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Electronic cigarette and oral implications – a narrative review

Faculty of Health Sciences

University Fernando Pessoa

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Master's degree in Dental Medicine

Alberto Esposito

ABSTRACT

Electronic cigarette have become increasingly popular in alternative to tobacco smoking that is one of the most common cause of mortality and mobility worldwide.
The aim of this study is to analyze why the electronic cigarette has become so widespread both among young people and among adult smokers and analyze its implications on the oral health.
It is essential, for the dental praticioner to understand the risks that the prolonged use of these devices can cause, at the level of general health for example in the respiratory system, and oral cavity. The effects in the oral cavity can vary form modifications in the oral microbiome and saliva, periodontal consequences to development of mouth cancer in the worst cases.

Keywords: oral cavity, oral health, ecigarette, vaping, electronic delivery systems, oral effects, oral cancer.

DEDICATION

"

"In twenty years, you will not be disappointed by the things you have done but by those you have not done.

So, lift anchor, leave safe havens, catch the wind in your sails. Explore. Dream. Find out "

Mark Twain

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To my family who supported me throughout this journey.

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ABBREVIATION

CC Conventional cigarette

DNA Deoxyribonucleic acid

EC Electronic cigarettes

FDA Food and drug administration

HNC Head and neck cancer

HOP Hydroxypyrene

IPA Polycyclic hydrocarbons aromatics

NNN N-nitrosonornicotine

NNAL 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol

PAH Polycyclic aromatic hydrocarbons

PG Propyleneglycol

ROS Reactive oxygen species

SAP Secreted aspartyl proteinase

TAOS Total antioxidant status

TSNA Tobacco specific nitrosamines

UA Uric acid

VG Vegetable glycerin

VOC Volatile organic compounds

I.INTRODUCTION

First electronic cigarette was commercialized in the United States in 2004, since them various improvements resulted in different generations of e-cigarette.(Rouabhia,2020)
Electronic cigarettes (EC) are devices, that aerosolize liquid that contains nicotine, humectants, and flavors(Cheng, 2014).
EC use has increased rapidly and globally, in particular among smokers and adolescents (King *et al.*, 2015). The number of users has increased since the introduction of ECs. In 2020 was estimated that 68 million of people were using this kind of devices. (Jerzyński *et al.*, 2021)

For the British Broadcasting Corporation, the industry of electronic cigarette was estimated in 2019 to be worth over US 19.3 billion per annum globally. (Holliday *et al.*, 2021)
The first organ in the body, that contact-with vaporized e-liquids is mucosal tissue of the upper respiratory tract and the upper part of the digestive tract. E-liquids contain chemical compounds, which can cause significant DNA damage and the mutagenicity of e-liquids cannot be excluded as a risk factor for HNC (Holliday *et al.*, 2021).
Exposure to these substances in the air remains a great health risk for smokers and people passively exposed to the EC vapor (Hess, Lachireddy and Capon, 2016)

Understanding the harmful effects and explaining them to the patient should start to be a part of routine dental appoints, has it has been done for tabaco, preventing the occurrence of negative effects on oral health and general health)

1 Materials e methods

The literature review was conducted" using the online search engines PubMed, Research gate. The consultation of the online database took place from November 2021 to March 2022, using the keywords "oral cavity", "oral health", "oral effects", "oral cancer'', "ecigarette", "vaping", "electronic delivery systems", the boleane conector "AND" "OR" was applied between then.

The articles included were clinical trials, randomized control trials, review, full text articles and systematic review without filter of time limit, the published literature was between 2004 to 2022.

The exclusion criteria were, no open access, languages other than English, articles not related to the main theme and articles without summary.

The inclusion/exclusion criteria have been applied, analyzing each article to be included in this narrative review, by the title, abstract and by reading the full text of the article.
In the first moment 59 articles were selected but finally the number of articles used for this narrative review was 27 for have met the pre-requisites set.

II. DEVELOPMENT

1. Number of e-cigarettes and vaping users

In 2020 approximately 68 million of e-cigarettes users was estimated worldwide. This numbers are based on data from 49 countries, but data from 152 countries was missing, for this reason these limitations indicate a surprising deficiency in the national and hence global monitoring of electronic cigarette's users.(Jerzyński *et al.,* 2021)

An estimated 8.1 million U.S. adults, were using on a daily base electronic cigarette (e-cigarette) in 2018. At least 14.9% of adults aged 18 and over, had at least once used an EC, those who had ever used an e-cigarette and those who were current users were more likely to be men compared with women, aged 18–24 compared with older ages. The percentage of adults who had ever used an e-cigarette was highest among those who were poor, and decreased as income increased.(Villarroel, Cha and Vahratian, 2018)

In Europe, based on the latest memorandum of the European community regarding "Attitudes of Europeans towards tobacco and electronic cigarettes" with a base of 28300 people interviewed (27 Eu + uk) about 7 out of 10 have never used the electronic cigarette. However, in 7 countries 2 out of 10 have experienced the electronic cigarette at least once: Ireland (29%),Estonia (25%), France and the United Kingdom (both 22%), Luxembourg and Latvia (both 21%) and Belgium (20%). On other side less than 1 in 10 has experienced it at least once Poland (6%), Malta, Portugal and Romania (all 7%) and Hungary (9%). In all countries, less than one in twenty are current e-cigarette users, with the only exceptions of Ireland (7%) and France (6%), where this proportion remains smaller.(European Commission. Directorate-General for Health and Food Safety., European Commission. Directorate-General Communication. and Kantar., 2020)

According to analyzes carried out in Portugal and interviewing 1061 subjects on which of the smoking products suits them best and who answered the electronic cigarette is 7% and is about 9% in men and 6% in women. As regards age, it is the 15-24 age group that prefers it in 15% of cases, it is 13% in the 25-39 age group, 6% between 40-54 and 2% in over 55 years . As regards the status of smoker, 26% are smokers, 5% have quit

smoking, 1% have never smoked and 2% are non-smokers.(EU27 +UK QC4a 1 Base: current smokers, 2020)(Image 1)

2. Composition and chemical evaluation of EC

An EC is composed by different parts with different functions: a cylinder with a cartridge that is a container for the liquid that can be prefilled or fillable, an atomizer that transforms a liquid into aerosol and the third part a rechargeable lithium battery. From 2004 different changes and improvement have been made do EC, resulting in different generations of e-cigarette.(Rouabhia, 2020)(Image 1)

The first generation was a type e-cigarette designed to be a single use. These devices were not rechargeable or refillable. The second generation is a rechargeable e-cigarette, product designed to be used multiple times and the cartridge is attached to a battery pen, which contains the battery.

The third generation is a type of rechargeable EC and they are modifiable devices ("mods"), allowing users to customize the substances in the device. The fourth generation is based by a pod (Centers for Disease Control and Prevention U.S.(2019).

The pod-based style consists of 2 main components: a liquid and heating coil-containing pod and a rechargeable battery. This type of EC is a device with the shape of USB flash drive which makes them easy to carry and use, making them popular by adolescents. Pod devices use nicotine salt "juice" in combination with the humectants, vegetable glycerin (VG) and propylene glycol (PG), and Pods represent over 40% of the e-cigarette retail market now a days. (Rouabhia, 2020).(Image 2)

Goniewicz and colleges, conducted a quantitative analysis of 15 different EC brands of nicotine generated from selected aerosols based on their popularity index. It was found that the variation of nicotine was between 0.5 to 15.4 mg per 300 puffs. Westengber instead tested three cartridges repeatedly and obtained results ranging between 8.04–13.0 mg of nicotine every 300 puffs.

These studies have shown that the amount of nicotine differs substantially from one brand to another.(Cheng, 2014)

Quantitative and qualitative studies have identified a large amount of chemical components in e-cigarette refills and aerosols. Identified substances include tobacco specific nitrosamines (TSNA), aldehydes, metals, volatile organic compounds (VOC), phenolic compounds, polycyclic hydrocarbons aromatics (IPA), flavors and solvents. ECs use solvent carriers, such as propylene glycol and glycerol, as humectants in EC solutions to produce aerosols that simulate conventional cigarette smoke. (Cheng, 2014) (Image 3)

3 Toxic components and general health

A variety of compounds are a part of ECs liquids constitution, as nicotine which is present in different concentrations depending on the type of device and cartridge. Nicotine poisoning occurs more and more often among young people and the most common adverse effects of high doses of nicotine intoxication are nausea, tachycardia, lethargy and vomiting. In the most severe cases it can also lead to apneas, muscle fasciculations, coma, cardiac dysrhythmia, cardiac arrest. The correct and moderate use of electronic cigarettes probably it would not induce acute toxicity, but this is more likely to occur accidentally for example in subjects who inhale the vapor of liquids poured directly on to the heating elements. (Tegin *et al.,* 2018)

Among other substances present is lead, a heavy metal that causes the reduction of the activity of antioxidant enzymes and whose acute exposure can cause abdominal pain, constipation, difficulty concentrating, headache and joint or muscle pain. Chronic exposure can lead to neurocognitive decline, kidney, liver, and dental inflammation. Cadmium is also found, if in toxic levels result in a decrease of bone mineral density and lung cancer. Nickel exposure could include lung inflammation, fibrosis, and alveolar macrophage hyperplasia. (Tegin *et al.,* 2018)

As carbonyl compounds are found in the vapors of EC, the most frequents are formaldehyde, acrolein and acetaldehyde which are produced by thermal decomposition that can lead to irritation of the nasal and lung cavity resulting in emphysema. (Tegin *et al.,* 2018)

There are volatile organic complexes among the constitution, mainly benzene or toluene can be neurotoxic, carcinogenic and haematotoxic and irritating to the tissues. Long term consequences of chronic exposure to these substances are still not clear, especially because they are present in small quantities in ECs.(Tegin *et al.*, 2018)

4 Effects of EC aerosol in health

E-cigarettes since their first marketing have been touted as a healthier alternative to traditional cigarette smoking. (Andrikopoulos, Farsalinos and Poulas, 2019)

Regarding ECs and smoking cessation, these devices are not clearly superior to approved nicotine replacement therapy. Pooled data from the available studies demonstrates no increased serious adverse events related to ECs for up to two years of follow-up but longer-term safety is unknow.(Ghosh and Bradley Drummond, 2017)

More studies show that EC aerosols contain toxic and cancerous agents and organic compounds produced by the thermal breakdown of solvents. (Andrikopoulos, Farsalinos and Poulas, 2019)

So far present who have compared the aerosol of ECs with that of traditional cigarettes have shown lower levels of toxic compounds such as formaldehyde
and acetaldehyde but have highlighted considerable levels of potential carcinogens including toxic metals such as nickel, lead, aluminum, cadmium, manganese; numerous organic compounds including carbonyls and potentially harmful compounds such as silicate beads, tin and various flavors. (Andrikopoulos, Farsalinos and Poulas, 2019)

Moreover, it has been reported that the aerosol of ECs as in tobacco smoke includes reactive oxygen species that cause oxidative stress alterations in cellular antioxidant activity and various types of DNA damage. (Andrikopoulos, Farsalinos and Poulas, 2019)

In addition, ROS /aldehydes / carbonyls derived from the aerosol of EC, can cause carbonylation of proteins, with negative effects such as production of autoantibodies, which can lead to matrix destruction and bone loss during periodontitis. Acrolein has been

reported to induce oxidative stress and inflammation resulting in loss of integrity of the endothelial cell barrier in the lung.(Andrikopoulos, Farsalinos and Poulas, 2019)

4.1 Secondhand and third hand smoke and their health impacts in non-smokers

Secondhand smoke is the smoke accidentally inhaled by a non-smoker. Combined with aerosols from cigarettes, ECs, are toxic and contain carcinogens products. Passive smoking is harmful to general health, as it can lead to death from ischemic heart disease, lower respiratory tract infections, asthma and lung cancer. (Almeida-da-Silva *et al.*, 2021)

Some harmful effects for children are an increasing risk of respiratory symptoms, obesity, disorders of the ear, nose, throat and sleep disturbances breathing. (Almeida-da-Silva *et al.*, 2021)

In 2009, third-hand smoke it was described for the first time. It is the residue of gases and particles of tobacco smoke (from conventional cigarettes, ECs and other tobacco products) that adhere to nearby surfaces such as clothes, bags, skin, hair and furniture after consumption. Residues can persist for minutes or months on surfaces. Young children are particularly vulnerable due to their habits of crawling and bringing their hands to their mouths thus carrying these residues into their mouths. ECs have been shown as a source of third-hand exposure that has been recovered from windows, walls, floor, wood and metals exposure to these residues can cause DNA damage and increase the risk in the short- and long-term health problems, including asthma and cancer.(Almeida-da-Silva *et al.*, 2021)(Image 4)

5. Oral implication of EC use in the oral cavity

EC, looking at the publish literature till now, is being related with a number of oral health consequences, including, but not limited to, xerostomia, oral candidiasis, oral mucosal lesions, dental caries, and periodontal disease, but some still need research. Basically, the oral cavity, being the first part of the body exposed to the constituents of EC or any other forms of tobacco, has an increased risk of exposure to the carcinogenic, microbial, and clinical effects of these products.(Alhajj *et al.,* 2022)

5.1 Oral microbiome analysis

Aerosols produced by the EC appear to induce adverse changes in the oral microbiome. Clinical studies have reported associations with a wide range of conditions, including throat irritation, gum bleeding and oral trauma from exploded e-cigarette devices.(Chaffee *et al.,* 2021)

Analyzing the bacteria found in plaque samples taken from EC users it emerged that these consumers have an oral microbiome different from that of non-smokers and traditional cigarette smokers. Many bacteria including Fusobacterium and Bacteroidales that are known to be associated with gum disease have been found.(Thomas *et al.,* 2022)

Several studies have shown that e-cigarettes with or without nicotine promoted the growth of candida albicans and also increased the expression of several SAP genes, such as SAP2, SAP3 and SAP9, which are known to contribute to the growth and virulence of C. albicans.(Alanazi *et al.,* 2019)

As exposed previously, Ebersole and collogues also described increased pathogenicity of Candida albicans when exposed to e-vapor. Direct comparison with non-exposed C. albicans cultures not exposed to the vapor highlighted significant interactions and enhanced adhesion of the fungus to gingival cells. Other interesting results were the nicotinic stomatitis and hairy tongue. (Ebersole *et al.,* 2020)

Dry mouth, irritation and throat symptoms are among the frequently reported adverse events effects of chronic use of EC. They may transiently increase mucosal blood flow in the oral cavity, in addition, hyposalivation is significant risk factor for the development of oral fungi infections, which may be the underlying etiology for the reported prevalence of these lesions in EC users.(Ebersole *et al.,* 2020)

5.2 Periodontal implications

Saliva is the first body fluid that has a direct contact with EC vapor and is the first line in antioxidant defense of the human body. Uric acid (UA) is the most important non-enzymatic antioxidant present in saliva, an increased in concentration in saliva might reflect a response to oxidative stress and can be related to periodontitis or cancer. Results of studies indicate that uric acid concentration in the saliva of EC smokers tend to be higher than traditional cigarettes users and non-smokers. Among patients with periodontitis, a decreased efficiency of antioxidant mechanisms has been observed. Konopka *et al.,* demonstrated lower values of TAOS in saliva among patients with periodontitis when compared to the control group. The decreased values of TAOS in saliva might be related to the depletion of antioxidants as a result of a chronic inflammation. The connection between periodontitis and the antioxidant potential of saliva, is also confirmed by a positive correlation between the concentration of uric acid in saliva and the parameters of periodontal tissues inflammation. Disorders of antioxidant potential are also related to the risk of oral cancer development and free radicals and ROS can induce DNA damage, which may lead to cancerous transformation. Those negative effects of ROS are counteracted by antioxidants. (Cichońska *et al.,* 2021)

Andrikopoulos and colleges stated that daily use of EC was associated with significantly increased odds of permanent loss of any tooth from non-traumatic causes in adults. In the United States and it has been indicated that vaping may be a risk factor for poor oral health outcomes, including periodontal disease and tooth loss. (Andrikopoulos, Farsalinos and Poulas, 2019)

6. Head and neck cancer

EC have in addition to nicotine (which is not present in all liquids) other cancerous substances such as formaldehyde and acetaldehyde. The two formers have been reported a connection with HNC. Formaldehyde is a risk factor for nasopharyngeal cancer and acetaldehyde associated with alcohol is considered a carcinogen for the esophagus and / or head and neck. Analysis of the e-liquids, aerosols and environmental emissions, showed that some substances, namely, TSNAs, carbonyl compounds and PAHs are similarly present. The TSNAs and PAHs have been the most heavily studied tobacco smoke ingredients with regard to carcinogenicity. Of the seven TSNAs identified in tobacco smoke, NNK N0-nitrosonornicotine (NNN), and 4-(methylnitrosamino)-1-(3-pyridyl)-1-butanol) (NNAL) are potent carcinogens and NNN reproducibly induces head and neck tumors in in vivo studies. The best studied carcinogenic constituents in PAH group include 1-hydroxypyrene (1-HOP) and benzo(a)pyrene. When in contact to the oral environment, PAH exposure results in tongue and esophageal cancers, and in tumors of the upper respiratory tract (larynx, trachea and nose), while inhalation exposure results in pharynx and esophagus tumors.(Szukalska *et al.,* 2020)

Two cases of oral cancer, were reported by Nguyen and colleagues, were associated with chronic use of EC are analyzed in two healthy individuals who have started using the electronic cigarette since 2003 and which lasted for more than 10 years. In both cases the patients had no family history or risk factors for oral cancer such as hematopoietic stem cell transplantation, chronic alcohol consumption, history of smoking, or papilloma virus infection. In both cases, patients were not diagnosed with acute or chronic oral infections caused by other microorganisms. It is very important to underline that in both cases the patients present the same symptoms: unintentional weight loss, dry mouth and difficulty swallowing. (Nguyen *et al.,* 2017)

Both cases were described by Nguyen *et al.* The first case is a 66-year-old man who presented to the otolaryngologist with the symptoms related before. His vaccination records were up to date for human papilloma virus, varicella zoster virus and hepatitis B Virus. His past medical history was insignificant and in his social, there was no alcohol

consumption, but had positive history of EC use (20 times a day in the past 13years) examination of the oral cavity showed areas of induration and paresthesia of the tongue. In the differential diagnosis were infection or carcinoma where the main clinical suspects laboratory tests were prescribed. Tissue biopsy was performed, and histopathological examination revealed a moderately collagen-infiltrated connective tissue stroma with nests and islets of tumor epithelial cells. A diagnosis of basaloid squamous cell carcinoma was administered. (Nguyen *et al.,* 2017)

The second case described by Nguyen et al is 59-year-old man presenting for examination with a 9-month ulceration on his lower lip. No history of trauma has been reported in the area and the patient denied a history of alcohol use. Patient reported that him had smoked 30 EC a day for the past 13 years. An incisional tissue biopsy was examined and histological analysis and histopathological examination revealed basaloid squamous cell carcinoma. (Nguyen *et al.,* 2017)

7. Role of EC in smoking cessation

Some research indicates that ECs have the potential to aid in smoking cessation, it is suggested that the release of nicotine into the bloodstream, might make the withdrawal symptoms that are associated with the abuse of conventional cigarette consumption, less noticeable with the EC. This form of nicotine consumption is also seen by its users as being less harmful compared to CC and may be useful hardware to reduce nicotine consumption (Rom *et al.,* 2015)

Biener *et al.* showed that EC can be useful in smoking cessation, and the usage pattern should serve in counting. Daily consumption with decreased doses of nicotine, seems to be more advantageous than altering day consumption, as the probability of deactivating smoking after one year is higher for users who reduce the nicotine amount every day. (Kalkhoran and Glantz, 2016)

Bullen et al. has already shown that ENDS and Nicotine Patches comparison have similar efficacy in smoking cessation at six months. (Bullen *et al.,* 2013)

Despite being used, for the most part, to reduce or consumption of tobacco, ECs in the United States are not FDA approved as a smoking cessation therapy. The evidence of its effectiveness must be evaluated considering the short- and long-term safety of use of the electronic cigarette(Hajek *et al.,* 2019) In addition, EC can be a form of initiation to the smoking, creating dependence and abuse of nicotine.(Rom *et al.,* 2015)

The role of EC in the fight against smoking is still questionable, and there are also studies that show little use in smoking cessation. (Patil *et al.*, 2020 Ghosh and Bradley Drummond, 2017)

III DISCUSSION

The exponential spread of electronic cigarettes is arousing a lot concern in that, not only by the perception of low toxicity can however, bring the youngest to potentially harmful habits, but mainly because there is a limited amount of toxicological data in relation to the effects of the use of these devices on human health.

In fact, the data research on the effects induced by the inhalation of vapors resulting from heating with consequent evaporation and condensation of e-liquids, are still incomplete and often discordant, mainly a due to the wide variety of existing devices and the variety of component in different brands. The results of the studies of Goniewicz et colleges have shown that the amount of nicotine differs substantially from one brand to another. (Cheng,2014)

Furthermore, these studies use commercial e-liquids which, however, are mixtures of carriers (glycol propylene and vegetable glycerol), nicotine and flavorings, and often contain contaminants such as heavy metals, making identification impossible of the molecules responsible for the damage induced by EC. (Tegin *et al.*, 2018)

Therefore, it turns out, it is important to understand the contribution of the individual components, of the individual flavoring molecules as these belong to potentially dangerous chemical classes, namely aldehydes, alcohols and foreigners.

ECs were born with the premise that they were safer than conventional cigarettes, that could be helpful in reducing and stop smoking by allowing a similar sensation when smoking without combustion and, consequently, not producing some of the harmful substances present in the conventional cigarette. For this reason, these devices have acquired great importance in recent years for studies.

The constituents EC chemicals pose some risks to their users, on the one hand nicotine is capable of creating addiction, on the other hand, glycerin and propylene glycol, when heated, form compounds such as acrolein, formaldehyde and acetaldehyde, with carcinogenic properties. Aromas are an additional danger, tests points that many of these aromas can cause oxidative stress and inflammatory responses that can cause cellular death and an increased risk of developing cancer. (Andrikopoulos, Farsalinos and Poulas, 2019). It is important that during routine appoints an thorough observation of the oral

cavity should be performed to look for subtle alterations that can indicated cellular changes in the oral tissues.

As with the conventional cigarettes, ECs are not just as harmful to their users as they also constitute a risk to third parties. Not only for the reasons exposed before, but they can be attractive and arouse curiosity in others and more in children that can be second or third hand smokers by being exposed to its toxicity by inhalation or ingestion of electronic liquids or its residual particles.((Almeida-da-Silva *et al.,* 2021). Other systemic consequences of exposure to nicotine can also occur, as said before by inhalation of vapors, causing irritation to the airways, cough, paleness, dizziness and vomiting. In extreme cases of nicotine poisoning can cause bradycardia, seizures, wheezing and respiratory arrest. (Tegin *et al.*,2018)

As regarding EC as a smoking cessation therapy, although EC seems safer than conventional cigarettes, its use as a first line of smoking cessation therapy is still controversial, having to be used only in the event of failure of other approved cessation therapies. Some publications have draft some positive results for smoking cessation, in people who use these devices every day, reducing the concentration of nicotine inhaled during the time until consumption ceases completely. Furthermore, it has shown some effectiveness in the fighting smoking, its use for this purpose is still controversial, because consumers end up smoking conventional cigarettes as well concurrently. On the other hand, ECs contain chemicals that are harmful to the health, often with unknown compositions and concentrations. So, the competent authorities do not recommend the use of the EC to combat the smoking, in priority given to approved treatments (Ghosh and Bradley Drummond, 2017), (Patil et al., 2020). (Hajek *et al.*, 2019)

IV CONCLUSION

Electronic cigarette is a device that has marked an epochal turning point in modern society, allowing it to be an alternative to tobacco.
However, the new technology raises a lot of quantity for a young population attracted by the novelties and the many fragrances available to try but underestimating the health risks that are by no means excluded. Furthermore, differences in the characteristics of the various devices and the possibility to customize them by replacing the various additional components notably makes it difficult to standardizing models for the study of their effects.

The long-term safety of ECs is still unknown, both about general health and oral health. More studies are needed to discover the main impacts of ECs on oral health.
Electronic cigarettes represent a relatively new topic for the dentist to discuss with their patients both in terms of their effects and in terms of smoking cessation. The lack of information on the long-term health effects makes it difficult to inform both young and adult patients about this new form of smoking.

Accompanying the patient in smoking cessation is essential and, as health professionals, a product about which so little is known but which the research appoints as danger to the health of patients and those around them cannot be recommended.

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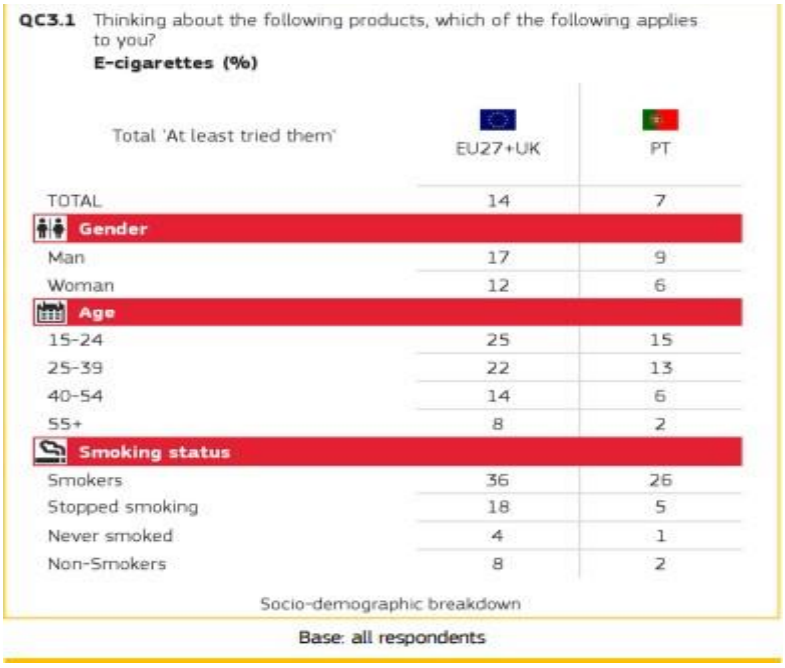
IMAGE INDEX



QC3.1 Thinking about the following products, which of the following applies to you?
E-cigarettes (%)

Total 'At least tried them'	EU27+UK	PT
TOTAL	14	7
Gender		
Man	17	9
Woman	12	6
Age		
15-24	25	15
25-39	22	13
40-54	14	6
55+	8	2
Smoking status		
Smokers	36	26
Stopped smoking	18	5
Never smoked	4	1
Non-Smokers	8	2

Socio-demographic breakdown

Base: all respondents

Image 1:Socio demographic representation in Portugal of EC utilisation preference

Source: European Commission. Directorate-General for Health and Food Safety., European Commission. Directorate-General Communication. and Kantar. (2020). *Attitudes of Europeans towards tobacco and electronic cigarettes :Portugal*. Htpps:Attitudes of Europeans towards tobacco and electronic cigarettes - Publications Office of the EU (europa.eu)

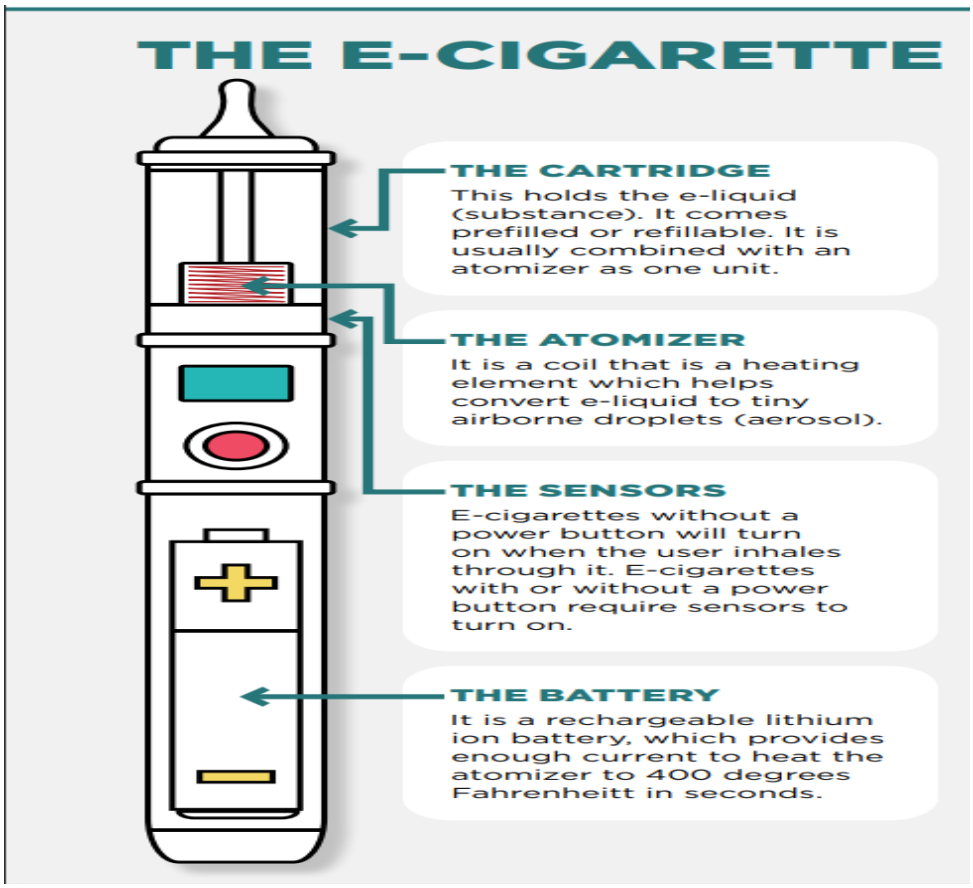


IMAGE 2: General composition of EC

Source: Centers for Disease Control and Prevention U.S. (2019) : E-cigarette, or vaping, products visual dictionary pp. https://stacks.cdc.gov/view/cdc/103783

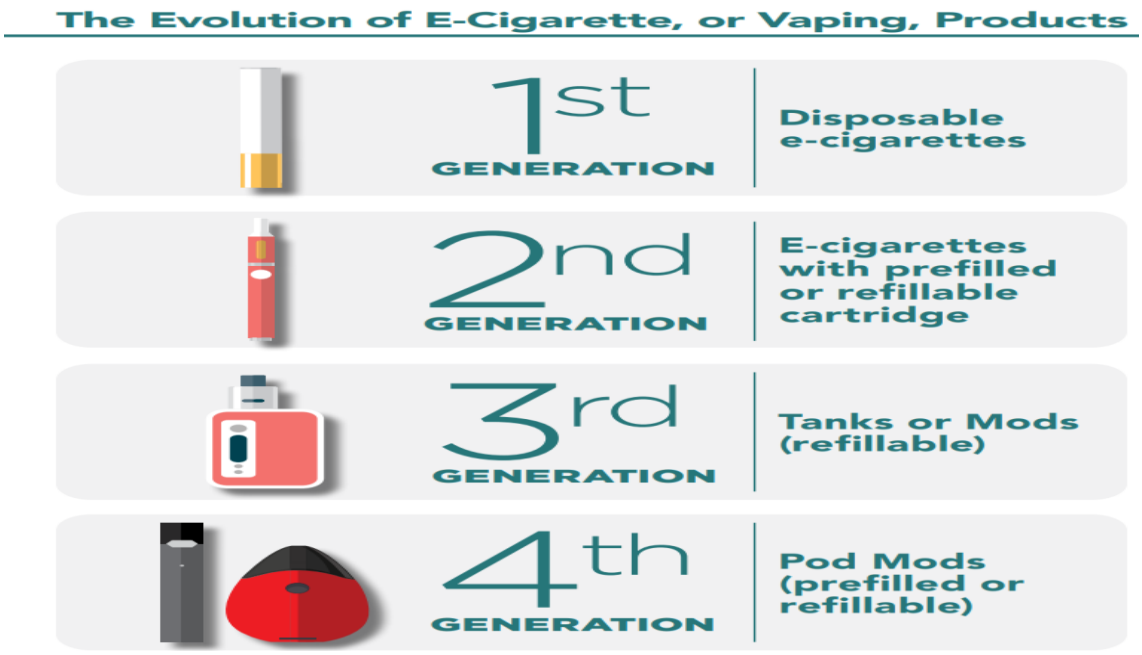


IMAGE 3: The evolution of EC and differentes generations

Source :Centers for Disease Control and Prevention U.S.(2019) : E-cigarette, or vaping, products visual dictionary pp. https://stacks.cdc.gov/view/cdc/103783

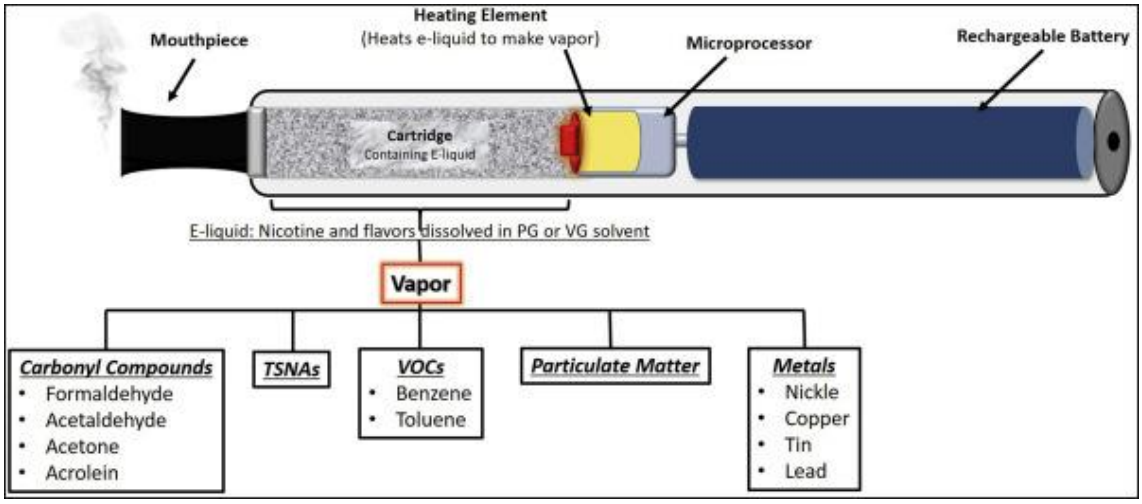


Image 4: Chemical components of EC

Source: https://els-jbs-prod-cdn.jbs.elsevierhealth.com/cms/attachment/ccb21635-91a6-4a2d-ac75-f617905a23ab/gr1.jpg

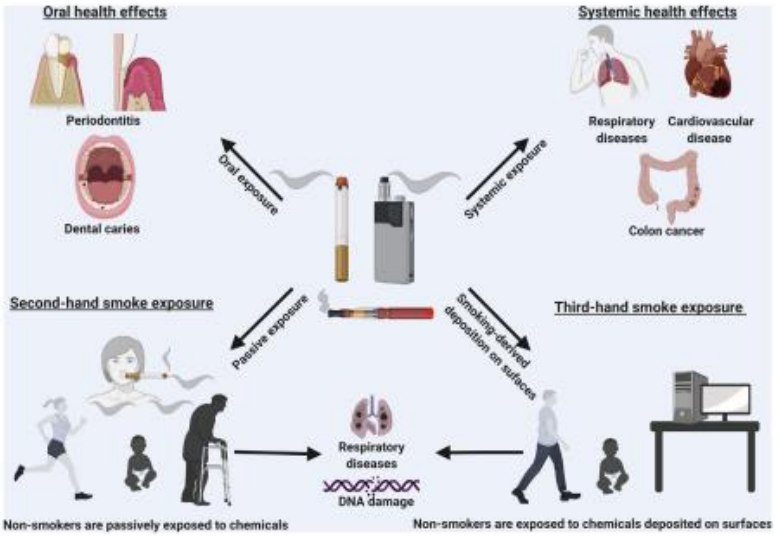


Image 5: Secondhand and third hand smoke

Source: (Almeida-da-Silva *et al.*, 2021)