



Nicotine's Oral Consequences: From Traditional To Modern Smoking Devices

¹Mili Bharatbhai Patel, BDS, Goregaon Dental Centre, India

²Rituparna Banerjee, BDS, SRM Dental College and Hospital, Chennai

³Neha Anand, BDS, Goregaon Dental Centre, India

⁴Dr Anoli Agrawal, MDS, Assistant Professor, Department of Public Health Dentistry, ACPM Dental College, Dhule, Goregaon Dental Centre, India

Corresponding Author: Mili Bharatbhai Patel, BDS, Goregaon Dental Centre, India

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Abstract

Most adult tobacco users discover that they are unable to stop using tobacco later in life due to a chemical and/or behavioural dependence on nicotine. Cigarette smoke contains more than 4,000 different substances. These compounds can be cytotoxic, antigenic, mutagenic, or carcinogenic. Nicotine is the primary toxic component in the particulate phase. When someone tries to stop smoking, they experience cravings, withdrawal symptoms, and a higher risk of relapsing. The mid-to late-2000s saw the introduction of electronic nicotine delivery systems (ENDS) as a strategy for reducing tobacco harm. The situation that they are actively marketed to juveniles and are accessible for purchase concerns WHO. Smoking increases the risk of almost all oral diseases that dentists treat and reduces the likelihood that many dental procedures will be effective.

Smoking and ENDS may change the oral microbiome and lower levels of immunoglobulin in the mouth. This may result in the growth of multiple pathogenic microorganisms. In addition to taste and olfactory perception changes, smoking causes discolouration of the tooth structure. Even though the manufacturers of e-cigarettes have in the past stated that the aerosol produced by these devices is "harmless vapour," some potentially dangerous ingredients are present in much lower concentrations in e-cigarettes than in traditional cigarettes. This study reviews the presence of cigarettes, e-cigarettes, and vapes, focusing on the carcinogens found in each. It underscores that both traditional and electronic nicotine delivery methods pose significant risks to oral health, highlighting the harmful effects these substances can have on the mouth's overall well-being.

Keywords: antigenic, immunoglobulin, discolouration, ENDS, carcinogenic.

Introduction

Adolescence is when most people start experimenting with tobacco, frequently as a result of social pressure and tobacco advertising. Most adult tobacco users discover that they are unable to stop using tobacco later in life due to a chemical and/or behavioural dependence on nicotine. Industrially produced tobacco products are still lawfully marketed and sold in almost every nation, in spite of their well-documented devastation, with yearly sales exceeding \$1 trillion USD. Smoking increases the risk of almost all oral diseases that dentists treat and reduces the likelihood that many dental procedures will be effective. In addition to periodontal and gingival diseases, smoking cigarettes has also been linked to dental caries and oral pain.¹

According to the global dataset, in 2022, 20.9% of all individuals aged 15 and above reported using tobacco products regularly. Eighty percent of these tobacco users were current smokers, with a prevalence of 16.7%. Of those who used tobacco products, 89% smoked cigarettes, with a current prevalence of 15.0% among people over the age of 15.² In certain countries in North America and Europe, E-cigarette(EC) use has increased dramatically. In the UK, the percentage of adults who use e-cigarettes increased from 1.7% in 2012 to 7.1% in 2019, while the percentage of smokers decreased from 19.6% to 14.7% during the same period. The range of vaping prevalence in EU member states is less than 0.2% to over 7%.³

Systems that employ heat-generating devices to turn liquids into aerosols that users inhale are known as electronic nicotine delivery systems (ENDS) and electronic non-nicotine delivery systems (ENNDS). While ENNDS are labeled as not containing nicotine,

ENDS are known to contain nicotine; however, this claim is not always true. E-cigarettes are the most widely used type of ENDS and ENNDS, along with e-pipes, e-hookahs, and other devices.⁴ The situation that they are actively marketed to juveniles and are accessible for purchase concerns WHO. Currently, there are no rules supervising the commerce of e-cigarettes in 74 countries, and there is no minimum age barrier in 88 countries. E-cigarettes with at least 16000 Flavors target children through influencers and social media.⁵

Researchers continue to investigate the impact of E-cigarettes on oral health regardless of their vigorous publicity as a socially acceptable and beneficial alternative to traditional cigarettes. Indeed, toxicology studies have uncovered concerning elements in e-cigarette products. Per the U.S. Department of Health and Human Services (2016), these include diacetyl, nicotine, ultrafine particulate matter, nickel, tin, and lead, including volatile organic compounds like benzene.⁶

Contrary to adults, the majority of adolescents do not use ENDS or ENNDS as a substitute for cigarettes, even though they may in some circumstances help adults stop smoking. Depending on the level of ENDS or ENNDS uptake and the regulatory environment, population effects modelling in the UK and the USA indicates that changes in ENDS or ENNDS use may have either net benefits or harms.⁴ E-liquids fluctuate significantly in their nicotine content. The concentrations are lower than those of traditional cigarettes, falling between 0.3% to 1.8%. Nicotine exposures, however, can sometimes exceed those from regular cigarettes. An average vaporizer user would inhale about 10 puffs a session, for an average of 150 puffs per day. 200 to 400 puffs from an electronic cartridge can generate a dose of nicotine same as two to three packs of regular cigarettes.⁷

Reduced blood flow and local vasoconstriction lowers gingival oxygen and are two of the effects of nicotine on the mouth. Furthermore, smoking and ENDS may change the oral microbiome and lower levels of immunoglobulin in the mouth. This may result in the growth of multiple pathogenic microorganisms. In addition to taste and olfactory perception changes, smoking causes discolouration of the tooth structure.⁸

This paper aims to evaluate the impact of cigarette smoking, e-cigarette use, and vaping on oral health, and to analyze how changes in e-cigarettes and vape technology have influenced their health effects and effectiveness relative to traditional smoking practices.

Materials and Methods

To review the literature, Studies were selected from PubMed, Scopus, Cochrane Library, Wiley Online Library, Web of Science, and Google Scholar with restrictions on publication year 2015-2024, to provide a comprehensive overview of how Cigarettes, E-Cigarettes and Vapes affect the oral health. The review focused on evaluating the detrimental effects of Cigarettes, E-Cigarettes and Vapes on oral health. The search terms included: "Cigarettes," "Vapes," "Oral health," "ENDS," "smoking," and "nicotine" The research encompassed Case reports, clinical studies, and systematic reviews.

The Dawn of Cigarette Culture

Native American communities in America were already using tobacco for religious purposes approximately 10,000 years ago. In religious ceremonies, smoking was inhaled in the context of offering sacrifices to the gods. Curiously, tobacco was a part of the "peace-pipe" in North America. It was, however, used in Central and South America in a rolled form, much like roll-up cigarettes.⁹

Following its introduction to Europe, tobacco use and production quickly expanded to other regions of the

world. Tobacco was grown in Southeast Asia, the Middle East, West Africa, China, India, and Japan by the early 17th century. Since cheap clay pipes were readily available, tobacco has been widely consumed in England since 1670. Europe became a hub for the production of pipes. Because of the smoking culture of coffee shops and alehouses, Dutch towns like Gouda were able to sustain 350 pipe manufacturers by the end of the 18th century.¹⁰

Because of the advancement of manufactured cigarettes, tobacco is now a mass-consumable product rather than a luxury. Originating in Spain and Portugal, as well as in their colonies throughout the world, tobacco sales experienced an additional boost when, in the middle of the 19th century, a high-temperature drying process was introduced in North Carolina, USA.⁹

It was the cigarette's golden age during the first part of the 20th century. Approximately 50% of people in developed nations smoked in 1950, but that percentage obscures the reality that up to 80% of adult men smoked regularly in nations like the UK.¹⁰

The mid- to late-2000s saw the introduction of electronic nicotine delivery systems (ENDS) as a strategy for reducing tobacco harm.¹¹ ENDS, which were first patented in China in 2003 and then brought to Europe and North America in 2006, have grown in popularity.¹² ENDS are battery-operated devices that aerosolize a solution (e-liquid) containing glycerol, propylene glycol, flavoring agents, and nicotine for the user to inhale.¹¹ In US markets, multiple brands of e-cigarettes were available for purchase by 2010. Since 2014, e-cigarettes have surpassed traditional tobacco products as the most commonly used tobacco product among youth, according to data from the National Youth Tobacco Survey (NYTS), which was implemented in 2011.¹³

Interestingly, ENDS are marketed to younger people, and unlike traditional cigarettes, there are less regulations on ENDS use by minors.¹²

Design Innovations in ENDS

The terms used to describe ENDS, active ingredients, product design, and engineering vary significantly amongst the roughly 500 distinct brands of ENDS. This leads to notable variations in nicotine delivery systems and, more crucially, toxin contents.¹¹ E-cigarette devices have undergone significant changes and evolution; therefore, to help characterize their great variability, they are frequently referred to as first-, second-, and third-generation products. "Cig-a-likes" are the term for first-generation e-cigarette products that resemble cigarettes. First-generation electronic cigarettes frequently come with a reloadable cartridge for multiple uses or are disposable. Vapes and vape pens, which are second-generation e-cigarettes, feature a refilled electronic cigarette liquid (e-liquid) reservoir. The device is made up of four parts: a lithium battery, a heating element, a tank or reservoir to hold the liquid, and a mouthpiece.⁷ Due to the ability to alter the voltage and wattage, third-generation e-cigarettes are commonly referred to as "mods" or tank systems. The e-cigarette brand JUUL has drawn a lot of media attention lately. The JUUL's small, sleek design and covert usage are two of its appealing features. The JUUL gadget is rechargeable through a USB port and has a flash drive-like appearance.¹³

Vaping is the process of using an electronic device with a specially formulated liquid that may or may not contain nicotine. The smoker inhales the viscous aerosol that is created when the heated liquid inside the device heats up. Aerosol particles are released into the atmosphere, part of which is absorbed into the

bloodstream and part of which sticks to the oral cavity's structures.⁷

Carcinogens in E-Cigarettes compared to Traditional Cigarette

Cigarette smoke contains more than 4,000 different substances. These compounds can be cytotoxic, antigenic, mutagenic, or carcinogenic. There are two types of cigarette smoke constituents: gaseous and particulate. Eighty to ninety percent of the smoke is in the gaseous phase, which is primarily composed of carbon dioxide, nitrogen, and oxygen. Other gaseous components include the carcinogenic hydrocyanic acid and hydrozine, as well as carbon monoxide, which reduces oxygen transport. The liquid-vapour portion of the smoke contains chemicals that have been identified as ciliotoxins and irritants, including formaldehyde, acrolein, and certain nitrosamines. Nicotine is the primary toxic component in the particulate phase. When someone tries to stop smoking, they experience cravings, withdrawal symptoms, and a higher risk of relapsing. The yield per traditional tobacco cigarette is between 0.5 and 1.5 mg. Tar and hydrocarbons are two more particulate constituents that are known carcinogens.¹⁴

EC may increase exposure to other toxic or potentially toxic compounds, some of which are not present in conventional tobacco smoke, even though it lacks combustion products, toxicants like carbon monoxide, and very low levels of nitrosamines unique to tobacco. EC liquid typically contains solvent carriers (>75%), which are typically water (20%), propylene glycol (PG) and/or vegetable glycerin (VG), flavouring chemicals (10%), and nicotine (2%). Aerosols derived from EC also typically contain similar amounts of these constituents. In addition, EC aerosols contain various trace materials, including heavy metals, phenolic compounds, polycyclic aromatic hydrocarbons, and

other potentially hazardous chemicals, as well as additional substances like formaldehyde and acrolein.¹⁵

Influence of Smoking and Vaping on Oral Health

There is a strong correlation between cigarette smoking and periodontal disease, which is characterized by increased attachment loss and periodontitis progression. Through oxygen shortage and other mechanisms, the harmful compounds in tobacco smoke can disturb the oral cavity's microbiome. Compared to non-smokers, smokers lose more periodontal tissue, the disease progresses more quickly, and as a result, they lose more teeth overall. It has been demonstrated that smoking increases the risk of periodontal disease by at least five to six times. For example, smoking reduces salivary flow, which in turn encourages xerostomia, which increases the buildup of dental plaque. Smoking alters the body's microbiota and immune system. The regenerative mechanisms of bone and soft tissue are less predictable due to smoking, as it generally causes delayed tissue healing. On the other hand, stopping smoking reduces the rate at which periodontitis advances and enhances the effectiveness of treatment.¹⁶

Leukoplakia and oral mucosal keratosis can result from the harmful effects of smoking products and high temperatures combined. Another keratotic disorder that smokers experience is known as "smoker's palate" or nicotine stomatitis. It results from smoking cigarettes and cigars, which raises the temperature in the oral cavity. After initially becoming erythematous, the palate mucosa eventually turns white and dry and has many irritated salivary gland openings scattered throughout the hard palate, which appear as red dots. Cigarette smoking can also cause halitosis and discolouration of the teeth and soft tissues. Usually, melanosis and a hairy black tongue are witnessed.¹⁶

Two significant risk factors for potentially malignant diseases and oral cancer are cigarette smoking and alcohol consumption. Toxic substances from cigarette smoke dissolve in alcohol and penetrate epithelial cells more deeply, increasing the risk of malignant tumor development. Through its effects on the immune system and its interference with DNA, smoking encourages the development of cancer.¹⁶

The majority of adult e-cigarette users are either current or former smokers, which makes it challenging to distinguish any effects of e-cigarette use from oral health issues brought on by conventional smoking, whether it be current or past. Additionally, since the risk of periodontal disease rises with age, the much higher prevalence of e-cigarette use among younger people may mask health effects that do not become apparent until later in life. The majority of epidemiologic studies currently conducted on the relationship between oral health and e-cigarettes use cross-sectional designs and self-reported health measures, which limits the quality of the evidence. Though new findings point to possible risks, it may take decades to determine with precision how e-cigarettes affect oral health at the population level.¹⁷

When vaping, thick, viscous aerosols are produced, and they may also contain a sizable amount of sucrose. The carrier substance in e-cigarettes, propylene glycol, is especially harmful to soft tissue and enamel. It also results in "dry mouth," which dehydrates tissue and has been connected to an increase in gum disease, cavities, and other oral health problems. Vegetable glycerin and flavorings together are another potentially harmful ingredient in e-cigarettes. Research indicates that the combination of flavorings and liquid viscosity increases the formation of biofilm and microbial adhesion to enamel by two and four times, respectively. The primary

ingredient in many e-cigarettes, nicotine, can alter genetic signaling, trigger inflammatory pathways, and deteriorate tooth structure, all of which may play a pathogenic role in tooth loss.¹⁸

In the absence of nicotine, e-cigarette aerosols damage DNA and lower cellular antioxidant defenses on the oral surface. Chronic inflammation may lead to the depletion of antioxidants, which may be the reason why patients with periodontitis have a lower level or decreased efficiency of antioxidant mechanisms. Even if e-cigarettes were less dangerous, their inflammatory effect, cell damage, and decreased reparability could still contribute to the development of periodontal diseases.¹⁸

Hyperplastic candidiasis is a common oral mucosal lesion among e-cigarette users, according to Bardellini et al. Hyperplastic candidiasis was found to be highly prevalent (17.8%) in the retrocommissural area of electronic cigarette users. Based on the chemical composition of e-liquids, the authors speculate that this high prevalence could be caused by a pH change.¹⁹

Even though the manufacturers of e-cigarettes have in the past stated that the aerosol produced by these devices is "harmless vapour," some potentially dangerous ingredients are present in much lower concentrations in e-cigarettes than in traditional cigarettes. When promoting the "safety" of vaping, which is based on theoretical grounds rather than observational science, it is important to keep in mind the differences between inhalation and oral toxicology.²⁰

Conclusion

E-cigarettes were initially promoted as a smoking cessation tool to replace traditional cigarettes, but extensive research has shown that they contain harmful chemicals and pose health risks. This revelation has led countries like the UK and New Zealand to implement age restrictions on the sale of cigarettes and E-cigarettes,

aiming to create smoke-free environments. Such measures should be adopted worldwide to combat the prevalence of smoking. Additionally, the advertising of E-cigarettes and vape pens must be closely monitored to ensure that it accurately reflects the potential health risks and harmful ingredients. While there is limited research on the oral health impacts of E-cigarettes, existing studies highlight significant health concerns that should not be ignored. Stricter regulations are necessary to control the marketing and use of E-cigarettes, particularly among younger individuals. By enforcing age restrictions and ensuring truthful advertising, countries can better protect public health and work towards reducing smoking-related diseases. The documented harmful effects of cigarettes and E-cigarettes underscore the urgency of implementing comprehensive measures to regulate their use and safeguard the health of future generations.

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