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Review

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

Shawna L. Carroll Chapman [a,*], Li-Tzy Wu [a,b]

[a] Department of Psychiatry and Behavioral Sciences, School of Medicine, Duke University Medical Center, Durham, NC, USA
[b] Center for Child and Family Policy, Duke University Durham, NC, USA

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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.

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

* Corresponding author. Department of Psychiatry and Behavioral Sciences, School of Medicine, Duke University Medical Center Box 3903, Durham, NC 27710, USA. Tel.: +1 785 840 6632; fax: +1 919 681 8400.
E-mail addresses: Shawna.Chapman@dm.duke.edu (S.L. Carroll Chapman), litzy.wu@duke.edu (L.-T. Wu).

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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