



Published in final edited form as:

*Subst Abus.* 2019 ; 40(1): 7–10. doi:10.1080/08897077.2019.1580241.

## Understanding the implications of the “vaping epidemic” among adolescents and young adults: a call for action

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### Abstract

In the past five years, the use of nicotine delivered through electronic cigarettes (“e-cigarettes”) has sky-rocketed among adolescents and young adults. E-cigarettes, with their high nicotine content, appealing flavors, low costs, wide availability and discreet designs threaten five decades of progress in the fight against tobacco use. Aside from the increased risk of subsequent use of traditional cigarettes, marijuana, opioids and other illicit drugs, building evidence indicates that e-cigarette use also exposes youth to several acute and long-term health risks that greatly outweigh the as-yet unfounded potential benefits from the use of e-cigarettes as a smoking reduction or cessation tool in this age group. We discuss some of the latest research on e-cigarettes highlighting risks and harms associated with their use in adolescents and young adults and suggest opportunities for action including the enforcement of age, sales and marketing limitations and concerted research and public health efforts to help curb what has become a new nicotine epidemic among youth.

### Keywords

adolescent; young adult; e-cigarettes; vaping; nicotine; policy

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**Author contributions:** NC drafted and designed the initial manuscript and contributed to the editing process. SEH and SKH contributed to the design of the initial draft and revised the final manuscript.

**Conflicts of interest:** The authors declare that this article content has no conflict of interest of any kind.

## INTRODUCTION

The rapidly increasing popularity of electronic cigarettes or “e-cigarettes” has effectively reversed five decades of decreasing nicotine use among youth.<sup>1</sup> From a product initially marketed as a smoking cessation aid for adults with long-time cigarette use, e-cigarette use, also referred to as “vaping”, is now two to three times more common among adolescents and young adults (AYAs) than among older adults.<sup>2,3</sup> Vaping products, including “mod pod” products manufactured by JUUL®—the leading e-cigarette manufacturer in North America—have completely transformed the landscape of nicotine use in youth, combining advanced technology and attractive design, and fueled by aggressive marketing and social media promotion.<sup>4,5</sup>

There is building evidence that exposure to nicotine during adolescence and young adulthood is not only associated with increased rates of use of other substances, but also that such exposure has long-term effects on the developing brain.<sup>6,7</sup> Chemical and heavy metal exposure from e-cigarette vapor and added flavorings, and risk of acute injuries and poisonings related to e-cigarettes are other reasons for concern.<sup>8</sup> Unlike for older adults and despite contrary claims, there is no clear evidence that e-cigarettes may be beneficial as a smoking reduction or cessation tool for youth, even among those who smoke cigarettes regularly and may be using them to help them quit.<sup>9</sup> While recent action has been taken at the federal level to limit youth exposure to e-cigarettes, we advocate that stricter regulations around the sale and marketing of e-cigarette products together with the development of effective educational, clinical and public health interventions are needed to help curb what has effectively become a new nicotine epidemic in our youth.

## E-CIGARETTE TRENDS AND HARMS

There has been a nearly five-fold decrease in traditional smoking rates in adolescents since the release of the first Surgeon General’s report in 1964 warning about the health risks of cigarette smoking.<sup>1</sup> In contrast, lifetime use of e-cigarettes rose 900% between 2011 and 2015 among adolescents (from 3% to 27%). Since 2014, e-cigarettes have been the most popular type of nicotine product used by adolescents,<sup>10</sup> and data from the 2018 National Youth Tobacco Survey showed a 78% increase in past-month e-cigarette use among high school students since 2017.<sup>11</sup> In 2018, 43% of high school seniors had tried vaping, nearly 20% more than the proportion that had tried traditional cigarettes.<sup>12</sup> National surveys show that the majority of middle and high school students who use e-cigarettes report using e-liquids that contain only flavoring, and yet 99% of e-liquids sold actually do contain nicotine.<sup>12,13</sup> Aggressive marketing minimizing the risks of e-cigarettes have contributed to misperceptions about e-cigarettes and what they contain, and a low level of perceived riskiness, in stark contrast to the high perceived riskiness of traditional cigarettes among youth.<sup>14</sup>

Adolescents, whose brains are still developing, have particular vulnerabilities with regard to the health consequences of e-cigarettes.<sup>9</sup> Animal studies have shown that although nicotine has short-term stimulating effects, it has a negative long-term impact on memory and attention, thought to be attributed to permanent inhibitory effects on neuronal connectivity,

which is being shaped during adolescence.<sup>15,16</sup> Moreover, the adolescent brain is more vulnerable to developing addiction and the addictive properties of nicotine are clearly established.<sup>17</sup> Nicotine withdrawal symptoms appear earlier and more frequently in youth compared to adults<sup>18</sup> and include headaches, irritability, sleep difficulty, difficulty concentrating and increased appetite.<sup>19</sup> Withdrawal symptoms, or fear of experiencing them, can represent an important obstacle to nicotine cessation.<sup>20</sup>

There is now a growing consensus that e-cigarettes increase risk of subsequent use of cigarettes, marijuana, alcohol and other substances.<sup>21</sup> Unsurprisingly, nearly one-third of adolescents who have used e-cigarettes in the past have used an e-cigarette to vape marijuana, often including high potency cannabis oils and concentrates.<sup>22</sup> It has also been shown that while vapors emitted by e-cigarettes may be less risky or toxic than those coming from traditional cigarettes, they nonetheless contain concerning concentrations of heavy metals and carcinogenic substances.<sup>8</sup>

Several investigators have looked at the impact of e-cigarette advertising in its various forms on adolescent perceptions and behaviors related to nicotine use. There is a close association between dollars spent on e-cigarette advertising and use among youth<sup>23</sup>. The availability of sweet, fruity and candy-like flavors is one of the main reasons why youth choose to use e-cigarettes.<sup>24</sup> Flavors like “Cherry Crush”, “Vivid Vanilla” and “Piña Colada” are examples of flavored e-liquids that also contain high levels of nicotine.<sup>25</sup> Youth exposed to e-cigarette advertising are more likely to use not only e-cigarettes, but also traditional cigarettes.<sup>26</sup> Moreover, it has been shown that receptivity to e-cigarette advertising is an important risk factor for progression to regular cigarette smoking and use of other tobacco products, highlighting the importance of controlling exposure to this type of marketing.<sup>27</sup>

Another concerning phenomenon is the self-promotion of e-cigarette products through social media. Through applications like Instagram, Snapchat, Pinterest and others, adolescents frequently share favorable opinions about e-cigarettes and pictures or videos of themselves using e-cigarettes.<sup>28</sup> A number of adolescents initiate e-cigarette use at least in part because of the intriguing and trendy nature of “vape tricks,” and teens who perform them (nearly 80% of adolescent e-cigarette users) have a lower risk perception of e-cigarettes.<sup>29</sup>

## A CALL FOR ACTION

Policies and regulations that have proven effective in reducing traditional cigarette use—taxation, for example—are a promising avenue for containing the increasing popularity of e-cigarettes among youth.<sup>30,31</sup> In 2016, the U.S. Surgeon General released a report on the risks of e-cigarette use in adolescents<sup>10</sup>, but legislative changes have been slow to follow and are only now starting to take form. At the time of writing, only 8 American states and the District of Columbia had e-cigarette excise taxes<sup>32</sup>. We suggest that e-cigarette products should be taxed in all states and that tax revenue from the sale of e-cigarettes should be re-invested towards prevention and research with a focus on youth.

Large scale public health education campaigns, such as campaigns led by the Truth Initiative have been highly successful in reducing traditional cigarette use in youth and could inform

similar efforts directed towards e-cigarettes.<sup>33</sup> Aggressive education campaigns such as “The Real Cost” launched by the Food and Drug Association in September 2018<sup>34</sup>—the first large-scale campaign detailing health risks of e-cigarette use in youth—are a step in the right direction, but should be assessed for their actual impacts on youth and, if needed, adjusted to mirror past successful campaigns for cigarettes and alcohol.<sup>35</sup>

One of the main challenges surrounding e-cigarette sales to minors has been the regulation of Internet sales. While some larger e-cigarette companies (including JUUL®) have protective mechanisms for age and identity verification, many smaller retailers or resellers lack these controls. For companies that do have controls, it remains relatively easy for young people to order e-cigarette products online.<sup>36</sup> As a consequence, student resale of vaping products in middle and high schools has become commonplace and highly problematic for schools trying to limit student exposure to nicotine.<sup>37</sup> We are supportive of state-driven efforts limiting the number of websites allowing sales to minors and hope that corrective fines or other penalties are enforced for companies with inappropriate content or age verification.

The FDA has recently sent an ultimatum to the five largest e-cigarette manufacturers in the U.S. to try to prevent the sale and marketing of vaping products to minors.<sup>38</sup> The FDA has also announced its intention to ban e-cigarettes from gas stations and corner stores and to limit the sale of flavored e-cigarette products.<sup>39</sup> We support these efforts as well as the stance of several cities and states that have increased minimum purchasing age of tobacco and e-cigarette products to age 21. School boards across the U.S. have taken several measures to try to reduce e-cigarette use in schools including strict e-cigarette bans, special disciplinary measures including potential referral to treatment when students are caught vaping and parent and student education events; more research is needed to determine the effectiveness of these approaches, but we commend the attention being paid to this problem.

An important clinical question remains: what to do with AYAs who have developed an addiction to nicotine through e-cigarettes? National and international guidelines have been developed to help youth quit using nicotine, but none of these directly address AYAs who primarily or exclusively use e-cigarettes.<sup>40,41</sup> The strongest evidence for nicotine cessation treatment in youth resides in behavioral interventions;<sup>42</sup> one could reasonably translate these recommendations and apply them to AYAs who use e-cigarettes only, but the appropriateness of adjunctive treatments that are usually supported for AYAs who regularly smoke traditional cigarettes and are highly effective in adults, such as nicotine replacement products and other pharmaceuticals, is more nebulous.<sup>43</sup> We call upon researchers and public officials to collaborate in research efforts leading to the development of evidence-based primary care practice guidelines to universally screen adolescents for e-cigarette use and determine the effectiveness of nicotine replacement therapy and other smoking cessation treatments for adolescents in cases where e-cigarette use is already established. In addition, while pediatric and young adult providers have a clear need for guidance, public health authorities should also support initiatives allowing middle and high schools to integrate evidence-informed vaping education in school health curricula.

In the span of only a few years, e-cigarettes have become the primary source of nicotine exposure among youth. Aggressive public health education and carefully crafted policy addressing the harmful effects of e-cigarettes in AYAs are greatly needed. There is also an important research gap on the acute and long-term risks of e-cigarettes in AYAs, which, while arguably less harmful than traditional cigarettes, are not risk-free. Strict regulation and government oversight of the e-cigarette industry yields promise but needs to happen quickly to help bend the curve of nicotine use in adolescents. E-cigarette use in youth has emerged suddenly; an equally dramatic policy and public education response will be needed to reverse the trend and protect the health of our youth.

## Acknowledgments

**Funding:** Dr. Hadland was supported by NIDA/NIH grant K23 DA045085, the Thrasher Research Fund Early Career Award, and the Academic Pediatric Association Young Investigator Award. Dr. Harris was supported by the Leadership Education in Adolescent Health Training Program T71 MC00009 and Cooperative Agreement UA6MC27378 (MCH/HRSA), and by National Institute on Alcohol Abuse and Alcoholism Grants 1R01AA021904 and 1R01AA02243. None of the funding sources were involved in the preparation or composition of this submission.

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