



## ELECTRONIC CIGARETTES: AN OVERVIEW OF KEY ISSUES

A significant number of adults and youth are using electronic cigarettes, which provide a relatively new way to deliver the addictive substance nicotine without burning tobacco. A 2018 report from the National Academies of Sciences, Engineering, and Medicine (NASEM) found that e-cigarettes are less harmful than cigarettes, but are not risk-free.<sup>1</sup> The report also found that many questions remain about the long-term health effects of these products for individual users and about the population-wide effects. Research is still needed to determine whether or not e-cigarettes will help people quit, discourage smokers from quitting completely, or lead to nicotine addiction and established tobacco use for new users, including kids, especially in an environment where the products continue to evolve. In 2016, the Surgeon General stated that “e-cigarette use among U.S. youth and young adults is now a major public health concern.”<sup>2</sup> The Surgeon General noted that while we continue to learn more about e-cigarettes, “we currently know enough to take action to protect our nation’s young people from being harmed by these products.”

### What are Electronic Cigarettes?

The term “electronic cigarettes” covers a wide variety of products now on the market, from those that look like cigarettes, pens or USB drives to somewhat larger products like “personal vaporizers” and “tank systems.” Instead of burning tobacco, e-cigarettes most often use a battery-powered coil to turn a liquid solution into an aerosol that is inhaled by the user. There are a wide range of reusable e-cigarettes, which enable users to replace a nicotine-containing cartridge or refill a tank with a liquid solution, and there are disposable e-cigarettes, which cannot be refilled. Also growing in popularity are “mods,” which are units that users assemble themselves from separate component parts, to allow variation in battery power, style, and size.<sup>3</sup> A study found more than 430 brands of e-cigarettes available for purchase online in 2017.<sup>4</sup>

The liquid solution used in e-cigarettes typically contains nicotine, propylene glycol, glycerin or some other solvent, and other additives. E-cigarettes and refill liquids or cartridges often contain flavorings, including fruit and candy flavorings that are not permitted in regular cigarettes. Many e-cigarettes and their refill liquids also come in sweet flavors, such as chocolate, gummi bear, chocolate chip cookies, and strawberry, which have long been considered attractive to kids. By 2017, researchers were able to identify more than 15,500 unique e-cigarette flavors available online.<sup>5</sup> In addition to the vast selection available online, thousands of “vape” shops have now opened throughout the country that allow consumers to sample and purchase refill liquids, including a combination of flavors chosen by the user and in varying levels of nicotine.



The e-cigarette market is projected to reach more than \$6 billion in the U.S. in 2018.<sup>6</sup> The three major U.S. tobacco companies – Altria/Philip Morris, Reynolds American/Lorillard and ITG Brands – have all invested in the e-cigarette market with their own brands. There are, however, hundreds of e-cigarette companies and thousands of “vape shops” in the U.S. market, leading to a wide variety of product

<sup>1</sup> For the purposes of this factsheet, the term “e-cigarettes” will be used to represent the entire category of products.

characteristics, including ingredients and nicotine content. A large proportion of e-cigarettes in the U.S. market are imported. Globally, more than 95 percent of e-cigarettes are estimated to be manufactured in China.<sup>7</sup>

### **E-Cigarette Marketing**

The 2016 Surgeon General report stated that, “E-cigarettes are marketed by promoting flavors and using a wide variety of media channels and approaches that have been used in the past for marketing conventional tobacco products to youth and young adults.”<sup>8</sup> E-cigarette manufacturers resurrected the marketing practices used by tobacco companies for decades to attract kids to smoking – including some tactics that have been prohibited for tobacco companies precisely because they appealed to kids.<sup>9</sup>

Some e-cigarette marketing tactics include ads that reach youth audiences; sponsorships and free samples at youth-oriented events such as auto races and music festivals; celebrity spokespeople who depict e-cigarette smoking as glamorous; social media marketing; and sweet, kid-friendly flavors with names like Cherry Crush, Chocolate Treat, Cotton Candy, and Gummy Bear.

Unlike cigarette and smokeless tobacco companies, e-cigarette companies are not currently required to report their marketing and promotional expenditures to the U.S. Federal Trade Commission (FTC), so the exact amount spent to advertise and promote these products is uncertain. However, e-cigarette marketing expenditures are estimated to have increased dramatically in the early years, from \$12 million in 2011 to \$125 million in 2014.<sup>10</sup> Other studies have also documented this significant increase in spending.<sup>11</sup> These figures likely underestimate the true extent of e-cigarette advertising, as the available marketing data are not comprehensive (e.g., social media and sponsored events—strategies widely used by numerous e-cigarette companies—are not included). Additionally, the nationwide rollout of the Vuse and MarkTen brands did not occur until mid-2014, so the full impact of these brands on e-cigarette marketing expenditures is unknown.

Social media helps to fuel the popularity of e-cigarettes, including the top-selling e-cigarette brand, JUUL. A study analyzing JUUL marketing noted that JUUL was one of the first major e-cigarette brands to rely heavily on social media to market and promote its products. The study found that JUUL’s initial marketing expenditures in traditional channels were modest compared to competing brands, and that these expenditures decreased as the brand increased content and received more promotion on social media channels like Instagram and Twitter.<sup>12</sup>

These advertising efforts have effectively reached youth and young adults. The Surgeon General concluded that, “E-cigarettes are marketed in a wide variety of channels that have broad reach among youth and young adults.”<sup>13</sup> The 2016 National Youth Tobacco Survey (NYTS) found that 78.2 percent of middle and high school students—20.5 million youth—had been exposed to e-cigarette advertisements from at least one source.<sup>14</sup> Another study found that 82 percent of 12-17 year olds and 88 percent of 18-21 year olds reported seeing e-cigarette advertising in 2015.<sup>15</sup> A 2016 study in *Pediatrics*, analyzing 2014 YTS data, found that exposure to e-cigarette advertising is associated with current e-cigarette use among youth and that greater exposure to e-cigarette advertising is associated with higher odds of use.<sup>16</sup>

### **Use of E-Cigarettes Among Adults and Youth**

E-cigarette use among youth exceeds the use of cigarettes and other tobacco products, and the number of youth using e-cigarettes is alarming and raises serious concerns. It is still an open scientific question whether e-cigarettes might be able to help adult smokers give up cigarettes; however, kids should not be using any tobacco product, including e-cigarettes.

**Youth Use.** According to the National Youth Tobacco Survey (NYTS), released by the U.S. Centers for Disease Control and Prevention (CDC) and the Food and Drug Administration (FDA), e-cigarettes have been the most commonly used tobacco product among youth since 2014. In 2018, 20.8 percent of high schoolers and 4.9 percent of middle schoolers reported current use of e-cigarettes. From 2017 to 2018, e-cigarette use increased by an alarming 78 percent for high schoolers and 48 percent for middle schoolers. Over 3.6 million high school and middle school students currently use e-cigarettes.<sup>17</sup>

The same survey found that among those students who had used e-cigarettes in the past 30 days in 2018, 27.7 percent of high schoolers and 16.2 percent of middle schoolers were frequent users of e-cigarettes, using e-cigarettes on at least 20 of the preceding 30 days. This amounts to more than 900,000 middle and high school students who were frequent users of e-cigarettes.<sup>18</sup>

Multiple national surveys show that flavored e-cigarettes are popular among youth. Data from FDA's 2013-2014 Population Assessment of Tobacco and Health (PATH) survey found that 81 percent of youth aged 12-17 who had ever used e-cigarettes had used a flavored e-cigarette the first time they tried the product. Moreover, 81.5 percent of current youth e-cigarette users said they used e-cigarettes "because they come in flavors I like."<sup>19</sup> More recent data from the 2014-2015 wave of the PATH study found that 79.3 percent of current youth e-cigarette users had used a flavored e-cigarette in the past month.<sup>20</sup> While the methodology is not comparable to the PATH study, the 2018 NYTS found that 67.8 percent of high school e-cigarette users had used a flavored e-cigarette in the past month, an increase from 60.9 percent in 2017. Current use of menthol or mint flavored e-cigarettes among high school e-cigarette users also increased from 42.3 percent in 2017 to 51.2 percent in 2018.<sup>21</sup>

**Adult Use.** Data from the National Health Interview Survey (NHIS) show that in 2017, 2.8 percent of adults currently used e-cigarettes every day or some days (it was 3.2 percent in 2016 and 3.5 percent in 2015).<sup>22</sup>

E-cigarette use is highest among younger adult populations. According to the 2017 NHIS, 5.2 percent of 18-24 year olds currently use e-cigarettes every day or some days (up slightly from 4.7 percent in 2016).<sup>23</sup> Earlier data from the 2015 NHIS showed that 40 percent of young adult e-cigarette users had never been cigarette smokers, raising concerns that e-cigarettes may be attracting young non-smokers to tobacco use.<sup>24</sup> Data from another survey, the 2016 Behavioral Risk Factor Surveillance System (BRFSS), estimates that 1.2 million young adult e-cigarette users are never-cigarette smokers.<sup>25</sup>

### **Health and Public Health Concerns**

Under the right circumstances, e-cigarettes could benefit public health if they help significantly reduce the number of people who use combustible cigarettes and die of tobacco-related disease. According to CDC and the 2018 NASEM report on e-cigarettes, e-cigarettes are less harmful than combustible cigarettes, but that doesn't mean that they are safe or without risk.<sup>26</sup> The NASEM report stated that "the absolute risks of the products cannot be unambiguously determined at this time."<sup>27</sup> Little is known about the long-term effects of e-cigarette use, and there is little data to assess the impact on cancer and heart disease risk. Thus, many questions still remain about the potential long-term risks to the public health posed by these products.

### **Individual-Level Health Risks**

***E-cigarette ingredients and constituents.*** There is insufficient research on the long-term effects of using e-cigarettes, which involves regular inhalation of nicotine, glycerin or some other solvent, and other additives.<sup>28</sup> According to the Surgeon General, "E-cigarette aerosol is not harmless. It can contain harmful and potentially harmful constituents, including nicotine."<sup>29</sup> The nicotine present in e-cigarette aerosol is absorbed by users and bystanders.<sup>30</sup> Studies have found other chemicals and toxins present in some e-cigarettes, including formaldehyde, acrolein, volatile organic compounds like toluene, tobacco-specific nitrosamines, and metals like nickel and lead.<sup>31</sup> These compounds are generally present at levels much lower than in cigarette smoke, although the compounds themselves are found on FDA's list of harmful or potentially harmful substances.<sup>32</sup> Because FDA has just begun to regulate e-cigarettes, which are available in hundreds of different brands,<sup>33</sup> there is no way for consumers to know for sure yet what is in the products or the aerosol.<sup>34</sup>

In addition, while some of the other substances, such as flavorings, used in e-cigarettes might be labeled as "generally recognized as safe," some researchers as well as the organization primarily responsible for granting that designation<sup>35</sup> have noted that it applies to ingestion, not for other exposures such as inhalation. The NASEM report committee expressed concern about flavor additives because even to-date, they "have not been widely tested for sensitizing, toxic, or irritating potency."<sup>36</sup> In its 2016 report, the Surgeon General stated that, "while some of the flavorings used in e-cigarettes are generally recognized

as safe for ingestion as food, the health effects of their inhalation are generally unknown” and noted that some of the flavorings found in e-cigarettes have been shown to cause serious lung disease when inhaled.<sup>37</sup> An article in the *Journal of the American Medical Association* raised concerns that the chemical flavorings found in some e-cigarettes and e-liquids could cause respiratory damage when the e-cigarette aerosol is inhaled deeply into the lungs.<sup>38</sup>

**Impact of Nicotine.** E-cigarettes and refill liquids contain widely varying levels of nicotine, and the nicotine delivered through the aerosol can also vary depending on the device characteristics and user practices.<sup>39</sup> While e-cigarettes can be used for non-nicotine products, including marijuana, the vast majority of e-cigarette products sold in traditional retail stores contain nicotine,<sup>40</sup> and more than two-thirds of youth e-cigarette users report using e-cigarettes exclusively for nicotine-containing products.<sup>41</sup> Nicotine is a highly addictive drug that can have lasting damaging effects on adolescent brain development and has been linked to a variety of adverse health outcomes for the developing fetus.<sup>42</sup> The Surgeon General concluded that, “The use of products containing nicotine poses dangers to youth, pregnant women, and fetuses. The use of products containing nicotine in any form among youth, including in e-cigarettes, is unsafe.”<sup>43</sup>

In general, nicotine has been found to impact the cardiovascular system.<sup>44</sup> The NASEM report found that the nicotine in e-cigarettes can increase heart rate and diastolic blood pressure in users shortly after use, but evidence was not available to determine an association between e-cigarette use and other cardiovascular outcomes such as heart disease and stroke. However, the NASEM report acknowledged that the nicotine in e-cigarettes could elevate cardiovascular disease risk in users with pre-existing cardiovascular disease.<sup>45</sup>

**Poisoning and Exposure to Liquid Nicotine.** Delivered in high doses, nicotine can be lethal. The Surgeon General’s report and the NASEM report both found that contact with e-liquids can cause adverse health effects and ingesting e-liquids can lead to death.<sup>46</sup> Exposure to liquid nicotine found in e-cigarettes has resulted in thousands of calls to poison control centers in recent years, peaking in 2014, according to the American Association of Poison Control Centers (AAPCC).<sup>47</sup> In 2014, more than half of these calls to poison hotlines were to report exposures among children under the age of six.<sup>48</sup> To begin to address the poisoning risk that e-cigarettes and liquid nicotine pose to young children, in 2016 Congress passed the Child Nicotine Poisoning Prevention Act, which gave the Consumer Product Safety Commission authority to enforce child resistant packaging standards for e-cigarette products. This law went into effect in July 2016.

**Number of calls to poison control centers involving exposures to e-cigarette devices and liquid nicotine.\***

2011	271
2012	460
2013	1,543
2014	4,023
2015	3,774
2016	2,907
2017	2,478
Through Oct. 2018	2,555

\* Preliminary data, as poison centers continue to update their reports.

## Population-Level Health Concerns

**Youth and Young Adults.** The number of youth using e-cigarettes raises serious concerns that e-cigarettes may function as a gateway to the use of more dangerous, combustible tobacco products. The Surgeon General found that while more research is needed, e-cigarette use is “strongly associated” with the use of other tobacco products among youth and young adults, including conventional cigarettes.<sup>49</sup> The NASEM report concluded that “[t]here is substantial evidence that e-cigarette use increases risk of ever using combustible tobacco cigarettes among youth and young adults.”<sup>50</sup>

**Dual Use and Cessation.** Data show that the large majority of e-cigarette users report using both e-cigarettes and conventional cigarettes, raising additional concerns beyond the potential health effects of e-cigarettes alone.

The currently available data indicate that most e-cigarette users report using both e-cigarettes and cigarettes. A 2015 survey found that the majority of current e-cigarette users (58.8 percent) were also current smokers.<sup>51</sup> The 2016 BRFSS reported similar findings, estimating that 54.6 percent of current e-cigarette users were also current smokers.<sup>52</sup>

Little data are available on what happens with dual users over time. Analysis of PATH data found that nearly 9 out of 10 early dual users were still smoking cigarettes at follow-up. Among adults who were dual users of e-cigarettes and cigarettes at Wave 1 (2013-2014), 44.3 percent maintained dual use, 43.5 percent discontinued e-cigarette use but maintained cigarette smoking, and only 12.1 discontinued cigarette use (5.1% discontinued cigarette use but continued e-cigarette use and 7.0% discontinued use of both products) at Wave 2 (2014-2015).<sup>53</sup>

Some e-cigarette users report that they believe that e-cigarettes will help them quit or reduce the number of cigarettes they smoke.<sup>54</sup> However, there is not enough evidence to conclude whether e-cigarettes are a safe and effective smoking cessation device.<sup>55</sup> The U.S. Preventive Services Task Force, which makes recommendations about the effectiveness of specific preventive care services after a thorough assessment of the science, concluded that “the current evidence is insufficient to recommend electronic nicotine delivery systems for tobacco cessation...”<sup>56</sup> The NASEM report concluded, “[o]verall, there is limited evidence that e-cigarettes may be effective aids to promote smoking cessation.”<sup>57</sup> According to researchers from the CDC, “There is currently no conclusive scientific evidence that e-cigarettes promote long-term cessation, and e-cigarettes are not included as a recommended smoking cessation method by the U.S. Public Health Service.”<sup>58</sup>

Existing research is limited and provides mixed results about the effectiveness of e-cigarettes in helping current smokers successfully quit. Two randomized controlled trials found that e-cigarettes are moderately effective in helping smokers quit, with rates of cessation with e-cigarettes similar to rates of cessation with nicotine replacement therapy (NRT).<sup>59</sup> A more recent analysis of PATH data found that smokers who used e-cigarettes to quit smoking were more successful than non-e-cigarette users. There was no significant difference in quitting smoking between smokers who were using e-cigarettes and those who were using FDA-approved cessation medications.<sup>60</sup> A 2018 longitudinal study using PATH data found that cigarette smokers who used e-cigarettes daily had significantly greater odds of quitting compared to non e-cigarette users. Cigarette smokers who used e-cigarettes less frequently had reduced odds of quitting.<sup>61</sup> Similarly, a 2014 longitudinal study of current smokers found that smokers who used e-cigarettes daily for at least one month were more than six times as likely to have quit smoking than those who never used e-cigarettes or only used them once or twice.<sup>62</sup> Nationally representative cross-sectional studies have also found an association between frequency of e-cigarette use and cessation behavior. One study found that daily e-cigarette users were significantly more likely than non-e-cigarette users to be former cigarette smokers and that smoking cessation was highest among daily e-cigarette users compared to any other demographic or behavioral subgroup.<sup>63</sup> Additional research shows that smokers who use e-cigarettes more frequently are more likely to have made a quit attempt than smokers who don't use e-cigarettes.<sup>64</sup> Product type is also an important factor, with one study noting that while daily use of tank-based or non-cartridge based e-cigarettes increases the likelihood of cessation, other types of e-cigarettes do not, even when used daily.<sup>65</sup>

Other studies have found that e-cigarette use is not associated with successful quitting, finding that e-cigarette users were not more likely to have quit smoking compared to non-users.<sup>66</sup>

- A 2018 study by Weaver et. al., did not find any evidence that ENDS help adult smokers quit at a higher rate than smokers who did not use these products despite ENDS users being more likely to make a quit attempt. In fact, the authors state that “findings indicate that, at the time of this study, ENDS under “real world” use and conditions may have suppressed or delayed quitting among some adult smokers.” Specifically, of the 27% of smokers who reported using ENDS at baseline, about 90% were still smoking at one year follow-up (53.5% continued to smoke and use ENDS and 37.4% were smoking but not using ENDS) and 9.2% had quit smoking (2.5% quit smoking and were using ENDS and 6.7% quit smoking and quit ENDS). Moreover, the study found that ENDS users quit at a lower rate than non-ENDS users regardless of frequency or duration of ENDS use, device type, quitting as reason for use, or e-liquid flavor.<sup>67</sup>
- A meta-analysis of 38 studies that examined the association between e-cigarette use and smoking cessation among adult smokers found that the odds of quitting were less among smokers using e-cigarettes.<sup>68</sup>

A study of current and former cigarette smokers found that e-cigarette users significantly reduced the number of cigarettes smoked per day compared to non-users, although at follow-up, e-cigarette users were not more likely to have quit smoking compared to non-users.<sup>69</sup> A more recent study (Weaver et. al.) did not find that the use of ENDS was associated with a reduction in cigarette consumption among those participants who had not quit smoking at follow-up.<sup>70</sup> Reducing the number of cigarettes smoked is a good thing if it eventually leads to quitting completely. However, e-cigarettes could ultimately reduce the number of smokers who would otherwise quit if smokers continue to use them in addition to, and not instead of, regular cigarettes. This would have a negative impact on public health. Smokers who continue to smoke (even fewer cigarettes per day) but also use e-cigarettes will increase their individual risk if this delays or prevents cessation. The NASEM report stated that a “reduction in rate of smoking does not ensure reduction in tobacco-related harm” and that, “there is no available evidence whether or not long-term e-cigarette use among smokers (dual use) changes morbidity or mortality compared with those who only smoke combustible tobacco cigarettes.”<sup>71</sup> Furthermore, CDC has highlighted the importance of quitting cigarettes completely, not just cutting down. According to the CDC, “If you only cut down the number of cigarettes you smoke by adding another tobacco product, like e-cigarettes, you still face serious health risks. Smokers must quit smoking completely to fully protect their health – even a few cigarettes a day are dangerous.”<sup>72</sup>

Several Surgeon General's Reports and other studies have indicated that the risk of cardiovascular disease and other smoking-related diseases depends largely on the length of time a person smokes, not just the number of cigarettes smoked. Compared to non-smokers, light and intermittent smokers are at greater risk for cardiovascular diseases, lung cancer and lower respiratory tract infections, among other things.<sup>73</sup>

Studies have found that smoking just one to four cigarettes a day increases the risk of developing or dying from heart diseases.<sup>74</sup> A recent review of 141 studies that examined the relationship between cigarette consumption and the risk for cardiovascular disease and stroke found that smoking even one cigarette per day carries a very high risk for developing cardiovascular disease and stroke. The authors concluded that, “Smokers need to quit completely rather than cut down if they wish to avoid most of the risk associated with heart disease and stroke.”<sup>75</sup> Thus, prolonging smoking, despite smoking fewer cigarettes from using e-cigarettes, will continue to put that person's health at greater risk than if he or she had quit smoking entirely.<sup>76</sup>

***Important unanswered questions:***

- *What are the long term health impacts of e-cigarette use?*
- *Do e-cigarettes help smokers quit more effectively than FDA-approved cessation products?*
- *Currently, the majority of e-cigarette users also smoke cigarettes. Will most e-cigarette users continue to be dual-users, or will they switch completely and become exclusive users of e-cigarettes?*
- *Will e-cigarette marketing renormalize tobacco use?*
- *Research shows a strong association between e-cigarette use and subsequent combustible cigarette smoking among youth and young adults. Will that translate into increased smoking rates in the long-term?*
- *Do e-cigarettes draw former smokers back into nicotine addiction and potentially back to cigarette smoking?*

There are many important unanswered questions regarding the short and long-term impact that e-cigarettes may have on public health. Effective regulation is needed to minimize the potential harms of e-cigarettes and maximize the potential benefits.

- <sup>1</sup> National Academies of Sciences, Engineering, and Medicine (NASEM), *Public Health Consequences of E-Cigarettes*, Washington, DC: The National Academies Press, 2018, <http://nationalacademies.org/hmd/Reports/2018/public-health-consequences-of-e-cigarettes.aspx>.
- <sup>2</sup> US Department of Health and Human Services (HHS), *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>3</sup> Wells Fargo, *Vape Shops – Springing Up Across The Country*, April 14, 2014.
- <sup>4</sup> Zhu, S-H, et al., "Evolution of Electronic Cigarette Brands from 2013-2014 to 2016-2017: Analysis of Brand Websites," *Journal of Medical Internet Research*, 20(3), published online March 12, 2018.
- <sup>5</sup> Zhu, S-H, et al., "Evolution of Electronic Cigarette Brands from 2013-2014 to 2016-2017: Analysis of Brand Websites," *Journal of Medical Internet Research*, 20(3), published online March 12, 2018.
- <sup>6</sup> Wells Fargo Securities, *Nielsen: Tobacco 'All Channel' Data 9/8*, September 18, 2018.
- <sup>7</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016. See also Jourdan, A. "Vaping" a slow burner in China, world's maker of e-cigarettes, 2014, <http://www.reuters.com/article/us-china-smoking/vaping-a-slow-burner-in-china-worlds-maker-of-e-cigarettes-idUSBREA0E1JX20140115>, accessed January 3, 2017.
- <sup>8</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>9</sup> "Gateway to Addiction? A Survey of Popular Electronic Cigarette Manufacturers and Marketing to Youth," April 14, 2014, <http://democrats.energycommerce.house.gov/sites/default/files/documents/Report-E-Cigarettes-Youth-Marketing-Gateway-To-Addiction-2014-4-14.pdf>
- <sup>10</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>11</sup> Kornfield, R, et al., "Rapidly increasing promotional expenditures for e-cigarettes," *Tobacco Control*, Published Online First, doi: 10.1136/tobaccocontrol-2014-051580, April 30, 2014. See also: Dutra, L, *Adolescent E-cigarette Use: What We Already Know*. 2014 data from Kantar Media. Presentation at the FDA "Electronic Cigarettes and the Public Health: A Public Workshop," June 1, 2015. Legacy, *Vaporized: E-Cigarettes, Advertising, and Youth*, April 2014, [http://legacyforhealth.org/content/download/4542/63436/version/1/file/LEG-Vaporized-E-cig\\_Report-May2014.pdf](http://legacyforhealth.org/content/download/4542/63436/version/1/file/LEG-Vaporized-E-cig_Report-May2014.pdf). Truth Initiative, *Vaporized: Youth and Young Adult Exposure to E-Cigarette Marketing*, November 2015, <http://truthinitiative.org/sites/default/files/VAPORIZED%20-%20FINAL%20VERSION.pdf>.
- <sup>12</sup> Huang, J, et al., "Vaping versus JUULing: how the extraordinary growth and marketing of JUUL transformed the US retail e-cigarette market," *Tobacco Control*, published online May 31, 2018.
- <sup>13</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>14</sup> Marynak, K, et al., "Exposure to Electronic Cigarette Advertising Among Middle School and High School Students—United States, 2014-2016," *Morbidity and Mortality Weekly Report*, 67(10):294-299, March 16, 2018.
- <sup>15</sup> Truth Initiative, *Vaporized: Youth and Young Adult Exposure to E-Cigarette Marketing*, November 2015, <http://truthinitiative.org/sites/default/files/VAPORIZED%20-%20FINAL%20VERSION.pdf>.
- <sup>16</sup> Singh, T, et al., "Exposure to Advertisements and Electronic Cigarette Use Among US Middle and High School Students," *Pediatrics*, published online April 25, 2016.
- <sup>17</sup> Centers for Disease Control and Prevention (CDC), "Use of Electronic Cigarettes and Any Tobacco Product Among Middle and High School Students—United States, 2011-2018," *Morbidity and Mortality Weekly Report (MMWR)*, 67(45): 1276-1277. [https://www.cdc.gov/mmwr/volumes/67/wr/mm6745a5.htm?s\\_cid=mm6745a5\\_w](https://www.cdc.gov/mmwr/volumes/67/wr/mm6745a5.htm?s_cid=mm6745a5_w). Current use defined as any use in the past month.
- <sup>18</sup> CDC, "Use of Electronic Cigarettes and Any Tobacco Product Among Middle and High School Students—United States, 2011-2018," *MMWR*, 67(45): 1276-1277. [https://www.cdc.gov/mmwr/volumes/67/wr/mm6745a5.htm?s\\_cid=mm6745a5\\_w](https://www.cdc.gov/mmwr/volumes/67/wr/mm6745a5.htm?s_cid=mm6745a5_w). Current use defined as any use in the past month.
- <sup>19</sup> Ambrose, BK, et al., "Flavored Tobacco Product Use Among US Youth Aged 12-17 Years, 2013-2014," *Journal of the American Medical Association*, published online October 26, 2015.
- <sup>20</sup> Schneller, M, et al., "Use of flavored electronic cigarette refill liquids among adults and youth in the US—Results from Wave 2 of the Population Assessment of Tobacco and Health Study (2014-2015)," *PLoS ONE* 13(8), published online August 23, 2018.
- <sup>21</sup> CDC, "Use of Electronic Cigarettes and Any Tobacco Product Among Middle and High School Students—United States, 2011-2018," *MMWR*, 67(45): 1276-1277. [https://www.cdc.gov/mmwr/volumes/67/wr/mm6745a5.htm?s\\_cid=mm6745a5\\_w](https://www.cdc.gov/mmwr/volumes/67/wr/mm6745a5.htm?s_cid=mm6745a5_w). Current use defined as any use in the past month.
- <sup>22</sup> CDC, "Tobacco Product Use Among Adults – United States, 2017," *Morbidity and Mortality Weekly Report*, 67(44): 1225, [https://www.cdc.gov/mmwr/volumes/67/wr/mm6744a2.htm?s\\_cid=mm6744a2\\_e](https://www.cdc.gov/mmwr/volumes/67/wr/mm6744a2.htm?s_cid=mm6744a2_e).
- <sup>23</sup> CDC, "Tobacco Product Use Among Adults – United States, 2017," *Morbidity and Mortality Weekly Report*, 67(44): 1225, [https://www.cdc.gov/mmwr/volumes/67/wr/mm6744a2.htm?s\\_cid=mm6744a2\\_e](https://www.cdc.gov/mmwr/volumes/67/wr/mm6744a2.htm?s_cid=mm6744a2_e). See also CDC, "Quick Stats: Percentage of Adults Who Ever Used and E-Cigarette and Percentage Who Currently Use E-Cigarettes, by Age Group—National Health Interview Survey, United States, 2016," *Morbidity and Mortality Weekly Report*, 66(33): 892, <https://www.cdc.gov/mmwr/volumes/66/wr/pdfs/mm6633a6.pdf> and [https://www.cdc.gov/mmwr/volumes/66/wr/mm6644a11.htm?s\\_cid=mm6644a11\\_w](https://www.cdc.gov/mmwr/volumes/66/wr/mm6644a11.htm?s_cid=mm6644a11_w)

- <sup>24</sup> CDC, "Quick Stats: Cigarette Smoking Status Among Current Adult E-Cigarette Users, by Age Group—National Health Interview Survey, United States, 2015," *Morbidity and Mortality Weekly Report*, 65(42): 1177, [http://www.cdc.gov/mmwr/volumes/65/wr/mm6542a7.htm?s\\_cid=mm6542a7\\_w](http://www.cdc.gov/mmwr/volumes/65/wr/mm6542a7.htm?s_cid=mm6542a7_w).
- <sup>25</sup> Mirbolouk, M, et al., "Prevalence and Distribution of E-Cigarette Use Among U.S. Adults: Behavioral Risk Factor Surveillance System, 2016," *Annals of Internal Medicine*, published online August 28, 2018.
- <sup>26</sup> National Academies of Sciences, Engineering, and Medicine (NASEM), *Public Health Consequences of E-Cigarettes*, Washington, DC: The National Academies Press, 2018, <http://nationalacademies.org/hmd/Reports/2018/public-health-consequences-of-e-cigarettes.aspx>. CDC, *Electronic Cigarettes: What's the Bottom Line?*, February 22, 2018, [https://www.cdc.gov/tobacco/basic\\_information/e-cigarettes/pdfs/Electronic-Cigarettes-Infographic-508.pdf](https://www.cdc.gov/tobacco/basic_information/e-cigarettes/pdfs/Electronic-Cigarettes-Infographic-508.pdf).
- <sup>27</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018.
- <sup>28</sup> CDC, "Dual Use of Tobacco Products." <http://www.cdc.gov/tobacco/campaign/tips/diseases/dual-tobacco-use.html#ten>. Accessed November 19, 2015.
- <sup>29</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>30</sup> CDC, "Dual Use of Tobacco Products." <http://www.cdc.gov/tobacco/campaign/tips/diseases/dual-tobacco-use.html#ten>. Accessed November 19, 2015.
- <sup>31</sup> Cheng, T, "Chemical Evaluation of Electronic Cigarettes," *Tobacco Control* 23:ii11-ii17, May 2014. [http://tobaccocontrol.bmj.com/content/23/suppl\\_2/ii11.full](http://tobaccocontrol.bmj.com/content/23/suppl_2/ii11.full). Goniewicz, ML, et al., "Levels of selected carcinogens and toxicants in vapour from electronic cigarettes," *Tobacco Control* 23(2):133-9, March 6, 2013. Williams, M, et al., "Metal and Silicate Particles Including Nanoparticles Are Present in Electronic Cigarette Cartomizer Fluid and Aerosol," *PlosOne*, 8(3), March 2013. See also Williams, M, "Electronic Cigarette Liquids and Vapors: Is It Harmless Water Vapor," presented October 3, 2013 at TRDRP Electronic Cigarette Webinar, <http://www.trdrp.org/docs/Williams%20ecig%20vapor%20this%20time%20slides%202013.pdf>. NASEM, *Public Health Consequences of E-Cigarettes*, 2018.
- <sup>32</sup> Goniewicz, ML, et al., "Levels of selected carcinogens and toxicants in vapour from electronic cigarettes," *Tobacco Control* 23(2):133-9, March 6, 2013. Williams, M, et al., "Metal and Silicate Particles Including Nanoparticles Are Present in Electronic Cigarette Cartomizer Fluid and Aerosol," *PlosOne*, 8(3), March 2013. NASEM, *Public Health Consequences of E-Cigarettes*, 2018. See also FDA, "Harmful and Potentially Harmful Constituents in Tobacco Products and Tobacco Smoke: Established List," March 2012, <http://www.fda.gov/TobaccoProducts/GuidanceComplianceRegulatoryInformation/ucm297786.htm>.
- <sup>33</sup> Zhu, S-H, et al., "Four Hundred and Sixty Brands of E-cigarettes and Counting: Implications for Product Regulation," *Tobacco Control*, 23(Suppl 3):iii3-iii9, 2014, [http://tobaccocontrol.bmj.com/content/23/suppl\\_3/iii3.full](http://tobaccocontrol.bmj.com/content/23/suppl_3/iii3.full).
- <sup>34</sup> CDC, "Dual Use of Tobacco Products." <http://www.cdc.gov/tobacco/campaign/tips/diseases/dual-tobacco-use.html#ten>. Accessed November 19, 2015.
- <sup>35</sup> Flavor and Extract Manufacturers Association of the United States (FEMA), *The Safety Assessment and Regulatory Authority to Use Flavors – Focus on E-Cigarettes*, Revised March 3, 2015, <http://www.femaflavor.org/safety-assessment-and-regulatory-authority-use-flavors-focus-e-cigarettes>.
- <sup>36</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018, p. 5-31.
- <sup>37</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>38</sup> Barrington-Trimis, JL, Samet, JM, & McConnell, R, "Flavorings in Electronic Cigarettes: An Unrecognized Respiratory Health Hazard?" *The Journal of the American Medical Association*, doi:10.1001/jama.2014.14830, published online November 10, 2014.
- <sup>39</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018.
- <sup>40</sup> Marynak, KL, et al., "Sales of Nicotine-Containing Electronic Cigarette Products: United States, 2015," *American Journal of Public Health*, Published online ahead of print March 21, 2017: e1–e4. doi:10.2105/AJPH.2017.303660.
- <sup>41</sup> CDC, "Characteristics of Electronic Cigarette Use Among Middle and High School Students—United States, 2015," *MMWR*, 65(50-51): 1425-1429, <https://www.cdc.gov/mmwr/volumes/65/wr/pdfs/mm655051a2.pdf>.
- <sup>42</sup> U.S. Department of Health and Human Services (HHS), *The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General*, CDC, Office of Smoking and Health (OSH), 2014, <http://www.surgeongeneral.gov/library/reports/50-years-of-progress/index.html>. See also: CDC Office on Smoking and Health, "Electronic Nicotine Delivery Systems: Key Facts," July 2015. Accessed November 19, 2015. <http://www.cdc.gov/tobacco/stateandcommunity/pdfs/ends-key-facts2015.pdf>
- <sup>43</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.
- <sup>44</sup> HHS, *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease: A Report of the Surgeon General*, Centers for Disease Control and Prevention, Office on Smoking and Health, 2010 <http://www.ncbi.nlm.nih.gov/books/NBK53017/>.
- <sup>45</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018.
- <sup>46</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016. NASEM, *Public Health Consequences of E-Cigarettes*, 2018.
- <sup>47</sup> American Association of Poison Control Centers, "Electronic Cigarette and Liquid Nicotine," <http://www.aapcc.org/alerts/e-cigarettes/>.
- <sup>48</sup> American Association of Poison Control Centers (AAPCC), E-Cigarette Devices and Liquid Nicotine, <http://www.aapcc.org/alerts/e-cigarettes/>, accessed July 13, 2016. Data from 2014-2017 are considered preliminary and the numbers may change as cases are closed and



additional information is received. See also: CDC, "Notes from the Field: Calls to Poison Centers for Exposures to Electronic Cigarettes — United States, September 2010–February 2014," *MMWR* 63(13):292-293, April 4, 2014, <http://www.cdc.gov/mmwr/pdf/wk/mm6313.pdf>.

<sup>49</sup> HHS, *E-Cigarette Use Among Youth and Young Adults. A Report of the Surgeon General*. Atlanta, GA: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health, 2016.

<sup>50</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018.

<sup>51</sup> CDC, "Quick Stats: Cigarette Smoking Status Among Current Adult E-Cigarette Users, by Age Group—National Health Interview Survey, United States, 2015," *Morbidity and Mortality Weekly Report*, 65(42): 1177, [http://www.cdc.gov/mmwr/volumes/65/wr/mm6542a7.htm?s\\_cid=mm6542a7\\_w](http://www.cdc.gov/mmwr/volumes/65/wr/mm6542a7.htm?s_cid=mm6542a7_w).

<sup>52</sup> Mirbolouk, M, et al., "Prevalence and Distribution of E-Cigarette Use Among U.S. Adults: Behavioral Risk Factor Surveillance System, 2016," *Annals of Internal Medicine*, published online August 28, 2018.

<sup>53</sup> Coleman, B., et al., "Transitions in electronic cigarette use among adults in the Population Assessment of Tobacco and Health (PATH) Study, Waves 1 and 2 (2013-2015)," *Tobacco Control*, published online April 25, 2018.

<sup>54</sup> Grana, R, et al., "E-Cigarettes: A Scientific Review," *Circulation* 129(19):1972-86, 2014, <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC4018182/pdf/cir-129-1972.pdf>.

<sup>55</sup> King, BA, et al., "Awareness and Ever Use of Electronic Cigarettes Among U.S. Adults, 2010-2011," *Nicotine & Tobacco Research*, 15(9):1623-7, 2013. See also, Fiore, MC, et al., *Treating Tobacco Use and Dependence: 2008 Update, U.S. Public Health Service Clinical Practice Guideline*, May 2008, [http://www.surgeongeneral.gov/tobacco/treating\\_tobacco\\_use08.pdf](http://www.surgeongeneral.gov/tobacco/treating_tobacco_use08.pdf). NASEM, *Public Health Consequences of E-Cigarettes*, 2018.

<sup>56</sup> U.S. Preventive Services Task Force, *Behavioral and Pharmacotherapy Interventions for Tobacco Smoking Cessation in Adults, Including Pregnant Women: U.S. Preventive Services Task Force Recommendation Statement, Annals of Internal Medicine, Vol. 163, No. 8, October 2015*, <http://www.uspreventiveservicestaskforce.org/Page/Document/UpdateSummaryFinal/tobacco-use-in-adults-and-pregnant-women-counseling-and-interventions1>.

<sup>57</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018.

<sup>58</sup> King, BA, et al., "Awareness and Ever Use of Electronic Cigarettes Among U.S. Adults, 2010-2011," *Nicotine & Tobacco Research*, 15(9):1623-7, 2013. See also, King, BA, et al., "Trends in Awareness and Use of Electronic Cigarettes among U.S. Adults, 2010-2013," *Nicotine & Tobacco Research*, first published online September 19, 2014 and Fiore, MC, et al., *Treating Tobacco Use and Dependence: 2008 Update, U.S. Public Health Service Clinical Practice Guideline*, May 2008, [http://www.surgeongeneral.gov/tobacco/treating\\_tobacco\\_use08.pdf](http://www.surgeongeneral.gov/tobacco/treating_tobacco_use08.pdf).

<sup>59</sup> Bullen, C, et al., "Electronic cigarettes for smoking cessation: a randomised controlled trial," *The Lancet* 382(9905):1629-37, November 16, 2013; Capanetto, P, et al. "Efficiency and Safety of an eElectronic cigarette (ECLAT) as tobacco cigarettes substitute: a prospective 12-month pilot study," *PLoS One* 8(6):e66317, 2013.

<sup>60</sup> Benmarhnia T, et al., "Can e-Cigarettes and Pharmaceutical Aids Increase Smoking Cessation and Reduce Cigarette Consumption? Findings from a Nationally Representative Cohort of American Smokers," *Am J Epidemiol*. 2018 Jun 27

<sup>61</sup> Berry, K. et al., "E-cigarette initiation and associated changes in smoking cessation and reduction: the Population Assessment of Tobacco Health Study, 2013-2015," *Tobacco Control*, vol. 2018:0:1-7, March 24, 2018.

<sup>62</sup> Biener, L. and J. Lee Hargrave, "A Longitudinal Study of Electronic Cigarette Use in a Population-based Sample of Adult Smokers: Association with Smoking Cessation and Motivation to Quit," *Nicotine & Tobacco Research*, October 9, 2014.

<sup>63</sup> Giovenco, DP and Delnevo, CD, "Prevalence of population smoking cessation by electronic cigarette use status in a national sample of recent smokers," *Addictive Behaviors*, 76: 129-134, published online August 3, 2017.

<sup>64</sup> See e.g., Giovenco, DP and Delnevo, CD, "Prevalence of population smoking cessation by electronic cigarette use status in a national sample of recent smokers," *Addictive Behaviors*, 76: 129-134, published online August 3, 2017. Levy, DT, et al., "The relationship of e-cigarette use to cigarette quit attempts and cessation: insights from a large, nationally representative U.S. survey," *Nicotine & Tobacco Research*, published online August 31, 2017.

<sup>65</sup> Berry, K. et al., "E-cigarette initiation and associated changes in smoking cessation and reduction: the Population Assessment of Tobacco Health Study, 2013-2015," *Tobacco Control*, vol. 2018:0:1-7, March 24, 2018.

<sup>66</sup> Adkison, S, et al. "Electronic Nicotine Delivery Systems: International Tobacco Control Four-Country Survey," *American Journal of Preventive Medicine* 44(3):207-215, 2013; Vickerman, KA, et al., "Use of Electronic Cigarettes Among State Tobacco Cessation Quitline Callers," *Nicotine & Tobacco Research* 15(10):1787-91, October 2013.

<sup>67</sup> Weaver, Scott R., et al., "Are electronic nicotine delivery systems helping cigarette smokers quit? Evidence from a prospective cohort study US adult smokers, 2015-2016," *Plos One* 13(7) July 9, 2018.

<sup>68</sup> Kalkhoran, Sara and Glantz Stanton, "E-cigarettes and smoking cessation in real-world and clinical settings: a systematic review and meta-analysis," *Lancet Respiratory Medicine*, 2016.

<sup>69</sup> Adkison, S, et al. "Electronic Nicotine Delivery Systems: International Tobacco Control Four-Country Survey," *Am J Prev Med*, 44(3):207-215, 2013.

<sup>70</sup> Weaver, Scott R., et al., "Are electronic nicotine delivery systems helping cigarette smokers quit? Evidence from a prospective cohort study US adult smokers, 2015-2016," *Plos One* 13(7) July 9, 2018.

<sup>71</sup> NASEM, *Public Health Consequences of E-Cigarettes*, 2018.

<sup>72</sup> CDC, "Powerful new Tips from Former Smokers" ads focus on living with vision loss and colorectal cancer," CDC Press Release, March 26, 2015, <http://www.cdc.gov/media/releases/2015/p0326-tips.html>. See also: CDC, "Dual Use of Tobacco Products," <http://www.cdc.gov/tobacco/campaign/tips/diseases/dual-tobacco-use.html#ten>

<sup>73</sup> Schane, RE, Ling, PM, & Glantz, SA, "Health Effects of Light and Intermittent Smoking: A Review," *Circulation* 121(3):1518-1522, 2010.

---

<sup>74</sup> Tverdal, A and Bjartveit, K, "Health Consequences of Smoking 1-4 Cigarettes per Day," *Tobacco control* 14(5), 2005. Hackshaw, A, et al., "Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports," *BMJ* 360:j5855, <http://doi.org/10.1136/bmj.j5855>, 2018.

<sup>75</sup> Hackshaw, A, et al., "Low cigarette consumption and risk of coronary heart disease and stroke: meta-analysis of 141 cohort studies in 55 study reports," *BMJ* 360:j5855, <http://doi.org/10.1136/bmj.j5855>, 2018.

<sup>76</sup> HHS, *The Health Consequences of Smoking: A Report of the Surgeon General*, CDC, OSH, 2004. HHS, *How Tobacco Smoke Causes Disease: The Biology and Behavioral Basis for Smoking-Attributable Disease*, CDC, OSH, 2010. HHS, *Preventing Tobacco Use Among Youth and Young Adults: A Report of the Surgeon General*, CDC, OSH, 2012, <http://www.surgeongeneral.gov/library/reports/preventing-youth-tobacco-use/index.html>. HHS, *The Health Consequences of Smoking: 50 Years of Progress. A Report of the Surgeon General*, CDC, OSH, 2014, Schane, RE, Ling, PM, & Glantz, SA, "Health Effects of Light and Intermittent Smoking: A Review," *Circulation* 121(3):1518-1522, 2010. Tverdal, A & Bjartveit, K, "Health consequences of reduced daily cigarette consumption," *Tobacco Control* 15:472-480, 2006.