

## REVIEW ARTICLES

### Vaping: A Pediatric problem?

#### Vaping: Um problema pediátrico?

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#### ABSTRACT

Electronic cigarettes were developed almost two decades ago. Their use, colloquially known as vaping, has gradually increased among young people.

Although initially marketed as an alternative to traditional cigarettes, electronic cigarettes expose users to substances associated with adverse health effects and are not recognized by the World Health Organization as a smoking cessation method. The use of new flavors, esthetically appealing devices, and low perceived risk appear to be contributing to increased use among adolescents worldwide, a trend also observed in Portugal. However, their health risks are not fully understood. Recently, a new entity - e-cigarette or vaping-associated lung injury (EVALI) – has been described, with increasing incidence and significant morbimortality. The treatment of nicotine dependence in adolescents who smoke electronic cigarettes is challenging.

Electronic cigarettes are addicting a new generation and posing associated health risks. Their increasing use should alert physicians and encourage the development of strategies to address this issue among adolescents.

**Keywords:** addiction; adolescent; cannabis; electronic cigarette; EVALI; nicotine; tobacco

#### RESUMO

Os cigarros eletrónicos foram desenvolvidos há quase duas décadas. A sua utilização, coloquialmente conhecida como “vaping”, tem aumentado progressivamente entre os jovens.

Apesar de inicialmente comercializados como uma alternativa ao cigarro tradicional, os cigarros eletrónicos expõem os consumidores a substâncias nocivas para a saúde, não sendo reconhecidos pela Organização Mundial da Saúde como um método de cessação tabágica. A utilização de novos sabores, estética atrativa e baixa perceção de risco parecem contribuir para o aumento da sua popularidade entre os adolescentes globalmente, uma tendência que também se verifica em Portugal. No entanto, as consequências para a saúde não estão totalmente esclarecidas. Foi recentemente descrita uma entidade específica - lesão pulmonar associada ao uso de cigarros eletrónicos (EVALI - *e-cigarette or vaping-associated lung injury*) - com incidência crescente e morbimortalidade significativa. O tratamento da dependência de nicotina em adolescentes que fumam cigarros eletrónicos é um desafio.

Os cigarros eletrónicos estão a viciar uma nova geração, com riscos para a saúde associados. O aumento do seu consumo deve alertar os profissionais de saúde e promover o desenvolvimento de estratégias de abordagem desta situação junto dos adolescentes.

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**Palavras-chave:** adolescente; canábis; cigarro eletrônico; dependência; EVALI; nicotina; tabaco

## INTRODUCTION

Electronic nicotine delivery systems (ENDS) are a group of devices that were initially promoted as an alternative to traditional cigarettes to aid smoking cessation.<sup>(1)</sup> Their use is colloquially known as vaping.<sup>(2)</sup>

Although the first electronic cigarettes (e-cigarettes) were designed to resemble traditional cigarette, they quickly evolved into devices in various shapes, from pen drives to inhalers, pens, etc.<sup>(3)</sup> The latest devices are very powerful and capable of delivering nicotine in similar or even higher doses than traditional cigarettes.<sup>(4)</sup>

The mechanism usually includes a small battery, a heating element, a vaporization chamber, a cartridge or reservoir, and a mouthpiece.<sup>(5)</sup>

Vaporization requires heating the chosen substance (nicotine solution, flavoring chemicals, propylene glycol, glycerin, or others), which produces an aerosol that is inhaled and absorbed systemically.<sup>(3,5)</sup>

Although they contain fewer toxic chemicals than traditional cigarettes, e-cigarette aerosols can expose users to ultrafine particles, heavy metals, and volatile organic compounds, among other health hazards.<sup>(1)</sup> In addition, the heating process produces more toxins and carcinogens, including acetaldehyde, formaldehyde, and acrolein.<sup>(3)</sup>

Although randomized controlled trials have shown a small benefit of e-cigarettes in smoking cessation, these results have not been confirmed by observational studies.<sup>(3)</sup>

On the other hand, the use of electronic cigarettes has been associated with a significant relapse rate to traditional cigarette use among ex-smokers.<sup>(3)</sup>

Currently, the World Health Organization (WHO) does not consider e-cigarettes to be a smoking cessation aid.<sup>(3)</sup>

The primary objective of this study was to review the epidemiology, use, and associated health risks of nicotine and cannabis vaping in adolescents. The secondary objectives were to discuss the clinical approach to prevention and cessation and to gather relevant information to share with physicians, especially those working directly with children and adolescents.

## RESULTS

### Epidemiology

The popularity of vaping has increased among middle and high school students, and this age group has had the highest growth in users worldwide over the past decade.<sup>(1,3)</sup> In 2014, its use among young people in the United States (U.S.) even surpassed traditional

cigarette smoking.<sup>(6)</sup>

The Portuguese reality has followed this trend. The results of the latest Study on the Consumption of Alcohol, Tobacco, Drugs and Other Addictive Behaviors and Dependencies (ECATD-CAD),<sup>1</sup> conducted in 2019, are in line with the conclusions of most recent studies conducted at national or regional level among young people.<sup>(7)</sup> In this study, alcohol was the main psychoactive substance consumed (68%), followed by tobacco (38%). Among the forms of nicotine consumption, traditional cigarettes stood out, followed by e-cigarettes, whose prevalence of experimentation (22%) is already close to that of traditional cigarette smoking (29%). More than 1/4 of smokers are daily users (28% traditional cigarette users and 22% e-cigarette users). Compared to the previous study in 2015, there was a decrease in traditional cigarette consumption and a slight increase in e-cigarette consumption, which was more pronounced among men.<sup>(7)</sup>

### Use of e-cigarettes in adolescence

E-cigarette companies target young people by promoting appealing flavors such as cotton candy, popcorn, caramel, and bubble gum.<sup>(3)</sup>

During adolescence, the brain is particularly sensitive to the pleasant effects of sweet flavors. Exposure to e-cigarettes with non-traditional flavors that produce sensory perceptions of sweetness (compared to flavors such as tobacco and menthol) leads to greater adherence and addiction.<sup>(8)</sup>

Among young people who vape, the use of non-traditional flavors is associated with vaping persistence and a greater number of inhalations per vaping episode. In addition, these products may have a higher addiction potential because they contain compounds that lower the pH, which can increase the bioavailability of nicotine absorbed by the user.<sup>(8)</sup>

The impact of this increased use at an early age deserves special attention, as changes in neurodevelopment during adolescence lead to greater vulnerability to substance abuse.<sup>(2)</sup>

The adolescent brain is susceptible to nicotine addiction, even with intermittent exposure.<sup>(9)</sup> On the other hand, while all nicotine products are addictive, pod-based systems with high concentrations of nicotine salts appear to be even more so.<sup>(3)</sup>

There is strong evidence that the use of e-cigarettes by adolescents

1 ECATD-CAD has been carried out in Portugal every four years since 2003. It is a cross-sectional study carried out among Portuguese public school students aged between 13 and 18, which results from the application of the ESPAD - European School Survey Project on Alcohol and Other Drugs questionnaire.<sup>7</sup>

is associated with greater progression to traditional cigarette use and from intermittent to regular use.<sup>(3,9)</sup>

It should also be noted that substances such as marijuana and methamphetamines can also be vaporized in some e-cigarettes, which poses an additional risk.<sup>(9)</sup>

The increased popularity of vaping among young people may also be due to other factors. Low perceived risk is a significant predictor of adolescent substance use and is probably one of the most important contributors.<sup>(5)</sup> Many are unaware that e-cigarettes contain nicotine and therefore do not understand the addictive potential they can create.<sup>(9)</sup> Vaping devices are also considered more convenient and discreet in public and produce a better taste and smell of the smoked substances.<sup>(5)</sup>

### **Cannabis vaping**

Cannabis is considered by young people to be one of the least harmful psychoactive substances, partly because it is perceived as more "natural" than others.<sup>(5)</sup>

Young people report increased levels of concentration and clarity and better communication with their use, although this has not been proven by objective testing.<sup>(5)</sup>

The emergence of legal cannabis markets for "therapeutic" and "recreational" use creates new challenges for adolescents' perceptions of the risks and potential benefits of cannabis. In fact, many see the list of indications as proof of safety and benefit, despite the lack of evidence for most, even in adults.<sup>(5)</sup>

The low-risk perception of cannabis as a substance and vaping as a mode of use may provide a false sense of security and be particularly attractive to young people seeking a "healthier form" of use.<sup>(5)</sup>

Although nicotine is the most commonly vaped substance, there has been an increase in cannabis vaping. This has been associated with several cases of acute lung injury, often involving high-potency forms of cannabis, with severe short and long-term consequences.<sup>(5)</sup>

According to a meta-analysis, the use of nicotine-containing e-cigarettes increases the odds of cannabis use by 3.5 times among adolescents and young adults, suggesting a strong association between the two substances.<sup>(10)</sup> E-cigarettes with pre-filled liquid cartridges (called "pod mods") can contain nicotine and/or cannabis, making it very easy to try both substances.<sup>(5)</sup>

Nicotine and cannabis dependence share genetic risk factors, and their simultaneous or sequential use may increase the severity of withdrawal symptoms and make quitting more difficult. In addition, nicotine consumed through e-cigarettes may increase cannabis dependence due to its rapid absorption and significant stimulation of the brain's reward center. This contributes to increased substance abuse among young people.<sup>(5)</sup>

Cannabis vaping has been largely responsible for the increase in the use of this substance compared to other forms of consumption.<sup>(5)</sup> According to some studies, cannabis vaping may produce fewer chemicals compared to traditional smoking, suggesting a less harmful

mode of consumption.<sup>(11)</sup> However, the high-potency concentrates found in vape pens have been associated with a higher incidence of physical and mental health problems, such as paranoia, psychosis, and cannabinoid hyperemesis syndrome. On the other hand, there is still no evidence of long-term pulmonary effects, with the significant presence of carbonyls, volatile organic compounds, nitrosamines, and heavy metals, which are considered toxic and carcinogenic, being of concern.<sup>(5)</sup>

### **Health risks**

E-cigarettes have only been on the market for about ten years, and products have changed rapidly, limiting scientific data and knowledge about this phenomenon. Given that the solutions and emissions contain nicotine and many of the toxins and carcinogens found in traditional cigarettes, it is reasonable to expect similar health effects from vaping.<sup>(9)</sup>

There is ample evidence that vaping can cause acute endothelial dysfunction, oxidative stress, DNA damage, and mutagenesis. It has also been shown to increase heart rate and both systolic and diastolic blood pressure.<sup>(12)</sup> Concerns about long-term harm are raised by epidemiologic studies linking e-cigarette use to acute myocardial infarction.<sup>(3)</sup>

There are risks associated with vape pens and vaporizers. There have been increasing reports of injuries (e.g., burns) associated with vaping device malfunctions or explosions. Their inappropriate use has also been associated with cases of acute nicotine poisoning from ingestion or skin exposure.<sup>(3,5)</sup> In addition, the packaging and attractive flavors of these products pose a risk of accidental poisoning in children, who may mistake them for candy or toys.<sup>(5)</sup>

The respiratory toxicity of vaping is exacerbated by the use of flavorings, many of which are known respiratory irritants.<sup>(3)</sup>

Numerous cases of respiratory disease associated with this practice have been reported in the literature, including cases of eosinophilic pneumonia, diffuse alveolar hemorrhage, hypersensitivity pneumonitis, organizing and lipoid pneumonia, and severe asthma.<sup>(3)</sup> More recently, a specific entity called e-cigarette or vaping-associated lung injury (EVALI) has been described, and is associated with increasing incidence and significant morbidity and mortality.<sup>(5)</sup>

As of December 2019, the Centers for Disease Control and Prevention (CDC) identified 2506 cases of severe lung injury requiring hospitalization associated with e-cigarette use in the U.S., including 51 deaths.<sup>(3)</sup>

EVALI often affects adolescents, who account for approximately 15% of diagnosed cases.<sup>(13)</sup> This entity is thought to result from oxidative stress induced by ingredients commonly found in ENDS products.<sup>(11)</sup> Although a specific causative agent has not been identified, more than 3/4 of patients with EVALI reported vaping tetrahydrocannabinol (THC) products that were illegally obtained.<sup>(5)</sup> The CDC has pointed to vitamin E acetate, a thickening agent added to diluted D-9-THC oil, as a potential culprit. In addition, other components of e-cigarette

aerosol, such as vegetable glycerin, propylene glycol, and flavorings, may cause lung inflammation and cytotoxicity.<sup>(2)</sup>

In a study published in July 2020, psychosocial stress risk factors were found in 54% of patients with EVALI in at least three of five risk domains (home environment, academic difficulties, behavioral problems, mental health, and substance use).<sup>(2)</sup>

Most patients diagnosed with EVALI present with severe respiratory symptoms (cough, chest pain, dyspnea) and may also report nausea, vomiting, diarrhea, abdominal pain, fever, or fatigue.<sup>(1,3)</sup> These symptoms can worsen rapidly, sometimes within 24 to 48 hours. Pulmonary infiltrates or opacities are seen on chest x-rays or computed tomography scans.<sup>(3)</sup>

EVALI is a diagnosis of exclusion and its treatment involves the use of systemic corticosteroids to attenuate the inflammatory response. Long-term effects are unknown and close monitoring is recommended. Vaping and tobacco cessation are essential to minimize the risk of recurrence.<sup>(3)</sup>

### **Clinical approach**

Clinicians should actively inquire patients about e-cigarette and tobacco use to help prevent or develop cessation strategies. Vaping is often not considered a form of smoking by young people, and asking if they "smoke" may not be enough to identify their use.<sup>(14-16)</sup>

The risk of initiation needs to be anticipated in non-smokers, and they need to be helped to find their own reasons for not consuming.<sup>(3,14-16)</sup>

For adolescents who smoke, the approach includes warning them about health risks, assessing their readiness and willingness to quit, and helping them develop strategies to resist social pressure. It is also important to help them recognize and manage withdrawal symptoms, which include anxiety, anger, irritability, depression, difficulty concentrating, insomnia, and tremors, in addition to the desire to smoke.<sup>(3,14-16)</sup>

The treatment of nicotine dependence in adolescents is challenging. Although the efficacy of nicotine replacement therapy for vaping cessation has not been directly demonstrated, strong indirect evidence of its efficacy for other forms of nicotine dependence supports its use in the presence of dependence symptoms and in combination with behavioral support.<sup>(3, 14-16)</sup>

Nicotine dependence is more common in patients with psychiatric comorbidities, and this should be evaluated. It is also important to consider that this may not be the only abuse substance.<sup>(3)</sup>

### **CONCLUSIONS**

E-cigarettes are addicting a new generation. The attractive flavors and devices are contributing to an increased use among teenagers, an age group vulnerable to substance abuse.

The use of nicotine-containing e-cigarettes enhances cannabis

vaping, creating greater dependence and exposing adolescents to the adverse effects associated with consumption.

Vaping was initially promoted as safer than traditional cigarettes, but several health hazards have since been uncovered. Therefore, its use in patients with unexplained respiratory or gastrointestinal symptoms should be questioned, as several cases of EVALI have been reported in the literature.

Vaping has also increased, albeit slightly, in Portugal. It is the physician's responsibility to address this issue at every child surveillance visit. Early prevention strategies should be adopted by identifying risk factors for smoking initiation. For adolescents who smoke, the importance of smoking cessation should be emphasized and information and support should be provided.

### **AUTHORSHIP**

Sara Monteiro - Investigation; Methodology; Visualization; Writing - original draft

Rui Almeida - Conceptualization; Methodology; Investigation; Supervision; Visualization; Validation; Writing - review and editing

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