Villanti AC, Abrams DB, Vallone DM. Patterns of tobacco use and dual use in US young adults: the missing link between youth prevention and adult cessation. *J Environ Public Health*. 2012;2012:679134.

11. King BA, Alam S, Promoff G, Arrazola R, Dube SR. Awareness and ever-use of electronic cigarettes among US adults, 2010-2011. *Nicotine Tob Res*. 2013;15(9):1623-1627.

12. Lee S, Kimm H, Yun JE, Jee SH. Public health challenges of electronic cigarettes in South Korea. *J Prev Med Public Health*. 2011;44(6):235-241.

13. de Andrade M, Hastings G. The marketing of e-cigarettes: a UK snapshot. http://blogs.bmj.com/tc/2013/04/06/the-marketing-of-e-cigarettes-a-uk-snapshot/. Accessed April 16, 2013.

14. Yamin CK, Bitton A, Bates DW. E-cigarettes: a rapidly growing Internet phenomenon. *Ann Intern Med*. 2010;153(9):607-609.

15. Etter JF. Electronic cigarettes: a survey of users. *BMC Public Health*. 2010;10:231.

16. Pokhrel P, Fagan P, Little MA, Kawamoto CT, Herzog TA. Smokers who try e-cigarettes to quit smoking: findings from a multiethnic study in Hawaii. *Am J Public Health*. 2013;103(9):e57-e62.

17. Vickerman KA, Carpenter KM, Altman T, Nash CM, Zbikowski SM. Use of electronic cigarettes among state tobacco cessation quitline callers. *Nicotine Tob Res*. 2013;15(10):1787-1791.

18. McMillen R, Maduka J, Winickoff J. Use of emerging tobacco products in the United States. *J Environ Public Health*. 2012;2012:989474.

19. Sutfin EL, McCoy TP, Morrell HE, Hoeppner BB, Wolfson M. Electronic cigarette use by college students. *Drug Alcohol Depend*. 2013;131(3):214-221.

20. Dockrell M, Morrison R, Bauld L, McNeill A. E-cigarettes: prevalence and attitudes in Great Britain. *Nicotine Tob Res*. 2013;15(10):1737-1744.

21. Adkison SE, O'Connor RJ, Bansal-Travers M, et al. Electronic nicotine delivery systems: international tobacco control four-country survey. *Am J Prev Med*. 2013;44(3):207-215.

22. Bullen C, Howe C, Laugesen M, et al. Electronic cigarettes for smoking cessation: a randomised controlled trial. *Lancet*. 2013;382(9905):1629-1637.

23. Popova L, Ling PM. Alternative tobacco product use and smoking cessation: a national study. *Am J Public Health*. 2013;103(5):923-930.

24. Centers for Disease Control and Prevention. *2011 National Youth Tobacco Survey Methodology Report*. Atlanta, GA: Centers for Disease Control & Prevention; 2011.

25. Centers for Disease Control and Prevention. Smoking and tobacco use: National Youth Tobacco Survey (NYTS). http://www.cdc.gov/tobacco/data_statistics/surveys/nyts/. Accessed September 15, 2013.

26. Chan A. Electronic cigarettes help you quit smoking as well as nicotine patches: study. http://www.huffingtonpost.com/2013/09/07/electronic-cigarettes-quit-smoking-nicotine-patches_n_3881863.html. Accessed September 7, 2013.

27. Durning MV. Electronic cigarettes may help you quit smoking, new study shows. http://www.forbes.com/sites/marijkevroomendurning/2013/09/10/electronic-cigarettes-may-help-you-quit-smoking-new-zealand-study-shows/. Accessed September 10, 2013.

28. Cahn Z, Siegel M. Electronic cigarettes as a harm reduction strategy for tobacco control: a step forward or a repeat of past mistakes? *J Public Health Policy*. 2011;32(1):16-31.

29. Laugesen M. Safety report on the Ruyan e-cigarette cartridge and inhaled aerosol. http://www.healthnz.co.nz/DublinEcigBenchtopHandout.pdf. Accessed October 4, 2013.

30. Goniewicz ML, Knysak J, Gawron M, et al. Levels of selected carcinogens and toxicants in vapour from electronic cigarettes. *Tob Control*. 2014;23(2):133-139.

31. Benowitz NL, Goniewicz ML. The regulatory challenge of electronic cigarettes. *JAMA*. 2013;310(7):685-686.

32. Liao C-Y, Chen Y-J, Lee J-F, Lu C-L, Chen C-H. Cigarettes and the developing brain: picturing nicotine as a neuroteratogen using clinical and preclinical studies. *Tzu Chi Med J*. 2012;24(4):157-161. doi:10.1016/j.tcmj.2012.08.003.

33. Dwyer JB, Broide RS, Leslie FM. Nicotine and brain development. *Birth Defects Res C Embryo Today*. 2008;84(1):30-44.

34. Dwyer JB, McQuown SC, Leslie FM. The dynamic effects of nicotine on the developing brain. *Pharmacol Ther*. 2009;122(2):125-139.

35. Slotkin TA. Cholinergic systems in brain development and disruption by neurotoxicants: nicotine, environmental tobacco smoke, organophosphates. *Toxicol Appl Pharmacol*. 2004;198(2):132-151.

36. Goriounova NA, Mansvelder HD. Short- and long-term consequences of nicotine exposure during adolescence for prefrontal cortex neuronal network function. *Cold Spring Harb Perspect Med*. 2012;2(12):a012120.

37. Gogtay N, Giedd JN, Lusk L, et al. Dynamic mapping of human cortical development during childhood through early adulthood. *Proc Natl Acad Sci U S A*. 2004;101(21):8174-8179.

38. The Lancet Oncology. Time for e-cigarette regulation. *Lancet Oncol*. 2013;14(11):1027.

39. Henningfield JE, Zaatari GS. Electronic nicotine delivery systems: emerging science foundation for policy. *Tob Control*. 2010;19(2):89-90.

40. Flouris AD, Oikonomou DN. Electronic cigarettes: miracle or menace? *BMJ*. 2010;340:c311.

Supplementary Online Content

Dutra LM, Glantz SA. Electronic cigarettes and conventional cigarette use among US adolescents: a cross-sectional study. *JAMA Pediatr*. Published online March 6, 2014. doi:10.1001/jamapediatrics.2013.5488.

eTable 1. Pooled analyses of the association between current e-cigarette use[a] and ever e-cigarette[b] use with experimentation with cigarettes[c], ever smoking[d], and current cigarette use[e] in the 2011 (n=17,353) and 2012 (n=22,529) National Youth Tobacco Surveys [f]

eTable 2. Current e-cigarette use[a] and ever e-cigarette[b] use and experimentation with cigarettes[c], ever smoking[d], and current cigarette use[e] in the National Youth Tobacco Survey (2011: n=17,353, 2012: n=22,529) [f]

eTable 3. Comparison of sociodemographic characteristics of respondents in the 2011 National Youth Tobacco Survey (NYTS) of respondents with no missing values (2011: n=17,353, 2012: n=22,529)[a] versus one or more missing values (2011: n=1513, 2012: n=2129)

This supplementary material has been provided by the authors to give readers additional information about their work.

eTable 1. Pooled analyses of the association between current e-cigarette use[a] and ever e-cigarette[b] use with experimentation with cigarettes[c], ever smoking[d], and current cigarette use[e] in the 2011 (n=17,353) and 2012 (n=22,529) National Youth Tobacco Surveys [f]

Dependent Variable	Experimentation[c] OR (95%CI)	Ever smoking[d] OR (95%CI)	Current smoking[e] OR (95%CI)
Ever e-cig use[b]	30.46 (25.39-36.53)	21.81 (18.39-25.86)	20.45 (17.20-24.31)
Current e-cig use[a]	28.65 (20.46-40.13)	23.47 (17.41-31.64)	24.35 (18.15-32.67)

[a] Used an e-cigarette in the past 30 days.
[b] Having ever tried an e-cigarette
[c] Ever tried smoking (cigarettes), even one or two puffs
[d] Smoked at least 100 cigarettes in lifetime.
[e] Smoked at least 100 cigarettes in lifetime and at least a puff of a cigarette in the past 30 days.
[f] Excludes respondents with missing values for e-cigarette use, cigarette smoking, and covariates

eTable 2. Current e-cigarette use[a] and ever e-cigarette[b] use and experimentation with cigarettes[c], ever smoking[d], and current cigarette use[e] in the National Youth Tobacco Survey (2011: n=17,353, 2012: n=22,529) [f]

	2011			2012		
Dependent Variable	**Experimentation[c]** OR (95%CI)	**Ever smoking[d]** OR (95%CI)	**Current smoking[e]** OR (95%CI)	**Experimentation[c]** OR (95%CI)	**Ever smoking[d]** OR (95%CI)	**Current smoking[e]** OR (95%CI)
Ever e-cig use[b,g]	24.81 (16.68-36.89)	22.80 (16.11-32.27)	21.86 (15.77-30.29)	32.16 (26.21-39.46)	21.50 (17.68-26.14)	19.92 (16.24-24.43)
Age (cont.)	1.41 (1.36-1.47)	1.60 (1.49-1.71)	1.57 (1.46-1.68)	1.40 (1.35-1.44)	1.46 (1.37-1.55)	1.46 (1.36-1.56)
NH White	REF	REF	REF	REF	REF	REF
NH Black	1.14 (0.92-1.41)	0.40 (0.24-0.65)	0.46 (0.28-0.75)	1.32 (1.07-1.62)	0.51 (0.32-0.81)	0.54 (0.34-0.85)
NH Other	1.48 (1.25-1.76)	0.90 (0.65-1.25)	0.94 (0.68-1.29)	1.40 (1.18-1.66)	0.85 (0.67-1.09)	0.88 (0.68-1.15)
Male	1.12 (0.99-1.26)	1.41 (1.15-1.74)	1.47 (1.19-1.82)	1.16 (1.06-1.28)	1.58 (1.33-1.89)	1.49 (1.25-1.79)
Ever e-cig use (unadjusted)	27.36 (18.33-40.85)	29.01 (20.86-4.33)	28.37 (20.74-38.83)	37.31 (30.41-45.78)	31.05 (25.44-37.68)	29.11 (23.79-35.62)
Current e-cig use[a,i]	22.10 (12.34-39.57)	22.15 (12.04-40.77)	20.20 (11.38-35.89)	32.64 (21.60-49.32)	23.90 (16.97-33.67)	26.02 (18.48-36.63)
Age (cont.)	1.43 (1.38-1.48)	1.64 (1.54-1.75)	1.62 (1.51-1.73)	1.43 (1.39-1.48)	1.59 (1.51-1.66)	1.59 (1.50-1.68)
NH White	REF	REF	REF	REF	REF	REF
NH Black	1.06 (0.86-1.31)	0.32 (0.20-0.52)	0.37 (0.23-0.59)	1.10 (0.89-1.37)	0.35 (0.22-0.55)	0.37 (0.24-0.58)
NH Other	1.43 (1.20-1.70)	0.83 (0.60-1.15)	0.86 (0.62-1.18)	1.26 (1.06-1.50)	0.71 (0.55-0.91)	0.73 (0.55-0.97)
Male	1.13 (1.00-1.27)	1.43 (1.16-1.76)	1.48 (1.20-1.83)	1.19 (1.07-1.31)	1.65 (1.36-2.00)	1.56 (1.29-1.89)
Current e-cig use (unadjusted)	20.46 (11.56-36.20)	21.61 (12.91-36.17)	20.68 (12.60-33.93)	34.44 (23.84-49.76)	29.42 (22.35-38.73)	32.14 (24.32-42.48)

[a] In 2011, 174 (1.1%) had used an e-cigarette in the past 30 days; in 2012, 462 (2.0%)
[b] In 2011, 511 (3.1%) had ever tried e-cigarettes; in 2012, 1450 (6.5%)
[c] Ever tried smoking (cigarettes), even one or two puffs
[d] Smoked at least 100 cigarettes in lifetime.
[e] Smoked at least 100 cigarettes in lifetime and at least a puff of a cigarette in the past 30 days.
[f] Excludes respondents with missing values for e-cigarette use, cigarette smoking, and covariates

eTable 3. Comparison of sociodemographic characteristics of respondents in the 2011 National Youth Tobacco Survey (NYTS) of respondents with no missing values (2011: n=17,353, 2012: n=22,529)[a] versus one or more missing values (2011: n=1513, 2012: n=2129)

	2011			2012		
	Non-missing %(n)	Missing % (n)	p-value	Non-missing %(n)	Missing % (n)	p-value
All						
Gender						
Male	50.6% (8544)	57.1% (740)	.0074	50.1% (11093)	61.8% (1276)	<.0001
Female	49.4% (8809)	42.9% (506)		49.9% (11436)	38.3% (839)	
Race			<.0001			<.0001
NH White	56.6% (6731)	39.5% (251)		54.7% (11311)	39.8% (503)	
NH Black	13.9% (3102)	18.5% (220)		13.5% (2886)	20.5% (228)	
Other	29.5% (7520)	42.0% (571)		31.8% (8332)	39.7% (612)	
Ever cigarette smoking[b]						
Ever smokers	5.6% (860)	5.8% (66)	.8376	4.5% (972)	5.2% (99)	.2748
Never smokers	94.4% (16493)	94.2% (1139)		95.5% (21557)	94.8% (1882)	
Dual ever use[b,c]	1.7% (232)	1.1% (12)		2.6% (562)	0.5% (35)	
Current cigarette smoking[d]						
Smoker	5.0% (778)	4.0% (41)	.2134	4.0% (869)	4.0% (77)	.9974
Nonsmoker	95.0% (16575)	96.0% (1141)		96.0% (21660)	96.0% (1885)	
Dual current use[d,e]	0.5% (75)	0.0% (0)		1.0% (230)	0.3% (4)	
Ever e-cig use[c]	3.1% (511)	3.0% (47)	.7669	6.5% (1450)	10.2% (139)	.0019
Current e-cig use[e]	1.1% (174)	0.8% (11)	.2964	2.0% (462)	2.9% (38)	.1140
	Mean (SD)			Mean (SD)		
Age (years)	14.7 (0.1)	14.3 (0.1)	.2795	14.6 (0.1)	14.2 (.10)	<.0001

[a] Participants without missing values are those with complete values for e-cigarette use, cigarette smoking, and covariates
[b] Smoked at least 100 cigarettes in lifetime
[c] Having ever tried an e-cigarette
[d] Smoked at least 100 cigarettes in lifetime and at least a puff in past 30 days
[e] Used an e-cigarette in the past 30 days