

Original Research Article

E-cigarette usage, awareness and harmful effects among dental students in Riyadh, Saudi Arabia

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ABSTRACT

Background: This study examines the rising prevalence of e-cigarette usage among dental students in Riyadh, Saudi Arabia. Initially designed for smoking cessation, e-cigarettes have become popular for their diverse flavors, believed health advantages compared to traditional smoking, and acceptance in social settings. Nonetheless, increasing worries surround their possible negative impacts, particularly on dental well-being. The research seeks to evaluate the understanding, utilization habits, and awareness of negative consequences among dental students, who will have a crucial role in guiding patients in the future.

Methods: The online survey was conducted on 419 dental students and interns in Riyadh, Saudi Arabia. Data collection was done using self-administered questionnaires that included age, e-cigarette use, reasons for use, health risks knowledge, and perceptions of effects on dental health. For exploring the association among academic level, gender, and awareness of e-cigarettes, Chi-square and logistic regression statistical analysis were used.

Results: Peer influence was the primary reason for using e-cigarettes, reported by 49% (n=206) of participants. The most common reason given-peer influence-was reported by 44% (206 of 419) participants who had tried e-cigarettes. The majority of respondents, 82% (343 of 419), believed that e-cigarettes could be damaging to oral health, although some, 10% (41 of 419), were not aware of this possibility. A significant association was found between the level of education and awareness of the harmful effects of e-cigarettes.

Conclusions: Our study shows that e-cigarettes are highly consumed among dental students, and there is a great need for awareness campaigns. Despite the high consumption, many students are aware of the potential health hazards of e-cigarettes, especially to oral health. Academic institutions should use educational programs that eliminate false information about e-cigarettes being a safer product and help young adults make informed choices.

Keywords: E-cigarette, Smoking, Smoking cessation aid, Vape, Nicotine

INTRODUCTION

Tobacco smoking is a significant public health issue among college students in the Kingdom of Saudi Arabia (KSA). Extensive research has already investigated the prevalence of tobacco smoking in this population, which is higher than the national Saudi smoking rate and that of neighboring countries. Rather than repeatedly documenting the high smoking prevalence, future studies

should shift their focus toward developing and evaluating intervention and prevention strategies. Electronic cigarettes (E-cigarettes) are devices that can vaporize a nicotine solution combined with liquid flavors instead of burning tobacco leaves. Since the beginning of 2004, it has become widely available, and its use has increased world widely.

E-cigarettes were advertised as a device that can aid in smoking cessation; as cheaper, healthier, and much more

socially acceptable than conventional cigarettes.¹ The availability and diversity of flavors linked with addictive nicotine are other reasons that make e-cigarettes more popular.² E-cigarettes provide various options of e-liquids with total nicotine concentrations in each container ranging between 6-24 mg/ml.³

Moreover, the lack of scientific evidence to prove harmful side effects with prolonged exposure to e-cigarettes is a leading cause of its popularity since it has been advertised extremely as a safer alternative to 2 of 10 smoking.^{4,5} The type of e-cigarette may also impact the levels of toxic components delivered to the aerosol. For instance, variation in the brands has been found to be related to differences in carbonyl levels.⁶ Nonusers can be exposed involuntarily to the emissions from the exhaled aerosol.⁷

There is an increasing prevalence of smoking among students in Saudi Arabia.⁸ However, the percentage of male smokers is high, 32.7% (778 of 2973), as compared to female students, 5.9% (181 of 3713).⁹ There are many different reasons why people smoke - some do it to unwind, some to establish their strength and importance, to gain acceptance from peers, to form social networks or to join groups. Research has shown that in Riyadh, Saudi Arabia, almost half of the participants who smoked had a previous history of e-cigarette use.¹⁰

One potential approach is to establish a tobacco surveillance system that tracks and records smoking behaviors among Saudi college students. Additionally, future research should explore the psychosocial and economic determinants of smoking, using theoretical and experimental designs, in order to identify effective strategies for promoting smoking cessation and prevention in this target group.

Recently, there have been few studies in Riyadh-Saudi Arabia that evaluate and analyze the knowledge and usage rate of e-cigarettes among dental students. Therefore, the aim of this research was to assess the usage, awareness, and harmful effects of e-cigarettes among dental students. Objectives of the study was to investigate the awareness and understanding of undergraduate dental students regarding e-cigarette usage, the factors influencing their usage patterns, and the associated risks. We also wanted to identify the adverse effects of e-cigarette use on oral health, on the oral mucosa, periodontal health, and potential changes such as dental caries.

Encouraging dental students to actively participate in tobacco cessation programs by equipping them with the knowledge and skills needed to educate patients about the risks of tobacco and e-cigarette use.

METHODS

This online cross-sectional survey was administered to dental students and interns in Riyadh, Saudi Arabia, in July of 2024. The institutional review board reviewed and

approved the study project number E-24- 8775 CDRC: (E-24-8775).

The instrument used was a self-administered questionnaire developed in Google Forms. The survey started with a brief description of the study itself, followed by a detailed informed consent explaining the participants' rights, the perceived risks and benefits of participation, and the measures the investigators took to keep their personal information confidential. The students could access the survey only after they agreed to informed consent. It took a participant around 2-3 minutes to complete the survey. A total of 419 students and interns who were at least 18 years old (inclusion criteria) and currently enrolled in the dental program, undergraduate studies, and internship responded to the survey. Students who didn't consent to participate were excluded from this study.

The questionnaire is divided into two main sections. The first section contains questions about the general information data (e.g., participants' age, gender, academic level, and college). The second section was about the frequency of using e-cigarettes if they were users, the primary reason for using them, and how they first learned about e-cigarettes (e.g., social media, friends/family, advertising, or school/education). Moreover, it included a few questions about the harmful effects, such as their opinion of the effect of e-cigarettes on oral health (e.g., dental caries, gum disease, oral mucosal lesions) and their beliefs that e-cigarettes were less harmful than conventional cigarettes. In addition, the questionnaire asked whether they received formal education or training regarding the potential health risks associated with e-cigarette usage and how often they discussed this topic with their colleagues. Furthermore, it was asked if they would, as dentists in the future, suggest their patients smoke e-cigarettes rather than tobacco cigarettes.

For statistical analysis, descriptive statistics (frequencies and percentages) were tabulated for all categorical variables. A Chi-square test was used to determine if gender and academic level were associated with e-cigarette awareness and harmful effects. All the tests were considered significant if the p value was less than 0.05. Statistical package for social sciences (SPSS; IBM, Armonk, US) version 23.0 software was used for data analyses.

RESULTS

A questionnaire was designed to assess the usage, awareness, and perceived harmful effects of e-cigarette use among dental students. The study included 419 dental students and interns, with a 100% participation response. A short preface introduced the study objectives, assured the confidentiality of the data, and concluded by asking to agree to participate. In brief, the questionnaire comprised three sections. The first section asked the demographic data: age, sex, marital status, and study level. The second section comprised questions related to e-cigarette

awareness and harmful effects, such as dental caries, gum diseases, and oral mucosal lesions. The last section had questions related to the participant's beliefs about e-cigarettes, such as e-cigarettes helping in smoking cessation, and the dentist's role in education about e-cigarettes. 3 of 10 The demographic details of the participants are presented in Table 1. Users were asked about their practices and attitudes. This section included questions related to the duration of smoking, frequency of use, and confidence to discuss the harmful effects of e-cigarette use and reasons for initiating e-cigarette use. Most of the participants, 88.4% (n=372) were in the 21-25 age group, and 52% (n=219) were males. The majority were from KSU, 40% (n=168), and in their internship 37% (n=157). Among the participants, 44% (n=183) had used e-cigarettes, 29% (n=120) of them were smoking daily,

9.5% (n=40) had stopped smoking, and 56% (n=235) reported no prior use of e-cigarettes. The majority of respondents, 42.5% (206 of 419) first learned about E-cigarettes from their friends and family, 26.5% (111 of 419) from social media, and 21% (88 of 419) from school. Peer influence was the primary reason for using e-cigarettes 49% (206 of 419), followed by curiosity 29% (120 of 419), and 13% (54 of 419) who had used them as a smoking cessation aid. While 42% (176 of 419) have tried to quit smoking before, and 18% (75 of 419) are currently trying to quit. Further, 62% (260 of 419) believed that the major barrier they encountered in trying to quit smoking E-cigarettes was social pressure followed by nicotine addiction 35% (147 of 419) then the lack of effective cessation aids 33% (138 of 419).

Table 1: Demographic and academic characteristics of the participants.

Q. no.	Questions	Level	N	%
0.1	What is your age?	<20	47	11.2
		21-24	169	40.3
		>25	203	48.4
0.2	What is your gender?	Male	219	52.3
		Female	200	47.7
0.3	What is your academic year?	1st year	46	11.0
		2nd year	31	7.4
		3rd year	70	16.7
		4th year	45	10.7
		5th year	71	16.9
		Dental Intern	156	37.2
0.4	Which college are you affiliated with?	Other	3	0.7
		KSU Dental College	167	39.9
		PNU Dental College	55	13.1
		REU Dental College	77	18.4
		KSAU Dental College	117	27.9
1	Have you ever used electronic cigarettes (E-cigarettes)?	Yes	183	43.7
		No	236	56.3
2	If yes, how frequently do you use E-cigarettes?	Daily	120	50.4
		Weekly	30	12.6
		Monthly	16	6.7
		Rarely	32	13.4
		Not any more	40	16.8
3	What is the primary reason for using E-cigarettes?	Curiosity	121	28.9
		Peer influence	206	49.2
		Smoking cessation aid	54	12.9
		Flavour preference	25	6.0
		No specific reason	12	2.9

Table 2: Responses and gender wise comparisons (Chi-square test) of the questions related to the E-cigarettes' awareness and harmful effects such as dental caries, gum diseases and oral mucosal lesions.

Q. no.	Question	Responses	Male	Female	Total	P value
4a	How did you first learn about E-cigarettes? Advertising	No	190	187	377	0.016
		Yes	29	13	42	
4b	How did you first learn about E-cigarettes? friends/family	No	139	102	241	0.007
		Yes	80	98	178	

Continued.

Q. no.	Question	Responses	Male	Female	Total	P value
4c	How did you first learn about E-cigarettes? people on the street	No	219	199	418	0.477
		Yes	0	1	1	
4d	How did you first learn about E-cigarettes? School/education	No	173	159	332	0.498
		Yes	46	41	87	
4e	How did you first learn about E-cigarettes? social media	No	155	153	308	0.112
		Yes	64	47	111	
5	Are you aware of the constituents present in E-cigarettes?	Yes	133	119	252	0.102
		No	67	51	118	
		Partially	19	30	49	
6	Do you believe E-cigarettes are harmful to oral health?	Yes	173	170	343	0.169
		No	19	16	35	
		Not sure	27	14	41	
7a	If yes, what specific oral health problems do you associate with E-cigarette usage? (select all that apply) dental caries	No	66	67	133	0.263
		Yes	153	133	286	
7b	If yes, what specific oral health problems do you associate with E-cigarette usage? (select all that apply) gum disease	No	43	39	82	0.536
		Yes	176	161	337	
7c	If yes, what specific oral health problems do you associate with E-cigarette usage? (select all that apply) oral mucosal lesions	No	58	30	88	0.003
		Yes	161	170	331	

*P value was significant at $p < 0.05$

Table 3: Responses and gender wise comparisons (Chi-square test) of the questions related to the participants' beliefs about E-cigarettes: 'E-cigarettes help in smoking cessation, 'and dentist role to educate about E-cigarettes.

Q. no.	Question	Responses	Male	Female	Total	*P value
8	Have you received formal education or training regarding the potential health risks associated with E-cigarette usage?	Yes	185	142	327	0.001
		No	34	58	92	
9	Do you think E-cigarettes are less harmful than tobacco cigarettes?	Yes	42	52	94	0.004
		No	150	106	256	
		Same effect	27	42	69	
10	Have you ever tried to quit using E-cigarettes?	Yes	102	73	175	0.001
		No	33	54	87	
		Trying to quit	48	26	74	
11a	What barriers, if any, have you encountered in trying to quit using E- cigarettes? (select all that apply) nicotine addiction	No	159	112	271	0.000
		Yes	60	88	148	
11b	What barriers, if any, have you encountered in trying to quit using E- cigarettes? (select all that apply) social pressure	No	76	85	161	0.062
		Yes	143	115	258	
11c	What barriers, if any, have you encountered in trying to quit using E- cigarettes? (select all that apply) lack of effective cessation aids	No	147	133	280	0.487
		Yes	72	67	139	
11d	What barriers, if any, have you encountered in trying to quit using E- cigarettes? (select all that apply) withdrawal symptoms	No	189	177	366	0.299
		Yes	30	23	53	
12	Do you believe that using E-cigarettes is less harmful than smoking traditional cigarettes?	Yes	66	62	128	0.973
		No	102	93	195	
		Not sure	51	45	96	
13	How often do you discuss E-cigarette usage and its potential health effects with your peers or classmates?	Frequently	42	32	74	0.608
		Occasionally	62	50	112	
		Rarely	86	89	175	
		Never	29	29	58	

Continued.

Q. no.	Question	Responses	Male	Female	Total	*P value
14	Have you noticed any changes in your oral health since starting to use E-cigarettes?	Yes	145	91	236	0.000
		No	38	62	100	

*P value was significant at $p < 0.05$

Table 4: Responses and gender wise comparisons (Chi-square test) of the questions related to the information about E-cigarette usage and suggesting it to their patients.

Questions	Responses	Male	Female	*P value
Would you be interested in receiving more information about the potential health risks associated with E-cigarette usage?	No	132	126	0.318
		51.2%	48.8%	
	Yes	87	74	
		54.0%	46.0%	
Total	Count	219	200	
	%	52.3%	47.7%	
Would you, as a dentist, suggest for your patients to smoke E-cigarettes rather than tobacco cigarettes?	No	113	129	0.013
		51.6%	64.5%	
	Yes	49	26	
		22.4%	13%	
	I don't know	57	102	
		26%	24.3%	
Total		219	200	
		52.3%	47.7%	

*P value was significant at $p < 0.05$

Table 5: Do you believe E-cigarettes are harmful to oral health?

Do you believe E-cigarettes are harmful to oral health?	What is your academic year?							Total	*P value
		1st year	2nd year	3rd year	4th year	5th year	Dental intern		
Yes	Count	32	17	64	37	51	142	343	0.000
	%	9.3	5.0	18.7	10.8	14.9	41.4	100.0	
No	Count	7	7	2	3	8	8	35	
	%	20.0	20.0	5.7	8.6	22.9	22.9	100.0	
Not sure	Count	7	7	4	5	12	6	41	
	%	17.1	17.1	9.8	12.2	29.3	14.6	100.0	
Total	Count	46	31	70	45	71	156	419	
	%	11.0	7.4	16.7	10.7	16.9	37.2	100.0	

*P value was significant at $p < 0.05$

DISCUSSION

Tobacco smoke, e-cigarette aerosol, and aerosolized nicotine solution are examples of nicotine aerosols with the right particle size distribution that deposit in the lungs' alveolar regions and are rapidly absorbed. It's important to remember that various research have explored the detrimental effects of vapes on oral tissues, periodontal health, and the development of oral illnesses. The literature has highlighted the need to understand the potential implications of the use of other devices (pod mods)-Bo, Kwit Stick, Mystic, Rubi, and Suorin are pronounced with nicotine present in their liquids. Protonated nicotine, which is used to refill some pod mods, is available in tastes including cotton candy, donut cream, and gummy bear and in concentrations as high as 60 mg/ml.

Based on the references included in our qualitative study, it can be concluded that vaping is associated with several adverse effects on oral health. The present study showed that 82% (343 of 419) of the participants were aware of the adverse after-effects of e-cigarette consumption. E-cigarettes may act as a smoking cessation tool for teenagers.¹¹ E-cigarettes' enticing tastes, creative marketing, and accessibility have sparked worries that they could persuade non-smokers-including teenagers-to start vaping and then switch to regular cigarettes.¹² In the present study, it has been estimated that currently, 44% (184 of 419) of dental students and interneers are consuming e-cigarettes. Peer influence was also very in vogue; 50.6% (212 of 419) of the current users consume e-cigarettes daily. 11.7% (49 of 419) of the participants followed the myth that e-cigarettes and regular cigarettes contain the same composition. Yet, there was a lack of awareness about self-regulation.

Misinformation about e-cigarettes, originating from various sources, can lead to confusion about their relative harms compared to traditional cigarettes. Studies show that tweets suggesting e-cigarettes are harmful or more harmful than smoking receive more engagement, deterring smokers from considering them as a less harmful alternative. Manufacturers often falsely advertise their products as harmless, contributing to the youth vaping epidemic. Sensationalized media reports can also contribute to misinformation, focusing on isolated incidents or unverified claims. Public health campaigns and healthcare professionals can help combat misinformation and provide accurate information.¹³

It's also important to consider how e-cigarettes affect society and the environment. Concerns regarding secondhand aerosol exposure have been raised by the rise in e-cigarette use. Even though e-cigarette aerosols are typically thought to be less dangerous than tobacco smoke, non-users may still be at risk for health problems if they are exposed to them for an extended period.¹⁴ To address these issues and safeguard non-smokers from possible harm, public policies and regulations must be created.

It also gives the prevalence of e-cigarette use compared with the Southeast Asian region, whereas our study presents a higher prevalence. The lifetime and current prevalence in a study from South Korea showed 11% and 2%, respectively; 2.1% in Chinese participants; and 4.3% current prevalence in Japanese adolescents.^{11,15,16} On the other hand, a systematic review of the global prevalence of e-cigarette uses in America, Europe, and Asia reported current prevalence at 10%, 14%, and 11%.¹⁶ Another recent study, in an effort to undertake a global assessment of tobacco, evaluated current e-cigarette use in individuals aged >15 years in 14 countries. The current prevalence of e-cigarette use ranged from 0.02% to 3.5%, reported here in ascending order: India (0.02%), Bangladesh (0.2%), China (0.9%), Costa Rica and Turkey (1.3%), Ukraine (1.7%), Romania (3.4%), and Russia (3.5%).¹⁷ Therefore, to fully comprehend the range of safety risks associated with this technology, extensive research encompassing a wide range of e-cigarette products is required. Lastly, it's critical to acknowledge that e-cigarettes are not risk-free. Aerosols may not be as dangerous as regular cigarettes. But, breathing them in still poses a risk to one's health. Therefore, the best course of action for people who do not currently use tobacco products is to completely avoid using either e-cigarettes or traditional cigarettes.

Limitations

To guarantee a thorough grasp of the safety of e-cigarettes in comparison to traditional cigarettes, several limitations must be acknowledged, from the reviewed studies. The lack of long-term data on the health effects of e-cigarettes is one of the main drawbacks of the literature currently in publication. Since e-cigarettes are a relative invention, most of the research has concentrated on immediate results. To properly evaluate the possible health risks

connected to prolonged e-cigarette use, longitudinal research spanning several years is necessary.

Drawing a general conclusion has become difficult due to the vast diversity of e-cigarette devices. Different devices can have various aerosol mixtures and operate at different temperatures, which may lead to varying health impacts. Additionally, some research might become outdated or less applicable to today's products because e-cigarette technology is changing quickly. The lack of uniform testing methods for evaluating the safety of e-cigarettes makes it difficult to compare findings accurately. Similarly, use of other tobacco products, or underlying health conditions of participants is also a concern that needs to be addressed in future study. Furthermore, the findings' applicability to a larger population is limited by the marginalization of various age groups, socioeconomic backgrounds, and ethnicities. The type used by respondents who used nicotine-containing e-cigarettes are unknown. Later-generation (e.g., "mods") e-cigarettes deliver nicotine to 9 of 10 blood in a higher level than first-generation e-cigarettes.

E-cigarettes are advanced devices with high customization and powerful performance. They come in various forms, such as box mods, mechanical mods, Pod systems, closed Pod systems, and vape pens. Box mods are known for their robust performance and versatility, while mechanical mods provide raw battery power directly to the coil. Pod systems are compact, user-friendly, and portable, while closed Pod systems are prefilled with e-liquid and require minimal maintenance. Vape pens are portable and easy to use, suitable for beginners. However, the long-term health effects of e-cigarettes are still being studied, and concerns about lung health and addiction are prevalent among youth.¹⁸⁻²⁰

Campaigns to dispel the myth that e-cigarettes are "safer" than conventional lights could be the main focus of public health initiatives. Long-term health hazards, including the systemic and oral effects of nicotine and other ingredients found in e-cigarettes, may also be included in educational programs. These raise awareness, and a decrease in e-cigarette usage among medical students may serve as a model for similar programs in the wider public. Bias in study design, execution, or result interpretation may be introduced by the tobacco and vaping industries' influence over research and funding. Research integrity requires open and honest disclosure of funding sources and possible conflicts of interest.

CONCLUSION

E-cigarette safety is a complex matter that necessitates careful evaluation of numerous aspects. E-cigarettes may be a less dangerous option for adult smokers, according to evidence, but it's important to consider the risks they pose and how they may affect non-smokers, particularly young people. Our research added novel findings to the existing knowledge on e-cigarette use in the literature. When

talking about e-cigarette trends, it is important to consider the factors that affect the age at which students start smoking and their intentions for future use. As new products with various features and formulations keep coming to market, the e-cigarette industry is always changing. Therefore, it's possible that new health effects linked to these innovative products aren't fully understood or sufficiently researched yet. Providing health education programs regarding this matter. Therefore, these programs should aim to increase awareness about the harmfulness of e-cigarettes among young people, particularly in school settings, regarding the seriousness of the issue with e-cigarettes, as well as the continued discussion on the safety of traditional cigarettes. They have the potential to have a significant impact on increasing awareness and promoting informed choices about e-cigarette usage. The discussion of the topic should also consider the safety of e-cigarettes in comparison to traditional cigarettes.

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