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Review Article

# E- Cigarettes: An Emerging Health Problem on the Horizon

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**Abstract**
*Despite extensive efforts, smoking remains a modern-day epidemic with profound health consequences. Advent of E-cigarettes (EC) was based on the assumption that by eliminating the toxic chemicals found in combustible tobacco, these products would have less impact on smokers' health and minimize the health-related consequences and thus a multi-billion industry started in 2003. Currently, the medical community is divided on its opinion about the use of e-cigarettes as a smoking cessation device. The scientific evidence that e-cigarettes are a useful aid for smoking cessation remains limited. Main health concerns about EC usage is the potential for toxic aldehyde emissions, which are known to be formed following heating of the EC-liquid main components propylene glycol and glycerol and other contaminants inhaled by an EC-smoker during a "vaporization" session which can be o-methyl-benzaldehyde, carcinogenic nitrosamines, terpenic compounds such as limonene (which are probably used by the manufacturers as flavoring agents), as well as heavy metal and silicate particles (> 1 µm) including nanoparticles (< 100 nm). Emerging data suggests that these are a cause of multitude health problems including death. Thus there is an urgent need to implement strict regulation or complete ban on its use.*
**Keywords**: *E-cigarette, health risk, nicotine dependence.*

## Introduction

E-cigarettes (EC) or vape pens/vaping devices are battery powered devices used to smoke or 'vape', a flavoured solution containing varying concentrations of nicotine, an addictive chemical found in cigarettes and other forms of tobacco products [1]. The first EC were developed in 1965 and were patented in 2003. Since then, multiple versions have been developed. Now, it is estimated that there are more than 400 different brand names available. E-liquids are now available in more than 7,000 unique flavors, including kid-friendly flavors like cherry, bubblegum, and chocolate[2]. E-liquids contain nicotine along with flavorings, propylene glycol, glycerin, and other ingredients. The liquid is heated by the device and aerosolized for inhalation. The vapor has been shown to contain lead, cadmium, nickel, formaldehyde, and hydrocarbons, among other chemicals[3,4]. The rapidity at which it is introduced into the body, age of first exposure and the dosage administered all add to determine the potential risk of a person being addicted to it throughout life. Nicotine

addiction is established more strongly when the exposure occurs in adolescence[1]. EC are manufactured in such a way to resemble conventional tobacco products such as cigarettes, pipes and cigars and common gadgets such as flash drives, flashlights or pens[5]. This makes collation of data on health effects more difficult for generation of scientific evidence.

### Increasing use of EC amongst the youth

There is an increasing trend of use of EC amongst the youth and adolescents in many countries where these products were introduced. In United States, a study suggests that about 21 per cent of high-school students and 5 per cent of middle-school students reported to have used e-cigarettes in the last 30 days in 2018, which represents an increase of 1.5 million youth from 2017 to 2018[1,5]. There is also an increasing trend of EC use amongst youth in European Union countries as evidenced by the Global Youth Tobacco Survey trends. A rapid increase in the use of EC has also been reported amongst adolescents in various other parts of the world[6,7]. Thus, the increasing use of EC by youth is a significant public health concern since the extent of potential harmful effects, beyond the demonstrated nicotine addiction of e-cigarettes, is still to be fully revealed and remains a cause for concern. E-cigarette use is strongly associated with the use of other tobacco products in youth and young adults[7].

### Potential harmful health effects of EC

The use of EC adversely affects almost all the human body system with impact across the life course, from the womb to tomb. The cartridges used in EC approximately contains about as much nicotine as a pack of 20 regular cigarettes [8] and can act as a source for nicotine addiction. Furthermore, the amount of nicotine and other chemicals in these products varies widely, and thus, the consumer remains unaware of the actual contents of these products they use.

In addition to the possible harmful effects of nicotine per se, the other main health concerns about EC-usage is the potential for toxic aldehyde emissions, such as formaldehyde, acetaldehyde, propanal and acrolein, which are known to be formed following heating of the EC-liquid main components propylene glycol and glycerol, as thermal decomposition products[6]. Other contaminants inhaled by an EC-smoker during a "vaporization" session can be o-methyl-benzaldehyde carcinogenic nitrosamines, terpenic compounds such as limonene (which are probably used by the manufacturers as flavoring agents)[9], as well as heavy metal

and silicate particles ($> 1$ μm) including nanoparticles ($< 100$ nm) [10]. These particles are can easily reach deep into the lungs and can cross into the systemic circulation [11].

There are great apprehensions regarding safety in pregnant women who are either users or are exposed to the passive (second-hand) EC aerosol due to higher sensitivity of stem cells to cytotoxicity, as compared to differentiated adult pulmonary fibroblast cells[12]. A study has reported that human bronchial cells grown in a medium-exposed to e-cigarette aerosol have shown a similar pattern of gene expression to those grown in a medium-exposed to tobacco smoke[1,6]. Moreover, EC can also induce DNA damage, adversely affect the cardiovascular system 19-21, contains known carcinogens 22,23, impair respiratory, immune cell function13, and thus pose risks to foetal, infant and child brain development[13-15]. Tests by the US-Food and Drug Administration have demonstrated the presence of diethylene glycol in some EC, which can lead to mass poisonings and deaths if inadvertently substituted for propylene glycol in consumer products [2,6].

Recent newspaper reports also have raised concerns over health related effects of EC, which includes increase in morbidity as well as mortality [16].

### EC as tobacco cessation aid: Myths and reality

EC are popularly perceived as smoking cessation aid, but its efficacy and safety as a quitting aid have not yet been firmly established. Although some smokers claim to have cut down smoking while using EC, the total nicotine consumption seems to remain unchanged[2,6]. Smokers' efforts to quit smoking may be undermined by the promotion of smoking cessation products because these products reduce their confidence in their ability to quit on their own by implying that quitting cannot be achieved successfully without the use of these aids [17].

Moreover, a considerable number of ex-smokers who have stopped cigarette use with the aid of EC continue using the latter product, thus sustaining nicotine dependence. In a survey carried out between July 2010 and June 2011, 70.4 per cent of the study subjects reported to have used EC as a way to obtain nicotine in smoke-free spaces, indicating that EC were being used to satisfy nicotine addiction during periods forced abstinence [12] thereby reducing cessation rates [18]. Systematic and meta-analysis of data from randomized controlled trials (RCTs), observational studies and cohort studies has reported low certainty of evidence and several limitations from which no credible inferences can be drawn regarding efficacy of EC as a cessation tool[19-20]. The International Association for the Study of Lung Cancer does not recommend the use of e-cigarettes for treating nicotine dependence due to the absence of sufficient evidence on their efficacy and safety [21]. The Indian Medical Association considered EC as an unhealthy and disguised form of tobacco addiction, with serious long-term health effects and unfit to be used for tobacco cessation[1].

### Marketing and promotion

In this new era of multimedia marketing, EC are advertised through all forms of media and internet, with youth being the main target group. These products are being marketed as safer alternatives or harm reduction products, in a glamorous manner, so as to make them attractive under the guise of being less harmful [1,2]. These techniques are aimed at targeting youth and adolescents and have gained significant popularity over social media. The industry tactics of launching EC to attract as potential customers persons who may not have wished to experiment with conventional cigarettes, as well as hold captive people who are trying to quit smoking by trapping them in new web of nicotine addiction is a worrying trend [1,6].

This market is growing rapidly, supported by relatively low barriers to entry and thus allowing many businesses to bring a diverse set of products to consumers through a variety of channels. A study has reported that at the end of 2016, sales of EC were expected to reach £6.1 bn globally from just £0.7 bn in 2010, an increase of around 800 per cent. By 2020, sales have been projected to rise just under £12 bn, increasing at a compound average growth rate of 17 per cent per year [22].

### Monitoring and regulation

Monitoring of these products differs from countries to countries. For example, in Britain, these are regulated as medicines from 2016 to ensure their quality and safety. On the other hand, sale of EC has been completely banned in 25 countries, including Singapore, Norway and Brazil. Market authorization is required in 17 other countries[23]. In the United States, EC that are marketed for therapeutic purposes are currently regulated by the US-FDA and Center for Drug Evaluation and Research and from 2016 [12]. Through a new law (often called the 'Deeming Rule'), the FDA has envisaged many strict, provisions for regulation of ENDS. For example, there are requirements of health warnings on EC, prohibits the sales of EC to youth under the age of 18 yr and requires that EC manufacturers receive marketing authorization from the FDA[2,6].

### Conclusions

Based on the currently available scientific and research data, there should either be complete

prohibition or strict supervision of EC in India in the greater interest of protecting public health, in accordance with the precautionary principle of protecting the population from a noxious substance. When we consider that EC contain nicotine solution, which is highly addictive, and also other ingredients such as flavouring agents and vapourizer, rendering these products harmful for health. Uses of EC have documented adverse effects on humans including DNA damage; respiratory, cardiovascular and neurological disorders; cellular, molecular and immunological toxicity; carcinogenesis and adverse impact on foetal development and pregnancy. For this reason, it is strongly recommended that ECs be brought under Drugs and Cosmetics act and their constituents be displayed properly.

The potential short-term and long-term health risks to the users is yet not fully understood as the products are relatively recent and are marketed in diverse forms. Moreover, the degree to which, if at all, the EC benefit as tobacco cessation aides is not firmly established. Emerging evidence and data suggests that there is a risk of dual use to some extent and initiation to tobacco addiction to non-smokers. The unmonitored marketing of EC can open the gateway to a new form of tobacco addiction especially amongst young and adolescents and can pose a serious health hazard in our future generations.

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