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.\(^1\) 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. In a 2020 report, the Surgeon General found that “the long-term health effects of using these products remain unknown, and short-term risks are only slowly coming into focus.”\(^2\)

Research is still needed to determine whether or not e-cigarettes will help people quit, discourage smokers from quitting completely, or lead to established tobacco use for new users, including kids, especially in an environment where the products continue to evolve. In December 2018, the Surgeon General issued an advisory on e-cigarette use among youth, “officially declaring e-cigarette use among youth an epidemic in the United States.” He called for “aggressive steps to protect our children from these highly potent products that risk exposing a new generation of young people to nicotine.”\(^3\)

**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. Over time, e-cigarette devices have become more sleek, more concealable, and the e-liquids contain more nicotine.

There are a wide range of reusable e-cigarettes and “pods,” which enable users to replace a nicotine-containing cartridge (such as Juul) or refill a tank with a liquid solution (such as Suorin), and there are disposable e-cigarettes, which cannot be refilled (such as Puff Bar). There are also “mods,” which are units that users assemble themselves from separate component parts, to allow variation in battery power, style, and size.\(^4\) A study found more than 430 brands of e-cigarettes available for purchase online in 2017.\(^5\) As of September 2021, pre-filled cartridges for pods made up 60.2% of sales in traditional retail outlets,\(^†\) while disposable e-cigarettes made up 39.8%, more than doubling their market share since February 2020.\(^6\)

\(^*\) For the purposes of this factsheet, the term “e-cigarettes” will be used to represent the entire category of products.

\(^†\) Convenience stores, gas stations, grocery stores, drugstores/pharmacies, mass merchandiser outlets, club stores, dollar stores, and military sales. Excludes Internet sales and sales from tobacco specialty stores like vape shops.
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 fruit punch, funnel cake, orange soda, and strawberry, which have long been considered attractive to kids. By 2017, researchers identified more than 15,500 unique e-cigarette flavors available online. In addition to the vast selection available online, refill liquids and disposables in a variety of flavors, and other e-cigarette products are available at vape shops.

The popularity of various flavors of e-cigarettes has changed over time. When e-cigarettes were first introduced in the U.S., only tobacco and menthol flavors were available, but very quickly, the number of flavors exploded. Beginning in 2017, as the popularity of Juul surged, other flavors like fruit, dessert, and candy made up the largest portion of sales. However, sales of mint-flavored products grew when Juul removed its mango, cucumber, and crème flavors from the market in late 2018. When Juul stopped sales of mint-flavored products in late 2019 and the FDA prohibited sale of cartridge-based products in flavors other than tobacco and menthol in February 2020, menthol-flavored e-cigarette sales grew dramatically. Sales of menthol-flavored e-cigarettes in traditional retail outlets increased by 46% between February 2020 and September 2021. As of September 2021, menthol-flavored products made up 38.6% of all unit sales in traditional retail outlets and 62% of sales of cartridge-based products like Juul. Menthol sales are followed in popularity by all other flavors, like fruit and candy (32.1%), tobacco (24.9%), and mint (4.4%).

Currently, no reliable estimate of the size of the overall e-cigarette market exists, but recent data show that continued growth in sales. Market sales data through July 11, 2021 show that e-cigarette unit sales in traditional retail outlets were at a record high, for the third month in a row. 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, though in late 2018, Altria announced it would end sales of its e-cigarette products and made a $12.8 billion investment in Juul Labs (for a 35% stake in the company). There are, however, hundreds of e-cigarette companies, thousands of “vape shops,” and many online retailers, leading to a wide variety of product characteristics, including ingredients and nicotine content. A large proportion of e-cigarettes in the U.S. market are imported. Globally, more than 95% of e-cigarettes are estimated to be manufactured in or sourced from China.

**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.” 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.

Some e-cigarette marketing tactics have included 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 use as glamorous; social media marketing; and sweet, kid-friendly flavors.

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, early studies showed increases in marketing spending in the years that youth e-cigarette use also rose. Social media has helped 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.
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.”\(^{19}\) The 2019 National Youth Tobacco Survey (NYTS) found that 69.3% of middle and high school students – 18.3 million youth – had been exposed to e-cigarette advertisements from at least one source.\(^{20}\) A 2016 study in *Pediatrics*, analyzing 2014 NYTS 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.\(^{21}\)

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

E-cigarettes have been the most popular tobacco product among youth since 2014, 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.

While e-cigarettes have become increasingly popular among youth and young adults, uptake has remained low among older adults.

**Youth Use.** According to the NYTS, e-cigarettes have been the most commonly used tobacco product among youth since 2014. In 2021, during the midst of the Covid-19 pandemic, 2 million youth, including 11.3% of US high schoolers and 2.8% of middle schoolers, were current e-cigarette users. While the data are not comparable to previous survey years due to methodology changes,\(^{‡}\) just prior to the pandemic in 2020, 19.6% of US high schoolers reported current e-cigarette use, about the same level as in 2018 when the Surgeon General first declared e-cigarette use an epidemic.\(^{22}\) Youth e-cigarette use remains a serious public health concern.

Kids are not just experimenting with e-cigarettes, but are using them frequently, leading to an addiction that is difficult to break. In 2021, 43.6% of high school e-cigarette users were frequent users of e-cigarettes, reporting use on at least 20 of the preceding 30 days. Alarmingly, 27.6% of high school users were daily users, a strong indication of addiction. In total, over 800,000 middle and high school students were frequent users of e-cigarettes in 2021, including half a million daily users.\(^{23}\)

Multiple national surveys show that flavored e-cigarettes are popular among youth. The 2021 NYTS found that about 85% of youth e-cigarette users use flavored products. Among high school students who currently used any type of flavored e-cigarette, the most commonly used flavor types were fruit (72.3%), candy/desserts/other sweets (33%), mint (30.5%) and menthol (29.8%).\(^{24}\) Earlier data from the 2016-2017 wave of the PATH study found that 96.1% of 12-17 year-olds who had initiated e-cigarette use since the last survey wave started with a flavored product. Additionally, it found that 97% of current youth e-cigarette users had used a flavored e-cigarette in the past month and 70.3% say they use e-cigarettes

\(^‡\) 2021 data is not comparable to previous years due to a methodology change. Whereas previous surveys were conducted entirely in-school, the 2021 survey included both in-school and at-home responses; students who completed surveys in school reported higher e-cigarette use. Pandemic-related factors such as reduced access to e-cigarettes due to fewer peer interactions may have impacted youth e-cigarette use in 2021.
“because they come in flavors I like." While the methodology is not comparable to the NYTS study, both surveys confirm that flavors are an important reason youth use e-cigarettes.

While cartridge (or "pod") systems like Juul initially drove the youth e-cigarette epidemic, disposable e-cigarettes are now the most popular e-cigarette devices among youth. In 2021, 55.8% of high school e-cigarette users reported using disposable e-cigarettes. Puff Bar is now the most popular e-cigarette brand among high school e-cigarette users (26.1%), followed by Vuse (10.8%), SMOK (9.6%), JUUL (5.7%) and Suorin (2.3%).

**Adult Use.** Data from the National Health Interview Survey (NHIS) show that in 2019, 4.5% of adults currently used e-cigarettes every day or some days, an increase from 3.2% in 2018.

- E-cigarette use is highest among younger adult populations. Compared to 3.0% of 45-64 year olds, 9.3% of 18-24 year olds currently use e-cigarettes every day or some days, an increase from 7.6% in 2018. Among all tobacco products, e-cigarettes were used by the highest proportion of 18-24 year olds (24.5%).
- A higher percentage of White, non-Hispanic adults use e-cigarettes (5.1%) compared to Black, non-Hispanic adults (3.4%) or Hispanic adults (2.8%).

As young adult e-cigarette use continues to rise, an increasing number of these young e-cigarette users have never been smokers. In 2019, NHIS data showed that more than half of 18-24 year-old current e-cigarette users (56.0%) had never been cigarette smokers, the highest proportion among the age groups. This youngest adult age group also had the lowest percentage of e-cigarette users who were former smokers. Similarly, data from the Behavioral Risk Factor Surveillance System (BRFSS), show that the proportion of young adult never smokers using e-cigarette users roughly doubled between 2016 and 2018, while e-cigarette use rates among older adult never smokers changed very little.

**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. However, these potential benefits must be weighed against the current epidemic of use among youth. As the Surgeon General stated in a 2020 report, "The potential benefit of e-cigarettes for cessation among adult smokers cannot come at the expense of escalating rates of use of these products by youth."

According to CDC, the Surgeon General, 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. The Surgeon General found that “the long-term health effects of using these products remain unknown, and short-term risks are only slowly coming into focus.” The NASEM report stated that “the absolute risks of the products cannot be unambiguously determined at this time,” 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. According to the Surgeon General, "E-cigarette aerosol is not harmless. It can contain harmful and potentially harmful constituents, including nicotine." The nicotine present in e-cigarette aerosol is absorbed by users and bystanders. 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. 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. Because FDA is still reviewing the wide variety of products on the market, there is no way for consumers to know for sure yet what is in specific products or the aerosol.

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 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.” 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. According to the FDA, “Flavorings that are safe for use in food may become toxic when these chemicals are heated and inhaled. Some have been shown to be harmful to the lungs.”

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. Some e-liquids are formulated with nicotine salts, which, according to the Surgeon General, “allow particularly high levels of nicotine to be inhaled more easily and with less irritation than the free-base nicotine that has traditionally been used in tobacco products, including e-cigarettes.” 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, and more than two-thirds of youth e-cigarette users report using e-cigarettes exclusively for nicotine-containing products.

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. 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.”

In general, nicotine has been found to impact the cardiovascular system. 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.

Poisoning and Exposure to Liquid Nicotine. Delivered in high doses, nicotine can be lethal. The Surgeon General’s 2016 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. Exposure to liquid nicotine found in e-cigarettes has resulted in thousands of calls to poison control centers, according to the American Association of Poison Control Centers (AAPCC). 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.

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.53
- 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.”54
- An analysis of data from the FDA’s nationally representative Population Assessment of Tobacco and Health (PATH) study found that from 2013 to 2016, youth (ages 12-15) e-cigarette use was associated with more than four times the odds of trying cigarettes and nearly three times the odds of current cigarette use. The researchers estimate that this translates to over 43,000 current youth cigarette smokers who might not have become smokers without e-cigarettes.55
- New research shows that the latest generation of high nicotine e-cigarettes like Juul that have fueled the youth e-cigarette epidemic are also associated with subsequent smoking initiation. An analysis of 2017-2019 data from the Truth Longitudinal Cohort, a study of young and young adults (ages 15-27), found that compared with those who had never used an e-cigarette, those who reported ever use of any e-cigarette (Juul or other brands) in 2018 had significantly higher odds of ever cigarette use one year later, and those who reported ever use of Juul in 2018 had significantly higher odds of current e-cigarette use one year later.56

Dual Use and Cessation. Data show that a significant number of e-cigarette users report using both e-cigarettes and conventional cigarettes, raising additional concerns beyond the potential health effects of e-cigarettes alone. According to the 2019 NHIS, 36.9% of adult e-cigarette users are also current cigarette smokers (dual users).57

Little data are available on what happens with dual users over time. A recent analysis of survey data from four countries (Canada, United States, United Kingdom, and Australia) reported that dual users were not more likely to quit smoking compared to those who did not vape.58 An older study of PATH Waves 1 and 2 (2013-2015) also found that nearly 9 out of 10 early dual users were still smoking cigarettes at follow-up,59 while a more recent analysis of Waves 3 and 4 (2015-2017) echoed similar findings: none of the survey participants who had used ENDS as a cessation aid with or without other methods had become ENDS-only users by follow-up.60 While few studies have compared toxicant exposures between dual users and cigarette-only smokers, those studies that have examined it continue to find that dual users have toxicant exposures that are similar to those who only used cigarettes.61

Some e-cigarette users report that they believe that e-cigarettes will help them quit or reduce the number of cigarettes they smoke; however, several studies have found that e-cigarette use is not effective in helping smokers quit. On the other hand, some research does acknowledge that e-cigarettes could help smokers stop smoking, especially if used under certain conditions, such as every day.62

While existing research provides mixed results about the effectiveness of e-cigarettes in helping current smokers successfully quit, leading public health authorities in the U.S. have found that there is not enough evidence to conclude whether e-cigarettes are a safe and effective smoking cessation device.63 For instance, the U.S. Preventive Services Task Force (USPSTF), which makes recommendations about the effectiveness of specific preventive care services after a thorough assessment of the science, recently updated its recommendation statement on tobacco smoking cessation adults and concluded that “the current evidence is insufficient to assess the balance of benefits and harms of electronic cigarettes (e-cigarettes) for tobacco cessation in adults... The USPSTF recommends that clinicians direct patients who use tobacco to other tobacco cessation interventions with proven effectiveness and established safety.”64 The 2020 Surgeon General Report on Smoking Cessation concluded that “there is presently inadequate evidence to conclude that e-cigarettes, in general, increase smoking cessation.” The Surgeon General also cautions that because e-cigarettes are not a single product, but “a continually changing and heterogeneous group of products” that “are used in a variety of ways,” it is difficult to make broad generalizations about the efficacy of e-cigarettes for smoking cessation based upon any one study or any one product.65
Quitting cigarette smoking completely is the most important step smokers can take to improve their overall health. 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 and mortality compared with those who only smoke combustible tobacco cigarettes.” 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.” Studies have found that smoking just one to four cigarettes a day increases the risk of developing or dying from heart diseases. 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.” 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.

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, six in ten adult e-cigarette users are either dual users (continue to smoke cigarettes) or had never smoked in the first place. Will most e-cigarette users continue to be dual-users or never users?
- 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 any potential benefits.

Campaign for Tobacco-Free Kids, December 27, 2021

---

Electronic Cigarettes: An Overview of Key Issues
Electronic Cigarettes: An Overview of Key Issues

41 Flavor and Extract Manufacturers Association of the United States (FEMA), The Safety Assessment and Regulatory Authority to Use Flavors – Focus on E-Cigarettes, 2013, p. 8-9.