IMPACT OF E-CIGARETTES ON DENTAL HEALTH: IS EROSION A RISK?

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ABSTRACT

Aim of the study. The current study investigated whether there is a link between tobacco consumption (traditional cigarettes and e-cigarette) and dental erosion. Tabacco dependence and perception of tooth wear were also assessed. **Material and methods.** A prospective study (was conducted on a sample of 78 participants (mean age 24+- 3 years), both men and women. The target population consisted entirely of smokers of various ages and social conditions. They were subjected to a clinical examination (BEWE score) and a single-choice questionnaire to assess dependence (Fagerström test) and the perception of tooth wear. A supplementary question was added in the questionnaire regarding the influence of COVID lockdown on the frequency of smoking. **Results.** No significant differences were identified between classic and electronic cigarette addiction (p=0.08). Generally, an increase in smoking dependence is not associated with a corresponding increase in dental erosion or vice versa (Pearson correlation= -0.082869). Although the BEWE score was higher in e-cigarette smokers, no significant correlation between smoking addiction and dental erosion was identified (p = 0.47). The evaluation of proportions or relative frequencies of the five levels of smoking dependence within each COVID impact group (medium, low, high) indicated that in the medium COVID impact group, more individuals with higher levels of smoking dependence (levels 3 and 4) were identified, compared to those with low or high COVID impact. **Conclusions.** E-cigarette may modestly modulate dental erosion through superficial changes in dental structures. COVID-19 pandemic had no detrimental impact on cigarette addiction.

Key words: e-cigarette; dental erosion; covid.

INTRODUCTION

The consequences of tobacco use are usually linked to cardiovascular or pulmonary diseases. However, the oral cavity is not spared from the harmful effects of smoking, as it represents the most common path for tobacco in the human body [GBD 2019].

Many studies have presented the oral cavity consequences of tobacco use, as it increases the risk of gingivitis, periodontitis and gingival recession. A decrease in the immune activity of saliva or a modification of breath have also been described. Conventional gingivitis differs from smoker's gingivitis where neither inflammation, nor bleeding on probing have been encountered, as nicotine causes ischemia and hypoxia, inhibiting defense mechanisms, allowing bacteria to be more aggressive. The chemotactic and phagocytic capacity also decreases [Helal et al. 2019].

The electronic cigarette is an electronic device that generates an aerosol intended to be inhaled. It produces a "vapor" visually resembling smoke from tobacco combustion. This vapor can be flavored and may or may not contain nicotine. Unlike the smoke from a traditional cigarette, this "vapor" does not originate from burned tobacco and therefore contains no carbon monoxide or tar. However, it still contains particles and carcinogenic or toxic substances, but in lower quantities than those found in cigarettes. Often, vaping is

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presented as a less harmful alternative to tobacco or as a substitute to aid in smoking cessation [Glover-Blondeau et al. 2014]. Nevertheless, the World Health Organization and national agencies such as the French National Public Health Agency have concluded, based on available studies, that the potential of vaping as an effective smoking cessation aid is not yet substantiated [WHO-Geneva 2019].

Vaping liquids, often referred to as "e-liquids" by manufacturers and specialized merchants are composed of several key components. First, a base mixture of propylene glycol (PG) and/or vegetable glycerin (also called glycerol, VG), occasionally combined with ethanol and/or water, which rarely exceeds 5% of the total mixture. Flavors are also added, predominantly sourced from the food industry. Nicotine is added at varying concentrations, typically ranging from 0% to 3.6%, though it can exceed 50 mg/ml; within the European Union, the maximum permissible nicotine content is 20 mg/ml [Glover-Blondeau et al. 2014].

Further discussions pertain to the potential dental health risks associated with vaping, with particular attention on dental erosion and caries. A significant number of e-cigarette fluids possess a pH below 5.5, which can contribute to dental erosion. A study examining 45 different vapes revealed that 38 of them had a pH level that posed a threat to dental health. Despite the common belief, the acidity of these liquids could not always be deduced from their flavor names. The authors contend that current labeling practices for vaping products are insufficient in conveying the risks associated with dental health, thereby preventing consumers and dental professionals from making informed safety assessments. Consequently, they advocate for vape companies to include warnings about potential dental erosion and caries on their product labels [Afrashtehfar et al. 2021].

In A synthesis on the effectiveness and toxicity of e-cigarettes, published in 2010-2011 in the Journal of Public Health Policy, Michael Siegel of the Boston University School of Public Health concluded the following [NCCDPHP- US 2016]:

- E-cigarettes contain few or no chemicals likely to pose serious health risks. Moreover, the quantities of toxins and carcinogens present are significantly lower than those found in conventional cigarettes.
- Many experts assert that e-cigarettes are less harmful than traditional cigarettes.
- Conversely, some studies suggest that e-cigarettes might be more hazardous than conventional cigarettes.
- E-cigarettes may effectively combat the urge to smoke, mainly because they mimic the act of smoking a traditional cigarette.
- This device could prove superior in efficacy compared to other nicotine self-administration methods, as the stimuli associated with smoking have a lasting effect against withdrawal symptoms.

A more recent evaluated the prevalence and severity of erosive tooth wear among Finnish prisoners, and its association with dental caries and the use of psychoactive substances. The study involved 100 prisoners from Pelso Prison, with detailed clinical examinations and interviews conducted. The results of the study indicated that 90% of prisoners needed preventive and operative treatment for dental erosion, with 19% experiencing severe erosion. A significant association was found between dental erosion and major alcohol consumption, as well as older age among prisoners. No strong links were found between dental erosion and the use of other psychoactive substances like tobacco and illicit drugs [Vainionpaa et al. 2019].

Dental erosion is the result of a biochemical degradation process that causes the dissolution of dental tissue by exogenous and/or endogenous acids. This lesion is not related to

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the presence of bacterial plaque. It generally affects multiple teeth [Donovan et al. 2021]. The development of dental erosive wear involves interactions among various factors, including chemical, biological, behavioral, dietary, socioeconomic, educational and general health aspects. Risk groups may include patients with eating disorders such as anorexia nervosa or bulimia nervosa, those with gastroesophageal reflux disease, and individuals with chronical alcohol abuse or dependence. Additionally, individuals with special dietary habits, such as high consumption of soft or sports drinks, vegetarian, vegan or raw food diets, as well as those who regularly consume drugs, medications and food supplements, are at increased risk for dental erosion [Struzycka et al. 2016, Goniewicz et al. 2014].

The main objective of this study was to establish whether there is a link between tobacco consumption (traditional cigarettes and e-cigarette) and dental erosion. Tabacco addiction and perception of tooth wear were also investigated. The null hypothesis asserts that there is no direct link between addiction on traditional or electronic cigarettes and dental erosion, and COVID-19 had a significant influence in smoking behavior.

MATHERIALS AND METHODS

A prospective study (Agreement from the Ethics Committee of UMFIH no. DEP 115/15.04.2024.) was conducted on a sample of 78 participants (mean age 24+- 3 years), both men and women. The target population consisted entirely of smokers of age between 20 and 30 years. They were subjected to a clinical examination and a single-choice questionnaire to assess dependence and the perception of tooth wear.

The inclusion criteria were: agreement to participate to the study, smokers (classic cigarette or electronic cigarette), age between 20 and 30 years, at least 2 natural teeth/sextant, good general health, no history of digestive or psychiatric disease.

The exclusion criteria were: disagreement to participate to the study, extensive prosthetic reconstructions, extensive edentulous spaces,

The clinical dental examination for BEWE score (Table 1) assessment was performed respecting the protocol for erosion evaluation. The BEWE is a partial scoring system that records the most severely affected tooth surface in a sextant (one of six divisions of the mouth), with a cumulative score guiding the practitioner's management based on four levels of wear severity [Bartlett et al. 2008]. The clinical evaluation was performed by an experienced clinician.

Table 1 – BEWE score.

Score	Characteristics
0	Absence of dental erosion
1	Initial loss of surface tissue (enamel)
2	Visible tissue loss (<50%)
3	Visible tissue loss (>50%)

The individual risk was assessed based on the total score obtained. High risk is considered when the total score exceeds 14, medium risk for a score of 9-13, low risk between 3 and 8, and no risk when the total score is less than or equal to 2.

Patients also responded to the Fagerström test. Based on the questionnaire responses, each patient received a score ranging from 0 to 10, being able to assess the dependency level as follows: 0-2 Very low dependency; 3-4 Low dependency; 5 Average dependency; 6-7 Strong dependency; 8-10 Very strong dependency. A supplementary question was added in the questionnaire regarding the influence of COVID lockdown on the frequency of smoking.

All information was collected and centralized in a Microsoft Excel form. T-test, Chi-square tests and Pearson correlation were conducted to investigate the data.

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RESULTS AND DISCUSSIONS

The average BEWE score identified was 5.87, indicating moderate dental erosion among the participants (Table 2). The average Fagerström score was 2.29, suggesting low to moderate nicotine dependence.

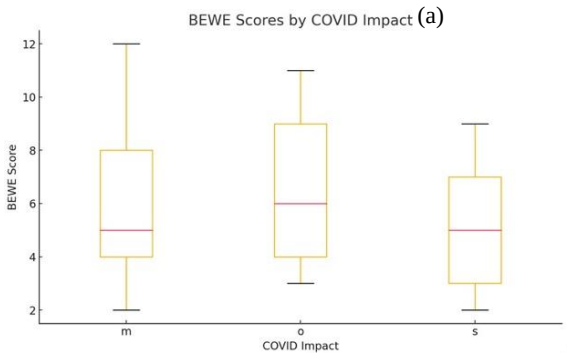
Table 2 – BEWE score.

Bewe score	**0**	**1**	**2**	**3**	**p**
	No. (%)	No. (%)	No. (%)	No. (%)	
Classic cigarette	4 (6)	52 (84%)	6 (10)	0 (0)	0,08
Electronic cigarette	0 (0)	7 (44)	9 (56)	0 (0)	0,47

Classic cigarette smokers presented a slightly higher average Fagerström score compared to electronic cigarette users, a higher average BEWE score was identified in electronic cigarette users, indicating more dental erosion.

Participants reporting a high impact of COVID-19 have higher nicotine dependence scores, while those with medium and low impacts have higher BEWE scores (Figure 1).

A weak negative correlation was identified between smoking and dental erosion (Pearson coefficient =0.082869). Generally, an increase in smoking was not associated with a corresponding increase in dental erosion or vice versa.



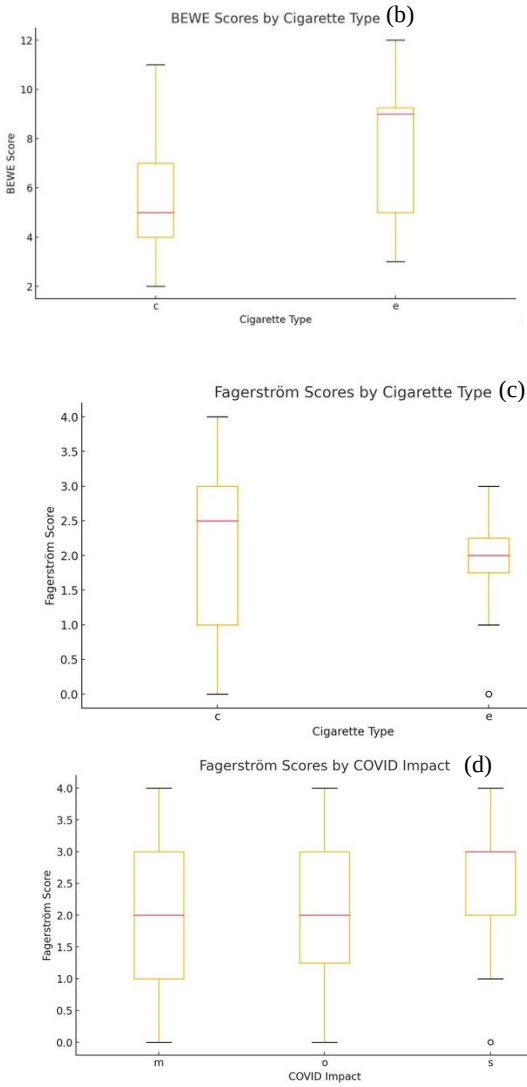


Figure 1. Correlation between BEWE score and COVID impact (a), BEWE score and cigarette type (b), Fagerström score and cigarette type (c) and Fagerström score and COVID impact (d).

Based on the data provided, COVID had no significant impact on smoking addiction.

The proportions or relative frequencies of the five levels of smoking addiction within each COVID impact group (medium, low, high) were also analyzed. In the medium COVID impact group, there are more individuals with higher levels of smoking addiction (levels 3 and 4) compared to those with low or high COVID impact. Whereas in the low COVID impact group, there is a relatively higher number of individuals with

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lower levels of smoking addiction -levels 0 and 1-, (compared to levels 0 and 1 in the medium and high COVID impact groups). However, these differences were not statistically validated, so no clear conclusions about the association between the COVID impact and smoking addiction, could be drawn (p=0.42).

The present study investigated a possible link between tobacco consumption (traditional cigarettes and e-cigarette) and dental erosion. Tabacco addiction and perception of tooth wear were also evaluated.

The null hypothesis was accepted, as no strong association between tobacco consumption (traditional cigarettes and e-cigarette) and dental erosion was identified.

The degree of dental wear can be evaluated through subjective and objective methods. In the current study, the evaluation of the degree of ETW was performed using the Basic Erosive Wear Examination (BEWE) system, which provides a comprehensive assessment of wear across all teeth within the oral cavity. This tool has been designed in a user-friendly format, to allow practitioners to use the BEWE index in clinical practice for a more systematic evaluation of erosion severity and effective management of associated risk factors. The findings form the current research were consistent with those of recent studies indicating that cigarette may modestly modulate dental erosion through superficial changes in enamel [Ferraz et al. 2019].

A recent study by Cichonska et al. [Cichonska et al. 2022] evaluated the physicochemical changes of saliva in e-cigarette smokers. The saliva of the screened participants underwent laboratory tests to check the pH and concentration of proteins, calcium and phosphates. As a result, e-cigarette users have altered pH, amount of protein, calcium and phosphates compared to the other conventional cigarette smokers and non-smokers.

However, studies have identified the toxic effects of e-cigarette use. In 2011, a statement from the French National Agency for Medicines and Health Products Safety (ANSM) underscored the toxicity of nicotine and emphasized that "regarding the risk of toxicity associated with solvents used in electronic cigarettes, particularly propylene glycol, definitive conclusions are difficult to made due to the insufficiency of comprehensive qualitative and quantitative data." The agency specifies that "up to the present time, no adverse effect or case of intoxication related to the presence of these solvents [...] has been reported" [ANSM- FR 2016].

In 2015, research conducted on animal models (laboratory mice) concluded that exposure to vapor from a commercial e-cigarette made the mice more susceptible to acute pneumonia and influenza. The study identified various compounds in the vapor capable of altering the animal's immune system yet emphasized the necessity for additional research to comprehensively elucidate this underlying mechanism [Sussan et al. 2015].

In May 2016, the Royal College of Physicians likewise assessed that the dangers of e-cigarettes are unlikely to exceed 5% of those linked to traditional cigarettes. However, within the same year, Vivek Murthy, Surgeon General of the United States, warned about "the prevalence of vaping among young Americans," which he characterized as "a major public health issue," as there has been a 900% increase in the use of e-cigarettes among high school students [Faiechild et al. 2021].

Moreover, the acidic Ph of vaping liquids can impact dental structures, necessitating long term studies to assess the progression of this condition [Kosendiak et al. 2023].

The results of the current study indicated that patients using electronic cigarettes tend to have higher BEWE scores despite having

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lower or similar Fagerström test scores compared to classic cigarette users. This underscores the potential impact of e-cigarettes on dental health.

Regarding smoking behaviors, our study did not identify statistically significant changes, leading us to reject our initial hypothesis regarding the detrimental impact of the COVID-19 pandemic on nicotine addiction. Similar results were obtained in a study of nursing students at Wroclaw Medical University in Poland, stating that there were no significant changes observed in smoking habits [Koopmann et al. 2021]. However, contrasting results were reported by other researchers. Studies conducted in Germany indicated that most individuals increased their smoking habits during the pandemic [Koopmann et al. 2021].

The currents study presents several limitations. Additional evidence or factors that might be considered to reject the null hypothesis include a larger sample size that provides greater statistical power, facilitating the detection of significant differences. The lack of regulation on the composition of e-cigarette liquids makes it difficult to assess the long-term effects of their use. Also, consistent findings from other researchers or independent studies would enhance the validity of the results and, the rejection of the null hypothesis.

CONCLUSIONS

1. E-cigarette may modestly modulate dental erosion through superficial changes in dental structures.
2. COVID-19 pandemic had no detrimental impact on cigarette addiction.

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