



Review

E-cigarette prevalence and correlates of use among adolescents versus adults: A review and comparison

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ABSTRACT

Perceived safer than tobacco cigarettes, prevalence of electronic cigarette (e-cigarette) use is increasing. Analyses of cartridges suggest that e-cigarettes may pose health risks. In light of increased use and the potential for consequences, we searched Google Scholar and Pubmed in July of 2013 using keywords, such as e-cigarette and vaping, to compare differences and similarities in prevalence and correlates of e-cigarette use among adolescents (grades 6–12) versus adults (aged ≥ 18 years). Twenty-one studies focused on e-cigarette use. Ever-use increased among various age groups. In 2011, ever-use was highest among young adults (college students and those aged 20–28; 4.9%–7.0%), followed by adults (aged ≥ 18 ; 0.6%–6.2%), and adolescents (grades 6–12 and aged 11–19; <1%–3.3%). However, in 2012 adolescent ever-use increased to 6.8% and, among high school students, went as high as 10.0%. While the identified common correlate of e-cigarette use was a history of cigarette smoking, a notable proportion of adolescents and young adults who never smoked cigarettes had ever-used e-cigarettes. E-cigarette use was not consistently associated with attempting to quit tobacco among young adults. Adults most often reported e-cigarettes as a substitute for tobacco, although not always to quit. Reviewed studies showed a somewhat different pattern of e-cigarette use among young people (new e-cigarette users who had never used tobacco) versus adults (former or current tobacco users). Research is needed to better characterize prevalences, use correlates, and motives of use in different population groups, including how adolescent and young adult experimentation with e-cigarettes relates to other types of substance use behaviors.

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1. Introduction

Electronic cigarettes (e-cigarettes) are battery operated nicotine delivery devices released in 2004 to provide a way to more safely mimic the experience of tobacco cigarettes (Cobb et al., 2010). Most e-cigarettes share a similar design, a plastic tube holding a battery, airflow sensor, vaporizer, and nicotine/flavor cartridge with a chemical component, such as propylene glycol, that turns liquid to vapor (Cobb et al., 2010). Multiple companies produce e-cigarettes (e.g. V2 Cigs, Bedford Slims), making them widely available (Yamin et al., 2010), and Bonnie Herzog of Wells Fargo estimates that in 2013 U.S. e-cigarette sales will reach \$1.7 billion (Mangan, 2013). E-cigarettes are perceived of as safer than tobacco and as tobacco

cessation devices. They have been found as effective, though not more, than nicotine patches for short-term cigarette cessation (Dockrell et al., 2013; Etter and Bullen, 2011; Bullen et al., 2013), and cartridge analyses find fewer toxins than are found in traditional cigarettes (Goniewicz et al., 2013a). However, in a randomized trial 29% of e-cigarette users continued e-cigarettes at 6-months compared to only 8% of patch users (Bullen et al., 2013), suggesting e-cigarette use might persist after other quit methods. In addition, cartridges have been found to contain hazards, such as cytotoxic heavy metal and silicate particles (Williams and Talbot, 2011). It is unclear how appealing e-cigarettes are to young people, and there is concern they may cause nicotine addiction or act as a gateway to tobacco use (Riker et al., 2012). We conducted a literature review to explore differences and similarities in prevalence and correlates of e-cigarette use among adolescents aged 13–18 years (grades 6–12) and adults aged ≥ 18 years. A previous review by Pepper and Brewer (2013) examined studies of e-cigarette beliefs and use. We add to it by comparing findings among different age groups and including additional studies on adolescents. We

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report findings with identified gaps in research and suggestions for future studies. [Tables 1–3](#)

2. Materials and methods

We searched Google Scholar and PubMed in July of 2013 using the keywords e-cigarette, electronic cigarette, vaping, vaper, and vapor. There were 2796 hits ([Fig. 1](#)). After removing patents and case law, we reviewed hits from 2004 to 2013. A total of 266 articles were reviewed and articles excluded (197) if they were not journal articles, not peer-reviewed, not published in English, and not focused on e-cigarettes. The 69 remaining articles were sorted into categories. This review focused on e-cigarette use, which was divided into studies of prevalence and correlates of use (12), preferences, habits, and perceptions of use (9), or both (3). An additional study was found after being referenced by the Washington Post, and a colleague sent two others, released while the article was being drafted.

3. Results

Twenty-one studies were identified. Six focused on adolescents ([Camenga et al., 2014](#); [Corey et al., 2013](#); [Pepper et al., 2013a, 2013b](#); [Goniewicz and Zielinska-Danch, 2012](#); [Cho et al., 2011](#)), three on young adults (aged 18–28 or college age) ([Choi and Forester, 2013](#); [Sutfin et al., 2013](#); [Goniewicz and Zielinska-Danch, 2012](#)), and seven on adults aged ≥ 18 ([Dockrell et al., 2013](#); [King et al., 2013](#); [Regan et al., 2013](#); [Vickerman et al., 2013](#); [Adkison et al., 2013](#); [Li et al., 2013](#); [Pearson et al., 2012](#)). Nine studies examined adult perceptions of use ([Etter, 2010](#); [Foulds et al., 2011](#); [Etter and Bullen, 2011](#); [Dawkins et al., 2013](#); [Dockrell et al., 2013](#); [Goniewicz et al., 2013b](#); [Vickerman et al., 2013](#); [Adkison et al., 2013](#); [Choi et al., 2012](#)).

3.1. Prevalence and correlates of use among adolescents

Six studies explored e-cigarette awareness and use among adolescents ([Camenga et al., 2014](#); [Corey et al., 2013](#); [Pepper et al., 2013a, 2013b](#); [Goniewicz and Zielinska-Danch, 2012](#); [Cho et al., 2011](#)). All were cross-sectional. Samples ranged from 228 to 20,240.

Adolescent e-cigarette use prevalence appears to be increasing in the U.S. Analyzing data from National Youth Tobacco Survey (NYTS), [Corey et al. \(2013\)](#) found that from 2011 to 2012 lifetime e-cigarette use prevalence among middle and high school students (grades 6–12) rose from 3.3% to 6.8% ($p < 0.05$) and current (past-month) use prevalence from 1.1% to 2.1% ($p < 0.05\%$). Prevalence was highest among high school students when compared to middle school students, with high school student lifetime use, current use, and current combined use of tobacco and e-cigarettes nearly doubling (4.7%–10.0%, 1.5%–2.8%, 1.2%–2.2%, respectively $p < 0.05$). Similarly, in analysis of survey data ($n = 4766$) from two suburban high schools (grades 9–12) in New York and Connecticut, [Camenga et al. \(2014\)](#) found that from February 2010–June 2011 past-month prevalence and past-month combined use of tobacco and e-cigarettes prevalence more than doubled (0.9%–2.3% $p = 0.009$, 0.8%–1.9% $p = 0.03$, respectively). Taken together, it appears that e-cigarette use prevalence among adolescents is increasing.

A notable proportion of adolescent e-cigarette users had never smoked a traditional cigarette. The 2012 NYTS data showed that 9.3% of lifetime and 20.3% of past-month middle and high school e-cigarette users had never smoked cigarettes ([Corey et al., 2013](#)). The highest prevalence of e-cigarette use among never smoking students was among those in middle school (20.3% lifetime and 38.9% current e-cigarette use) vs. high school (7.2% lifetime and 19.5% current e-cigarette use) ([Corey et al., 2013](#)). [Camenga et al. \(2014\)](#)

also found that a proportion of high school e-cigarette users had never smoked cigarettes (12.5% of current users in February 2010, 17.2% in October 2010, and 16.1% in June 2011). Thus, e-cigarette use is not always tied to traditional cigarette use in adolescents ([Corey et al., 2013](#)).

Among 228 males aged 11–19 years participating in an internet survey panel exploring attitudes about vaccinating males against human papillomavirus ([Reiter et al., 2011](#)). [Pepper et al. \(2013a\)](#) found that in 2011 only two (<1%) participants had ever tried e-cigarettes. Both were cigarette smokers. However, 67% of remaining participants knew of e-cigarettes, with older (14–19 years) adolescents most likely to know of them. Greater awareness of cigarettes increases the likelihood of initiating them ([DiFranza et al., 2006](#)). Awareness of e-cigarettes may also increase odds of trying them. [Pepper et al. \(2013a\)](#) also found that 18% of participants were willing to try e-cigarettes if offered by a best friend. This increased to 74% among smokers. The data suggest that in some regions a high proportion of adolescent males know of and a notable proportion are willing to try e-cigarettes.

Health care providers may come in contact with adolescents who have tried e-cigarettes. [Pepper et al. \(2013b\)](#) surveyed 561 Minnesota health providers in April of 2013 and found that 11% reported treating ≥ 1 adolescent who had ever-used e-cigarettes. Family medicine practitioners were more likely than pediatricians or nurse practitioners to know of e-cigarettes (97% vs. 88% vs. 88%, respectively) and feel comfortable discussing them with patients (means 2.7 vs. 2.2 and 2.2 respectively). Adolescent providers may benefit from e-cigarette education.

Adolescent e-cigarette use is also a concern outside the U.S. [Goniewicz and Zielinska-Danch \(2012\)](#) analyzed survey data collected from Polish high school and university students from September 2010–September 2011 and found that 23.5% of 11,893 high school students aged 15–19 had ever-used an e-cigarette, and 8.2% had used one within the past 30 days. Of the 11,893 participants, most (54.8%) believed e-cigarettes were safer than tobacco, and 3.2% of those who had never tried a tobacco cigarette had tried an e-cigarette. Similarly, [Cho et al. \(2011\)](#) analyzed data from a 2008 Korean survey of middle and high school students and found that 10.2% knew of e-cigarettes, and 0.5% had tried them.

For studies of adolescents, only [Camenga et al. \(2014\)](#) and [Pepper et al. \(2013a\)](#) reported the race/ethnicity variable. When comparing white to non-white students, [Camenga et al. \(2014\)](#) found white students had an increased adjusted odds ratio (AOR) of past-month use in February 2010 (AOR 3.92, 95% CI 1.30–11.78) but not in October 2010 or June 2011. [Pepper et al. \(2013a\)](#) found Hispanics/Latinos (50%) were the least likely to know of e-cigarettes, while whites (71%) the most. Only the two international studies examined e-cigarette use by gender, finding that being male increased the likelihood of e-cigarette use ([Cho et al., 2011](#); [Goniewicz and Zielinska-Danch, 2012](#)). These studies also found that tobacco smoking increased the likelihood of using e-cigarettes ([Cho et al., 2011](#); [Goniewicz and Zielinska-Danch, 2012](#)).

In summary, e-cigarette ever-use prevalences among U.S. adolescents ranged from <1% (males from a 2011 online survey) to 10.0% (high school students from a 2012 national survey). A notable proportion of high (7.2%) and middle school (20.3%) ever-users had never used cigarettes. Findings suggest an emerging pattern of e-cigarette use among adolescents and warrant research to understand why and how adolescents use e-cigarettes. Use prevalences varied among the few international studies, with ever-use ranging from 0.5% in 2008 in Korea to 23.5% among Polish high school students in 2010–2011. Reasons for variation are unclear. Differences may relate to e-cigarette availability or popularity within each country. Correlates of lifetime use were being male and smoking. Data also suggest that whites may be more likely than

Table 1
Adolescents prevalence and correlates of e-cigarette use.

Citation	Data source	Country	Sample size	Study type	Findings
Corey et al., 2013	2011 & 2012 National Youth Tobacco Survey	United States	Not provided	Cross-sectional ^b	<p>From 2011–2012</p> <ul style="list-style-type: none"> Grades 6–12: ever-use rose from 3.3% to 6.8%, current use^a from 1.1% to 2.1%, and current use of conventional and e-cigarettes from 0.8% to 1.6% ($p < 0.05$). Middle School: ever-use rose from 1.4% to 2.7%, current use from 0.6% to 1.1%, and current use of conventional and e-cigarettes cigarettes from 0.3% to 0.7% ($p < 0.05$); High School: ever-use rose from 4.7% to 10.0%, current use from 1.5% to 2.8%, and current use of conventional and e-cigarettes from 1.2% to 2.2% ($p < 0.05$); <p>In 2012</p> <ul style="list-style-type: none"> 9.3% of ever-users, 20.3% of middle school students, and 7.2% of high school students never smoked conventional cigarettes.
Pepper et al., 2013a	Internet Survey	United States	228 males aged 11–19 years	Cross-sectional ^b	<p>In November 2011</p> <ul style="list-style-type: none"> While <1% had tried e-cigarettes, 67% had heard of them; 18% were willing to try an e-cigarette, with current tobacco smokers more willing than non-smokers (74% vs. 13%); Awareness was highest among older (aged 17–19 years, 76%) and non-Hispanic (71%) adolescents; Sons of parents with greater than high school education were less likely to be aware of e-cigarettes (61% vs. 76%), as were sons living in urban versus rural areas (64% vs. 83%); Participants aged 14–16 were more likely to know of e cigarettes (OR 2.12, CI 1.06–4.26) compared to those aged 11–13, as were participants ages 17–19 (OR 2.61, CI 1.21–5.64). In bivariate analysis those less willing to try e-cigarettes included: sons of current smokers (compared to sons of those who had never or rarely smoked) and sons living in households with annual incomes of \geq\$60,000 (compared to those with lower household incomes); Participants willing to try e-cigarettes had less negative beliefs about the typical smoker; In multivariate analysis, willingness to try e-cigarettes was lowest among those with negative beliefs about tobacco smokers.
Pepper et al., 2013b	Internet Survey	Minnesota	561	Cross-sectional ^b	<ul style="list-style-type: none"> 92% had heard of e-cigarettes; 11% had treated an adolescent patient who had tried an e-cigarette; Family practitioners were more likely to know of and feel comfortable discussing e-cigarettes with adolescents than pediatricians or nurse practitioners; 88.3% of providers endorsed wanting to learn more about e-cigarettes.
Camenga et al., 2014	Surveys at 2 suburban high schools	United States	4766	Cross-sectional ^b	<p>From February 2010–June 2011</p> <ul style="list-style-type: none"> Current use increased from 0.9% to 2.3% ($p = 0.009$); Current use among tobacco cigarette users increased from 0.8% to 1.9% ($p = 0.03$); Most e-cigarette users also used tobacco cigarettes (range 82.8%–87.5%); In October of 2010, 12th graders were less likely to have used e-cigarettes in the past 30-days (OR 0.28, CI 0.08–0.99).
Goniewicz and Zielinska-Danch, 2012	Surveys at 176 high schools & universities	Poland	20,240	Cross-sectional ^c	<p>From September 2010–June 2011</p> <ul style="list-style-type: none"> 3.2% of never tobacco cigarette smokers had ever-used e-cigarettes; 23.5% of students aged 15–19 years had ever-used e-cigarettes; 8.2% of students aged 15–19 had used e-cigarettes in the past 30 days; E-cigarettes were the fourth most common source of nicotine after tobacco cigarettes, water pipes, and snuff;

(continued on next page)

Table 1 (continued)

Citation	Data source	Country	Sample size	Study type	Findings
Cho et al., 2011	2008 Health Promotion Fund	Korea	4341	Cross-sectional ^f	<ul style="list-style-type: none"> Those living in an urban area, with smoking parents, and with a smoking partner were more likely to have ever-used e-cigarettes or to have used them in the past 30 days. <p>In 2008</p> <ul style="list-style-type: none"> 444 (10.2%) had heard of or seen e-cigarettes; 22 (0.5%) had used e-cigarettes Students primarily learned of e-cigarettes through the Internet (46.4%), friends (27.9%), or television (11%). Boys, those with a cigarette smoking family member, those who reported lower satisfaction in school, and who previously smoked cigarettes had greatest likelihood of reporting e-cigarette use.

^a Current use = use in the past 30 days.

^b Convenience sample.

^c Randomly selected sample.

non-whites to know of (Pepper et al., 2013a) or use e-cigarettes (Camenga et al., 2014).

3.2. Prevalence and correlates of use among young adults

Three studies explored e-cigarette use among young adults (Choi and Forester, 2013; Sutfin et al., 2013; Goniewicz and Zielinska-Danch, 2012). All were cross-sectional (sample size: 2624 to 20,240). Choi and Forester (2013) analyzed responses from 2624 individuals aged 20–28 years participating in the 2010–2011 Minnesota Adolescent Community Cohort and found that 69.9% knew of e-cigarettes, 7.0% were lifetime users, and 1.2% past-month users. Among those aware of e-cigarettes, 52.9% reported they were less harmful and 26.4% less addictive than tobacco. Those perceiving e-cigarettes as less harmful or addictive than traditional cigarettes had the highest prevalence of use. In another study of young adults, Sutfin et al. (2013) surveyed 4444 North Carolina (NC) college students (mean age 20.5 years) in 2009 and found 4.9% had ever-used e-cigarettes, with 1.9% reporting past-month use. Of lifetime e-cigarette users, 12.0% had never used tobacco, indicating e-cigarette initiation by non-tobacco users. Lifetime e-cigarette use also did not associate with tobacco-quit intent among current smokers. Prevalence of lifetime e-cigarette use was higher in young adults than adolescents in grades 6–12 (7.0% and 3.3% in 2011, respectively).

In a similar study, Goniewicz and Zielinska-Danch (2012) analyzed data from a survey of Polish high school and university students conducted from September 2010–September 2011. They found that 19.0% of university students ($n = 1894$) reported lifetime e-cigarette use, with 5.9% reporting current use. Over half (54.5%) of participants perceived e-cigarettes as safer than tobacco.

All three studies found that males were more likely than females to use e-cigarettes (Sutfin et al., 2013; Choi and Forester, 2013; Goniewicz and Zielinska-Danch, 2012). In terms of race/ethnicity, Sutfin et al. (2013) found that odds of lifetime use were greater for Hispanics (AOR 2.02, 95% CI 1.03–3.98) and Other Race (AOR 2.06, 95% CI 1.12–3.77) students when compared to whites. Choi and Forester (2013) found similar odds of use between whites and Non-whites.

In summary, young adult e-cigarette use prevalences (e.g., college students) appear similar to adolescent use data, with past-month use in 2011 ranging from 1.1% to 2.3% and young adult past-month use ranging from 1.2% to 5.9% in 2010–2011. Of the three studies, young adult lifetime use prevalences ranged from 4.9% among U.S. university students in 2009 to 19% among Polish

university students in 2010–2011. Slightly more than half of young adults in a U.S. study believed e-cigarettes were safer than tobacco.

3.3. Prevalence and correlates of use among adults

Seven studies examined e-cigarette use prevalence and correlates among adults (Dockrell et al., 2013; King et al., 2013; Regan et al., 2013; Vickerman et al., 2013; Adkison et al., 2013; Li et al., 2013; Pearson et al., 2012). All were cross-sectional. Sample sizes ranged from 657 to 12,597.

Three studies examined e-cigarette use among U.S. national samples. King et al. (2013) analyzed data from the 2010 and 2011 HealthStyles surveys and found a doubling in lifetime e-cigarette use prevalence (2.1%–3.3% to 6.2%). In both years, lifetime-use prevalence and the increase were highest among current smokers (6.8%–9.8% to 21.2%). Similarly, Regan et al. (2013) analyzed data from the 2009 and 2010 ConsumerStyles surveys and found a quadrupling of lifetime e-cigarette use prevalence ranging from 0.6% to 2.7%, also with the greatest increase among current smokers (20.7%–49.6%). In 2010, 1.2% of adults reported past-month use. Pearson et al. (2012) combined data from a national internet survey ($n = 2649$) with a longitudinal survey of tobacco smokers ($n = 3658$) and found that 3.4% of online respondents reported lifetime e-cigarette use, with 35.9% of users using it in the past 30 days. Current tobacco smokers were most likely to ever-use e-cigarettes (11.4%), followed by former smokers (2.0%). Taken together, these limited numbers of studies suggest that e-cigarette use prevalence is increasing among U.S. adults and that the 2011 adult lifetime use prevalence is comparable to that of young adults (6.2% and 7.0%, respectively).

Among cigarette smokers calling a tobacco quit-line (2758), Vickerman et al. (2013) found that 30.9% reported ever using e-cigarettes. Most (61.7%) users had used for <1 month. A small proportion of non-smoking adults had also tried e-cigarettes. Among never smokers, King et al. (2013) reported the highest lifetime e-cigarette use prevalence (2010–2011 range = 1.2%–1.3%), followed by Regan et al. (2013) (2009–2010 = 3.6%) and Pearson et al. (2012) (2010 = 0.77%). The proportion of adults that had never used cigarettes but had tried e-cigarettes was much lower than the same proportion among adolescents (ever-use prevalence 9.3% among non-tobacco-using middle and high school students).

In a study comparing 2010 and 2012 U.K. survey data, Dockrell et al. (2013) found that 21.6% of current tobacco smokers had a history of e-cigarette use in 2012. Among ex-smokers, lifetime prevalence was 3.7%. Among never smokers, it was 0.5%. Similar to 2010–2011 estimates in the U.S. (King et al., 2013), prevalences for

Table 2
Young adult prevalence and correlates of e-cigarette use.

Citation	Data Source	Country	Sample size	Study type	Findings
Choi and Forester, 2013	Minnesota Adolescent Community Cohort	United States	2624 Participants aged 20–28 years	Cross-sectional from a larger prospective cohort study ^c	<p>From 2010–2011</p> <ul style="list-style-type: none"> 69.9% were aware of e-cigarettes, 7.0% reported ever-use, and 1.2% reported current use^a; Having heard of e-cigarettes positively correlated with: male sex, enrollment in or graduation from college, current and former tobacco smoker, having a close friend who smoked; Ever-use correlated with young age (aged 20–24 years), male sex, being a current or former tobacco smoker, and having at least one close friend who smoked.
Sutfin et al., 2013	2009 Internet Survey	United States	4444 Students from 8 North Carolina colleges	Cross-sectional ^c	<p>Fall 2009</p> <ul style="list-style-type: none"> 4.9% reported ever-use of e-cigarettes, and 1.9% reported current use; 12% of users had never smoked a tobacco cigarette; Correlates of ever-use were: being male, a Greek member or pledge, living off-campus, greater sensation seeking, tobacco smoker status, lifetime hookah use, current binge drinking, current marijuana use, lifetime other illegal drug use, and harm perceptions about e-cigarettes; Among current tobacco smokers, ever-use correlates were: being male, higher sensation seeking, current binge drinking, ever use of an illicit drug, and harm perceptions of e-cigarettes.
Goniewicz and Zielinska-Danch, 2012	Surveys at 176 high schools & universities	Poland	13,787	Cross-sectional ^c	<p>From September 2010–June 2011</p> <ul style="list-style-type: none"> 19.0% of students aged 20–24 years had ever-used e-cigarettes; 5.9% of students aged 20–24 years reported current use; Past use of tobacco cigarettes, male gender, living in an urban area, and having parents who smoke tobacco cigarettes positively associated with ever-use of e-cigarettes.

^a Current use = use in the past 30 days.^c Randomly selected sample.

adult awareness, trial, and e-cigarette use more than doubled from 2010 to 2012. Data from U.K. studies also suggest increasing e-cigarette use prevalences.

Regional differences may affect knowledge and use prevalence. Adkison et al. (2013) surveyed 5939 current and former cigarette smokers in the U.S., U.K., Canada, and Australia in July 2010–June 2011 and found that e-cigarette knowledge and ever-use were greatest where products are legal (U.S., U.K.) compared to illegal (Canada, Australia) (awareness: U.S. 73.4%, U.K. 54.4%, Canada 39.5%, Australia 20.0%, ($p < 0.001$); ever-use: U.S. 20.4%, U.K. 17.7%, Canada 10.1%, Australia 10.9% ($p < 0.001$)). Around 3% of respondents were current e-cigarette users. Non-daily smokers and those reporting e-cigarettes as less harmful than cigarettes were more likely to ever-use (OR 1.85, 95% CI 1.23–2.78 & OR 3.74, 95% CI 2.64–5.30). In New Zealand, where e-cigarettes are legal, Li et al. (2013) found that only 7% of the 480 current and former cigarette smokers surveyed in 2011 had ever-purchased an e-cigarette, and that, of the 360 current or former smokers surveyed in 2012, 41% endorsed switching to e-cigarettes if cheaper than tobacco. Taken together, findings suggest

that socio-cultural factors, such as legal status, may affect e-cigarette use and awareness.

U.S. findings by racial/ethnic group are mixed. In a national sample ($N = 10,739$, race proportions not provided), King et al. (2013) found that in 2010–2011 the lifetime use prevalence among whites (6.8%, 95% CI 5.6–8.1) did not differ from the prevalence among individuals who identified as Other Non-Hispanic (6.1%, 95% CI 1.8–10.4), Black (4.5%, 95% CI 1.6–7.3), or Hispanic (3.9%, 95% CI 1.1–6.7). In analyses of 2010–2011 survey data from current and former U.S. smokers, Adkison et al. (2013) found that whites were more likely than nonwhites to know of e-cigarettes (75.8% vs. 64.6%, $p < 0.0001$) and that being white positively correlated with ever-use (statistics not reported). In a 2010 national sample ($N = 10,587$, race proportions not provided), Regan et al. (2013) found that Blacks (25.8%, 95% CI 21.7–29.9) were similar to Hispanics (28.5%, 95% CI 24.6–32.5) and people of Other Race (32.3%, 95% CI 26.7–38.0), but were less likely than whites (33.9%, 95% CI 32.1–35.7) to report being aware of e-cigarettes. Additionally, Blacks (8.9%, 95% CI 4.9–12.9) and Hispanics (8.2%, 95% CI 4.6–11.7) were as likely as whites (8.3%, 95% CI 6.4–10.1) and people of

Table 3
Adult prevalence and correlates of e-cigarette use.

Citation	Data source	Country	Sample size	Study type	Findings
Dockrell et al., 2013	2010 & 2012 Population Survey	Great Britain	2010–12,597 Including 2297 cigarette smokers; 2012–12,432 including 2093 cigarette smokers	Cross-sectional ^c	<p>From 2010–2012</p> <ul style="list-style-type: none"> E-cigarette awareness, trial, and current use^a more than doubled; Trial and use occurred most often among current tobacco smokers; E-cigarette ever-use among tobacco smokers rose from 5.5% to 15.0%; Young respondents (aged 18–34 years) were more likely to report ever-use than older participants (aged ≥55 years); Daily tobacco smokers more often reported ever-use than occasional smokers; The most common reason for trying an e-cigarette was to smoke where tobacco was not allowed.
Vickerman et al., 2013	Cigarette quit-line	United States	2758	Cross-sectional ^b	<ul style="list-style-type: none"> 30.9% reported e-cigarette ever-use; 61.7% used them for less than a month; 9.2% continued to use e-cigarettes at 7-months; Those who tried e-cigarettes were more likely to be abstinent (30 day point prevalence) at 7-months than those who had not tried them; More (77.9%) callers who used e-cigarettes for >1 month had multiple quit attempts compared to having one or no attempts ($p < 0.05$); More callers who never used e-cigarettes (70.2%) also had multiple quit attempts compared to one or no attempts ($P < 0.05$); The majority of callers who used e-cigarettes for >1 month (58.0%) or used them for < 1 month (63.4%) lived or worked with a tobacco user ($p < 0.001$) when compared to those who never used e-cigarettes;
Adkison et al., 2013	July 2010–June 2011 International Tobacco Control Survey	U.S. U.K. Canada Australia	5939 Current and former cigarette smokers	Cross-sectional ^c	<ul style="list-style-type: none"> Knowledge and ever-use were greatest in countries where products are legal; ~3% of respondents were current users, and this did not vary by country. Smokers (vs. nonsmokers), daily smokers (vs. non daily smokers and quitters), menthol (vs. non-menthol smokers), those who allowed smoking in the home (vs. home smoking ban), and those who took the survey on the web (vs. on the telephone) were more likely to know of e-cigarettes; Non-daily smokers were more likely than daily smokers to have tried e-cigarettes; Established quitters were less likely than continuing smokers and those who perceived of e-cigarettes as safer than tobacco were more likely to have tried e-cigarettes; In the U.S., menthol smokers (vs. non-menthol smokers) and those without a home smoking ban (compared to those with one) were less likely to know of e-cigarettes; In U.K., smokers (vs. quitters) and those taking the survey on the web (vs. telephone) were more likely to know of e-cigarettes; In Australia and Canada, those who took the survey on the web (vs.

Table 3 (continued)

Citation	Data source	Country	Sample size	Study type	Findings
King et al., 2013	2010 & 2011 HealthStyles mail and Internet Survey	United States	2010–6689 2011–4,050	Cross-sectional ^c	<p>telephone) were more likely to know of e-cigarettes.</p> <p>In 2010</p> <ul style="list-style-type: none"> • 38.5% of mail respondents and 40.9% of Internet respondents were aware of e-cigarettes; • 2.1% of mail respondents and 3.3% of internet respondents ever-used e-cigarettes; <p>In 2011</p> <ul style="list-style-type: none"> • Awareness rose to 57.9%; • Ever-use rose to 6.2%; • Use was highest among current smokers compared to former and never-smokers.
Li et al., 2013	2011 & 2012 New Zealand Smoking Monitor	New Zealand	2011–480 2012–360	Cross-sectional ^c	<p>Of 480 respondents first surveyed:</p> <ul style="list-style-type: none"> • 7% had purchased an e-cigarette; • 18–24 year olds were more likely to purchase e-cigarettes than those aged ≥45 years (95% CI 1.17–16.16); <p>Of 360 respondents later surveyed:</p> <ul style="list-style-type: none"> • 41% reported they would switch to e-cigarettes if they were cheaper than tobacco, with those of low income 3 times more likely to say so (95% CI 1.51–5.88); • 58% said they would use e-cigarettes to help them quit smoking, with those aged 18–24 3 times more likely to say so than those aged ≥45 years (95% CI 1.17–9.69).
Regan et al., 2013	2009 & 2010 Mail Survey (Consumer-Styles)	United States	2010–10,587 2011–10,328	Cross-sectional ^c	<p>From 2009–2010</p> <ul style="list-style-type: none"> • E-cigarette awareness rose from 16.4% to 32.2%, with increased awareness greatest among current smokers (20.7%–49.6%); • Ever-use rose from 0.6% to 2.7%; • Of those who had tried e-cigarettes, 1.2% had used them in the past month; • Ever-use was most common among women, those with lower education, and current tobacco users; • Those with an income <\$15,000 who had heard of e-cigarettes were more likely to try them than those earning ≥\$60,000; • Blacks and Hispanics were less likely to have heard of e-cigarettes but as likely to have tried e-cigarettes than when compared to Whites.
Pearson et al., 2012	National Survey & Longitudinal Survey	United States	2649 – Online survey ^c & 3658 longitudinal cohort of tobacco smokers ^b	Cross-sectional ^b	<p>In 2010</p> <ul style="list-style-type: none"> • 40.2% of on-line respondents were aware of e-cigarettes; • Of on-line respondents, 57.1% of ever-smokers had heard of e-cigarettes (vs. 41.5% of former smokers and 32.5% of never smokers); • In the longitudinal sample, 58.2% of current smokers had heard of e-cigarettes (vs. 57.1% of former smokers); • 11.4% of current smokers used e-cigarettes & 2.0% of former smokers; • Online respondents who indicated quit intent attempt were more likely to use e-cigarettes than those who did not intend or had not attempted to quit; • 70.6% of online respondents and 84.7% of the longitudinal sample

(continued on next page)

Table 3 (continued)

Citation	Data source	Country	Sample size	Study type	Findings
					<p>thought e-cigarettes were less harmful than tobacco cigarettes.</p> <ul style="list-style-type: none"> • On-line survey participants perceiving poor health were less likely to have ever-used e-cigarettes than those in good or fair health; • Those intending to quit in the next 6-months were more likely to have ever-used e-cigarettes than those not interested in quitting or who planned to quit in the next 30 days

^a Current use = use in the past 30 days.

^b Convenience sample.

^c Randomly selected sample.

Other Race (8.9%, 95% CI 4.5–13.3) to have tried them. Past-month use prevalence among Blacks (5.8%) did not differ from that of individuals self-identifying as Other (4.3%), white (3.3%), or Hispanic (3.1%). Analyzing data from a 2010 national survey (71.8% white, 11.3% Black, 10.9% Hispanic, and 6.1% Other) and a longitudinal sample of cigarette smokers (74.4% white, 11.8% Black, and 7.0% Hispanic, and 6.8% Other), Pearson et al. (2012) found no racial/ethnic differences in ever-use prevalence of e-cigarettes: individuals self-reporting as Other Race (18.1%, 95% CI 8.4–34.6), whites (11.8%, 95% CI 9.4–14.7), Hispanics (10.2%, 95% CI 5.1–19.6), and Blacks (8.2%, 95% CI 3.6–17.7). However, the wide range of CI of estimates suggests that a larger sample size is needed to produce more reliable estimates. Among quit-line callers, Vickerman et al. (2013) found that e-cigarette ever-users were more likely to be white (~75%) than non-white (<0.001). Overall, overlapping CIs indicate a need for research on race/ethnicity in diverse and large samples.

Outside the U.S., race/ethnicity results are also mixed. Of current and former cigarette smokers in the U.K., Adkison et al. (2013) found that minorities were more likely than whites to know of (55.0% vs. 44.0%, $p < 0.05$) and to have tried (statistics not provided) e-cigarettes. Of current and former New Zealand smokers, Li et al. (2013) found that non-Maori were twice as likely Maori to believe e-cigarettes were safer than cigarettes. Diversity in findings may relate to differences regarding perceptions, cost, and legal status of e-cigarettes in different regions. Dockrell et al., (2013) did not report findings by race.

The available, limited data suggest some similarities in the e-cigarette use prevalence among women and men. King et al. (2013) found that lifetime use prevalence increased similarly among men (2010–2011: 2.3–5.8) and women (1.9–6.6%). Regan et al. (2013) found that women did not differ from men in lifetime e-cigarette use (women: 10.5%, 95% CI 7.9–13.2; men: 6.5%, 95% CI 4.9–8.0) and past-month use (men: 3.6%; women: 3.5%). Likewise, Pearson et al. (2012) found no difference in men and women's ever-use of e-cigarettes (men: 12.6%, 95% CI 9.2–16.9; women: 10.3%, 95% CI 7.7–13.7). Among those calling a tobacco quit-line, Vickerman et al. (2013) found no gender difference in e-cigarette ever-use. Additional research on a large sample is needed to better characterize patterns of recent or active use in both genders. Results are also mixed outside the U.S. When analyzing data from current and former U.S., U.K., Canadian, and Australian smokers, Adkison et al. (2013) found that the odds ratio of e-cigarette awareness was greater in men than women, but found no gender differences in ever-use. Results from the survey data in U.K. showed a higher prevalence of e-cigarette awareness among men than women (57.7% vs. 51.1%, $p < 0.01$) Dockrell et al. (2013) found no significant gender differences in ever or current use, and Li et al. (2013) found no significant gender differences in ever-use, perceived safety,

perceived efficacy for smoking cessation, willingness to switch to e-cigarettes if cheaper than cigarettes, or willingness to use e-cigarettes to quit cigarettes.

Only three studies reported results involving income (Adkison et al., 2013; Regan et al., 2013; Li et al., 2013). Regan et al. (2013) found no difference in awareness based on income but found that, among those aware of e-cigarettes, those of low income ($\leq \$15,000$) were more likely than high-income ($\geq \$60,000$) individuals to try them. When analyzing U.S., U.K., Canadian, and Australian data, Adkison et al. (2013) found that the awareness prevalence was higher among those with high compared to low income (47.8% vs. 43.1%, $p < 0.001$). However, ever-use was more common among those of high versus low income in the U.S. and U.K. (exact statistics not provided). In New Zealand, high-income individuals were more likely than those with moderate or unspecified income to have bought e-cigarettes, and low-income individuals were more likely to perceive of e-cigarettes as less effective for tobacco cessation but were more willing to switch to e-cigarettes if cheaper than tobacco. This suggests that awareness is greater among high-income versus low-income individuals but that those with less income may be more likely to try and use e-cigarettes, particularly if cheaper than tobacco.

Similar prevalences were found for younger and middle-aged individuals. King et al. (2013) found that more non-elderly adults were aware of e-cigarettes than elderly adults aged 65 + years (in 2011: ages 45–54: 65.4%, 95% CI 61.1–69.6; ages 55–64: 61.2%, 95% CI 56.8–65.6; ages 35–44: 60.0%, 95% CI 55.4–64.6; ages 25–35: 58.3%, 95% CI 52.6–63.8; ages 18–24: 56.8%, 95% CI 49.7–63.9; ages 65 + years: 44.6%, 95% CI 40.0–49.2). Lifetime-use prevalences were similar across age groups. Regan et al. (2013) also found that awareness prevalence was higher among younger compared to older and elderly adults (ages 18–24: 41%, 95% CI 32.4–49.6; ages 25–34: 40.5%, 95% CI 37.3–43.8; ages 35–44: 37.1%, 95% CI 34.7–39.5; ages 45–54: 33.9%, 95% CI 32.0–35.7; ages 55–64: 25.6%, 95% CI 23.3–27.8; ages 65+: 15.1%, 95% CI 13.4–16.8), but lifetime and past-month use were similar across ages. Pearson et al. (2012) found that age inversely related to awareness and use in an on-line survey. Among those calling a tobacco quit-line, Vickerman et al. (2013) found that callers who used e-cigarettes for < 1 month were more likely to be 18–24 than aged 25–40 and ≥ 41 years. Data suggest similar lifetime use prevalences across age groups.

Outside the U.S., age differences were found. In the U.K., Dockrell et al. (2013) found that persons aged 18–34 (Reference group) were more likely than those aged ≥ 55 years (OR 0.58, 95% CI 0.43–0.78) to have ever-used e-cigarettes. Similarly, analyzing U.S., U.K., Canadian, and Australian data, Adkison et al. (2013) found that younger aged individuals appeared to be more likely to be aware of (aged 18–24 through ≥ 55 years: 67.8%–41.7%, $p < 0.001$) and to

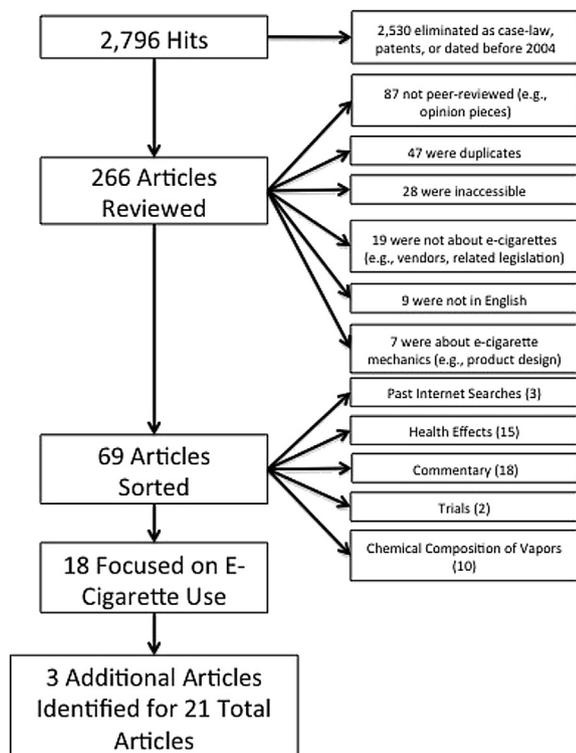


Fig. 1. Literature review search results.

ever-use e-cigarettes (age 18–24 years: reference group; ages 25–39: OR 0.53, 95% CI 0.33–0.84; ages 40–54: OR 0.34, 95% CI 0.21–0.55; ages ≥ 55 : 0.35, 95% CI 0.21–0.57). Among participants in a New Zealand study, Li et al. (2013) also found younger individuals (aged 18–24) were more likely than those aged ≥ 45 years to purchase e-cigarettes (OR 4.36, 95% CI 1.17–16.16) and say they would use them to help quit cigarettes (OR 3.37, 95% CI 1.17–9.69). Thus, in some regions young individuals may be more likely than older individuals to use e-cigarettes.

Available data presented conflicting results on education. Regan et al. (2013) found that those with < high school were less likely than those with some college or a college degree to know of e-cigarettes (OR 0.67, 95% CI 0.47–0.96). However, they were more likely to have ever-used (OR 2.90, 95% CI 1.13–7.45) and used e-cigarettes in the past 30 days (OR 3.47, 95% CI 1.15–10.46) than those with higher education. Pearson et al. (2012) found increased education increased likelihood of e-cigarette use among those in the longitudinal sample of smokers but not the online survey (<high school reference group; high school diploma or GED OR 1.96, 95% CI 1.00–3.85; some college OR 2.14, 95% CI 1.05–4.38; college degree OR 2.72, 95% CI 1.33–5.59). Of quit-line callers, Vickerman et al. (2013) found that 47.1% of those who used e-cigarettes for < 1 month, 46.6% of those who used them for ≥ 1 months, and 43.6% of those who ever-used e-cigarettes had \leq high school ($p < 0.001$). King et al. (2013) found no differences based on education. In the U.S., Adkison et al. (2013) found that those with a moderate level of education (78.7%) were more likely than those with a low (68.8%) or high (73.5%) education level to be aware of e-cigarettes ($p < 0.001$). More research is needed to understand how education relates to e-cigarette awareness and use in the U.S. Analyzing U.S., U.K., Canadian, and Australian data, Adkison et al. (2013) found those with a moderate level of education were more likely than those with a low education level to have heard of e-cigarettes, and those with a high education level were more likely

than those with a low education level to be current users. No significant results were found for ever-use.

Outside the U.S., results from data examining education were also not clear. In Canada, those with a moderate education level (44.1%) were more likely to know of e-cigarettes than those with a low (35.5%) or high (38.8%) education level ($p < 0.05$). In the U.K. and Australia, those with a high education level (60.6%, 30.0%, respectively) were more likely than those with a low (54.1%, respectively) or moderate (50.1%, 21.0%, respectively) education level to know of e-cigarettes. In New Zealand, Li et al. (2013) found no significant differences based on education level (up to or above secondary school) in ever-use, perceived safety, perceived efficacy for smoking cessation, willingness to switch to e-cigarettes if cheaper than cigarettes, or willingness to use e-cigarettes to quit cigarettes in New Zealand. Dockrell et al. (2013) did not examine e-cigarette use based on education. Additional data are needed to explore how education level relates to e-cigarette awareness and use.

In summary, only one study reported past-month prevalence of e-cigarette use among U.S. adults without additional subgroup stratification (by cigarette smoking status, gender, race, etc.), which was 1.2% in 2010. Reported lifetime prevalences increased over time, ranging from 0.6% in 2009 to 6.2% in 2011. Among adults, the use prevalence was higher among current smokers than non-current smokers. A similar trend was found in U.K. data. Current smokers in U.K. data were also the most likely than non-current smokers to try e-cigarettes. Studies have not found distinct patterns of use prevalences across racial/ethnic groups, which appears to be a limitation of the sample size. Younger and older individuals appeared equally likely to have ever used e-cigarettes in the U.S., but younger individuals were more likely to ever-use them in other regions. Use prevalences among men and women were similar. High-income individuals may be more likely to know of e-cigarettes, but low-income individuals may be more likely to have used them.

3.4. E-cigarette use pattern, preference, and reasons of use

Eight descriptive studies examined user perceptions of e-cigarettes (Etter, 2010; Foulds et al., 2011; Etter and Bullen, 2011; Dawkins et al., 2013; Dockrell et al., 2013; Goniewicz et al., 2013b; Vickerman et al., 2013; Adkison et al., 2013). One examined young adult perceptions of e-cigarettes (aged 18–26 years) (Choi et al., 2012). Only one study included respondents aged <18 years (3%) (Goniewicz et al., 2013b), not exploring the data by age group.

Convenience samples of e-cigarette users are mostly male former-tobacco smokers. Foulds et al. (2011) surveyed 104 adults at a 2011 e-cigarette enthusiast meeting in Philadelphia. Most were former-heavy smokers (88%), male (74%), and white (88%). Similarly, in a 2011–2012 survey posted to two e-cigarette vendor websites (33 countries), Dawkins et al. (2013) found most respondents ($n = 1,347$, 72% European) were male (70%), white (90%), and current or former smokers (100%). Of 3587 U.S., U.K., Canadian, or French adults visiting a smoking cessation website in 2010, Etter and Bullen (2011) found 84% reported lifetime e-cigarette use; of them, 65% were male. Of English speaking respondents (78.9%), 84.8% self-identified as former and 65.0% as current smokers. In 2009, Etter (2010) also surveyed 81 French, Canadian, Belgium, and Swiss lifetime e-cigarette users visiting a tobacco cessation website. Of respondents, 77% were male, 63% were former, and 37% current smokers. Goniewicz et al. (2013b) examined data from 179 Polish e-cigarette users to an internet survey and found that most respondents were male (83%) and current smokers (86%). These

descriptive findings of convenience samples suggest that most e-cigarette users are male and white.

Use prevalences vary. Among e-cigarette enthusiasts, [Goniewicz et al. \(2013b\)](#) found that 98% used everyday, 46% had used them for <1 month, and 40% had used them 1–6 months. [Foulds et al. \(2011\)](#) found that 69% had used e-cigarettes for ≥ 1 year and on a daily basis. Respondents preferred larger models with higher voltage batteries to models sold as cigarette replacements, with only 8% using devices the same size as cigarettes. Additionally, 35% of respondents used e-cigarettes more often than they had smoked cigarettes. In qualitative interviews with 15 e-cigarette enthusiasts in St. Louis, [McQueen et al. \(2011\)](#) similarly found that experienced users preferred modified devices with larger batteries. Among international respondents, the mean length of e-cigarette use was 10 months, with ex-smokers using longer and sooner after waking than current smokers ([Dawkins et al., 2013](#)). When asked if they used e-cigarettes the same way as cigarettes, 56% endorsed yes; moreover, 29% reported that they used e-cigarettes more often than they used cigarettes. Ex-smokers were more likely than current smokers to use a custom device. [Etter and Bullen \(2011\)](#) found that, in an international sample of 3,587, the median duration of e-cigarette use was 3 months, with 15% using it for ≥ 1 year. Taken together, e-cigarette users may use devices for several months, may use them more often than cigarettes, and overtime may prefer larger models than those designed for tobacco replacement.

Adult e-cigarette users reported similar reasons for use. Among those calling a tobacco quit-line, 51.3% used e-cigarettes to quit and 15.2% to replace tobacco ([Vickerman et al., 2013](#)). [Adkison et al. \(2013\)](#) also found most users wanted to reduce cigarette consumption (75%). [Goniewicz et al. \(2013b\)](#) found that equal proportions (41%) used e-cigarettes to quit or as a healthier alternative to tobacco, and [Dawkins et al. \(2013\)](#) found that 76% of respondents used e-cigarettes as a tobacco alternative. However, only 7% used them to quit tobacco. [Dockrell et al. \(2013\)](#) found most users thought e-cigarettes might satisfy tobacco cravings (60%), help them reduce tobacco (55%), or give up tobacco (51%). [Foulds et al. \(2011\)](#) found that 99% of users believed e-cigarettes helped them quit tobacco. [Etter and Bullen \(2011\)](#) also found that most (92%) users said e-cigarettes helped them reduce tobacco. Most former smokers said e-cigarettes helped them quit (96%), and 79% were afraid they might relapse if they stopped e-cigarettes. [Etter \(2010\)](#) asked 81 respondents to explain why they used e-cigarettes and found that 53 (65%) reported it was to quit tobacco, and 49 (60%) for their health.

Some tobacco users also perceive e-cigarettes are safer than tobacco or other methods of cigarette cessation. [Dockrell et al. \(2013\)](#) found that 71% of smokers perceived e-cigarettes were safer than cigarettes and 22% were unsure which was safer. Surprisingly, 28% also perceived e-cigarettes safer than nicotine replacement therapy, and 32% were unsure which was safer. In focus groups with 66 individuals aged 18–26 years in Minnesota, [Choi et al. \(2012\)](#) found that young adults perceived e-cigarettes were safer than cigarettes. [Etter and Bullen \(2011\)](#) also found that 84% of users used because they perceived e-cigarettes were safer than cigarettes, and [Adkison et al. \(2013\)](#) found that 70.3% of those aware of e-cigarettes perceived them as less harmful than cigarettes.

Users also identified disadvantages for e-cigarettes. [Dockrell et al. \(2013\)](#) found that the most often cited disadvantage of e-cigarettes was cost (53%), followed by the possibility e-cigarettes would not satisfy tobacco smoking desire (39%) or might be mistaken for a cigarette (35%). [Dawkins et al. \(2013\)](#) examined potential side effects and found that 6.6% of respondents reported being embarrassed to use e-cigarettes in public sometimes,

followed by 2.6% not liking the taste, and 1.4% feeling e-cigarettes were too heavy. [Etter and Bullen \(2011\)](#) found that respondents disliked e-cigarettes burning their throat or giving them a dry mouth (26%), that respondents wanted the vapor to be more concentrated (20%) and easier to inhale (20%), and that some (18%) felt batteries ran out too quickly. [Etter \(2010\)](#) found e-cigarette users complained of the poor quality of devices, reported e-cigarettes could be difficult to use, that the dosage was difficult to adjust, the liquid sometimes leaked, and that there was no information about vapor composition.

We only identified one study that asked respondents about their use of e-cigarettes to consume substances other than those intended for use with an e-cigarette device. [Etter and Bullen \(2011\)](#) found that 0.9% of lifetime users had used their device to consume such a substance, with the most popular being cannabis (0.2%). Other substances used included vitamins, flavors, and vodka.

In summary, convenience samples of adult e-cigarette users included predominantly whites, men, or cigarette smokers. Reasons given for use varied but usually related to replacing cigarettes, often attempting to quit. The perceived ability of e-cigarettes to help users quit tobacco and perceived less harmfulness than cigarettes were commonly endorsed reasons for use.

4. Discussion

It appears that e-cigarette use prevalences are increasing among various age groups. Based on the most recent comparable U.S. data (2011), lifetime use was higher among young adults (aged 20–28 years and college students, range: 4.9%–7.0%), followed by adults (aged ≥ 18 , range: 0.6%–6.2%) and then adolescents (grades 6–12, range: <1%–3.3%). However, lifetime use prevalence among adolescents increased to 6.8% in 2012, comparable to the prevalence in the 2011 young adult and adult data, and in 2012 the use-prevalence among older adolescents (grades 9–12) reached 10.0%. In addition, Polish data showed a higher lifetime use prevalence among high school (23.5%) compared to university (19.0%) students. E-cigarette use among adolescents is a unique concern, as the extent of adverse health effects are unknown and reasons for use are unclear ([Corey et al., 2013](#)). Besides effects from the toxic impurities in cartridges ([Williams and Talbot, 2011](#)), nicotine may affect adolescent brain development ([Dwyer et al., 2009](#)) and increase likelihood of addiction ([Corey et al., 2013](#)). Research data are needed to inform reasons for use (including factors influencing continued use and use motives among never users of cigarettes) and health effects of e-cigarette use.

Among young adults, lifetime e-cigarette use was not associated with cigarette-quit attempts, and 12% of users never tried cigarettes ([Sutfin et al., 2013](#)). However, no studies have addressed reasons for adolescent or young adult use. [Pepper et al. \(2013a\)](#) found a notable proportion of adolescent males would try e-cigarettes if offered by a friend, suggesting that peers may influence experimentation in this young population. Among U.S. middle (20.3%) and high (19.5%) school students, about one-fifth of lifetime users had never smoked a cigarette ([Corey et al., 2013](#)). Reasons for e-cigarette use may differ among different age groups; which deserves research to help characterize onset and escalation of use among smokers vs. non-smokers, especially adolescents and young adults. Adolescence is the time when individuals often experiment with and initiate substances ([Wu et al., 2011](#)). It is likely that even among adolescents who had used cigarettes, e-cigarette use did not relate to a desire to quit tobacco. Problem behavior theory suggests that problem behaviors cluster because they serve the same purpose socially, developmentally, and psychologically or are the

manifestation of similar underlying factors (Jessor et al., 1991; DuRant et al., 1999). Alternatively, the gateway and reverse gateway theories suggest that adolescent use of one substance increases the likelihood of using other substances (Fergusson et al., 2008). Additionally, sensation seeking, or the need for new, different, or complex sensations and experiences and the willingness to take risks to achieve them, associates with adolescent substance use and may increase e-cigarette experimentation (Zuckerman, 1979; Crawford et al., 2003). Adolescents trying cigarettes may be more likely to try e-cigarettes and vice versa. This is troubling as a majority of young adults viewed e-cigarettes as safer than cigarettes, and it is unclear if e-cigarette use may reduce inhibitions toward tobacco or other harmful substances. It is possible that e-cigarettes may renormalize cigarettes and work as a gateway to tobacco (Bullen et al., 2013). Studies should explore how e-cigarette use relates to other kinds of substance use. Etter and Bullen (2011) also found that a small proportion of adults experimented with e-cigarettes to deliver cannabis and alcohol. Young people may experiment with variable ways to use these devices, and studies should explore whether adolescents use them for substances beyond nicotine.

Cigarette smoking was the only common correlate of e-cigarette use identified from this review. Research should conduct in-depth analyses to further understand correlates of different use patterns and use motives among different age groups. While e-cigarettes may play a role in tobacco treatment, particularly for those with severe nicotine dependence, research data are needed to establish the benefits and potential harms of use beyond 12-months (Bullen et al., 2013). Additionally, while e-cigarettes are often presented as a tobacco alternative, adolescents and young adults may not use them this way. Additional research is recommended to discern how adolescent and young adult experimentation with e-cigarettes relates to other types of substance use patterns.

Contributors

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Conflict of interest

Authors declare they have no conflicts of interest.

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