2018

Electronic Cigarette Use Prevalence, Associated Factors, and Pattern by Cigarette Smoking Status in the United States From NHANES (National Health and Nutrition Examination Survey) 2013-2014

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Citation

Electronic Cigarette Use Prevalence, Associated Factors, and Pattern by Cigarette Smoking Status in the United States From NHANES (National Health and Nutrition Examination Survey) 2013–2014

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Background—To examine the prevalence and patterns of recent electronic cigarette (e-cigarette) use in a nationally representative sample of US adults and adolescents.

Methods and Results—Using tobacco information from NHANES (National Health and Nutrition Examination Survey) 2013–2014, 5423 adults and 895 adolescents (aged 13–17 years) were included in this analysis. Demographic, tobacco use, and drug use information were self-reported. Recent e-cigarette use (within the previous 5 days) was stratified by smoking status. Of 125 e-cigarette users, 116 participants were aged ≥18 years, corresponding to 2.6% (95% confidence interval [CI], 2.0–3.1) and 1.21% (95% CI, 0.3–2.1) prevalence of e-cigarette use among US adults and adolescents, respectively. E-cigarette adult users were current smokers (68.1%), former smokers (23.7%), and never smokers (8.2%). The highest prevalence of e-cigarette use was among current smokers (8.2%; 95% CI, 6.3–10.1), followed by former smokers (2.7%; 95% CI, 1.4–4.1), and then never smokers (0.4%; 95% CI, 0.2–0.6). After adjusting for age, sex, and ethnicity, e-cigarette users had higher odds of being exposed to secondhand smoke (odds ratio: 6.3; 95% CI, 3.6–11.1) and drinking alcohol (odds ratio: 4.2; 95% CI, 1.8–10.0) and lower odds of having at least a college education or a higher income, compared with tobacco nonusers.

Conclusions—Between 2013 and 2014, e-cigarette use in the United States was more common among younger people, those with low socioeconomic status, and current and former smokers. These findings will help inform future research as well as public policy and regulatory actions. (*J Am Heart Assoc*. 2018;7:e008178. DOI: 10.1161/JAHA.117.008178.)

Key Words: adult • e-cigarette • National Health and Nutrition Examination Survey • tobacco

E lectronic cigarettes (e-cigarettes), vaporizers, vape pens, hookah pens, and electronic pipes are some of the many types of electronic nicotine delivery systems that were introduced in the United States in 2006–2007 and have since increased in popularity across all age groups.[1] A review

of the literature including 21 articles comparing the prevalence and correlates of e-cigarette use showed that the prevalence of ever using e-cigarettes in 2011 was highest among young adults (aged 18–28 years; 4.9–7.0%), with overall prevalence of ever using e-cigarettes among all adults

Clinical Perspective

What Is New?

- Clinicians are increasingly encountering patients who use electronic cigarettes (e-cigarettes), and further understanding of related epidemiology in the US population is needed.
- In a population-representative US sample between 2013 and 2014, the prevalence of adult e-cigarette use in the previous 5 days was 2.6%, with most users concurrently using traditional cigarettes.
- E-cigarette users have greater secondhand smoke exposure and alcohol use and lower socioeconomic status than those who do not use e-cigarettes.

What Are the Clinical Implications?

- Given the coming epidemic of e-cigarette use, including dual use of e-cigarettes and traditional cigarettes, further data on related potential cardiovascular toxicity are urgently needed.

(aged ≥18 years) ranging from 0.6% to 6.2%. This review also showed that the prevalence of lifetime use of e-cigarettes among US adults was rising, with prevalence 2 to 4 times higher in 2012 than between 2009 and 2011.[2]

E-cigarettes were originally marketed as alternative nicotine delivery devices purported to cause less harm and to hold potential to aid in smoking cessation. Consequently, initial growth in the prevalence of use of these products was noted among cigarette smokers.[3] Over time, however, extensive marketing,[4] improvements in design, extensive flavor options,[5] and a widespread perception that e-cigarettes were safer than cigarettes led to their increased popularity, especially among youth[6–10] and those who never smoked tobacco.[9,10] This increasing popularity has raised public health concerns, given the paucity of high-quality longitudinal evidence on the health effects of e-cigarette exposure and uncertainly about the data supporting their use as smoking-cessation devices.[1]

Whether e-cigarettes are predominantly used as smoking-cessation aides or as part of persistent dual tobacco use is controversial. Findings from limited national studies showed that most e-cigarette users may be concurrently using other tobacco products. The prevalence of ever using e-cigarettes, for example, has been reported to be the highest among current tobacco smokers (11.4%), followed by former smokers (2.0%).[11] Between 2009 and 2012, the prevalence of ever using e-cigarettes among never smokers was reported to be between 0.77%[11] and 3.6%.[12]

Few studies have provided precise estimates of current e-cigarette use and patterns of use by tobacco smoking status. In addition, prior studies have not been representative of the total US population, so the size of the US population currently using e-cigarettes, by cigarette smoking status, could not previously be estimated.

The present study is the first to investigate e-cigarette use in NHANES (National Health and Nutrition Examination Survey), a well-designed survey that includes information about tobacco use in a nationally representative sample of US adults. Using NHANES 2013–2014, the first wave that included questions about current e-cigarette use, this study aimed (1) to quantify the crude and smoking status–specific prevalence of e-cigarette use and provide robust estimates of the total number of e-cigarette users in the United States by smoking status (current, former, and never); (2) to identify the unique demographic and behavioral characteristics of e-cigarette users by cigarette smoking status; (3) to compare e-cigarette users with individuals who never used tobacco products; and (4) to compare the prevalence of sole and dual use of e-cigarettes and other common tobacco products including cigars, smokeless cigarettes, and nicotine replacement therapy (NRT).

Methods

Study Population and Design

NHANES is a series of ongoing cross-sectional surveys conducted by the National Center for Health Statistics (NCHS) of the Centers for Disease Control and Prevention (CDC). The NHANES sampling procedure oversampled targeted populations, such as Hispanic, non-Hispanic black, non-Hispanic Asian, older adult, and low-income people, to obtain adequate samples for meaningful subgroup analyses and more reliable variance estimates.[12,13] A major objective of NHANES is to estimate the number and percentage of people in the US population and in designated subgroups with selected diseases and risk factors.[14]

In total, 10 175 individuals were included in both the NHANES 2013–2014 interview and the mobile examination center component. There were 125 e-cigarette users. Nine (4.0%) of them were aged 13 to 17 years, and the remaining 116 (96%) were adults aged ≥18 years. Because of the large differences in tobacco-use patterns between adults and adolescents and because only 4% of e-cigarette users in this survey were aged 13 to 17 years, this study primarily focused on adults who were ≥18 years (n=6113); however, individuals aged 13 to 17 years (n=895) were retained in a secondary analysis. Figure 1 provides details about the study population and sample selection.

Demographic information such as age, sex, race/ethnicity, education, employment, income, and tobacco and drug use information were self-reported during the home-based interview. The NCHS institutional review board approved the study protocol, and all participants provided written informed
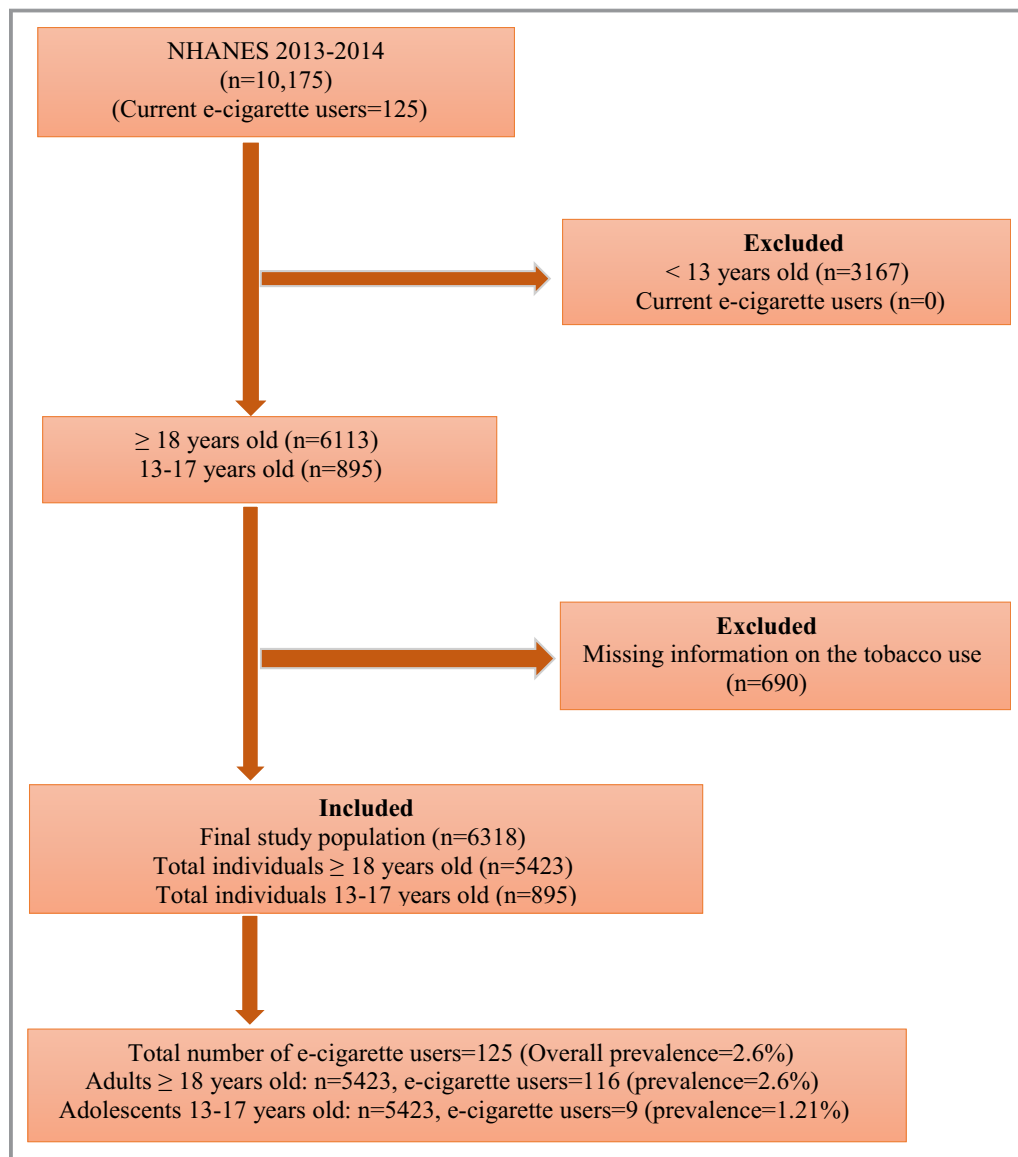
Figure 1. Selection of study participants from NHANES (National Health and Nutrition Examination Survey) 2013–2014 to examine the prevalence of electronic cigarette (e-cigarette) use in the US population.

consent. The detailed design and weighting methods were explained previously.[15]

Data Collection and Measures

Trained study personnel performed a home-based interview and collected demographic information by asking participants about their age, sex, race/ethnicity, education, employment, income, tobacco, and drug use information. The mobile examination center interview collected information about smoking, including e-cigarette and NRTs within the previous 5 days. The Computer-Assisted Personal Interviewing (CAPI) system was used by trained study personnel to collect data from adults aged ≥18 years. CAPI is programmed with built-in

consistency checks to reduce data-entry errors. Questions were available in Spanish and English languages.

Measures

E-cigarette and other tobacco-use methods in the previous 5 days

Information about e-cigarette and other tobacco use (eg, cigarettes, water pipes, patches) in the previous 5 days was obtained from the Recent Tobacco Use (SMQRTU_H) data set (NHANES 2013–2014). The data and study materials are available to the public at the official CDC website.[14] A single multiple-choice question listing all tobacco-use methods was used. The participant was given the opportunity to check >1

option. The question also allowed the participant to select the never-smoking option "never smoked even a puff." Considering never smoking as reference, dummy variables were created for all tobacco-use methods, and cells were replaced by "1" if the participant reported using that particular method and by "0" if anything else.

Cigarette smoking status

A *never smoker* was defined as someone who did not smoke in the previous 5 days and who had smoked <100 cigarettes in his or her life.[16] A *current smoker* was identified as someone who reported smoking ≥100 cigarettes in his or her life and was presently smoking at the time of the interview, and a *former smoker* smoked ≥100 cigarettes in his or her lifetime and was not presently smoking at the time of the interview.[17] The average number of cigarettes smoked per day in the previous 30 days was obtained from the question, "During the past 30 days, on the day that you smoked, about how many cigarettes did you smoke per day?" Former smokers were categorized according to their time since quitting: ≤90 days, 91 to 365 days, and >365 days. Smoking status was defined as (1) never smoker, (2) former smoker for >365 days, (3) former smoker for 91 to 365 days, (4) former smoker for ≤90 days, and (5) current cigarette smoker.

Other measures

Household income in NHANES was based on resident self-report. If participants from the same household reported different household income, the highest value was selected. Body mass index was calculated as weight in kilograms divided by height in meters squared (kg/m²) and was categorized using criteria established by the National Institutes of Health as *underweight* (<18.5), *normal* (18.5–24.9), *overweight* (25.0–29.9), and *obese* (≥30). Participants who used marijuana in the previous 30 days were considered marijuana users. Drinking alcohol at least 12 times in the previous year was used to categorize alcohol consumption status in NHANES 2013–2014.

Statistical Analysis

For the primary analysis of adults, after excluding 690 participants with missing information about tobacco use, 5423 of 6113 adults (aged ≥18 years) remained for analysis. "Proc Survey" commands in SAS were used to obtain the summary measures, such as proportions and means, and to perform logistic regression. The relationship between each of the demographic and behavioral factors and e-cigarette use was examined separately after adjusting for age, sex, and race/ethnicity. All estimates were weighted, accounting for complex survey data by full-sample 2-year mobile examination center exam weights, as provided by NCHS, to adjust for

nonresponse and to account for unequal selection probabilities among participants. Information about the size of the US population was retrieved from US Census Bureau estimates for 2014.

The significance level was set at α<0.05. All analyses were conducted using the statistical analysis software SAS v9.4 (SAS Institute).

Results

Prevalence and Pattern of E-Cigarette Use Among Adolescents Aged 13 to 17 Years

A total of 125 individuals used e-cigarettes for at least one day in the last 5 day, and 9 of them were between 13 and 17 years old. The prevalence of e-cigarette use among adolescents aged 13 to 17 years was 1.21% (95% confidence interval [CI], 0.3–2.1). Among this group of adolescents, only one person was using e-cigarette everyday. Of the 9 adolescent e-cigarette users, 5 (64.6%) did not use any other tobacco products. None of the e-cigarette users was aged <13 years.

Prevalence and Pattern of E-Cigarette Use Among Adults

In total, 5423 adult participants (51.8% women) were included in this study. The mean age of participants was 47.5 years (SD: 18.5 years). As reported by the study participants, 25% used at least 1 tobacco product in the previous 5 days. Among this sample of adults, 116 people reported current e-cigarette use in the previous 5 days. The weighted overall prevalence of e-cigarette use among adults was 2.6% (95% CI, 2.0–3.1), estimated as 5 639 000 individuals in the US adult population. E-cigarettes and cigars were the second most common actively used tobacco products after traditional combustible cigarettes (Figure 2).

The most prevalent tobacco-use method among e-cigarette users was cigarette smoking, followed by cigar use (Figure 3). Of the e-cigarette users, 68.1% (95% CI, 58.5–77.6) were current smokers, 23.7 (95% CI, 15.2–32.3) were former smokers, and 8.2% (95% CI, 3.4–13.0) were never smokers (Figure 4). The prevalence of recent e-cigarette use was highest among current smokers (8.2%; 95% CI, 6.3–10.1), followed by former smokers (2.7%; 95% CI, 1.4–4.1), whereas the lowest prevalence was noted among never smokers (0.4%; 95% CI, 0.2–0.6; Figure 5). Among current cigarette smokers who used e-cigarettes in the previous 5 days, 26.2% (95% CI, 16.9–35.5) used e-cigarettes daily, 5.5% (95% CI, 0–11.3) used them for 4 days, 8.1% (95% CI, 0.2–15.9) used them for 3 days, and 34.4% (95% CI, 17.9–50.9) used them for 1 or 2 days.
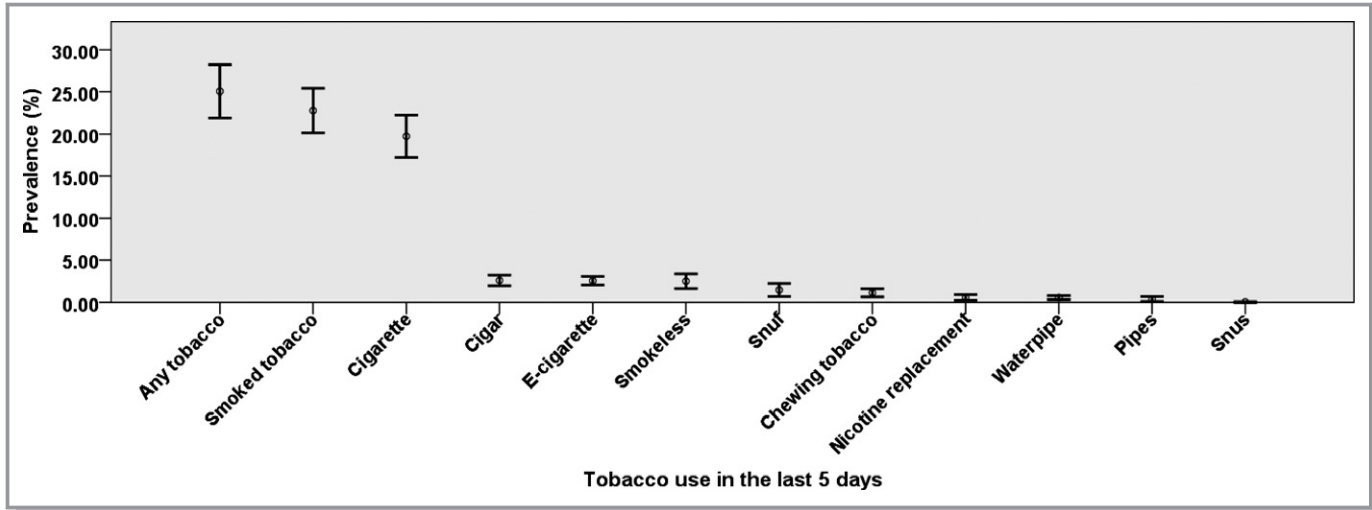
Figure 2. Self-reported tobacco use in the previous 5 days among adults aged ≥18 years from NHANES (National Health and Nutrition Examination Survey; n=5423). E-cigarette indicates electronic cigarette.

Demographic and Behavioral Characteristics of the Study Participants by Cigarette Smoking Status and E-Cigarette Use

Table 1 shows characteristics of the total population divided by cigarette smoking status. Current cigarette smokers were more likely to be using e-cigarettes (8.2%) than any other tobacco-use method, including NRT (1.0%). In contrast, former smokers were more likely to be users of smokeless tobacco (3.7%), snuff (2.9%), and cigars (2.9%) compared with e-cigarettes (2.7%).

Table 2 shows the prevalence of e-cigarette use in key subgroups, with a further breakdown by cigarette smoking
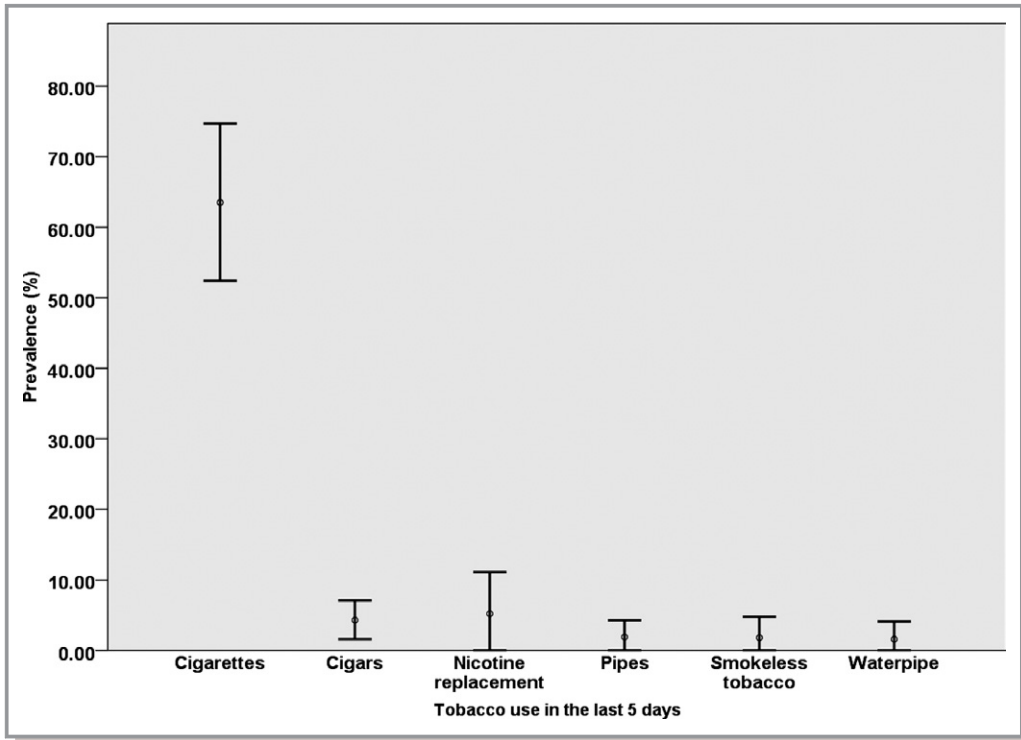

Figure 3. Self-reported tobacco use in the previous 5 days among adult electronic cigarette (e-cigarette) users from NHANES (National Health and Nutrition Examination Survey; n=116).
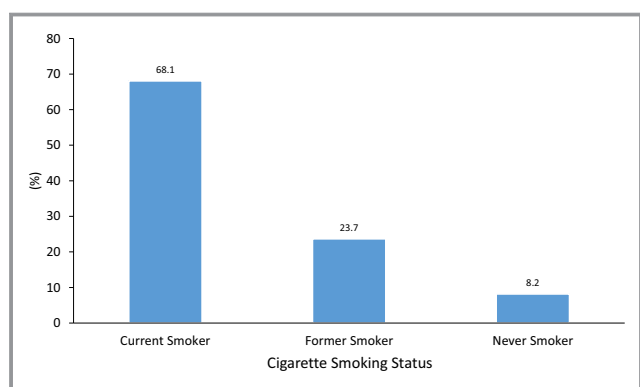
Figure 4. Cigarette smoking status of the electronic cigarette (e-cigarette) users from NHANES (National Health and Nutrition Examination Survey) 2013–2014. All percentages are weighted by the weighting factors provided by NHANES.

status. Men had a higher prevalence of e-cigarette use than women. Among races/ethnicities, non-Hispanic black participants had the lowest prevalence of e-cigarette use. The highest prevalence of e-cigarette use was noted in the youngest age group (aged 18–39 years). Although ≈63% of these young adults were also current smokers, this age group also had the highest proportion of e-cigarette users who were never smokers (15.1%). All e-cigarette users who were aged ≥40 years were ever smokers (either former or current). Figure 6 provides more details about the age and smoking status–specific prevalence of e-cigarette use among this sample of adults.

Burden of Smoking in Dual Users of Cigarettes and E-Cigarettes

Among current smokers, 1168 participants reported the number of cigarettes smoked per day during the 30 days that

preceded the survey, and of these, data were available by e-cigarette use status for 1049 participants. Of these 1049 individuals, 64 were e-cigarette users and 985 were nonusers. Using these data, there was a small numerical difference in the average number of cigarettes smoked per day between those who reported e-cigarette use in the previous 5 days (mean: 9.9; 95% CI, 7.9–11.9) and those who did not (mean: 11.6; 95% CI, 10.2–12.9); however, this difference was not statistically significant (*P*=0.21). Of the daily and occasional cigarette smokers, 46.9% (95% CI, 24.1–69.8) and 62.4% (95% CI, 30.2–75.9), respectively, used e-cigarettes for ≥3 days during the previous 5 days.

E-Cigarette and NRT Use

The overall weighted prevalence of NRT use in the previous 5 days was 0.56% (95% CI, 0.21–0.90). Of the NRT users, 1.52% (95% CI, 0.0–4.30) never smoked cigarettes, 28.0% (95% CI, 3.14–52.88) were former cigarette smokers, and 70.5% (95% CI, 44.59–96.36) were current cigarette smokers. Considering both the e-cigarette and NRT user data, only 5 participants used both methods, with an estimated prevalence of 0.13% (95% CI, 0.00–0.28). The prevalence of dual use of e-cigarette and NRT was 0.58% (95% CI, 0.00–1.32) among current cigarette smokers, 0.05% (95% CI, 0.00–0.14) among former smokers, and 0.0% among those who never smoked cigarettes. Among e-cigarette users, the prevalence of NRT use was 5.2% (95% CI, 0.0–11.1).

E-Cigarette Users Compared With Never Tobacco Users

Table 3 shows the characteristics of e-cigarette users versus never users of tobacco, including calculation of adjusted odds ratios (ORs) for characteristics associated with current
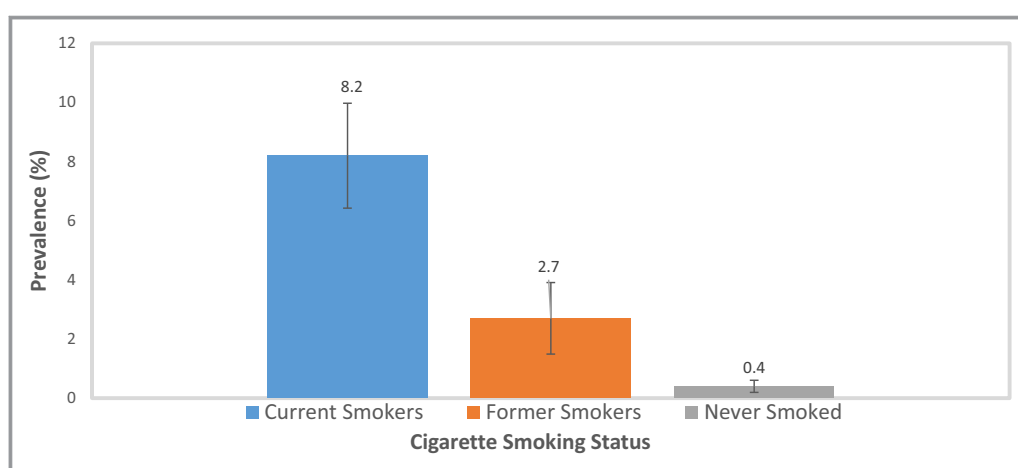

Figure 5. Prevalence of electronic cigarette (e-cigarette) use by cigarette smoking status (NHANES [National Health and Nutrition Examination Survey], 2013–2014).

Table 1. Description of the Study Population (Aged ≥18 Years) by Cigarette Smoking, Demographic, and Behavioral Characteristics From NHANES 2013–2014

	Cigarette Smoking Status, %, (95% CI)		
	Never (n=3374)	Former (n=1244)	Current (n=1296)
Sex			
Male	43.2 (41.0–45.3)	56.8 (53.4–60.2)	52.1 (48.9–55.7)
Female	56.9 (54.7–59.0)	43.2 (39.8–46.7)	47.9 (44.3–51.5)
Age group, y			
18–39	42.1 (38.8–45.4)	21.6 (19.2–24.0)	46.5 (42.0–51.0)
40–59	34.9 (32.2–37.7)	32.9 (29.8–36.1)	40.1 (36.2–44.0)
≥60	23.0 (20.3–25.7)	45.5 (42.5–48.4)	13.4 (10.8–16.0)
Race/ethnicity			
Mexican American	11.1 (6.6–15.6)	7.5 (4.4–10.6)	6.7 (3.3–10.2)
Other Hispanic	6.2 (3.9–8.5)	5.4 (3.0–7.8)	3.9 (1.6–6.2)
Non-Hispanic White	61.3 (53.2–69.3)	74.3 (68.2–80.3)	67.8 (59.9–75.7)
Non-Hispanic Black	12.0 (8.1–15.8)	7.0 (4.5–9.5)	14.9 (10.5–19.4)
Mixed non-Hispanic	9.5 (7.5–11.1)	5.8 (3.7–8.0)	6.7 (4.5–8.9)
Education			
Less than high school diploma	12.3 (8.7–15.8)	15.1 (11.6–18.6)	23.1 (18.8–27.4)
High school diploma	18.2 (15.1–21.3)	22.4 (19.4–25.4)	30.3 (25.3–35.4)
College graduate	69.5 (64.3–74.7)	62.5 (58.3–66.6)	46.6 (42.0–51.2)
Income			
<$20 000	12.3 (9.5–15.1)	12.7 (9.2–16.2)	25.6 (19.0–32.1)
$20 000–44 999	23.8 (20.4–27.1)	28.0 (24.6–31.4)	32.5 (26.4–38.6)
$45 000–74 999	20.0 (17.4–22.5)	24.5 (16.7–24.3)	22.4 (17.8–26.9)
≥$75 000	44.0 (38.3–49.6)	38.9 (33.3–44.3)	19.6 (14.1–25.0)
Marital status			
Never married	18.3 (15.5–21.1)	11.0 (8.3–13.7)	28.0 (23.6–32.5)
Lives with partner	65.3 (61.5–69.1)	66.9 (63.1–70.6)	50.0 (46.1–53.9)
Widowed, divorced, or separated	16.4 (14.1–18.6)	22.2 (19.9–24.4)	22.0 (18.1–25.8)
Body mass index			
<18.5	2.1 (1.5–2.7)	1.9 (1.0–2.8)	4.5 (3.3–5.7)
18.5–24.9	30.3 (27.3–33.2)	21.1 (18.6–23.6)	31.3 (28.2–34.4)
25–29.9	31.5 (30.0–33.0)	34.6 (30.9–38.3)	30.5 (27.1–33.9)
≥30	36.1 (33.1–39.1)	42.4 (38.7–46.2)	33.7 (28.9–38.4
Drank alcohol ≥12 times in the previous year	65.7 (58.0–73.3)	89.5 (87.7–91.3)	89.8 (87.5–92.0)
Cigarettes smoked inside household	42.5 (34.6–50.5)	55.1 (41.7–68.4)	60.2 (53.7–66.7)
Exposure to secondhand smoking	19.7 (17.3–22.2)	26.1 (22.0–30.3)	58.8 (53.9–63.7)
Marijuana use in the previous month	7.1 (5.6–8.5)	9.8 (7.0–12.5)	35.2 (31.1–39.3)
Tobacco use in the previous 5 days			
Cigar	1.3 (0.9–1.7)	2.9 (2.0–3.8)	5.8 (3.5–8.0)
E-cigarette	0.4 (0.2–0.6)	2.7 (1.4–4.1)	8.2 (6.3–10.1)
Smokeless tobacco	2.2 (1.4–3.1)	3.7 (1.5–5.8)	2.0 (1.1–3.0)
Snuff	1.1 (0.4–1.9)	2.9 (0.7–5.0)	0.8 (0.3–1.4)

Table 1. Continued

	Cigarette Smoking Status, %, (95% CI)		
	Never (n=3374)	Former (n=1244)	Current (n=1296)
Chewing tobacco	1.1 (0.5–1.7)	1.1 (0.3–1.9)	1.2 (0.3–2.2)
Nicotine replacement	0.01 (0.0–0.1)	0.7 (0.0–1.6)	1.8 (0.6–3.1)

Weighted column percentages were reported. CI indicates confidence interval; e-cigarette, electronic cigarette; NHANES, National Health and Nutrition Examination Survey.

e-cigarette use status. After adjusting for age, sex, and race/ethnicity, compared with participants who never used any tobacco products, e-cigarette users had higher odds of being 18 to 39 years old (OR: 6.7; 95% CI, 2.7–16.9); widowed, divorced, or separated (OR: 3.17; 95% CI, 1.37–7.34), exposed to secondhand smoke (OR: 6.3; 95% CI, 3.6–11.1), alcohol drinkers (OR: 4.2; 95% CI, 1.8–10.0), and marijuana users (OR: 11.6; 95% CI, 7.3–18.4). E-cigarette users had lower odds of having a household income >$75 000 (OR: 0.2; 95% CI, 0.1–0.9) compared with never users of tobacco.

Discussion

NHANES 2013–2014 is the first NHANES wave to collect information on e-cigarette use in the United States and the first to provide the prevalence of recent tobacco use (in the previous 5 days) including e-cigarettes. Findings from this survey showed that the prevalence of e-cigarette use in the previous 5 days among adolescents in the United States was 1.21%, which was estimated to represent ≈236 000 US adolescents. The prevalence of e-cigarette use among US adults was 2.6%, which was estimated to be ≈5.6 million US adult users. More than two thirds of the adult e-cigarette users were current smokers. Among current adult smokers, there was no difference between e-cigarette users and nonusers in the number of cigarettes smoked per day. Compared with tobacco nonusers, e-cigarette users were more likely to be younger; widowed, divorced, or separated; alcohol drinkers; and exposed to secondhand smoking and less likely to be college graduates or to have high incomes.

The prevalence of e-cigarette use among adolescents in this study was somewhat lower than those previously reported by other studies in the United States such as the National Youth Tobacco Survey.[13] Most studies of tobacco use among adolescents in the United States have relied on use in the previous 30 days. NHANES relied on tobacco product use in the previous 5 days. This 5-day period might be interpreted as a more accurate measure of the prevalence of current use by teenagers, especially in light of the previously reported intermittent pattern (1 or 2 times in the previous 30 days) of adolescent e-cigarette use.[16] A study reported by Warner questioned whether the definition of

e-cigarette use within 30 days was a useful indicator of a growing public health crisis of e-cigarette use by teenagers.[16] This study reported that nonsmoking high school students were highly unlikely to use e-cigarettes; among those who did use, most used e-cigarettes on only 1 to 2 of the previous 30 days. These results seem to mirror the low use reported in the previous 5 days in this study. However, studies with longitudinal data suggest a gateway from e-cigarette use to cigarette smoking among adolescents, placing them at risk of becoming adult cigarette smokers, which may reverse the achievements of years of fighting against tobacco and argues for continued study of this important group.[17]

An important finding from this study is that more than two thirds of the adult e-cigarette users were current cigarette smokers, and most of the remaining adult users were former cigarette smokers. A growing body of evidence supports dual tobacco-product use as the most prevalent tobacco-use pattern.[18–20] In line with our findings, the PATH (Population Assessment of Tobacco and Health) study, the CDC, and the NHIS (National Health Interview Survey) have indicated that e-cigarette users are more likely to be current or former smokers.[18–20] The high prevalence of e-cigarette use among current smokers should be interpreted carefully. Some studies have implied that this result means that e-cigarettes are being used as smoking-cessation devices,[21] whereas others stated that dual use increases exposure to nicotine and may perpetuate abuse liability instead of encouraging smoking cessation.[22] Indeed, newer devices, even with low concentrations of nicotine, can deliver similar or higher levels of nicotine than cigarettes.[23,24]

Prevalence of e-cigarette use appears to be higher in younger age groups. In particular, all e-cigarette users in NHANES who were free of a history of cigarette smoking (ie, sole users) were aged <40 years. Consistent with our findings, the PATH study showed that the prevalence of e-cigarette use is higher among younger than older adults.[18,25] The use of e-cigarettes has become more popular among young-adult, never-smoking individuals.[25] Consequently, the prevalence of e-cigarette and traditional cigarette use should be monitored closely over successive NHANES cycles, given that young-adult e-cigarette users have shown a greater tendency toward initiating cigarette use than

Table 2. Prevalence of E-Cigarette Use Among Adults (Aged ≥18 Years) and Distribution by Cigarette Smoking Status (NHANES 2013–2014)

	Weighted Prevalence, % (95% CI)	Distribution of E-Cigarette Users By Cigarette Smoking Status, % (95% CI)		
		Never	Former	Current
Overall	2.6 (2.0–3.1)	8.2 (3.4–13.0)	23.7 (15.2–32.3)	68.1 (58.5–77.6)
Sex				
Male	2.8 (2.0–3.5)	9.6 (2.4–16.7)	28.0 (17.2–38.8)	62.4 (48.7–76.2)
Female	2.3 (1.6–3.1)	6.7 (0.0–13.8)	18.8 (5.6–32.0)	74.5 (60.1–88.9)
Age group, y				
18–39	3.6 (2.3–5.0)	15.1 (4.7–25.6)	21.6 (7.7–35.5)	63.3 (47.1–79.5)
40–59	2.7 (1.4–4.1)	0.0	26.4 (18.5–34.3)	73.6 (65.7–81.5)
≥60	0.8 (0.2–1.4)	0.0	25.5 (0.0–52.9)	74.5 (47.1–100.0)
Race/ethnicity				
Mexican American	1.6 (0.1–3.1)	34.2 (0–87.3)	11.6 (0.0–29.6)	54.2 (0.0–100)
Other Hispanic	2.5 (0.2–4.9)	9.4 (0.0–29.1)	38.9 (0.7–77.1)	51.7 (11.4–92.0)
Non-Hispanic White	2.8 (2.1–3.5)	3.2 (0.0–7.8)	24.1 (12.5–35.7)	72.8 (60.4–85.2)
Non-Hispanic Black	1.5 (0.5–2.4)	5.6 (0.0–17.2)	24.1 (0.0–49.5)	70.3 (42.2–98.5)
Mixed non-Hispanic	3.2 (1.2–5.3)	8.0 (0.0–7.8)	19.2 (12.5–35.7)	72.9 (47.0–98.7)
Education				
Less than high school diploma	3.1 (1.2–5.0)	0.0	29.1 (5.6–52.5)	70.9 (47.5–94.4)
High school diploma	3.3 (2.3–4.4)	4.6 (0.0–11.1)	15.9 (0.0–33.6)	79.5 (62.9–96.4)
College graduate	2.0 (1.6–2.4)	8.9 (0.6–17.2)	27.4 (9.2–45.6)	63.7 (44.8–82.6)
Income				
<$20 000	3.7 (0.6–6.7)	0.0	20.2 (9.0–31.4)	79.8 (68.6–91.0)
$20 000–44 999	3.3 (2.1–4.4)	12.2 (0.0–25.8)	21.1 (4.1–38.0)	66.7 (46.6–86.8)
$45 000–74 999	2.3 (1.3–3.2)	10.5 (0.7–20.4)	25.58 (0.0–51.7)	63.9 (40.7–87.1)
≥$75 000	2.0 (1.2–2.8)	9.4 (0.0–19.6)	27.7 (12.1–43.3)	62.9 (44.2–81.7)
Marital status				
Never married	3.8 (1.9–2.7)	13.6 (2.0–25.3)	11.5 (0.0–24.4)	74.8 (59.3–90.4)
Married or lives with partner	1.8 (0.9–2.7)	2.0 (0.0–6.4)	32.5 (15.4–49.7)	65.5 (47.0–83.9)
Widowed, divorced, or separated	3.2 (1.7–4.7)	4.4 (0.0–15.2)	23.7 (4.8–42.7)	71.8 (47.9–95.8)
Body mass index				
<18.5	2.4 (0.0–6.6)	0	0	100 (100–100)
18.5–24.9	2.8 (1.6–4.0)	7.6 (0.0–19.1)	13.5 (0.6–26.4)	78.9 (63.7–94.1)
25–29.9	2.6 (1.7–3.5)	5.4 (0.0–12.9)	27.6 (17.7–37.4)	67.0 (56.0–78.1)
≥30	2.3 (1.5–3.2)	12.0 (0.0–24.2)	31.0 (16.0–45.9)	57.0 (39.3–74.7)
Drank alcohol ≥12 times in the previous year				
Yes	3.0 (2.3–3.8)	8.5 (3.5–13.60)	25.0 (15.2–34.7)	66.5 (55.1–78.0)
No	0.9 (0.2–1.6)	6.4 (0.0–17.1)	14.1 (0.0–41.8)	79.6 (50.6–100)
Exposure to secondhand smoking				
Yes	5.4 (3.7–7.1)	9.6 (2.5–16.6)	20.4 (8.9–31.8)	70.1 (58.1–82.1)
No	1.4 (0.9–1.9)	7.1 (0.0–17.0)	31.3 (19.8–42.8)	61.7 (47.6–75.7)

Continued

Table 2. Continued

	Weighted Prevalence, % (95% CI)	Distribution of E-Cigarette Users By Cigarette Smoking Status, % (95% CI)		
		Never	Former	Current
Marijuana use in the previous month				
Yes	9.1 (5.8–12.3)	6.7 (0.0–17.4)	12.7 (0.0–27.3)	80.61 (62.8–98.4)
No	2.1 (1.4–2.8)	11.2 (1.7–20.8)	29.3 (19.4–39.2)	59.5 (49.2–69.7)
Tobacco use in the previous 5 days				
Cigar				
Yes	4.2 (1.9–6.6)	23.5 (0.0–73.6)	7.1 (3.6–10.7)	69.3 (18.8–100)
No	2.5 (2.0–3.1)	7.5 (2.8–12.3)	24.5 (15.5–33.4)	68.0 (58.0–78.1)
Smokeless tobacco				
Yes	1.8 (0.0–5.2)	0.0	81.0 (34.4–100)	19.0 (0.0–65.6)
No	2.6 (2.0–3.1)	8.4 (3.4–13.2)	22.7 (14.0–31.3)	69.0 (59.1–78.9)
Nicotine replacement				
Yes	24.1 (7.3–40.9)	0.0	7.5 (0.0–24.8)	92.6 (75.2–100)
No	2.4 (1.9–3.0)	8.7 (3.7–13.7)	24.6 (15.6–33.7)	66.7 (56.7–76.8)

Prevalence estimates are all weighted. CI indicates confidence interval; e-cigarette, electronic cigarette; NHANES, National Health and Nutrition Examination Survey.

nonusers.[26] This group is particularly important, especially in the light of the recent decision by the US Food and Drug Administration to directly regulate nicotine in traditional cigarettes but with delayed nicotine regulation for other tobacco products. E-cigarette use can introduce tobacco–naïve individuals to nicotine, which may predispose them to
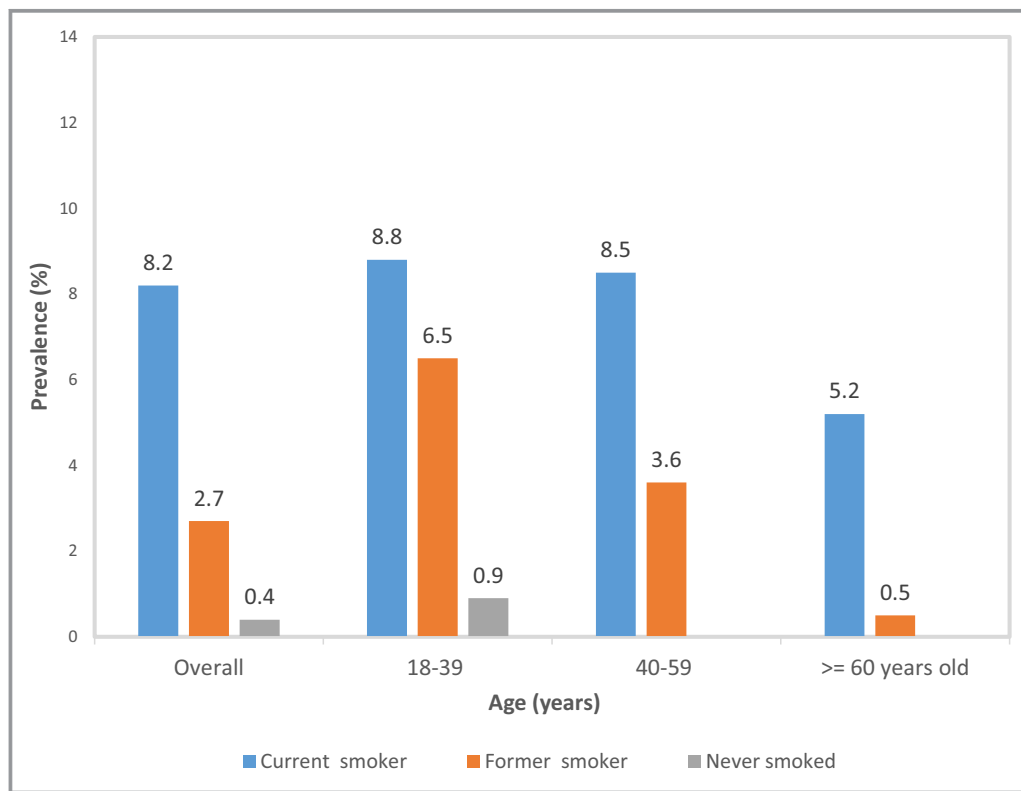

Figure 6. Age– and cigarette smoking status–specific prevalence of electronic cigarette (e-cigarette) use among adult from NHANES (National Health and Nutrition Examination Survey) 2013–2014.

Table 3. Age-, Sex-, and Ethnicity-Adjusted Differences in Demographic and Behavioral Characteristics Between Adult E-Cigarette Users and Those Who Never Used Tobacco (NHANES 2013–2014)

	Electronic-Cigarette,* n (%)	Never Tobacco, n (%)	Adjusted OR for electronic-Cigarette vs Never Tobacco,† OR (95% CI)	P Value
Overall	116 (2.6)	4063 (75.0)		
Sex				
Male	62 (53.2)	1801 (45.2)	1.35 (0.91–2.01)	0.13
Female	54 (46.8)	2262 (54.7)	Ref	
Age group, y				
18–39	64 (54.3)	1406 (35.3)	6.73 (2.68–16.92)	<0.01
40–59	40 (37.6)	1231 (33.7)	4.59 (1.87–11.30)	<0.01
≥60	12 (8.0)	1426 (30.8)	Ref	
Race/ethnicity				
Mexican American	9 (5.6)	651 (10.4)	0.41 (0.14–1.25)	0.12
Other Hispanic	8 (5.5)	398 (5.9)	0.73 (0.22–2.45)	0.61
Non-Hispanic White	68 (72.8)	1655 (65.7)	1.14 (0.58–2.24)	0.71
Non-Hispanic Black	15 (6.3)	753 (9.9)	0.56 (0.22–1.46)	0.24
Other non-Hispanic or multiracial	16 (9.6)	606 (7.9)	Ref	
Education				
Less than high school diploma	18 (18.6)	718 (12.5)	Ref	
High school diploma	25 (29.5)	771 (18.8)	0.67 (0.29–1.54)	0.35
College graduate	62 (51.9)	2335 (68.6)	0.28 (0.15–0.54)	<0.01
Income				
<$20 000	24 (20.7)	670 (11.9)	Ref	
$20 000–44 999	39 (32.7)	1066 (24.6)	0.67 (0.26–1.72)	0.41
$45 000–74 999	20 (17.8)	744 (20.2)	0.39 (0.13–1.18)	0.10
≥$75 000	28 (28.5)	1256 (43.1)	0.23 (0.07–0.79)	0.02
Marital status				
Never married	32 (28.8)	618 (15.5)	2.07 (1.05–4.10)	0.04
Widowed, divorced, or separated	27 (24.3)	814 (17.6)	3.17 (1.37–7.34)	<0.01
Married or lives with partner	46 (46.7)	2394 (66.7)	Ref	
Body mass index				
Underweight (<18.5)	2 (2.2)	100 (1.9)	1.42 (0.21–9.62)	0.72
Normal (18.5–24.9)	40 (31.3)	1137 (27.6)	Ref	
Overweight (25–29.9)	37 (32.5)	1291 (32.6)	1.00 (0.59–1.72)	0.99
Obese (≥30)	37 (34.0)	1535 (37.9)	0.94 (0.51–1.73)	0.84
Drank alcohol ≥12 times in the previous year				
Yes	102 (91.7)	2604 (71.2)	4.19 (1.75–10.00)	<0.01
No	13 (8.2)	1452 (28.7)	Ref	
Exposure to secondhand smoking				
Exposed	66 (62.1)	795 (19.7)	6.32 (3.61–11.06)	<0.001
Not exposed anywhere	44 (37.8)	3007 (80.2)	Ref	

Table 3. Continued

	Electronic-Cigarette,* n (%)	Never Tobacco, n (%)	Adjusted OR for electronic-Cigarette vs Never Tobacco,† OR (95% CI)	*P* Value
Marijuana use in the previous 30 days				
Yes	44 (42.11)	181 (6.36)	11.57 (7.27–18.38)	<0.001
No	55 (57.89)	2404 (93.64)	Ref	

e-cigarette indicates electronic cigarette.

*Any current e-cigarette user.

†OR (odds ratio) was adjusted for age, sex, and ethnicity. OR was adjusted for age and ethnicity for sex, for sex and ethnicity for age, and for age and sex for ethnicity.

nicotine dependence and subsequent use of additional tobacco products.

In addition, this study was able to identify particular groups with high prevalence of e-cigarette use. Compared with those who did not use tobacco, e-cigarette users were more likely to be younger; widowed, divorced, or separated; alcohol drinkers; marijuana users; and exposed to secondhand tobacco and less likely to be college graduates or to have high incomes. Similar patterns were shown for current smokers in this study, suggesting common determinants of tobacco use in general that are worthy of further study.

Our study has some notable limitations. First, it is based on data from a 5-day period before the examination, and no data were collected about lifetime e-cigarette use. Likewise, no specific use-pattern data were available to inform the prevalence of regular daily e-cigarette use. Second, because there are no standard measurements to define current e-cigarette use, comparison between our study and prior studies remains difficult, so conclusions about longitudinal trends should be drawn with caution. Third, given small sample sizes, caution is needed in interpreting unstable estimates, especially among adolescents. Finally, the pattern of e-cigarette use is rapidly changing, and these data should be considered to represent only 2013–2014, with trends likely evolving in the years since.

In conclusion, using data from NHANES 2013–2014, the prevalence of e-cigarette use in the previous 5 days was 1.21% (n≈236 000) among adolescents and 2.6% (n≈5.6 million) among adults in the United States. More than two thirds of e-cigarette users also concurrently smoked cigarettes. This study is among the first to detail the prevalence of recent e-cigarette use in a nationally representative survey in the United States. Findings from this study may inform the tobacco regulatory agencies about the prevalence of e-cigarette use compared with other tobacco-use methods. In addition, this study provides baseline information about the prevalence and the pattern of e-cigarette use that allow for monitoring of incident changes in use patterns. Providing the prevalence of e-cigarette use by demographic and behavioral factors is crucial for identifying areas for future research and calculating the required sample size and for prioritizing and implementing group-based interventions.

Sources of Funding

Disclosures

None.

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