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### A review of Electronic Cigarettes and Its Related Effects on Health

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<b>KEYWORDS</b> Electronic cigarettes, electronic nicotine delivery system, vaping devices, health and individual health, public health	Abstract With the grow to concentrat likely to use otherwise sm cigarettes. Ro consequences term repercu mechanisms distinct in tl inflammatory public cardio smoking cess factors that ir	wing problem of using electronic cig e on their harmful effects on health e-cigarettes in recent years, but it toked cigarettes or if they are just esearchers found that e-cigarette e on people, animals, and cells, even ssions of e-cigarette consumption of electronic cigarettes are comparal that the former mostly manifest a responses. Overall, electronic cig vascular and respiratory health. Inte ation need to address both traditiona fluence its used among young indiv	arettes, recent research paper has started . Young adults being significantly more s unclear if these users would not have replacing traditional cigarettes with e- xposure may have potentially harmful though the safety evaluation of the long- is yet unknown. While the toxicity le to those of regular cigarettes, they are s DNA damage, oxidative stress, and arettes also affect both individual and rventions aimed at improving health and and electronic cigarettes and the various duals.
roduction and backgrou	und	cartridge, or ta	nk-based, systems are "open", meaning

#### Int

A decade has passed since the introduction of the electronic cigarettes (ECs), also known as the electronic cigarette, e-cig, electronic vaping device, personal vaporizer, or electronic nicotine delivery system (ENDS). ECs are promoted as safe devices that give pure nicotine and release innocuous water vapor that quickly dissipates, simulating conventional smoking without the negative side effects (Pisinger & Døssing, 2014). Ecigarettes can be defined as portable devices that work by heating a liquid, usually flavorings and nicotine. Instead of breathing in smoke, you may inhale nicotine vapor with e-cigarettes. This may be because ecigarettes do not burn tobacco, users are not exposed to the same levels of toxins as those who smoke traditional cigarettes (Hartmann-Boyce et al., 2021).

### Electronic cigarettes (ECIGs) and their design features

The majority of ECIGs are composed of an aerosolized liquid for user inhalation, an electrical heater, and a battery. In reality, there are many different design types that fall under the umbrella of electronic cigarettes. These vary from items that mimic regular cigarettes (also called "first-generation devices" or "cigalikes") to more substantial tools that usually contain a battery that is independent of the cartridge or tank and may utilize one to carry the liquid (Breland et al., 2016). Researchers call these goods "ECIGs," both closed and open because most cigalikes are "closed," meaning that the user is not supposed to replace the atomizer or battery, and many

that users are often allowed to replace certain parts and reload the system. In addition, ECIGs go by many different names, including "vapes", "mods", "ehookahs", and "vape pens" (Breland et al., 2016).



features adopted from (Breland et al., 2016)

Product	Description	Some Brands NJOY OneJoy, Aer Disposable, Flavorvapes
Disposable e-cigarette	Cigarette-shaped device consisting of a battery and a cartridge containing an atomizer to heat a solution (with or without nicotine). Not rechargeable or refillable and is intended to be discarded after product stops producing aerosol. Sometimes called an e-hookah.	
Rechargeable e-cigarette	Cigarette-shaped device consisting of a battery that connects to an atomizer used to heat a solution typically containing nicotine. Often contains an element that regulates puff duration and /or how many puffs may be taken consecutively.	Blu, GreenSmoke, EonSmoke
Pen-style, medium-sized rechargeable e-cigarette	Larger than a cigarette, often with a higher capacity battery, may contain a prefilled cartridge or a refillable cartridge often called a clearomizer). These devices often come with a manual switch allowing to regulate length and frequency of puffs.	Vapor King Storm, Totally Wicked Tornado
Tank-style, large-sized rechargeable e-cigarette	Much larger than a cigarette with a higher capacity battery and typically contains a large, refillable cartridge. Often contains manual switches and a battery casing for customizing battery capacity. Can be easily modified.	Volcano Lavatube

Figure .2 Illustrations of several electronic cigarettes (e-cigarettes) adopted from (Grana et al., 2014)

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#### Prevalence of electronic cigarettes

Between 2008 and 2012, adult and teenage awareness of e-cigarettes and e-cigarette trials at least quadrupled in a number of nations. In the USA, women are more likely to try e-cigarettes than men are, although awareness is higher among males. According to national polls, about the same percentage of adult respondents from the US and the European Union said they had used e-cigarettes. The use of e-cigarettes by adolescents has grown significantly in recent years, but it's unclear if these users would not have otherwise smoked cigarettes or if they are just replacing traditional cigarettes with e-cigarettes (Barrington-Trimis et al., 2016).

In Saudi Arabia, the prevalence of electronic cigarettes has significantly increased among respondents who tried to cease conventional smoking in Jeddah city. However, most of participants that assessed in the research study conducted by Alzahrani et al. (2022) used e-cigarettes for entertainment purposes. A higher use of e-cigarettes amongst users who tried to cease traditional cigarettes are associated with increased e-cigarettes usage overall.

### Cardiovascular and respiratory diseases

However, rather than simply being a predictor of health consequences, electronic cigarettes are increasingly impacting upon health related to cardiovascular disease. In a systematic review, carried out to assess the influence of electronic cigarettes on the cardiovascular system. The results show that although there is a wealth of information on the harm that smoking e-cigarettes causes to the heart, little is known regarding their impacts (Qasim et al., 2017). Evidence from systematic review highlights the effects of electronic cigarettes on the cardiovascular system. The results found that by stimulating the sympathetic nervous system, oxidative stress, endothelial dysfunction, and platelet activation, ecigarettes may be having a negative impact to the heart (Kennedy et al., 2019).

Interestingly, Benowitz and Fraiman (2017) studied the impact of electronic cigarettes on the cardiovascular system. The outcomes revealed that most of the cardiovascular effects of EC usage in humans are consistent with the well-known sympathomimetic effects of nicotine. Thus, although ECs may carry some cardiovascular risk, particularly for individuals with preexisting CVD, experts believe this risk is likely smaller than that of cigarette smoking.

Another research study conducted in order to elicit an indepth results on how e-cigarettes affect the cardiovascular, pulmonary, and immunological systems. Findings found that using e-cigarettes has been associated with increased blood pressure, heart rates, arterial stiffness, and lung resistance to airflow in healthy individuals. It has been shown that inhaling the aerosol of e-cigarettes causes young people who have never used tobacco to create more immunomodulatory cytokines and have immunological responses (Keith & Bhatnagar, 2021).

To ascertain how electronic cigarettes affect the respiratory system, a systematic review by Gotts et al. (2019) highlighted the relationship between respiratory and e-cigarettes. Researchers found that the aerosol from e-cigarettes can negatively impact immune system performance as well as a number of lung cellular and organ physiologies. These results imply that there is some lung damage associated with long-term and potentially even short-term use of e-cigarettes, along with the many lines of evidence from human, animal, and in vitro trials.

Further research was conducted to explore the toxicity mechanisms of electronic cigarettes on the respiratory system to provide better knowledge and direction about the impact of e-cigarettes on human health. Findings discovered that while the safety assessment of the longterm effects of e-cigarette usage is yet unknown, exposure to e-cigarettes may have potentially negative effects on humans, animals, and cells. While the toxicity mechanisms of electronic cigarettes are comparable to those of regular cigarettes, they vary in that the primary manifestations of these mechanisms are DNA damage, oxidative stress, and inflammatory responses (Wang et al., 2022).

### **Toxicity and e-cigarettes**

Although the toxicity of e-cigarettes has been investigated, researchers have not yet determined the exact mechanisms underlying this toxicity. However, prior studies have demonstrated a link between oxidative stress, DNA damage, and the inflammatory response about the deleterious effects of electronic cigarettes (Cao et al., 2021). For instance, a study conducted on toxicity assessment of electronic cigarettes to update of toxicity profile, identification of knowledge gaps, and definition of future goals for e-cigarette found that nicotine plays a significant role in the harmful effects of solvents, even if solvents by themselves have no detrimental effects (Wang et al., 2019).

Canistro et al. (2017) did an exploration on the toxicological consequences of e-cigarettes, which may

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increase the risk of cancer. This study looked at several toxicological problems associated with e-cigarette use, including potential mutagenic and co-mutagenic consequences, using a rat model. The findings illustrated that e-cigarettes dramatically increase the oxidation of DNA to 8-hydroxy-2'-deoxyguanosine and the production of oxygen free radicals. Additionally, they significantly enhance the activity of phase-I carcinogenbioactivating enzymes, such as those that activate polycyclic aromatic hydrocarbons (PAHs).

In addition, toxicity was also examined among rats if ecigarette are just as harmful to skin flap survival as tobacco cigarettes. Comparing the possible negative effects of tobacco and e-cigarettes on the microcirculatory system. When comparing the groups exposed to medium and high nicotine e-cigarettes to the group exposed to tobacco cigarettes, the researchers found that the levels of flap necrosis and hypoxia were similar. Nicotine-containing e-cigarette vapor is equally detrimental to skin flap survival as regular tobacco cigarettes (Rau et al., 2017). However, due to a lack of experimental data and inconsistent findings, it is difficult to draw clear conclusions concerning the toxicological, immunological, and clinical consequences of e-cigarette aerosols. Although, a study provided a significant information on e-cigarettes. Numerous harmful substances found in tobacco smoke have also been shown to be present in the aerosols from e-cigarettes, according to research by Kaur et al. (2018). Aerosol toxins of electronic cigarettes were examined to assess their effects on memory and learning processes. The study also explored the influences of ECIG aerosol exposure on antioxidant enzyme activity in the hippocampus, and brain-derived neurotrophic factor (BDNF) expression in rats. Results found that the aerosol from electronic cigarettes (ECIGs) altered brain chemistry, which is linked to reduced function and oxidative stress as well as a decline in functional memory (Alzoubi et al., 2021).

### Oral health and e-cigarette

The relationship between the potentially detrimental consequences of chemical released by electronic cigarettes and oral cavity health was explored among young people. The findings present an update on the chemistry and environmental components of e-cigarettes today, as well as a summary of the few data about possible long-term effects on oral health that may occur from regular e-cigarette usage. The results illustrated that e-cigarettes may contain reactive carbonyls and nitrosamines, among other potential carcinogens (Ebersole et al., 2020).

In another study, Abdelfattah et al. (2021) examined the effects of e-cigarette vapor on the histological alterations submandibular gland in rats. Their analysis was to clarify any possible structural changes in rat SMG after being exposed to e-cigarettes and any possible recovery after stopping usage. Findings showed that although electronic cigarettes reduce withdrawal symptoms to some extent, they also promote degenerative changes in the histological structure of the submandibular salivary gland. Abdul et al. (2020) assessed and compared the oral health-related knowledge and awareness of Saudi dental patients on the effects of shisha and electronic cigarette smoking. Results found that compared to dental patients with lower levels of education, smokers and non-smokers with higher levels of education had a stronger comprehension and awareness of the detrimental effects of smoking on oral health.

#### **Teenagers and smoking e-cigarettes**

A further cohort study in the USA examined the relationship between youth use of e-cigarettes and the subsequent initiation of tobacco use. The study's objective was to assess the relationships between previous use of e-cigarettes and other tobacco products and the initiation of tobacco use within a two-year follow-up period. Considering the participants, environment, and architecture, and using data from waves 1 through 3 of the Population Assessment of Tobacco and Health research (PATH) (2013-2016), teenagers aged 12 to 15 who had never smoked cigarettes, e-cigarettes, or other tobacco products at wave 1 were evaluated as well. Researchers found that, particularly in young persons who are not at high risk, smoking e-cigarettes is associated with an increased risk of beginning and using cigarettes. To the general population, using e-cigarettes may contribute to the initiation of teenage cigarette smoking (Berry et al., 2019).

In order to understand, the relationships between adolescent wheeze and chronic bronchitis symptoms, McConnell et al. (2017) performed a survey on 2,086 teenagers on e-cigarette usage and respiratory symptoms. The study was conducted to examine the relationships between self-reported e-cigarette usage and symptoms of wheezing and chronic bronchitis (chronic cough, phlegm, or bronchitis). Findings

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revealed that adolescents who used e-cigarettes had a greater incidence of symptoms associated with chronic bronchitis.

Conner et al. (2017) carried out a prospective research in the UK among 2836 teenagers to determine if electronic cigarettes encourage teenage smoking using evidence from a 12 month prospective research that examined the potential relationship. At baseline, the percentage of kids receiving free school meals, carbon monoxide breathing levels, self-reported e-cigarette and cigarette consumption, sex, age, friends and family smoking, and attitudes toward cigarette use were all measured in relation to socioeconomic status. During the 12 months follow-up, carbon monoxide breathing levels were utilized to verify and examine self-reported cigarette usage. Researchers found correlations between the initiation and advancement of teen cigarette smoking in the UK and those who had ever used e-cigarettes. The beginning of e-cigarette use was strongly correlated with its use, although the growth in consumption was not as much.

A further review highlights the harmful consequences of vaping and electronic cigarettes on teenagers and young adults. The study examined the known and potential toxicity of electronic cigarettes, or "e-cigarettes," among teens and young adults in an effort to increase awareness of the risks and uncover challenges related to their usage. Findings found that because kids are not using ecigarettes as a tool to help them stop smoking rather, flavoring additives and ads target them as new users, they are more vulnerable to the risks involved with using them. The most urgent of the rapidly emerging pulmonary risks related with vaping is the disease known as "electronic cigarettes/vaping associated lung injury" (EVALI) (Overbeek et al., 2020).

### Adults and smoking e-cigarettes

Research exploring smoking cessation using e-cigarette has shown that e-cigarettes are not associated with a greater rate of adult smoking cessation. In RCTs, the distribution of complimentary e-cigarettes as a therapeutic intervention was associated with greater rates of smoking cessation (Wang, Bhadriraju, & Glantz, 2021). In a study conducted on the health effects of ecigarettes on the population level, it was reported that millions of Americans use e-cigarettes. Despite their extensive usage, little is known about their effects on health. Some claim that e-cigarettes are probably less risky than regular tobacco cigarettes because they shield users from toxicants produced during combustion (Stratton et al., 2018).

A study carried out by Clapp and Jaspers (2017) to examine the association between the health effects of nicotine, vegetable glycerin, propylene glycol, and flavorings, which are present in e-cigarette aerosols, and to discuss the relevance of the findings in relation to asthma. The results identified that when e-cigarettes and traditional cigarettes are compared for their toxicity and health effects, the focus is often on smoking-related clinical endpoints like cancer, bronchitis, and chronic obstructive pulmonary disease (COPD), as well as toxicants found in cigarette smoke (CS), such as formaldehyde and nitrosamines. However, this approach disregards the potential toxicity of flavored e-cigarette components like PG, VG, and the many flavoring ingredients, which may result in respiratory symptoms that smokers are less likely to experience.

Similarly, a study conducted to examine the relationship between adults wheeze and associated respiratory symptoms with smoking and using electronic cigarettes. Overall, vapers had a lower incidence of wheeze and related respiratory problems than current smokers or dual users, but a higher risk than non-users. Concurrent use and smoking increased the risk of wheezing and related respiratory issues significantly (Li et al., 2020).

#### Knowledge and perception of electronic cigarettes

In Egypt, a community based research study carried out to determine the level of awareness, perceptions, and frequency of usage of electronic cigarettes among the Egyptian population found notable results. The majority of respondents with age range from 15 to 39 found to have a substantial quantity of knowledge about electronic cigarettes. E-cigarettes were also perceived as safer alternative to traditional cigarettes or as a help for quitting smoking. No respondent reported smoking electronic cigarettes at all (Abo-Elkheir & Sobh, 2016). In a study conducted during COVID-19 pandemic, young adults use and knowledge of electronic cigarettes were examined among university students in the United Arab Emirates population. The study aimed to provide decision-makers with information on public perceptions of smoking and vaping, as well as to highlight research that may be useful in the creation of initiatives to educate them about nicotine. Results discovered that having friends or family members who use e-cigarettes was the most prevalent reason young individuals started vaping. However, relatively small percentage of students

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declared they used nicotine products more frequently during the epidemic. The findings support the development of various public health preventive initiatives, including raising awareness through circulars, rules at universities, social media, and other educational programs, as men appear to believe that there is less overall risk from e-cigarette use (Abbasi et al., 2022).

Qanash et al. (2019) conducted a study on electronic cigarettes among Saudi medical students to explore the prevalence of e-cigarette use in Jeddah. It assesses the effectiveness of e-cigarettes as a smoking cessation aid in addition to its potential for addiction. In short, the findings showed that vaping with e-cigarettes is more popular among students, than smoking regular cigarettes. Merely 50% of e-cigarette consumers utilize them as a means to help them stop smoking. Although, for some smokers, quitting e-cigarettes is a simpler process. However, users claim that it is equally as addicting as smoking regular cigarettes.

In Saudi Arabia, a study conducted to explore the attitudes and understanding on the clinical usage of ecigarettes. This study evaluated medical students' knowledge and attitudes of e-smoking, with a particular emphasis on their favorable opinions of using ecigarettes to reduce damage or quit smoking. The results found that non-scientific opinions about e-cigarettes' therapeutic applicability in harm reduction and smoking cessation were influenced by a variety of incorrect assumptions about how addictive they are and a lack of awareness about their detrimental effects (Alzahrani et al., 2021).

Karbouji et al. (2018) explored smokers' awareness and attitudes about using vaping devices or e-cigarettes among 1404 in Saudi Arabia. The main objective was to evaluate the attitudes and knowledge of Saudi Arabian smokers regarding the dangers of vaping e-cigarettes. The fact that a sizable percentage of Saudis were wellinformed about vaping and e-cigarettes highlights the importance of youth-focused media, health initiatives, and government support for the general health of Saudi citizens. A further systematic review found that ecigarettes are not as safe as their users believed. There is enough evidence to draw the conclusion that using conventional tobacco products can have virtually as many detrimental consequences as using e-cigarettes (Khanagar et al., 2019).

#### **Discussion and conclusion**

In this review, the research indicated that e-cigarettes explain a variety of potentially hazardous and poisonous substances and are not, as some people assume, emission-free. It is still up for debate whether or not these toxicant levels are lower than those seen in regular traditional smoking. According to recent research, the chemicals released by e-cigarettes are similar to those found in tobacco smoke, and the amount released varies based on a number of factors, such as device type, eexperience, and terrain. liquid, vaping The cardiovascular system is sensitive, and the "smoke" nonlinear dose-response/toxicity connection makes it crucial to assess the cardiovascular safety of e-cigarettes (Qasim et al., 2017).

Smokers who use e-cigarettes also highlight the possible advantages of it as tools that might assist users of traditional tobacco cigarettes in quitting, hence lowering the hazards associated with tobacco use. However, others worry that about their potential harmful compounds found in -cigarette emissions, particularly in young people and kids who have never used tobacco products. Although, the state of the developing research about e-cigarettes and health is reviewed and critically evaluated in public health consequences of e-cigarettes because there has not been much time for research on the health impacts of e-cigarettes to develop due to their relatively recent debut (Stratton et al., 2018).

Finally, use of electronic cigarettes has been confirmed that the heated flavoring components' adsorptive properties are harmful to host cells. Furthermore, ecigarettes have the potential to negatively significant implications on oral health in addition to being an efficient way to deliver large nicotine dosages (Ebersole et al., 2020). Similar findings were identified that using e-cigarettes damages peripheral blood DNA at the chromosomal level, where they induce micronuclei to grow in reticulocytes and strand breakage in leucocytes, as well as at the gene level as shown by point mutations in urine (Canistro et al., 2017). As noted above, ecigarette usage may be bad for people's health, especially for younger and more susceptible users.

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