Where There Is (No) Smoke, There Is Still Fire: a Review of Trends, Reasons for Use, Preferences and Harm Perceptions of Adolescent and Young Adult Electronic Cigarette Use

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Abstract

Purpose of the review To review the current prevalence, trends, perceptions, and effects of e-cigarette or vaping product use associated lung injury (EVALI) on e-cigarette use among US adolescents and young adults.

Recent findings COVID-19 diagnosis was more likely among the current/ever dual cigarette and e-cigarettes users, as well as ever e-cigarette only users. Additionally, the EVALI outbreak may have influenced harm perceptions, as daily nicotine vaping declined significantly from 2019 to 2020, and more youth and young adults perceived vaping as harmful.

Summary The prevalence of e-cigarette use, specifically flavored use, remains high among adolescents and young adults, which is concerning due to the short-term and unknown long-term effects of e-cigarettes and their association with future cigarette and other substance use.

Keywords Adolescent vaping · Youth and young adult e-cigarette use · Youth flavored e-cigarette use · Vaping and COVID-19 · EVALI

Introduction

Electronic cigarettes, also known as e-cigarettes, Electronic Nicotine Delivery Systems (ENDS), or e-hookah, are devices that deliver nicotine without the combustion of tobacco [1–3]. Invented by Chinese pharmacist Hon Lik in 2003, e-cigarettes have gained widespread popularity throughout the USA over the past decade after emerging into the US market in 2007 [3, 4]. These devices heat an e-liquid, commonly containing propylene glycol, nicotine, flavoring agents, and other additives into an inhaled aerosol [1, 3]. E-cigarette aerosols have been shown to contain heavy metals and other carcinogenic substances, although these levels are generally lower than what is in combustible cigarettes [5, 6]. These devices are highly variable in design, shape, and size and can deliver varying levels of nicotine [2, 5, 7] While these products have been marketed as a healthier alternative to smoking combustible tobacco, more is to be learned about their long-term safety and efficacy as a smoking cessation aide [1, 3, 7] in adolescents. E-cigarettes may benefit long-term tobacco users through harm reduction.

Prevalence of e-cigarette use

E-cigarettes are currently the most commonly used tobacco product among youth [8]. In the 2019 National Youth Tobacco Survey (NYTS), a nationally representative sample of 19,018 middle and high school students, the prevalence of current e-cigarette among US high school and middle school students was about 27.5 and 10.5%, respectively [9•]. The 2020 NYTS data show a decline back to 2018 levels. Of the current e-cigarette users, over half of high schoolers and middle schoolers reported JUUL as their usual e-cigarette brand [9•]. Among the exclusive e-cigarette users (no dual use of tobacco cigarettes) about 72% of high schoolers and 60% of middle schoolers used

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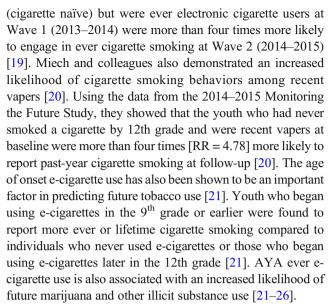2   Harvard Medical School, Boston, MA, USA

flavored e-cigarettes, with fruit, menthol or mint, and candy, desserts, or other sweets reported as the most common flavors [9•]. Data from the 2019 Monitoring the Future study, another nationally representative survey demonstrate a high prevalence of nicotine and cannabis vaping [10•, 11•]. Current nicotine vaping reported among the US 8th, 10th, and 12th graders were 9.0, 20.2, and 25.4%, respectively [11•]. Current cannabis vaping among the US 8th, 10th, and 12th graders were 3.9, 12.6, and 14%, respectively [10•].

Rise of e-cigarette use

Studies show both nicotine and cannabis use among adolescents and young adults have increased significantly over the years [10•, 11•, 12–15]. Cullen and colleagues analyzed data from the 2011–2018 National Youth Tobacco Survey (NYTS), a cross-sectional, voluntary, school-based, self-administered, pencil-and-paper survey of US middle and high school students [12]. They found that current e-cigarette use among high school students, defined as having used an e-cigarette in the past 30 days, increased significantly from 1.5 to 20.8% between 2011 and 2018 [12]. A significant increase was also seen among middle school students, rising from 0.6 to 4.9% between 2011 and 2018 [12]. Current e-cigarette use among high school students increased 78% from 2017 to 2018, a rise that could be attributed to the recent popularity of discrete USB shaped devices, such as the JUUL [12, 16]. As of 2019, JUUL was the most popular brand of e-cigarettes [17]. The Truth Longitudinal Cohort, a nationally representative sample of adolescents and young adults, showed a significant increase in ever and current e-cigarette use and JUUL use from 2018 to 2019 [13]. Vallone and colleagues also saw an increase in the frequency of past 30-day JUUL use from 2018 to 2019, with more participants reporting using JUUL 10–30 days [13]. Increasing JUUL prevalence and frequency of use among youth and young adults is particularly concerning given JUUL's nicotine salt-based 'pods' (e-cigarette cartridges), which provide exposure to high amounts of nicotine [9•, 18]. Disposable e-cigs are now on the rise in youth after the national ban on most other pod based systems in 2020.

E-cigarette use and subsequent tobacco and other substance use

While this view is controversial, adolescent and young adult (AYA) e-cigarette use is associated with future cigarette use in some studies [19–21]. The 2013–2015 Population Assessment of Tobacco and Health Study (PATH), a nationally representative longitudinal cohort study of US youth, showed that participants who had never smoked a cigarette

(cigarette naïve) but were ever electronic cigarette users at Wave 1 (2013–2014) were more than four times more likely to engage in ever cigarette smoking at Wave 2 (2014–2015) [19]. Miech and colleagues also demonstrated an increased likelihood of cigarette smoking behaviors among recent vapers [20]. Using the data from the 2014–2015 Monitoring the Future Study, they showed that the youth who had never smoked a cigarette by 12th grade and were recent vapers at baseline were more than four times [RR = 4.78] more likely to report past-year cigarette smoking at follow-up [20]. The age of onset e-cigarette use has also been shown to be an important factor in predicting future tobacco use [21]. Youth who began using e-cigarettes in the 9th grade or earlier were found to report more ever or lifetime cigarette smoking compared to individuals who never used e-cigarettes or those who began using e-cigarettes later in the 12th grade [21]. AYA ever e-cigarette use is also associated with an increased likelihood of future marijuana and other illicit substance use [21–26].

However, it is important to emphasize that this view is controversial. The question is how many youth who never have experimented with tobacco products and start with e-cigarettes become smokers. Most who try e-cigarettes have already tried other tobacco products. So, there is another side to the debate that argues that maybe e-cigarette use discourages some youth who are risk takers and trying tobacco products from becoming smokers. Clearly, more research is needed to fully understand the impact of e-cigarettes and future smokers before causality can be determined.

Reasons for vaping

Unlike adults, who often report quitting cigarettes as their primary reasons for e-cigarette use, adolescent and young adults are less likely to use for this reason [27]. In the Monitoring the Future 2015–2016 survey, only 7.3% of youth reported vaping to replace cigarettes, while 29.4% endorsed 'Vaping for Experiment' and 63.4% endorsed 'Vaping for taste and entertainment' [28]. The top reasons for use consistently reported within the literature include experimentation/curiosity, taste/flavors available, entertainment/enjoyment, or because someone they knew (i.e., friends or family) used e-cigarettes [28–35].

Flavor preferences and use

Nontraditional flavors of e-cigarettes may be appealing due to their ability to mask the aversive taste of nicotine with sweet or cool sensory experiences [36•]. In a 2019 national sample of US middle and high schoolers, most current e-cigarette users reported use of flavored e-cigarettes, with fruit, menthol or mint, and candy, desserts, or other sweets being the most

commonly reported flavors [9•]. The youth are more likely to initiate e-cigarette use with a non-traditional flavor compared to adults and are more likely to be interested in trying an e-cigarette from a friend if it is flavored like candy, menthol, or fruit [36•, 37–39]. The 2013–2014 PATH study showed 81% of youth reported that the first e-cigarette they used was flavored [38]. Additionally, adolescents and young adults are also more likely to prefer flavor fruit, alcohol, and other flavors, compared to adults who disproportionally favor tobacco, menthol/mint, spice, and coffee e-liquids [40]. Given the widespread use of flavored e-cigarettes by adolescents and young adults, a federal policy banning all cartridge-based e-cigarette products (excluding menthol and tobacco flavors) was put into effect on February 6th, 2020 [41]. While a step in the right direction, this policy does little to hinder youth use [42]. Kid-friendly flavors in disposable and refillable cartridge devices not covered under this policy are still available in many states. Some states such as Massachusetts have taken more stringent action, banning all flavored e-cigarettes regardless of the type of device [43]. Continued efforts should be made to reduce the use of and access to flavored tobacco/nicotine products [42].

Harm perceptions

Many youth and young adults harbor misconceptions about the harm and addictiveness associated with e-cigarette use [44]. A 2014–2015 survey of 9th and 12th graders showed 19.05% of participants believed that smoke from e-cigarettes was water [44]. Studies show AYA also believes that e-cigarettes are less harmful and less addictive than regular cigarettes [44–48]. For example, the PATH 2012 and 2014 survey of students 6 to 12th graders showed almost 75% believed that e-cigarettes were less harmful than cigarettes and 47% believed e-cigarettes were less addictive than cigarettes [48]. While it may be beneficial for tobacco smokers to substitute with e-cigarettes, any form of tobacco use by the youth is unsafe [49]. Ever and current e-cigarette users have significantly lower harm and addiction perceptions compared to never users [46]. Studies also demonstrate that harm and addictiveness perceptions differ by flavor. Pepper and colleagues found that adolescents viewed flavored e-cigarettes as less harmful to health than tobacco flavors [39]. In a 2018 survey of high school students, participants perceived fruit flavors as less likely to cause lung cancer, contain less harmful secondhand smoke and be more addictive compared to tobacco flavors [50]. These findings show that increased efforts should be made to educate the youth and young adults about the potential harm, addictiveness, and additives in e-cigarettes.

Effects of e-cigarette or vaping product use associated lung injury

In the summer of 2019, a nationwide outbreak of e-cigarette or vaping product use associated lung injuries (EVALI) increased safety concerns about the use of e-cigarettes [51, 52]. Fifty-two percent of the 2668 hospitalizations and deaths from EVALI were under 25 years old [53]. These highly publicized cases may have influenced perceptions about e-cigarettes and their safety. The Monitoring the Future survey of 10th and 12th graders from 2017 to 2020 showed that students who perceived great harm from occasional nicotine vaping increased significantly from 21% in 2019 to 27% in 2020 [54••]. Perceptions of the harm of regular vaping also increased significantly [54••]. Daily vaping significantly declined from 2019 to 2020 [54••]. Even with this decline and increased awareness of the potential harms of vaping, youth use still remains high. It is important to note that the cause of EVALI was determined to be contaminants used in THC vaping products and not commercial e-cigarette use. So while EVALI discouraged e-cig use among the youth, a good thing, use of commercial e-cigarette containing nicotine only was not the cause.

Vaping and COVID-19

The effects of smoking and vaping on COVID-19 susceptibility are unknown [55]. A recent study showed a strong association between COVID-19 diagnosis and e-cigarette use in a survey of adolescents and young adults [56••]. Among the survey participants, COVID-19 diagnosis was 5 times more likely among ever only e-cigarette users, 7 times more likely among ever dual-users, and 6.8 times more likely among past 30-day dual users [56••]. Additionally, COVID testing was 9 times more likely among past 30-day dual users, and 2.6 times more likely among past 30-day e-cigarette only users [56••]. Future studies should explore these associations further, as they have a direct impact on health care providers in screening for e-cigarette use in COVID-19-affected youth.

Conclusions

E-cigarettes remain the most used tobacco product among youth and young adults. This is problematic not only because of the harms from nicotine exposure and other health risks associated with e-cigarette use, but e-cigarette use may be associated with future cigarette and other substance use. The main reasons for user use reported are attraction to flavors, entertainment/curiosity, and because someone they knew used e-cigarettes. Efforts should be made to educate the youth about the negative effects of e-cigarette use on their health

and increase their awareness of potential harm. Health care providers and policymakers should continue to work to prevent access to and use of e-cigarettes.

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