

Brief report

Patterns of Electronic Cigarette Use Among Adults in the United States

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Abstract

Introduction: Amid increasing rates of electronic cigarette (e-cigarette) use in the United States, there is an urgent need to monitor patterns of use at the population level in order to inform practice, policy and regulation. This article examines how patterns of e-cigarette use among adults differ between users and nonusers of cigarettes using the most current national data.

Methods: We analyzed data from the 2014 National Health Interview Survey. We estimated prevalence of ever, current, and daily e-cigarette use and examined how use patterns differed by demographic subgroups and measures of cigarette smoking status that accounted for the recent availability of e-cigarettes in the US marketplace.

Results: Current e-cigarette use is extremely low among never cigarette smokers (0.4%) and former smokers who quit cigarettes 4 or more years ago (0.8%). Although e-cigarette experimentation is most common among current cigarette smokers and young adults, daily use is highest among former smokers who quit in the past year (13.0%) and older adults. Compared to daily cigarette smokers, recently quit smokers were more than four times as likely to be daily users of e-cigarettes (AOR: 4.33 [95% CI: 3.08–6.09]).

Conclusions: Extremely low e-cigarette use among never-smokers and longer term former smokers suggest that e-cigarettes neither promote widespread initiation nor relapse among adults. Recognition of the heterogeneity of smokers, including the time since quitting, is critical to draw accurate conclusions about patterns of e-cigarette use at the population level and its potential for public health benefit or harm.

Implications: Data from 2014 National Health Interview Survey indicate that e-cigarettes have not been attracting adult non-smokers or promoting relapse in longer term former smokers. Moreover, the data are suggestive that some recent quitters may have done so with the assistance of e-cigarettes. Creating measures of smoking status that treat former smokers as a homogenous group is insufficient to assess the epidemiology of e-cigarette use and the potential impact on public health.

Introduction

When the Family Smoking Prevention and Tobacco Control Act (FSPTCA) became law in 2009, electronic cigarettes (e-cigarettes) were still peripheral tobacco products. Subsequently, e-cigarettes entered the traditional tobacco retail environment and quickly gained mainstream status. Since 2010, e-cigarette sales have grown significantly and are expected to generate \$3.5 billion in sales by the end of 2015.¹ Increases in sales are mirrored by increased prevalence of use among both youth^{2–5} and adults,^{6–9} although the majority of e-cigarette users are experimenters and have a history of tobacco use.^{6,8,10–12} Occurring concomitantly with the rise in e-cigarette use is a substantial decline in current smoking rates among adults, which have reached their lowest levels in decades, according to recently released CDC data.¹³ Regulators, policymakers and practitioners are interested in emerging evidence of patterns of e-cigarette and cigarette use and to what extent this evolving market for alternative nicotine delivery products may be beneficial or harmful to the population of users and nonusers.

Evidence to date indicates that e-cigarettes release far fewer toxins and carcinogens and at much lower levels compared to cigarettes.^{14–16} Despite their reduced risk promise, questions remain as to whether e-cigarettes are effective aids for smoking cessation, promote uptake by nontobacco users, discourage cessation via dual use, or encourage relapse to cigarette use among former smokers. Existing observational studies are largely uninformative due to methodologic flaws.^{17,18} Much of the early population-level studies on adult e-cigarette use have relied on crude measures of use, such as once or more in the past 30 days,¹⁹ or ever use,^{6,20} which do not capture frequency, intensity, or reasons for use.^{11,18,21} Two randomized trials suggest e-cigarettes may facilitate cigarette cessation or reduction.²² Studies suggest higher cigarette abstinence with adherence to daily e-cigarette use.^{23,24}

E-cigarettes are currently unregulated, but the FDA recently issued a deeming notice and intends to regulate them. This article uses the recently released 2014 National Health Interview Survey (NHIS) data to document e-cigarette use patterns among adults in the United States. In particular, we focus on “daily” e-cigarette use—a stronger measure of “established use”—and its association with demographic characteristics and cigarette smoking status.

Methods

We analyzed data from the 2014 NHIS, the first NHIS survey year to include measures on e-cigarette use. Details about the NHIS methodology are published elsewhere.²⁵ Briefly, the NHIS is a cross-sectional survey that collects data on a variety of health indicators via computer assisted personal interviewing. It uses a multi-stage area probability sampling design to produce nationally representative estimates of the noninstitutionalized, civilian adult (≥ 18 years) population. The 2014 NHIS collected data from 36 697 adults.

The main outcome of interest, e-cigarette use status, was derived from two questions that addressed ever use (ie, “Have you ever used an e-cigarette, even one time?”) and current use (ie, “Do you now use e-cigarettes every day, some days, or not at all?”). Individuals responding “no” to the ever use question were considered “never users,” and those who had ever used e-cigarettes but now used “not at all” were considered “former triers.” Remaining respondents were classified as “some day” or “daily” e-cigarette users. Three separate logistic regressions modeled the odds of being an “ever,” “current” (ie, some day or daily) and “daily” e-cigarette user. Covariates included

age group, gender, race/ethnicity, census region, and cigarette smoking history. The cigarette smoking history variable was constructed with six categories: current daily cigarette smoker (12.8%), current some day cigarette smoker (3.9%), recent quitter (ie, quit 1 year ago or less; 2.9%), former smoker who quit 2 to 3 years ago (1.7%), former smokers who quit 4 or more years ago (17.2%), and never-smokers (61.1%). The former smoker categories reflect the timeframe in which e-cigarettes gained popularity in the marketplace.

Data were analyzed using SUDAAN, version 11.0.1,²⁶ which corrects for the complex sampling design. Sample weights corrected for varying probabilities of selection and yielded weighted distributions for gender, age, race/ethnicity and census region on par with population patterns for adults in the United States. Adjusted odds ratios (AORs) with 95% confidence intervals (95% CIs) are reported, and a *P* value of less than .05 determined statistical significance.

Results

Overall, 12.6% of adults report having ever tried e-cigarettes, 3.7% report using e-cigarettes currently and 1.1% report using e-cigarettes daily (Table 1). Ever use is highest among males, young adults (aged 18–24), whites, and those with a history of smoking. For example, nearly half (49%) of daily cigarette smokers have ever tried an e-cigarette, compared to 12.6% of all US adults. A closer examination of current e-cigarette users reveals substantial group-level differences in the frequency of e-cigarette use. Whereas “some day” use of e-cigarettes is most common among daily and some day cigarette smokers, the highest prevalence of daily e-cigarette use is seen among former smokers who quit within the past year. These recent quitters are nearly four times more likely to be daily users of e-cigarettes than current cigarette smokers (13.0% vs. 3.5%, respectively).

In a multivariable logistic regression, age group, race/ethnicity, cigarette smoking status, and geographic region were all significantly related to ever and current e-cigarette use, such that young adults, whites, daily smokers, and those living in the West had higher odds of e-cigarette experimentation and current use than their comparison groups (Table 2). However, demographic patterns of use change when daily use is examined. Although current e-cigarette use was significantly less likely among older adults compared to the youngest age group, this relationship disappears in the model assessing daily e-cigarette use, and in fact, older adults had a slightly higher prevalence of daily use. Compared with daily cigarette smokers, former smokers had lower odds of ever or current (ie, some day or daily) e-cigarette use, but this pattern reverses for daily e-cigarette use. Indeed, the odds of being a daily e-cigarette user were more than four times greater for recently quit smokers compared to daily smokers (AOR: 4.33 [95% CI: 3.08–6.09]). A similar relationship was noted among former smokers who quit between 2–3 years ago (AOR: 1.96 [95% CI: 1.15–3.34]).

Discussion

The NHIS is the nation’s primary source for estimates of adult health behaviors and is considered to be the gold standard for US Health Survey Data. This study presents the first NHIS estimates of ever, current and daily e-cigarette use and highlights how e-cigarette use patterns differ by various smoking status and sociodemographic subgroups. E-cigarette experimentation was extremely low for adults who never smoked cigarettes or who quit more than 4 years ago. This suggests that e-cigarettes are neither attracting nonsmokers nor leading

Table 1. Electronic Cigarette (E-Cigarette) Use Patterns Among US Adults by Demographics and Smoking Status, 2014 National Health Interview Survey (n = 36 697)^a

	Never user	Former trier ^b	Someday ^c	Daily
	% (95% CI)	% (95% CI)	% (95% CI)	% (95% CI)
Sex				
Male (48.2%)	85.8 (84.8–86.7)	10.1 (9.4–10.7)	2.9 (2.3–3.5)	1.3 (1.1–1.6)
Female (51.8%)	88.9 (88.1–89.6)	7.8 (7.3–8.3)	2.4 (1.9–2.9)	1.0 (0.8–1.3)
Age group				
18 to 24 (12.6%)	78.4 (75.9–80.7)	16.5 (14.7–18.6)	4.3 (2.9–6.1)	0.9 (0.5–1.4)
25 to 44 (34.2%)	83.4 (82.4–84.4)	11.9 (11.1–12.8)	3.2 (2.8–3.7)	1.5 (1.2–1.8)
45 to 64 (34.5%)	89.8 (88.9–90.7)	6.6 (6.1–7.3)	2.3 (1.8–2.9)	1.2 (1.0–1.5)
≥65 (18.7%)	96.3 (95.8–96.8)	2.2 (1.9–2.7)	0.8 (0.6–1.2)	0.6 (0.4–0.9)
Race/ethnicity				
White, NH (66.3%)	85.2 (84.3–86.0)	10.3 (9.7–10.9)	3.1 (2.7–3.7)	1.4 (1.2–1.7)
Black, NH (12.0%)	92.4 (91.5–93.2)	5.6 (4.9–6.4)	1.5 (1.1–2.1)	0.4 (0.3–0.7)
Hispanic (15.3%)	91.4 (90.2–92.4)	6.5 (5.6–7.5)	1.7 (1.2–2.3)	0.5 (0.3–0.7)
Other, NH (6.4%)	91.5 (89.9–92.9)	6.1 (5.0–7.4)	1.4 (0.9–2.0)	1.0 (0.5–1.9)
Cigarette smoking status				
Daily smoker (12.8%)	50.9 (48.5–53.3)	32.8 (30.9–34.8)	12.7 (10.9–14.8)	3.5 (2.7–4.4)
Some day smoker (3.9%)	57.4 (53.6–61.1)	27.7 (24.4–31.4)	11.5 (9.2–14.2)	3.4 (2.2–5.2)
Recent quitter—quit 1 year ago or less (2.9%)	52.0 (47.2–56.8)	29.9 (25.8–34.4)	5.0 (3.2–8.0)	13.0 (10.5–16.1)
Former smoker—quit 2 to 3 years ago (1.7%)	66.6 (61.5–71.4)	23.0 (18.7–27.9)	3.8 (2.4–6.2)	6.5 (4.2–9.9)
Former smoker—quit 4+ years ago (17.2%)	95.8 (94.9–96.5)	3.5 (2.9–4.1)	0.6 (0.2–1.3)	0.2 (0.1–0.4)
Never-smoker (61.1%)	96.8 (96.4–97.2)	2.8 (2.5–3.2)	0.3 (0.2–0.5)	0.1 (0.0–0.1)
Region				
Northeast (17.3%)	90.3 (89.0–91.4)	7.3 (6.4–8.4)	1.5 (1.1–1.9)	0.9 (0.6–1.5)
Midwest (23.0%)	84.9 (83.5–86.2)	10.6 (9.8–11.5)	3.2 (2.4–4.3)	1.2 (0.9–1.7)
South (37.2%)	87.7 (86.6–88.7)	8.4 (7.7–9.2)	2.7 (2.1–3.4)	1.2 (1.0–1.5)
West (22.5%)	87.2 (86.2–88.2)	9.0 (8.2–9.9)	2.7 (2.2–3.2)	1.1 (0.8–1.4)
Overall	87.4 (86.8–88.0)	8.9 (8.5–9.3)	2.6 (2.3–3.0)	1.1 (1.0–1.3)

CI = confidence interval; NH = non-Hispanic.

^aPrevalence estimates used weighted data.

^bHave ever tried an e-cigarette but currently use “not at all”.

^cCurrently use e-cigarettes “some days”.

to relapse back to smoking among long term former smokers. Recent quitters may well be using e-cigarettes to prevent a return to smoking, but more precise measures of when, why, and how e-cigarette use was initiated and is continuing are needed. Such questions and also longitudinal cohort studies will help to better understand issues such as dual use, exclusive e-cigarette use and/or e-cigarette use as a potential cessation aid among this subgroup of recent former smokers. Coupled with a significant drop in the US cigarette smoking rate it is unlikely that e-cigarette use is slowing or undermining cessation of cigarettes and it is plausible that e-cigarette use is helping some smokers quit and stay quit. Consistent with earlier studies,^{6,9,10} young adults report the highest prevalence of e-cigarette experimentation compared to older adults. However, daily use is substantially more common among older adults aged 25–64, suggesting that reasons for e-cigarette use may differ by age. Our findings add to a growing literature linking higher e-cigarette experimentation and occasional use with current cigarette smoking,^{6–8,11,10} but reveal that daily e-cigarette use is most common among adults who have recently quit smoking cigarettes. Indeed, recent cigarette quitters are nearly four times more likely than current cigarette smokers to be daily users of e-cigarettes (13.0% vs. 3.5%, respectively). The cross-sectional nature of the study precludes examination of whether these former adult smokers used e-cigarettes to quit, but, these findings are consistent with two recent longitudinal studies that found an association between sustained daily e-cigarette use and cigarette smoking cessation behavior in adults.^{23,24}

Our analytic approach differs from most published literature in that we considered the heterogeneity of former smokers; specifically, we categorized this group based on the amount of time since they quit. Traditionally, population level analyses treat smoking status as a four-level variable (ie, daily, someday, former, never). In a post hoc sensitivity analysis, the standard four category measure of smoking status resulted in former smokers having *lower* odds of daily e-cigarette use (AOR: 0.84 [95% CI: 0.60–1.16]), a complete reversal from our study’s findings. Nearly 1 in 5 adults in the United States is a former smoker, with 17.2% of adults having quit prior to e-cigarette availability. Temporal factors, such as the availability of e-cigarettes in traditional retail setting, or implementation of the Affordable Care Act in 2010 which resulted in increased focus on prevention in healthcare, including smoking cessation, can change the conditions under which quitting behaviors occur. Grouping former smokers into a single broad category potentially ignores important contextual information about the public health landscape during their quit attempts that could influence conclusions.

A recent report commissioned by Public Health England concluded that e-cigarette use may have contributed to declines in cigarette smoking rates and should be considered for smoking cessation among smokers unable or unwilling to quit using other evidenced-based cessation methods.²⁷ In the United States, the 2014 Surgeon General’s Report suggested that less risky cigarette substitutes, such as e-cigarettes, may aid in reducing tobacco-caused disease.²⁸ As

Table 2. Adjusted Odds Ratio of Ever, Current, and Daily Electronic cigarette (E-Cigarette) Use, 2014 National Health Interview Survey ($n = 36\,697$)^a

	Ever		Current ^b		Daily	
	AOR ^c (95% CI)	P	AOR (95% CI)	P	AOR(95% CI)	P
Sex						
Male	1.1 (0.97–1.25)	.15	1 (0.79–1.27)	.98	1.02 (0.74–1.40)	.93
Female	1 [Reference]		1 [Reference]		1 [Reference]	
Age group						
18 to 24	1 [Reference]		1 [Reference]		1 [Reference]	
25 to 44	0.44 (0.33–0.58)	<.001	0.77 (0.53–1.12)	.17	1.6 (0.96–2.66)	.07
45 to 64	0.22 (0.16–0.29)	<.001	0.62 (0.43–0.91)	.01	1.59 (0.94–2.70)	.08
≥65	0.1 (0.07–0.13)	<.001	0.4 (0.26–0.60)	<.001	1.24 (0.69–2.21)	.47
Race/ethnicity						
White, NH	1 [Reference]		1 [Reference]		1 [Reference]	
Black, NH	0.37 (0.31–0.44)	<.001	0.42 (0.30–0.58)	<.001	0.34 (0.20–0.60)	<.001
Hispanic	0.54 (0.45–0.66)	<.001	0.58 (0.42–0.80)	<.001	0.42 (0.26–0.68)	<.001
Other, NH	0.58 (0.45–0.75)	<.001	0.69 (0.46–1.02)	.06	1.03 (0.51–2.10)	.93
Cigarette smoking status						
Daily smoker	1 [Reference]		1 [Reference]		1 [Reference]	
Some day smoker	0.68 (0.56–0.83)	<.001	0.91 (0.71–1.17)	.47	1.09 (0.64–1.85)	.76
Recent quitter—quit 1 year ago or less	0.8 (0.63–1.00)	.05	1.08 (0.81–1.42)	.61	4.33 (3.08–6.09)	<.001
Former smoker—quit 2 to 3 years ago	0.5 (0.38–0.64)	<.001	0.6 (0.41–0.89)	.01	1.96 (1.15–3.34)	.01
Former smoker—quit 4+ years ago	0.06 (0.05–0.08)	<.001	0.05 (0.03–0.09)	<.001	0.06 (0.03–0.12)	<.001
Never-smoker	0.03 (0.02–0.03)	<.001	0.02 (0.02–0.03)	<.001	0.02 (0.01–0.04)	<.001
Region						
Northeast	0.56 (0.46–0.68)	<.001	0.52 (0.38–0.71)	<.001	0.76 (0.43–1.34)	.35
Midwest	0.71 (0.60–0.85)	<.001	0.74 (0.55–1.00)	.05	0.75 (0.47–1.19)	.22
South	0.73 (0.62–0.87)	<.001	0.84 (0.65–1.10)	.2	0.93 (0.65–1.33)	.7
West	1 [Reference]		1 [Reference]		1 [Reference]	

CI = confidence interval; NH = non-Hispanic.

^aPrevalence estimates and logistic regression output used weighted data.

^bCurrently use e-cigarettes “every day” or “some days”.

^cAOR: adjusted odds ratio (adjusted for all variables displayed in table).

such, there is an urgent need to better understand the potential pros and cons of e-cigarette use at the population level. Until longitudinal data are available on the behavioral trajectories of e-cigarette use, policymakers must rely on cross-sectional data to inform critical policy, practice and regulatory decisions. Improved and standardized measures of e-cigarette use are needed to understand how these products are being used, as well as the progression from experimentation to regular use and the influence of e-cigarette uptake on tobacco use trajectories. Careful measurement, proper categorization, and consideration of contextual factors such as temporal trends in the tobacco retail environment are necessary to accurately describe use of emergent products like e-cigarettes. Failing to do so can yield inaccurate conclusions that may improperly inform practitioners, policymakers and the regulation of these devices.

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Declaration of Interests

CDD, DPG, ACV, JLP, RSN, and DBA have no competing interests. MBS is currently consulting for Arena pharmaceutical.

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