

The Health Risks of Electronic Cigarettes Use in Adolescents

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The use of electronic cigarettes (e-cigarettes) and other types of vaping devices has risen in popularity, particularly among teenagers.¹ Several studies indicate that e-cigarettes might help smokers quit tobacco cigarettes, benefiting their long-term health.² However, further studies suggest that vaping may be driving an increase in nicotine use for teens, caused by their exposure to elevated levels of this alkaloid.^{2,3} Due to the highly addictive nature of nicotine, it has been hypothesized that young vaping device users might switch from their initial use to traditional cigarettes, or that nicotine exposure may function as a gateway to drugs.⁴ Concern also was raised on the risks of exposure to other chemicals through vaping. Acute respiratory distress syndrome, pulmonary illnesses, and asthma have been reported to be induced by vaping substances.⁵⁻⁸ The Minnesota Department of Health reported that a significant number of patients have been classified as having e-cigarette, or vaping, product use-associated lung injury.⁹

The working group on social pediatrics and public health of the European Paediatric Association/Union of National European Paediatric Societies and Associations is actively engaged in monitoring health and wellbeing.^{10,11} The purpose of this commentary is to raise the attention of healthcare professionals on the escalating use of e-cigarettes and vaping among adolescents, and the possible health implications of this broad social phenomenon.

Definition of Vaping and Vaping Products

E-cigarettes and similar devices, such as pens and other types of products, including advanced personal vaporizers or modified e-cigarettes, have been introduced and mass marketed in Europe (2006) and in the US (2007). A typical vaping device includes a mouthpiece, a battery, a cartridge to be filled with e-liquid or e-juice, and a heating component for the device. When the device is switched on, the battery heats up the heating component, which turns e-liquids into an aerosol vapor that is inhaled into the lungs and then exhaled. Vaping is the act of inhaling and exhaling this aerosol, which consists of many fine particles typically containing varying amounts of toxic chemicals that have been linked to harmful health events in individuals.^{7,8,12} Commercialized e-liquids for use in vaporizer products usually contain a propylene gly-

col or vegetable glycerin-based liquid with nicotine, flavoring, and other chemicals and metals.

Epidemiology of Vaping in Teens and Adolescents

During the past 5 years, the popularity of vaping among adolescents has risen significantly.¹³ The US National Institutes of Health (NIH) reports an increase in the use of vaping devices by high school seniors, from 27.8% in 2017 to 37.3% in 2018.¹⁴ The NIH study estimates that the overall number of middle school and high school students reporting the use of e-cigarettes rose from approximately 2.1 million recorded in 2017 to 3.6 million documented in 2018, with a jump of 78% (from 11.7% to 20.8%), doubling rates of the past 2 years. The NIH data suggest that although it is illegal to sell e-cigarettes to anyone younger than 21 years of age in the US (18 or 19 years in some US states) and 18 years in the European Union^{15,16} (Table; available at www.jpeds.com), age restrictions do not seem to be a limitation to widespread use.¹⁴ Young people who have never smoked traditional cigarettes seem to be intrigued by the use of vaping, which is available in more than 1500 flavors, including fancy aromas like bubble gum and candy floss.¹⁷⁻¹⁹ In a survey involving US youths aged 12-17 years, 81% of e-cigarette users reported that they have been prompted to vaping by the availability of flavored products. In Europe, the European Tobacco Products Directive legislation regulates the fundamental rules for the production of inhalation fluids.^{15,16} Reliable statistics on the use of e-cigarettes in the European population younger than 18 years old are limited.²⁰ Among the available data, a study in Germany showed that the 1-year prevalence of subjects younger than the age of 18 who had ever used an e-cigarette was 14.6%.²¹ Although 2.8% of them currently

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used e-cigarettes, 0.2% had regularly used a vaping device in the past, and 11.6% had tried it at least once in the past.²¹ The use of e-cigarettes among 11- to 15-year-olds in England increased from 22% in 2014 to 25% in 2016.^{22,23} A 2018 report indicated that 16.0% of 11- to 18-year-olds in the United Kingdom had tried vaping at least once, an increase compared with 12.7% recorded in 2015.²² In Italy, a study on the general consumption of nicotine by traditional cigarettes and vaping devices showed a 41.1% rate of use among students, which adding to the list the other available formulas (ie, snuff tobacco, water pipe, and cigarettes without combustion), reaches 47.3%, equal to a total of more than 1 million students.²⁴ Regarding the reasons for using vaping, 76.1% of e-cigarette smokers reported having tried it the first time out of curiosity, 15.7% because offered by friends, and 8.3% for quitting smoking.²⁴

Potential Health Risks

Studies on e-cigarette products, including disposable and refillable commercial articles, and e-liquids, report that they contain an average of 6.2 flavoring chemicals, and that e-cigarettes with sweet flavors have a significantly greater number of flavoring chemicals when compared with tobacco- and menthol-flavored products.²⁵ More than 20% of commercial products were found to contain flavoring chemicals with a potential risk of inhalation toxicity, including benzyl alcohol, benzaldehyde, and vanillin.^{25,26} Additional toxicants, such as acrolein and diacetyl, have been identified in several vaping products.²⁵ Measurable levels of tobacco-specific nitrosamines were detected in 70% of tested products.²⁵ Further studies suggest that use of e-cigarettes may negatively influence cardiovascular health²⁷ and that flavorants in e-cigarettes present potential hazards, such as risk of obstructive lung diseases.²⁸ In addition, nicotine, often used in vaping, confers a series of risks, including anomalies in the development of the hippocampus and cerebral cortex among adolescents.²⁹⁻³¹ Smoking is a highly efficient form of drug administration. Inhaled nicotine enters the circulation rapidly through the lungs and moves into the brain within seconds, with fast rates of absorption, reinforcing the effects of the drug.^{32,33} Moreover, adolescent

e-cigarettes users show increased rates of chronic bronchitis symptoms and asthma.³⁴ E-cigarettes contain several constituents, which may present potential risks for lung, stomach, bladder, and esophageal cancer.³⁵ Finally, e-cigarette vapor has been linked to cancer in mice.³⁶

Conclusions

E-cigarettes and vaping devices have been introduced on the market as a safer and healthier alternative to traditional cigarettes, and available data suggest that they may help smokers to stop smoking long term, or to facilitate smokers unable to stop smoking entirely, to reduce their tobacco cigarette consumption.³⁷ Studies have shown that regular, daily e-cigarette use is positively associated with a significant decrease in the number of cigarettes smoked per day, as well as with an increase in smoking-cessation attempts.^{38,39} However, substantial uncertainty surrounds the potential impact of e-cigarettes on health, and this important public health issue is currently widely debated. The evidence to date suggests that vaping is not a safe alternative to smoking tobacco.⁴⁰ This, coupled with the worrying trend of young nonsmokers being attracted to vaping, raises fears of yet another generation suffering from chronic lung disease and other acute and chronic health conditions.⁴¹ Finally, due to the insufficient regulations in several countries,⁴² up-to-date data on the prevalence of e-cigarette use and studies on the health's implications of their use are urgently needed to inform policy at a national and international level (ie, European Union). Pediatricians are typically on the front line for identifying emerging risks for children and adolescents; therefore, they may effectively help increase awareness about the potential danger of vaping on health.^{43,44} Information on the use of vaping devices should be implemented worldwide and included in public health information and prevention programs.^{45,46} ■

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Table. Summary of rules on tobacco products and electronic cigarettes use, issued by the EU (Directive 2014/40/EU) and enforced in EU countries since 20 May 2016

General rules

- prohibits cigarettes and roll-your-own tobacco with characterizing flavors
- requires tobacco industry to report to EU countries on the ingredients used in tobacco products
- requires health warnings on tobacco and related products: combined health warnings (picture, text, and information on how to stop) must cover 65% of the front and back of cigarette and roll-your-own tobacco packages
- sets minimum dimensions for warnings and prohibits small packages for certain tobacco products
- bans promotional and misleading elements on tobacco products, e-cigarettes, and herbal products for smoking
- introduces EU-wide tracking and tracing to combat the illicit trade of tobacco products
- allows EU countries to prohibit internet sales of tobacco and related products
- sets out safety, quality, and notification requirements for electronic cigarettes
- obliges manufacturers and importers to notify EU countries about novel tobacco products before placing them on the EU market

Summary of rules for e-cigarettes sold as consumer products:

Safety and quality requirements for e-cigarettes

- The Directive sets a maximum nicotine concentration and volume for cartridges, tanks, and nicotine liquid containers.
- E-cigarettes should be child-resistant and tamper-evident and have a mechanism that allows refilling without spillage to protect consumers.
- E-cigarette ingredients must be of high purity
- E-cigarettes should deliver the same amount of nicotine when puffed at the same strength and duration.
- Manufacturers and importers must notify all products they place on the EU market through a standardized electronic format.

Packaging and labeling rules for e-cigarettes

- Health warnings for e-cigarettes advising consumers that they contain nicotine and should not be used by nonsmokers are mandatory
- Packaging must include a list of ingredients contained in the product, information on the product's nicotine content
- A leaflet with instructions for use and information on adverse effects, risk groups, addictiveness, and toxicity must be included in packaging
- Promotional elements are not allowed on e-cigarette packaging
- Cross-border advertising and promotion of e-cigarettes is prohibited.

EU, European Union.