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Article

Dental caries experience and salivary total protein concentration in relation to electronic cigarette smoking

*Zainab Mahdi Abdul-Jabbar [1, *], Nibal Mohammed Hoobi [2]*
[1] Master student, Department of Pediatric and Preventive Dentistry, College of Dentistry, University of Baghdad.
[2] Assist. Prof., Department of Pediatric and Preventive Dentistry, College of Dentistry, University of Baghdad.
** Correspondence: zainabmahdi994@gmail.com*
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ABSTRACT

The study was conducted among college students in Al-Najaf City/Iraq, where it included evaluating dental caries experience, salivary flow rate, salivary pH and salivary total protein concentration in relation to electronic cigarette smoking. A cross-sectional method was used to compare dental caries experience, salivary flow rate, salivary pH and total protein concentration of 40 electronic cigarette smokers and 40 non-smokers considered a control group. SPSS version 22 was used to analyze the data, and statistical significance was determined at $p<0.05$. The results showed no significant difference in the dental caries experience between the two groups except DMFT. The result was significant, but there was a significant difference between the groups' salivary flow rate and pH. Moreover, there was no statistically significant difference in the salivary total protein concentration of the groups. This study concluded that electronic cigarettes had potentially detrimental effects on oral health and selected physicochemical properties of saliva.

Keywords: Electronic Cigarette, Dental Caries Experience, Salivary Flow Rate, Salivary pH, Total Protein.

INTRODUCTION

As alternatives to conventional tobacco cigarettes, the rapid emergence and increasingly widespread use of electronic nicotine delivery systems (ENDS) and electronic cigarettes (ECs) in particular[1] has been seen. The components of an electronic cigarette include a battery, a vaporization chamber, and a solvent combination cartridge. It gives consumers a smoking experience that is comparable to that of regular cigarettes[2]. Special liquids are introduced to the refillable cartridge. The major component of the device is the atomizer, where the liquid is heated and turned into an aerosol that looks similar to that of cigarette smoke[3,4]. Both open-system and closed-system electronic cigarettes are available

to users. Electronic cigarettes with open systems can be refilled with e-liquids in various flavors and nicotine levels. They must be charged, and they are usually larger than ordinary cigarettes. In contrast, electronic cigarettes with closed systems are usually disposable after use and cannot be refilled with e-liquids, while certain models may also be rechargeable. They come in a small selection of flavors and nicotine levels. They resemble traditional cigarettes more and are smaller than open-system electronic cigarettes[5].

Electronic cigarettes have the same negative effects on oral health as conventional cigarettes[6-8]. Because the oral cavity is the first area of the body to come into contact with the chemicals included in electronic cigarettes or any other type of tobacco, it is more likely to be exposed to the products' cancer-causing, immunologic, microbiological, and clinical impacts. Streptococcus mutans, a key contributor to dental cavities, is encouraged to colonize by the viscosity of the liquid used in electronic cigarettes[6]. Vegetable glycerin, along with other flavored ingredients, can increase microbe adhesion to enamel and encourage the development of biofilms, which causes enamel hardness to diminish[9]. The use of electronic cigarettes was linked to significant increases in tooth decay, toothaches, and dental damage, according to Jeong (2019)[10]. Saliva is a complex biological fluid with many functions that preserve oral well-being[11]. Many studies have shown that electronic cigarette smokers have reduced salivary flow rate and pH compared to non-smokers[12-14]. Electronic cigarette usage affects saliva, including saliva's antibacterial [15] and antioxidant properties [16]. The salivary total protein concentration was found to be higher in electronic cigarette smokers compared to non-smokers[17]. As saliva surrounds hard and soft oral tissues and contains the essential elements necessary for host protection, it could probably be a useful biomarker source for oral diagnostics[18]. The salivary total protein identification as a biomarker for dental caries was proved by many studies[19-22]. This study aimed to evaluate dental caries experience, salivary flow rate, salivary pH and total protein concentration in relation to electronic cigarette smoking among college students in Al-Najaf City/Iraq.

MATERIALS AND METHODS

This study was conducted after obtaining ethical approval from the Scientific and Ethical Committee at the Pedodontics and Preventive Dentistry Department/College of Dentistry/University of Baghdad, Iraq. The study used a cross-sectional design to compare dental caries experience, salivary flow rate, salivary pH and total protein concentration of 40 electronic cigarette smokers and 40 non-smokers enrolled as a control group. In this study, 80 college students who had been vaping for at least 60 minutes every day[23] for at least a year[14] in Al-Najaf city/Iraq participated. Their ages ranged from 18 to 25[24], and they were all active male smokers of electronic cigarettes.

Dental caries experience was diagnosed and recorded according to the Decayed, Missing and Filled (DMF) index for permanent teeth described by WHO (2013)[25] using a plane mouth mirror and WHO community periodontal index (CPI) probe. To compare salivary flow rate, salivary pH and total protein concentration, samples of unstimulated saliva were taken between 9 and noon. Before saliva was collected from participants, they were instructed to avoid eating, drinking, and smoking for 60 minutes. The salivary flow rate was measured by dividing the volume of the collected saliva on time and represented as milliliters per minute (ml/min). A digital pH meter was used to measure the salivary pH; the device was calibrated using a buffering solution (standard pH) before usage. Between each reading, the electrode was washed with distilled water and wiped dry[27]. Each salivary sample was then centrifuged and stored at (-20^{o}C) until sent to the laboratory to assess the level of salivary total protein[28]. Using a ready kit, the

colorimetric method was used to measure the amount of salivary total protein in mg/ml[29]. The manufacturer's procedure instructions carried out the reagent preparation process, technique assay, and result calculation.

Statistical analysis was done using SPSS version 22 (Statistical Package for Social Sciences) using frequency and percentage for the qualitative variable, mean and standard deviation for the quantitative variable, independent two-sample T-test and Pearson correlation used as inferential statistics. At $p<0.05$, the data were considered statistically significant.

RESULTS

(Table 1) shows the mean value of dental caries experience among electronic cigarette smokers and non-smokers. Electronic cigarette smokers had a higher mean value of dental caries experience than those in the control group but with no statistically significant difference ($p>0.05$) except DMFT; the result was significant ($p<0.05$). The result of the present study illustrates that the mean value of salivary flow rate and salivary pH was significantly lower among electronic cigarette smokers compared to non-smokers ($p<0.05$) (Table 2). The concentration of salivary total protein was lower among electronic cigarette smokers than in non-smokers, with no statistically significant difference ($p>0.05$) (Table 3).

The results in (Table 4) show the correlation coefficient between dental caries experience and salivary total protein. In the study group, the correlation between DS, FS, DMFS and DMFT with salivary total protein was positive, not significant. In contrast, the correlation between MS with salivary total protein was negative, not significant ($p>0.05$). In the control group, all correlations between dental caries components and salivary total protein were positive and insignificant ($p>0.05$).

Variables	Groups					
	Study		Control			
	Mean	±SD	Mean	±SD	T-test	P value
DS	9.675	7.367	8.175	4.574	1.094	0.277
MS	0.700	2.221	0.500	1.519	0.470	0.640
FS	2.950	4.012	2.025	4.335	0.990	0.325
DMFS	13.325	7.947	10.700	7.780	1.493	0.140
DMFT	9.750	5.396	7.650	4.004	2.102	0.048*

Table 1. Dental caries experience (DS, MS, FS, DMFS and DMFT) (Mean ± SD) and statistical difference in study and control groups.* *significant p<0.05*

Variables	Groups	Mean	±SD	T-test	P value
flow rate	Study	0.488	0.187	2.056	0.043*
	Control	0.647	0.452		
pH	Study	7.155	0.579	2.614	0.011*
	Control	7.415	0.247		

Table 2: Salivary flow rate (ml/min), pH (Mean ± SD), and statistical difference in study and control groups * significant p <0.05

Variable	Groups	Mean	±SD	T-test	P value
Total protein	Study	3.114	1.802	1.299	0.198
	Control	3.577	1.351		

Table 3: Concentration of salivary total protein (mg/ml) (Mean ± SD) and statistical difference in study and control groups.

Groups		Total protein	
		r	P
Study	DS	0.112	0.491
	MS	-0.108	0.508
	FS	0.079	0.628
	DMFS	0.114	0.484
	DMFT	0.278	0.082
Control	DS	0.124	0.446
	MS	0.015	0.926
	FS	0.003	0.984
	DMFS	0.078	0.633
	DMFT	0.173	0.285

Table 4: Correlation coefficient between dental caries experience and salivary total protein in study and control groups.

DISCUSSION

Electronic cigarettes are causing a lot of controversy and are becoming the focus of scientific inquiry despite their initial perception as a less harmful substitute for smoking regular cigarettes[30]. Given that the average age of electronic cigarette users is 19, compared to 34 for cigarette users, this study focused on college students between the ages of 18 and 25[31,32].

The present study revealed that dental caries experience was higher among electronic cigarette smokers than the control group, with a statistically significant difference regarding DMFT (Table 1). The difference in biofilms between the study and control groups, which is the primary factor in the etiopathogenesis of

dental caries, may be responsible for this outcome[33]. Electron microscope scanning revealed that Streptococcus mutans exposed to high nicotine levels formed thicker biofilms. Caries that grow on the surface of teeth are accelerated by thick biofilms[34]. This finding, however, conflicts with other research that found no significant differences between study and control groups' DMFT[12,35,36].

The salivary flow rate was found in this study to be significantly lower among electronic cigarette smokers than the control group (Table 2). This result agreed with some other studies[13,37] while disagreeing with Lestari et al. (2020), who found no statistically significant difference in salivary flow rate between study and control groups[12]. According to reports, nicotine causes sympathetic nerves to release neurotransmitters like catecholamine. This may influence the alpha receptor in the blood vessels, causing vasoconstriction. Vasoconstriction may reduce the activity of the salivary glands and saliva production [38].

(Table 2) showed that electronic cigarette smokers had lower salivary pH compared to non-smokers, with a statistically significant difference. This research's findings are consistent with those of other studies[12-14]. However, they differ from Cichonska et al. (2022), who observed no statistically significant difference in salivary pH between the study and control groups[17]. This result may be attributed to the fact that nicotine decreased saliva buffering response; thus, salivary flow rate and pH gradually decrease[d 39,40].

In this study, the salivary total protein concentration among the control group was higher than the study group, with no statistically significant difference (Table 3). This result disagreed with a study by Cichonska et al. (2022) that found lower salivary total protein concentration among the control group than the study group but also with no statistically significant difference[17]. The salivary flow rate, the glandular saliva's protein contributions, and the crevicular fluid proteins are generally the main factors influencing the protein concentration and composition of whole saliva[41].

Salivary proteins adsorb on the tooth surfaces and may decrease the risk of dental caries[19]. This concept comes in agreement with various studies that found higher salivary total protein concentration in the caries-free group compared to the caries-active group[19-22] while disagreeing with others[42,43] in addition to the present study that found a positive, not significant correlation between salivary total protein concentration and dental caries experience (DS, DMFS, DMFT) (Table 4).

CONCLUSION

This study has demonstrated that using electronic cigarettes may negatively affect oral health and saliva's physicochemical properties. Due to the widespread perception that electronic cigarettes are less harmful than traditional cigarettes, there is undoubtedly an increase in the number of electronic cigarette users worldwide. As a result, there must be action taken to resolve this issue.

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Conflicts of Interest: No conflicts of interest are disclosed by the authors.

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