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## Public Health Considerations for Adolescent Initiation of Electronic Cigarettes

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### Abstract

Adolescent use of electronic cigarettes (e-cigarettes) has increased dramatically, with younger and nicotine-naïve adolescents starting to use these devices and use them more frequently than combustible cigarettes. In emerging evidence, it is shown that e-cigarettes are not effective in helping adult smokers quit and that youth using e-cigarettes are at risk for becoming nicotine dependent and continuing to use as adults. Important gaps in our knowledge remain regarding the long-term health impact of e-cigarettes, effective strategies to prevent and reduce adolescent e-cigarette use, and the impact of provider screening and counseling to address this new method of nicotine use.

### YOUTH INITIATION VERSUS ADULT CESSATION? THE PUBLIC HEALTH DAMAGE OF E-CIGARETTES

Electronic cigarettes (e-cigarettes; also known as e-cigs and vapes) are presented as a potential solution for adult smoking cessation,<sup>1</sup> an argument made by e-cigarette manufacturers, some physicians, and adult smokers who are in favor of e-cigarettes. In contrast, an increasing number of adolescents are initiating tobacco use through e-cigarettes versus cigarettes or other tobacco products. E-cigarettes first came on the US market in 2007. Since 2015, new pod-based e-cigarettes using a salt-based nicotine formula that is less harsh on the throat were popularized by Juul Laboratories, Inc.<sup>2,3</sup> Youth are attracted to these newer e-cigarette devices that have a high nicotine concentration,<sup>4</sup> are easy to conceal, come in diverse and appealing flavors, and are aggressively marketed as safer and cool to use.<sup>3,5</sup>

In a bid to reform their image of targeting youth, the latest advertising claims by e-cigarette manufacturers appear to target adult smokers to “make the switch” from cigarettes to e-cigarettes, arguing that they are safer to use. However, with growing evidence and media attention on the youth vaping epidemic and a large number of e-cigarette or vaping product use-associated lung injuries and related deaths, the reason for existence of e-cigarettes has

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come under serious question. We present evidence regarding the role of e-cigarettes in enabling adult smoking cessation versus causing the youth vaping epidemic. Then, we present gaps in knowledge and conclude with possible actions to support timely responses by pediatricians and the public health community.

## **LACK OF EVIDENCE OR GUIDELINES SUPPORTING E-CIGARETTES AS ADULT SMOKING CESSATION DEVICES**

There is limited evidence to suggest that e-cigarettes help adults quit smoking. In systematic reviews and meta-analyses, it is shown that cigarette-smoking adults who used e-cigarettes to help quit conventional cigarette smoking were 28% less likely to quit cigarette use, compared with those who had not used e-cigarettes,<sup>6</sup> and that e-cigarettes had no impact on adult smoking cessation.<sup>7</sup> In another review, it is suggested that adults substitute cigarettes with e-cigarettes as a way to continue using tobacco in places with smoke-free policies.<sup>8</sup> In a new review, it was found that e-cigarettes were likely associated with adults quitting smoking; however, 3 randomized controlled trials reported limitations such as participants who were already motivated to quit, and that device heterogeneity and poor acceptability of older devices were factors responsible for their positive findings.<sup>9</sup> In an oft-cited randomized controlled trial of adults motivated to quit smoking cigarettes, half of whom were assigned to e-cigarettes and half to nicotine replacement therapy (NRT) to stop smoking, it was shown that e-cigarettes helped adults quit cigarettes. However, 80% of the smokers continued to use e-cigarettes after 1 year compared with only 9% who continued to use NRT.<sup>10</sup> Other studies concluded that e-cigarettes were unlikely to reduce harm for current cigarette users, as most adults do not completely switch to e-cigarettes and instead use e-cigarettes and cigarettes concurrently.<sup>11</sup> In addition, dual users are not likely to quit in the long-term.<sup>12</sup>

Given these and other data, e-cigarettes are not recommended as a pharmacotherapy, NRT, or as a clinical cessation intervention by the World Health Organization, US Food and Drug Administration (FDA), National Academies of Sciences Engineering and Medicine, and the American Academy of Pediatrics.<sup>13–15</sup> The National Academies of Sciences Engineering and Medicine report commits to endorsing e-cigarettes as an alternative to smoking only if smokers switched completely; however, the absence of such evidence prevents broad-scale promotion of e-cigarettes.<sup>16</sup>

## **ADOLESCENTS INITIATE TOBACCO THROUGH E-CIGARETTES**

Tobacco-naive adolescents are initiating tobacco through e-cigarettes. First, e-cigarettes have become the most commonly used tobacco product by adolescents in the United States, with .3 million users, compared with 2 million users of cigarettes and other combustible tobacco products.<sup>17</sup> Second, adolescent e-cigarette use is growing dramatically, with a 78% increase in any past 30-day use among high school students and a 48% increase in any past 30-day use among middle school students, from 2017 to 2018.<sup>18</sup> Third, in nationally representative data, it is shown that children as young as 7 years of age are initiating e-cigarette use, compared with the average of youth 14 to 15 years of age who initiate cigarette smoking.<sup>19</sup> Using e-cigarettes more than doubled the odds of nicotine dependence symptoms if youth started when they were 13 years of age.<sup>20</sup> Fourth, the increased

availability of higher concentrations of nicotine in e-cigarettes encourages more frequent use,<sup>21,22</sup> potentially leading to the increased likelihood for youth addiction. Fifth, adolescents who use e-cigarettes are 3 to 4 times more likely to later initiate cigarette smoking,<sup>14,23,24</sup> and youth who begin using e-cigarettes generally had no intention of smoking cigarettes.<sup>25</sup> Finally, e-cigarettes are a potential gateway or catalyst for use of other tobacco products<sup>15,26</sup> as well as for vaping marijuana.<sup>27,28</sup>

## **DECLINING ADOLESCENT CIGARETTE USE IS NOT DUE TO E-CIGARETTES**

There is a lack of evidence that e-cigarette use is responsible for lower cigarette use among adolescents. Presently, adolescent cigarette use is at an all-time low,<sup>29</sup> with ,10% prevalence of past 30-day use.<sup>30</sup> Cigarette use has been declining steadily since the mid-1990s per nationally representative, survey-based studies.<sup>31–33</sup> It is unlikely that this decline in adolescent cigarette smoking is due to e-cigarettes, as the increase in e-cigarette use began in 2014, with a dramatic increase occurring within the 2017 to 2018 timeframe. Although a recent study combining 3 national surveys argues that adolescent uptake of e-cigarettes was a plausible explanation for an accelerated decline in cigarette use, it identified the need to analyze the impact of temporal effects of e-cigarette use and tobacco control policies.<sup>34</sup> Such studies ought to consider the concurrent impact of state-level tobacco control activities, increase in federal tobacco taxes, and national media campaigns aimed at lowering cigarette use as well as e-cigarette use.<sup>29,35</sup>

In the data, it is clearly shown that e-cigarettes have led to an increase in overall tobacco use among adolescents.<sup>31</sup> Historically, the increase in prevalence of adolescent e-cigarette use is the highest increase ever recorded for any substance used by 10th- and 12th-graders in the past 44 years.<sup>36</sup> Almost 90% of US adults who use tobacco started when they were ,18 years of age, and .60% of high school tobacco users become adult smokers.<sup>37</sup> As such, it appears that the tobacco industry's strategy is to reach the adolescent population, which has a dwindling interest in cigarette smoking and yet a growing interest in e-cigarette use.

## **PREVENTING AND REDUCING ADOLESCENT E-CIGARETTE USE**

Flavors are a major reason why adolescents use e-cigarettes<sup>3,38,39</sup> and unregulated advertising and promotion of e-cigarettes contribute to a perception of low risk that leads adolescents to believe e-cigarettes are safer than cigarettes.<sup>40–42</sup> Consequently, it is not surprising that the likelihood of future e-cigarette use increased when adolescents perceived low risk<sup>43</sup> and were exposed to more e-cigarette advertisements.<sup>44,45</sup> Messages that e-cigarettes lead to adult cessation make adolescents believe that e-cigarettes are “healthier than cigarettes,” which potentially attracts nonusers.<sup>46</sup> Given that such messages are purported by the tobacco industry, it is important to design counter messages and prevention efforts that directly explain the risks of e-cigarettes and that adolescents should not be using them. Although concurrent strategies are required to address adult cigarette-smokers who have an elevated risk for death and disease, there is a need to generate more evidence on the long-term health impacts, prevention strategies, and the role of the pediatrician in preventing and reducing youth e-cigarette use.

## Long-Term Health Impacts of E-Cigarette Use on Adolescents

E-cigarettes have been widely available for less than a decade. There is emerging evidence from short-term human and animal studies that e-cigarettes harm the brain,<sup>47</sup> heart,<sup>48,49</sup> and lungs.<sup>50</sup> E-cigarette users inhale toxic aerosols from liquid chemicals, such as nicotine, glycerol, propylene glycol, formaldehyde, nickel, and flavorants.<sup>51</sup> Different types of e-cigarettes, diverse flavors of e-cigarette juices and pods, and the presence of knock-off products that heat chemicals to different temperatures imply that there is likely great variation in the content of e-cigarettes. Most studies related to adverse health effects of e-cigarettes have been conducted among animals or adult e-cigarette users in the short-term, postulating that the results can be generalized to adolescents. In addition, because cigarette smoking was unknown as a cause of lung cancer for decades after cigarettes had been on the market, it is likely that it will take long-term longitudinal studies to fully understand the health effects of e-cigarettes. Thus, researchers must continually assess and estimate the damage to the adolescent mind and body in the long-term.

## Effective Prevention and Cessation Strategies

Evidence-based prevention and intervention programs are needed to help prevent and reduce youth e-cigarette use. Multiple new programs aim to prevent adolescent e-cigarette use, such as the Coordinated Approach to Child Health (“CATCH”) My Breath e-cigarette prevention modules,<sup>52</sup> the Stanford Tobacco Prevention Toolkit,<sup>53</sup> and the Campaign for Tobacco-Free Kids’ “Protect Kids: Fight Flavored E-Cigarettes” initiative.<sup>54</sup> More studies on the effects of these and other programs are needed. Although educational curricula should address the effects of social influence, health effects, and marketing appeals, studies are needed to compare a nuanced approach explaining relative risk to outright messages on abstinence from e-cigarette use. In addition, research must be focused on the role of mass media campaigns in shaping perceptions related to health risks of e-cigarettes versus tobacco-industry advertising. Finally, it is imperative that prevention programs developed by the tobacco industry are not implemented.<sup>55</sup>

Effective strategies for adult cessation include NRT, nicotine patches, gum and inhalers, and counseling, including cognitive behavioral therapy.<sup>13</sup> However, there are no FDA-approved NRT for youth, 18 years of age to quit e-cigarette use. Moreover, given that the nicotine levels delivered by pod-based e-cigarettes, such as Juul, may be higher than those found in a pack of cigarettes,<sup>56</sup> the dosaging of the nicotine replacement is unclear. More specifically, it is currently unknown what amount (in milligrams) of nicotine should be delivered in the NRTs (eg, gum, lozenge, patch). Other promising interventions include telephonic quit lines such as QuitLogix,<sup>57</sup> digital cessation programs such as BecomeAnEX,<sup>58</sup> and educational, social influence interventions for youth caught in school using e-cigarettes. Research evaluating the effectiveness of different NRTs for youth are needed to obtain FDA approval and inform providers’ practice and suggestions for alternative behaviors, especially because youth are using e-cigarettes in exponentially higher numbers.

## Pediatrician Screening and Advice

An outbreak of thousands of vaping-related lung illnesses and potential addiction necessitate action by pediatricians interacting with youth, especially because it is difficult to assess if

adolescents are using e-cigarettes and if they are using THC in their e-cigarettes. The current guidance recommends that youth and young adults should not use any e-cigarette product.<sup>59</sup> To improve the overall public health response through surveillance and testing, it is crucial for pediatricians to ask every youth whether they have used any e-cigarette product by specifically using terms like vaping or Juuling. Further, although vaping-related lung illness may be declining, there are other lung health concerns associated with e-cigarette use; therefore pediatricians should ask about any symptoms of respiratory illness in the past 90 days. Also, pediatricians should inquire about all cigarette use because youth who used e-cigarettes and then learned of the related health concerns may have recently switched to using traditional cigarettes to maintain their nicotine intake. It is also crucial to report such cases of lung injury potentially caused by e-cigarettes to the state or local health department. Updated guidelines and resources for pediatricians are available on the Centers for Disease Control and Prevention Web site ([www.cdc.gov](http://www.cdc.gov)) regarding history-taking, evaluation, and treatment.<sup>59</sup>

Pediatricians asking adolescents about use of e-cigarettes will likely encourage adolescents to discuss related physical or psychological issues, help adolescents to expand knowledge about the risks of using e-cigarettes, and modify their perceptions, with the ultimate goal of preventing nicotine dependence. However, there is no evidence to demonstrate the positive impact of screening and counseling adolescents about e-cigarettes. Unsurprisingly, most pediatricians do not screen or counsel adolescents about e-cigarette use.<sup>60</sup> Thus, future research is needed on the impact of pediatricians in reducing e-cigarette use, with an emphasis on specific aspects of the need for screening, content and details of counseling, and what pediatricians need to be more prepared for to support youth cessation of e-cigarettes. In addition, evidence-based strategies are needed to enable up-to-date and relevant communication about risks, rapid product changes,<sup>61</sup> familiar terms related to devices, perceptions, and health impacts. Lastly, researchers should compare whether explaining the knowns and unknowns related to e-cigarettes makes adolescents overestimate the safety of e-cigarettes, which may perpetuate use.

## CONCLUSIONS

Although it is shown in emerging evidence that e-cigarettes have damaging health consequences, they continue to be aggressively marketed and sold in the United States and around the world. In the latest evidence, it is suggested that escalating adolescent e-cigarette use is the collateral damage from a yet-unproven experiment: that e-cigarettes would enable adults to quit smoking. After the damage caused by the e-cigarette or vaping use-associated lung injury outbreak, curtailing the youth e-cigarette epidemic is a priority that may be achieved if claims of e-cigarettes being healthier and safer are avoided. It is the responsibility of the public health community to conduct research on effective strategies to reduce adolescent e-cigarette use and to educate and work with youth to prevent and reduce e-cigarette use.

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## ABBREVIATIONS

<b>e-cigarette</b>	electronic cigarette
<b>FDA</b>	US Food and Drug Administration
<b>NRT</b>	nicotine replacement therapy

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