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HEALTH IMPACT OF E-CIGARETTES: A LITERATURE REVIEW

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ABSTRACT

E-cigarettes, also known as electronic cigarettes, are used as an alternative to traditional tobacco cigarettes, also for quitting and reducing smoking. In e-cigarettes, the combustion of tobacco is replaced by e-liquid heating, which attributed to safer consumption of E-cigarettes than tobacco consumption. However, currently available evidence confirms that E-cigarettes if, healthier than regular smoking, seriously affect lung health. A new disease that can develop due to vaping has been recently registered - EVALI, which stands for e-cigarette or vaping use-associated lung injury. ECs exposure seems to have unfavourable effects on oxidative stress markers. And there are concerns over oral dryness, irritation, and gingival diseases in EC smokers.

The aim of this work is to raise awareness to health risks of E-cigarettes and their impacts on our body.

Methods: We have analyzed articles on pubmed and specialized textbooks in detail. We focused on both the impact of electronic cigarettes on various aspects of health and the description of these specific disease effects.

Conclusion: The popularity of electronic cigarettes has been increasing globally and especially among young people. Therefore their long term negative effects on the respiration and cardiovascular systems should be thorougly investigated.

Keywords: electronic cigarettes, vaping, nicotine, EVALI, oxidative stress, addiction.

INTRODUCTION

The beginning of research on the creation of a safe nicotine product began in the 1960s, but the first modern electronic cigarette was created only in 2003.

Chinese pharmacist Lik Hon created the first prototype in connection with the death of his father from lung cancer due to the use of tobacco products.[6]

Electronic cigarettes, also known as e-cigarettes or vapes, are electronic devices that mimic the experience of smoking a traditional cigarette. They consist of a battery, an e-liquid tank, and a heating element. In e-cigarettes, the combustion of tobacco is replaced by e-liquid heating, which has led some manufacturers to propose that e-cigarettes have less harmful effects on the respiratory system than tobacco consumption. [14]

As in the case of regular cigarettes, a vacuum is created in the device during puffing. This starts the process of heating the liquid to a temperature of 150-180 Celsius degrees. In this way, the solution is vaporized and an aerosol is created that is inhaled by the user. There is no relationship of combustion and pyrolysis here, as in the case of traditional cigarettes.[20]

E-liquids are made up of varying proportions of vegetable glycerin (VG), propylene glycol (PG), nicotine and flavorings that form an aerosol when heated. Some fluids also contain water, ethanol, preservatives and viscosity regulators such as polyethylene glycol or sodium alginate. Nicotine content varies widely, but concentrations of 16 to 24 mg/mL are the most common in premixed e-liquids. [5,20]

Exposure to liquid components such as propylene glycol and glycerin causes not only eye and respiratory irritation, but also affects the nervous system, behavioral sphere and spleen function. E-cigarette particles have the size of respirable particles, and e-smoking leads to their deposition in the lungs. The components of e-liquid cause inflammation in the lungs, are a source of oxidative stress, reduce the concentration of glutathione, which leads to an imbalance of oxidants and antioxidants.[12]

Numerous scientific studies have shown that the concentration of TSNA (tobacco-specific N-nitrosamine), volatile compounds and carbonyl compounds is 9 to 450 times lower in e-cigarette aerosol than in tobacco smoke.[20] Also, the exposure of passive smokers to toxic substances and nicotine when exposed to an aerosol from electronic cigarettes, compared to tobacco smoke, is 10 times lower in the case of passive aerosol inhalation. [20]

It should be emphasized that the use of e-cigarettes by people who have not been smokers before can lead to nicotine addiction due to its content in e-liquids.

Due to the growing problem of the popularity of electronic cigarettes, the **aim of our work** is to raise awareness of their harmfulness and impact on our body. Before reaching for this stimulant, everyone should know what effects it can bring.

METHODS

We have analyzed articles on pubmed and specialized textbooks in detail. We focused on both the impact of electronic cigarettes on various aspects of health and the description of these specific disease effects.

RESULTS AND DISCUSSION

NEGATIVE IMPACT OF ELECTRONIC CIGARETTES ON THE RESPIRATORY AND CARDIOVASCULAR SYSTEMS

E-cigarettes, also known as electronic cigarettes, are used as an alternative to traditional tobacco smoking. There are scientific studies confirming a negative impact on the respiratory and cardiovascular systems, as well as being a source of nicotine addiction. Inhaled aerosol causes oxidative stress and induces apoptosis, leading to irreversible changes in tissues. It is important to know that the health effects of e-cigarettes are still being studied and the full extent of health effects may not yet be known.

Although electronic cigarettes are often considered a safer alternative to traditional cigarettes, this does not mean that they do not affect the functioning of the body. Research is ongoing into the long-term health effects of e-cigarette use, especially in terms of respiratory and cardiovascular effects.

EFFECT OF ELECTRONIC CIGARETTES ON THE RESPIRATORY SYSTEM

Inhalation of chemicals resulting from the combustion of e-cigarettes leads to acute and chronic lung diseases including bronchitis, asymptomatic and incidental radiographic findings, lipoid pneumonia, acute eosinophilic pneumonia, hypersensitivity pneumonitis, and diffuse alveolar hemorrhage (DAH), as well as exacerbation of bronchial asthma symptoms.

Compared to non-smokers, E-cigarette users are more likely to report respiratory symptoms. [4]

In the pathogenesis of changes, among others, glycol and vegetable glycerol sprayed in the respiratory tract as a result of smoking e-cigarettes are involved. They cause chronic local inflammation and features of atelectasis by interfering with the natural elimination of bronchial secretions, foreign bodies and microorganisms entering the respiratory tract. Due to significant hyperosmosis, they limit the tightness of the alveolar-capillary barrier and the secretion of surfactant. Moreover, as a result of combustion, they are responsible for the release of potentially toxic compounds such as acrolein, formaldehyde and acetaldehyde. [**9**]

The respiratory system is damaged in the mechanism of excessive immune response with the release of a cascade of pro-inflammatory factors, oxidative stress, DNA damage, and induction of apoptosis. Exposure to

nicotine-containing e-cigarettes promotes cytokine expression, airway hyperresponsiveness, and lung tissue destruction. [24] In vitro studies have shown a dose-dependent reduction in bronchial epithelial cell viability after exposure to e-cigarette vapor. Studies show that this occurs as a result of DNA damage, depletion of glutathione stores and an increase in cell membrane permeability. [25]

A study conducted by Man Ping Wang, Sai Yin Ho, Lok Tung Leung et al with 45,000 adolescents showed that adolescents who used e-cigarettes in the previous month were more likely to report chronic cough and expectoration than non-smokers. In addition, in a study by Rob McConnell, Jessica L. Barrington-Trimis, Kejia Wang et al., involving 2,000 high school students using current or past e-cigarettes, the risk of developing chronic bronchitis was almost 2 times higher compared to adolescents non-smoker. [4,25]

There are case reports of bronchiolitis-related interstitial lung disease, acute respiratory distress syndrome pneumonia, and e-cigarette-induced acute eosinophilic pneumonia among e-cigarette smokers. [8,19,1]

Lipid pneumonia is a disease entity described in connection with the use of electronic cigarettes and vaping. It is associated with the presence of lipophages - macrophages loaded with lipids, and their isolation in a sputum culture, biopsy material or bronchoalveolar lavage combined with biochemical and imaging diagnostics may confirm the diagnosis. [9]

The relation between smoking electronic cigarettes and respiratory infections and lung cancer is associated with the release of metal particles during repeated heating and cooling, which, reaching the lung epithelium, damage it. [25]

However, no association has been found between smoking e-cigarettes and COPD. The clinical situation is aggravated by simultaneous smoking of conventional cigarettes. [24]

Recently, a new disease entity of respiratory failure associated with the use of e-cigarettes has been introduced. This new entity, dubbed EVALI, initially confused clinicians as to its cause, although it emphasized the temporal link between electronic cigarette use and lung disease. [3] It was officially identified in 2019. EVALI has been linked primarily to the addition of vitamin E acetate (VEA) to e-liquids, mainly derived from e-cigarettes containing tetrahydrocannabinol (THC). EVALI usually presents as an acute or subacute respiratory disease with non-specific symptoms such as shortness of breath, cough, chest pain and/or haemoptysis. This is clinically overt respiratory failure with symptoms appearing within 90 days of e-cigarette use, lung infiltrates on imaging (X-ray or CT scan), no infection, and no evidence of alternative causes of respiratory failure such as cardiological, rheumatological or neoplastic process. Respiratory virus panel negative, influenza PCR negative, and all other clinically indicated tests for respiratory infectious diseases (e.g. urine antigen Streptococcus pneumoniae and Legionella, sputum culture for productive cough, BAL culture (if performed), blood culture HIV-related opportunistic respiratory infections, if necessary) test negative. [18]

Popcorn lung - bronchiolitis obliterans, is a rare disease that develops as a result of the use of electronic cigarettes. In the pathogenesis, the influence of diacetyl found in artificial flavors used in packaged popcorn and e-cigarettes stands out. [10] Irrespective of other ingredients, they disrupt the expression of genes associated with ciliary cells and the cytoskeleton of bronchial epithelial cells. [2] The alveoli become chronically inflamed, scarred, and constricted, resulting in impaired gas exchange. Clinically manifests as fever, cough, shortness of breath, wheezing, weakness, weight loss, and night sweats. Symptoms appear two weeks to two months after exposure to the toxic gas. Due to similar symptoms, differentiation from chronic obstructive pulmonary disease (COPD) and asthma can be difficult. [10]

EFFECT OF ELECTRONIC CIGARETTES ON THE CARDIOVASCULAR SYSTEM

Oxidative stress is a well-known factor in cardiovascular diseases. Short-term use of both traditional and electronic cigarettes leads to increased oxidative stress, impaired antioxidant protection, and endothelial dysfunction, which are associated with increased morbidity and mortality from cardiovascular causes. Traditional cigarettes cause a greater increase in endothelial damage markers, including prostaglandins, compared to electronic cigarettes. [3,7]

Smoking e-cigarettes increases the bioavailability of nitric oxide and increases the levels of NO metabolites in the bloodstream, which contribute to oxidative stress. [11] Furthermore, a reduction in blood vessel dilation has been observed after using electronic cigarettes. [3]

The short-term effects of e-cigarette use on cardiovascular biomarkers may not be useful in predicting the future risk of cardiovascular diseases. For instance, while abnormal subendocardial dilation or aortic stiffness are strong predictors of future cardiovascular events, the acute stimulus caused by e-cigarette use, resulting in transient abnormalities, may not be a significant indicator, especially if e-cigarettes are used only occasionally. Nicotine can narrow blood vessels, leading to a momentary increase in aortic pulse wave velocity, which is not equivalent to narrowed vessels due to chronic vascular disease. [21]

Nicotine present in e-cigarettes increases heart rate after overnight abstinence. [22]

A 2019 study found that switching from traditional cigarettes to first-generation e-cigarettes for one month significantly improved blood vessel dilation and increased PWV (pulse wave velocity). [11] This suggests that e-cigarettes have less harm on the vascular system compared to traditional cigarettes.

Electronic cigarettes may be less harmful than standard cigarettes, as patients with hypertension who switched to e-cigarettes benefited from reduced mean arterial blood pressure and better blood pressure control. [17]

Moreover, e-cigarettes cause platelet aggregation and activation, albeit to a lesser extent than traditional cigarettes. [16] Platelet activation and aggregation play a significant role in diseases such as thrombosis, atherosclerosis, and heart attacks, so it is necessary to study the long-term effects of e-cigarette use on blood platelets.

In a cross-sectional analysis of 400,000 adult respondents from the 2016 BRFSS study, nearly 70,000 individuals reported using electronic cigarettes, which was associated with a 71% increased risk of stroke, a 59% higher risk of acute myocardial infarction, and a 40% higher risk of angina and coronary artery disease. Furthermore, the risk of transitioning to conventional cigarettes was twice as high. [15]

In a prospective study, smoking an e-cigarette for >30 minutes (considered equivalent to smoking traditional cigarettes for >5 minutes) had an adverse, acute impact on aortic stiffness and blood pressure, both of which are known predictors of cardiovascular risk and overall cardiovascular complications. [23]

EFFECT OF ELECTRONIC CIGARETTES ON THE ORAL CAVITY

It has been shown that the aerosol of electronic cigarettes contains numerous harmful substances, and some of them are carcinogenic. They get into the oral cavity, causing a detrimental effect on its epithelium. In vitro studies have shown a number of changes in the epithelium, but they are less pronounced than the effects of exposure to tobacco smoke. [13] In vitro studies have shown that e-cigarette smokers have a distinct microbiome, and there are indications that this may be harmful. [13, 26] However, studies on oral effects are still limited, most of them involving small study groups or only in vitro studies.

In one study (Chaffee, Jakubovics, Kist i in, 2021), e-cigarette aerosol was shown to cause changes in the cells of the oral cavity. This was an in vitro study and we still do not know the effects in vivo.[13]

There was also a study (Franco, Trapasso, Puzzo i in. 2016) that examined buccal scrapings from people who smoked electronic cigarettes.[9] The authors of the study found that the damage to oral cells in these patients was similar to that in non-smokers.

Summarizing many studies, scientists concluded that the risk of periodontal disease in patients who smoke electronic cigarettes is lower than when exposed to cigarette smoke, but higher than in non-smokers. [13]

Many studies also highlight that e-cigarettes also cause mouth dryness and irritation.

To know exactly and in detail their impact on the oral cavity, it should be further researhed, because this is an unexplored topic.

CONCLUSION

Electronic cigarettes have been consumed for about two decades. They can be made with nicotine or nicotine free, with fruit and sweet flavors. However, based on currently available evidence ECs have adverse effects, in the first place, on the respiratory system, cause oxidative stress and oral health problems. We should not underestimate their potential long term harms and spread awareness of their damage.

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