



ENDS  
(e-cigarettes)

# E-Cigarettes

## Brief

### Electronic Nicotine Delivery Systems (ENDS)

ENDS are highly heterogeneous products that consist of a mouthpiece, a tank or a cartridge for e-liquid, a battery, and an atomizer, which affects the performance, the inhalation of aerosol, as well as nicotine delivery. In consideration of their easily accessible and easy-to-use nature, ENDS are raising public health concerns, as youth consumption rates are increasing.

## What is an e-cigarette?

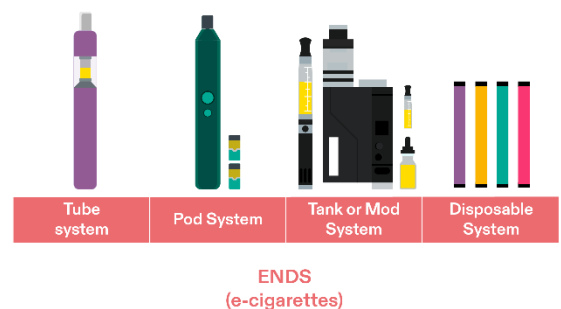
Electronic cigarettes go by many names – the most common name is “e-cigarette,” but other terms include e-cigs, vapes, vape pens, mods, and tanks.<sup>1</sup> Most accurately they are called electronic nicotine delivery systems (ENDS) and are devices used to inhale an aerosol received by heating a liquid that is often composed of glycerol, flavourings, nicotine, and/or other chemicals (this does not include heated tobacco products).<sup>2</sup> Although generally considered a single product class, ENDS constitute a diverse, heterogeneous group with significant differences in the production of toxicants and delivery of nicotine. Generally, ENDS consist of a mouthpiece, a tank or a cartridge for e-liquid, a battery, and an atomizer. The atomizer design is particularly important, as it affects the performance of the e-cigarette, and has a wicking material that delivers liquid to a battery-powered heating coil. The e-liquid, upon heating (in most cases to around 200-300°C), forms an aerosol inhaled by the user. Most of them are marketed by the industry as tobacco-free products that are a safer alternative to conventional cigarettes.<sup>3,4</sup>

Different generations of ENDS<sup>a</sup> may be classified into closed and open systems depending mainly on the degree of control that users have over the e-liquid used and the voltage and resistance applied to heating the e-liquid and ventilation features.<sup>5</sup> E-cigarette tubes and e-cigarette tanks or mods for example are open system refillable devices. Closed system pod e-cigarettes are usually smaller, low-powered ENDS that come with disposable e-liquid pods that are replaced when empty. Such as the popular JUUL, pod-ENDS were the first designed to look and feel like a slick, modern fashion



accessory, and to efficiently deliver nicotine. Since 2019, closed system, disposable e-cigarettes, such as the brand Puff Bars, entered the market (see [Puff Bar Brief](#)). Like other ENDS, Puff Bar devices heat up the containing e-liquid to create aerosols. They resemble sleek, USB flash drives small enough to fit

Current ENDS devices on the market



<sup>a</sup> There are currently five generations of ENDS devices, with some coexisting on the market: first-generation or so-called cigarette lookalikes, second-generation pre-filled tank systems, even larger third-generation or personal tank mods, fourth generation cartridge-based pod-mods, and fifth generation disposable “Puff Bar” e-cigarettes (CDC & SCHEER). Further information on [stopsmoking](#)

in your pocket, allowing for stealth consumption among youth. Unlike the JUUL pod system though, Puff Bars are pre-charged and pre-filled, and once the vapour runs out, they cannot be recharged or refilled, thus making them single-use, disposable devices.<sup>6</sup> Since their release, various Puff Bar copycat ENDS have flooded the market, growing in popularity among youth, largely due to their cheap and disposable nature.

## Consumption of e-cigarettes

E-cigarette or ENDS use among young people has skyrocketed in recent years: about one in five high school students in the U.S. used ENDS in 2020, many of whom were not smokers in the first place. In 2017, about 15% of the European population had tried ENDS at least once.<sup>2</sup> In Switzerland, ENDS have become increasingly popular among youth. A running Swiss survey published in 2018 showed that among 15-year-old students, 50.9% of boys and 34.8% of girls had used an e-cigarette at least once. Moreover, the authors stated that in the 30 days prior to the survey, 20.6% of boys and 12.9% of girls had used an e-cigarette at least once.<sup>7</sup> Another multi-year study conducted in the Canton of Zurich showed that six- to 12-year-olds are already using ENDS. Of the youth aged 16 to 17, 70% of girls and 60% of boys were found to smoke occasionally or regularly. Moreover, every fifth youth indicated that they smoked several times a week, or daily, with ENDS being the most popular method by far (73%).<sup>8</sup> New types of ENDS are likely to exacerbate the problem.

Flavourings are one of several significant factors that influence the willingness to try ENDS.<sup>9</sup> A 2016 WHO report reviewing scientific literature on ENDS stated that certain flavours, such as fruit or candy-like aromas, appeal to children, and play a role in motivating experimentation among them.<sup>5</sup> This has been confirmed by numerous other studies.<sup>10-16</sup> At the time of the WHO report in 2016, close to 8,000 unique e-liquid flavours had been reported.<sup>5</sup> A subsequent study from 2019 reported that this number had increased to more than 15,000 different flavour chemicals.<sup>17</sup> Particularly in Switzerland, not only have the selection of flavours increased, but also their accessibility via online shops, kiosks, and vape shops.



## ENDS Cessation Aid and Harm Reduction

Because ENDS are combustion-free, and because most of the damaging and well-known effects of tobacco are derived from this reaction, there is a common and widely spread assumption that the consumption of ENDS is safer than conventional cigarette smoking. This has led to an ongoing debate on the use of ENDS as a cessation or harm reduction measure for tobacco smokers. Currently, the scientific evidence regarding the effectiveness of ENDS as a smoking cessation aid is still insufficient and of low certainty, making it difficult to draw reliable conclusions. Moreover, while the vapour from e-cigarettes does not contain some of the harmful substances in traditional cigarettes, depending on the type of product, its heating temperature, and the user maintenance of the appliance, it does contain other harmful substances in different degrees not found in them.<sup>2,18</sup>

In 2021, the Scientific Committee on Health, Environmental and Emerging Risks (SCHEER), on request by the EU Commission, reviewed the most recent scientific and technical information on e-cigarettes.<sup>16</sup> They stated that while there is some evidence that e-cigarettes help smokers to stop smoking compared with placebo e-cigarettes (nicotine free), these studies tended to be methodologically weak. Thus, in regard to the role of e-cigarettes used as cessation measure of conventional tobacco smoking, SCHEER concluded that, given the scarcity and low quality of scientific evidence, there is only weak evidence for the support of e-cigarette effectiveness in helping smokers quit.<sup>16</sup> Similarly, the recent 2020 Surgeon General’s report on Smoking Cessation stated that, “The evidence is inadequate to infer that electronic cigarettes, in general, increase smoking cessation.”<sup>19</sup>



A second generation ENDS next to a traditional cigarette

The WHO echoes these conclusions, stating that whether ENDS can be used as a cessation measure “is still a subject of debate between those who want their use to be swiftly encouraged and endorsed on the basis of available evidence, and others who urge caution, given the existing scientific uncertainties as well as the performance variability of products and the diversity of user behaviour.”<sup>15</sup> They conclude that if the great majority of tobacco smokers who are unable or unwilling to quit would switch without delay to using ENDS, and eventually stop using it as well, this would represent a significant contemporary public health achievement. However, current trends show that this shift is not occurring, with either the prevalence of ENDS users, or dual users of both ENDS and tobacco cigarette use increasing.<sup>20-24</sup> In terms of harm reduction, e-cigarettes may seem a preferable alternative to combustible cigarettes, however evidence remains insufficient to prove that the risk trade-off of e-cigarettes benefits the overall health of the population.<sup>25</sup> Finally, promoting nicotine use to youth is bad public health policy and this would be one of the crucial risks associated with the support of ENDS, thus meriting strong caution when promoting ENDS use.

The European Public Health Association (EUPHA) similarly supports the precautionary approach in regards to the safety of ENDS, stating that the support of ENDS “may well worsen the tobacco epidemic first by deflecting smokers from using proven smoking cessation strategies and shifting them to e-cigs, which, for most smokers, reduce successful smoking cessation, and second by deflecting discussion from measures opposed by the tobacco industry.”<sup>26</sup>

In Switzerland, the use of ENDS is a subject of debate. While tobacco and addiction prevention professionals consider that the first choice is to stop smoking completely, they recognize that there are people who cannot, or do not want to stop using nicotine. For these individuals, if prior efforts of nicotine replacement therapy and counselling are ineffective, controlled use of specific e-cigarettes may aid the cessation therapy. Heated tobacco products are not included in this controlled use, but only certain types of re-fillable e-cigarettes, where the dosage of nicotine may be reduced with time. Until now, there is no research supporting the effectiveness of ENDS in cessation therapy.



A test tube rack with examples of different e-cigarettes.

## Health Risks of ENDS use

In order to stop smoking and to help manage the craving caused by withdrawal symptoms, nicotine may be required. However, while the use of nicotine as a cessation aid is acceptable, one of the main concerns with e-cigarette use, especially among youth, is the particularly high amount of nicotine that can be inhaled in a short period of time, as well as the renormalization or social acceptance of smoking.<sup>25</sup> For example, ENDS with nicotine salts have been shown to deliver more nicotine compared to a tobacco cigarette.<sup>27-29</sup> Different ENDS also appear to use different types of synthetic nicotine with varying levels of S-nicotine and R-nicotine, which vary in their absorption.<sup>30</sup> Additionally, the simplicity of the use and the increasing accessibility of ENDS are further factors increasing the number of young users.<sup>25</sup> The strong dependence on nicotine subsequently rewires the brains of youth to be more susceptible to other, more dangerous addictions, as well as the development of depression.<sup>31-35</sup> In addition to dependence, nicotine can have adverse effects on the development of the foetus during pregnancy and may contribute to cardiovascular disease. Although nicotine itself is not a carcinogen, it may function as a “tumour promoter” and seems to be involved in the biology of malignant diseases, as well as of neurodegeneration.<sup>36</sup> The evidence is sufficient to warn children and adolescents, pregnant women, and women of reproductive age against the use of ENDS with nicotine (see [www.stopsmoking.ch](http://www.stopsmoking.ch)).<sup>5</sup>

ENDS also contain varying amounts of toxic substances, including arsenic, aluminum, and lead, which affect the nervous system.<sup>35</sup> Other studies have shown that ENDS aerosols can contain toxic chemicals like acrylonitrile, propylene, oxide, and crotonaldehyde.<sup>3 37-39</sup> In a 2021 publication, John Hopkins researchers showed that they found thousands of unknown chemicals, including industrial chemicals in e-cigarettes.<sup>18</sup> Research has also shown that ENDS aerosols harm the lungs, with e-cigarette associated lung injury outbreaks pointing to the dangers of inhaling countless unregulated aerosols from carefully engineered e-cigarette devices intended to maximize the aerosol dose reaching the lungs.<sup>40-43</sup> Other studies demonstrate that ENDS can increase the risk of lung infections, with the nicotine in ENDS weakening the immune system.<sup>44-46</sup> A 2021 updated overview of e-cigarette impact on human health lists further respiratory complications and increased cardiovascular risk, including increased inflammatory markers and cytotoxicity.<sup>17</sup>

## Gateway to Tobacco Smoking

Recent studies suggest that ENDS use is especially increasing among non-smokers.<sup>47-48</sup> One publication showed that among Irish teenagers, never-smokers who tried e-cigarettes rose from 33% in 2015 to 67% in 2019.<sup>49</sup> With more youth increasingly beginning ENDS use, several studies and reviews in the past years have begun to report that ENDS use even predisposes people to future cigarette smoking.<sup>50-53</sup> A 2020 publication demonstrated that e-cigarette users 11 to 16 years old were more than twice as likely to later start cigarette smoking.<sup>54</sup> One study showed that young adult participants identified a significant risk of ENDS acting as a gateway to tobacco cigarette use.<sup>47</sup> ENDS thus acting as a gateway to smoking traditional cigarettes is a public health concern. Chapman et al. (2019) explain that there are several plausible reasons for such a transition that opponents of the gateway assumption seldom consider.<sup>55</sup> These include:

1. **Increased Accessibility:** ENDS and cigarettes are often sold alongside one another. Adolescents who might never visit a tobacco retailer will now be exposed to promotions and discount offers.
2. **Smoking Experience:** ENDS use may erode negative feelings about cigarettes and facilitate experimentation. This includes the renormalization of the smoking “performance.”<sup>55</sup>

Relevant data in Switzerland is very poor. Nevertheless, available evidence on the health risks of ENDS use in other countries is currently strong, and it is clear that using ENDS carries its own set of consequences. Moreover, the e-cigarette industry is expanding the nicotine market, which youth are

particularly susceptible to, not only facilitating the development of addiction, but also predisposing youth to future tobacco smoking.

## Environmental Impact

Because e-cigarettes contain toxic chemicals, heavy metals, and residual nicotine, their waste is a serious threat to our water, air, and land. In short, vape trash isn't just litter, it's toxic waste. E-cigarette waste cannot biodegrade even under severe conditions. Cartridges and pods discarded on streets mix with leaf litter and get pushed around by weather events, eventually breaking down into microplastics and chemicals that flow into storm drains to pollute waterways and endanger wildlife. Some vapes can even leak heavy metals and residual nicotine into the environment.<sup>1</sup> Moreover, the mining and manufacturing of materials for ENDS, and the disposal of ENDS can be harmful to the environment.<sup>56</sup> Particularly single use, disposable e-cigarettes like Puff Bars pose the biggest threat to the environment, because as the name suggests, they are used only once, and then discarded with their plastic exterior, and lithium-ion battery, which is made of lithium, cobalt, and nickel. Moreover, other than their batteries and plastics, they typically contain metal coils and harmful chemicals with heavy metals like lead, as well as nicotine leaking out and posing a biohazard risk. In consideration of the major raw materials required to make various ENDS, the production chain of these devices has a destructive impact on ecosystems and communities, as the raw materials needed are acquired through unsustainable mining.<sup>57</sup>



ENDS, like fourth generation Juuls, are often not be disposed of correctly.



## Regulation of e-cigarettes in the EU and Switzerland

The WHO urges countries to restrict the sale, promotion, and use of electronic cigarettes. As of May 2016, all EU countries must comply with the EU Tobacco Products Directive that includes regulations for ENDS. The Directive states that ENDS packaging should provide information on toxicity and addictiveness, health warnings, and a list of all the substances contained in the product, including the exact level of nicotine (that should be in a concentration level of no more than 20 mg/mL). The Directive also requires that advertising and promotion rules for tobacco products also apply to electronic cigarettes.<sup>58</sup> In April 2018, a ban on sales of e-cigarettes with nicotine was overturned by the Swiss Federal Administrative Court. Currently, ENDS in Switzerland fall within the scope of the Food Act, which states that ENDS on the market must meet the technical requirements of an EU member state. No further other federal rules have been implemented to prevent harms from e-cigarette use. Only in 2021, Switzerland adopted a new law on tobacco products that ensures that minors under 18 cannot purchase e-cigarettes, which is predicted to become active in 2023-2024.<sup>59</sup>

Regulations standardizing the labelling of nicotine concentration on web-based retail platforms and on product packaging are still needed to facilitate consumer awareness. Additionally, regulations that create barriers for entry of similar products and disincentivize consumers to switch to other flavoured products will be crucial for future policies.

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