



Assessment of Knowledge, Awareness, and Attitudes Regarding the Impact of E-cigarette Use on Oral Health Among Undergraduate Dental Students: A Cross-Sectional Study

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Abstract

Background

Electronic cigarette (E-cigarette) use is increasing among young adults, and current dental students will soon be responsible for counseling patients about its potential health effects. This study assessed knowledge, awareness, and attitudes regarding the impact of e-cigarette use on oral health among undergraduate dental students.

Materials and methods

A cross-sectional, questionnaire-based study was carried out among undergraduate dental students at the School of Dental Sciences, Krishna Vishwa Vidyapeeth, Karad, India, using a self-administered Google Forms questionnaire and convenience sampling. The questionnaire covered demographics, knowledge of the oral effects of e-cigarettes (vaping), attitudes toward patient counseling, awareness of the ban on e-cigarettes in India, and two open-ended questions. Data were analyzed using descriptive statistics only; no inferential tests were performed.

Results

A total of 248 undergraduate dental students aged 18 to 25 years (mean age 21.0 ± 1.7 years; 72.6% female) in Karad, India, were included. Overall, 96.4% of participants who provided valid responses believed that vaping can affect oral health, and 73.8% considered smoking and vaping equally harmful. Most students recognized the increased risk of dental caries associated with vaping (88.3%), identified sweeteners as the cariogenic component of e-liquids (83.5%), agreed that nicotine affects gum health and healing (87.1%), and identified nicotine as the addictive substance (89.1%). However, 70.2% recognized that smoking can mask gingival bleeding, and 66.9% agreed that the absence of smoke does not make e-cigarettes harmless. Routine patient counseling was rated moderately or very important by 80.2%, while 11.7% believed vaping has no side effects. Awareness of the e-cigarette ban was 60.1%, and 21.8% of all respondents correctly identified 2019 as the ban year. Male students were more often aware of the ban than female students (72.1% vs. 55.6%; descriptive comparison only). Periodontal problems and oral cancer were the concerns mentioned most often, and social media campaigns were the most frequently suggested awareness strategy.

Conclusions

Dental students showed good general awareness of the oral health effects of vaping, but important gaps remain, particularly the belief that vaping is free of side effects, limited recognition that smoking can mask gingival bleeding, and incomplete knowledge of the legal status of e-cigarettes. These gaps are practical targets for curricular reinforcement and counseling training.

Categories: Public Health, Oral Medicine, Dentistry

Keywords: attitude, awareness, dental students, e-cigarette, india, knowledge, oral health, vaping

Introduction

Electronic cigarettes (e-cigarettes) were introduced as a less harmful alternative to combustible tobacco, and their popularity has grown quickly, particularly among adolescents and young adults. In this article, “e-cigarette use” is the principal term; “vaping” is used as a synonym where it mirrors the wording of the questionnaire. These devices heat a liquid that usually contains nicotine and flavoring agents and deliver the resulting aerosol through the mouth, which makes the oral cavity the first site of exposure [1]. Even so, the idea that vaping is essentially safe is still widely held among young people, and surveys of young adults continue to uncover misconceptions about its harms [2].

How to cite this article

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Although evidence regarding the oral health effects of e-cigarette use continues to emerge, existing findings raise concerns. Systematic reviews suggest that e-cigarette use may be linked to mouth and throat discomfort, changes in the oral mucosa and the oral microbiome, and poorer periodontal status when compared with non-smokers [3,4]. Dental complaints such as caries, tooth sensitivity, and cracked teeth have also been reported among e-cigarette users in the existing literature [3,5]; because these findings are drawn primarily from review articles, they should be interpreted as reported associations rather than established causal effects of e-cigarette use. Laboratory work offers a plausible mechanism for caries: aerosols generated from sweet-flavored e-liquids behave much like sugary, sticky confectionery on the tooth surface and may increase cariogenic potential [6]. Periodontal assessment can be misleading as well, because nicotine constricts gingival blood vessels and smokers may show less bleeding than their periodontal condition would suggest [7]. Larger, well-designed longitudinal studies are still needed to clarify how much of this translates into clinical disease in e-cigarette users [1,3].

Dental professionals are well positioned to address these concerns because they regularly interact with patients and can recognize the oral signs of tobacco and nicotine use. Furthermore, interventions delivered by dental teams have been shown to support tobacco cessation more broadly [8], although this evidence relates primarily to conventional tobacco rather than e-cigarette cessation specifically. However, the effectiveness of counseling depends partly on the knowledge and attitudes of the clinician providing it, which are shaped during undergraduate training. A US survey of young adults examined knowledge, attitudes, and practices on the oral health effects of e-cigarette use [9]. Cross-sectional studies of undergraduate dental students at one Saudi university [10], in a multinational survey [11], and at one Palestinian dental school [12] have identified gaps in knowledge and confidence and, in some settings, called for more education on the subject.

The regulatory context in India presents additional considerations. E-cigarettes were first prohibited by an ordinance in September 2019, followed by an Act of Parliament passed in December 2019 [13]. Consequently, future dentists in India may need to counsel patients about a prohibited product that remains accessible to some young people. Studies among adolescents and young adults suggest that awareness of e-cigarettes and of their harms is incomplete [14,15]. Indian research among dental students is limited. A survey of 150 dental students in Chennai found that most were aware of e-cigarettes, although many lacked knowledge of e-liquid composition, and approximately 71% considered e-cigarettes less harmful than conventional cigarettes [16]. Another survey of college students in Chennai examined e-cigarettes alongside smokeless tobacco and areca nut [17]. To our knowledge, existing Indian studies among dental students have primarily assessed general knowledge, awareness, and attitudes toward tobacco or e-cigarette use, with limited assessment of their understanding of specific oral health consequences of vaping, perceived role in counseling, and awareness of the legal status of e-cigarettes. This study addresses these gaps by jointly assessing knowledge, awareness, and attitudes about the oral health effects of e-cigarette use, including students' counseling perspectives and knowledge of the legal position in India.

We therefore carried out a cross-sectional study. The primary objective was to describe awareness of e-cigarettes and of their oral health effects among these students; the secondary objectives were to describe knowledge of specific effects, attitudes toward counseling, and awareness of the legal status of e-cigarettes in India, and to identify knowledge gaps that could inform teaching.

Materials And Methods

Study design and setting

This descriptive, questionnaire-based cross-sectional study was conducted among undergraduate dental students at the School of Dental Sciences, Krishna Vishwa Vidyapeeth (Deemed to be University), Karad, Maharashtra, India. The overall study, from planning through data collection and report writing, spanned three months. Data were collected from 13 August 2026 to 22 September 2026.

Ethical considerations

The Institutional Ethics Committee of Krishna Vishwa Vidyapeeth approved the study (approval number: 139/2026-2027; date: August 13, 2026). Participation was voluntary, and all participants provided informed consent before beginning the questionnaire. No personal identifiers were collected, and responses were kept anonymous and confidential. During consent, participants were informed that anonymized responses, including open-ended answers, could be used for publication.

Participants and sampling

Undergraduate dental students at the study institution, from first year through internship, were eligible for inclusion. A convenience (non-probability) sampling technique was used: the questionnaire link was made available to all students present at the institution during the data collection period, and students completed it if they chose to. Of 320 eligible students, 248 completed the questionnaire (response rate 77.5%). No reminders or incentives were used; students who did not respond were not followed up, and self-selection bias cannot be excluded, since students who chose to respond may differ from those who did not.

Inclusion and exclusion criteria

Eligible participants were undergraduate dental students enrolled at the institution, aged 18 or older, and willing to provide informed consent. Exclusion criteria were questionnaires with more than 20% of items left unanswered and responses classified as unclear (see Statistical Analysis).

Potential confounders

Potential confounders included participants' personal history of smoking, vaping, or other tobacco use; prior curricular exposure to tobacco- or vaping-related education; and exposure to public awareness campaigns or media coverage. These factors were not measured, and no adjustment for potential confounding was performed. Year of study was recorded as a demographic characteristic but was not included in comparative or stratified analyses.

Sample size

The minimum sample size was calculated at a 95% confidence level using the formula

$$n = \frac{Z^2 pq}{L^2}$$

where n is the required sample size, p is the expected proportion (0.773), q = 1 - p (0.227), and L is the allowable error (0.07).

$$n = \frac{(1.96)^2 \times 0.773 \times 0.227}{(0.07)^2}$$

$$n = \frac{3.8416 \times 0.773 \times 0.227}{0.0049}$$

$$n = \frac{0.6747}{0.0049}$$

$$n = 137.69$$

$$n \approx 138$$

Based on a reported awareness of e-cigarettes of 77.3% among dental students in an earlier Indian survey [16], with q = 22.7% and an allowable error of 7%, the required sample was 137.56, rounded to 138 participants. In total, 248 students completed the questionnaire, which exceeded the minimum requirement. The calculation was designed to estimate the awareness proportion with 7% precision and is not a power calculation for subgroup comparisons; no subgroup comparison was powered, and no explicit nonresponse allowance was built into the formula.

Study instrument

A structured, self-administered questionnaire was used (Appendices). The questionnaire was developed following a review of the literature on e-cigarettes and oral health. Relevant items were adapted from previously published surveys assessing knowledge, awareness, and attitudes toward e-cigarette use [9,10,16] and modified for dental students. The questionnaire was reviewed for content validity, relevance, and clarity by two subject experts (in public health dentistry and in oral medicine and radiology); a formal Content Validity Index was not calculated. It was then pilot-tested among 10 undergraduate dental students who were not included in the final study sample. Based on their feedback, minor modifications to wording and presentation were made before final administration. The first section collected demographic information (age, gender, and year of study). The second section contained 13 items. Eleven were closed-ended and covered whether vaping affects oral health, the relative harm of smoking and vaping, caries risk related to dry mouth and e-liquid ingredients, the role of sweeteners as a source of fermentable sugars, the effect of nicotine on gum health and healing, the masking of gingival bleeding by smoking, whether the absence of smoke implies safety, the addictive substance in e-cigarettes, the perceived importance of routinely asking patients about vaping and counseling them, and awareness of the ban on e-cigarettes in India together with the year it was introduced. The final two items were open-ended and asked students to name the most important oral health concern associated with vaping and to suggest ways of improving awareness among young people. For knowledge items with a single correct answer, such as sweeteners as the source of fermentable sugars and nicotine as the addictive substance, responses were classified as correct or incorrect. Sweeteners were defined as the correct response because sweetening agents are the principal fermentable-sugar source relevant to caries risk, as distinct from non-fermentable base components such as propylene

glycol or glycerin [6]. For reporting purposes, the 13 items were categorized into three domains: knowledge (items 4 and 6-11; seven items), awareness (items 13-15; three items), and attitudes (items 5, 12, and 16; three items).

Data collection

The questionnaire was developed using Google Forms (Google LLC, Mountain View, CA, USA), and the link was shared with eligible students through official class WhatsApp groups (Meta Platforms, Inc., Menlo Park, CA, USA). Each student was asked to respond only once. However, no technical mechanism, such as a sign-in requirement, was implemented to prevent duplicate submissions because this could have compromised anonymity. This represents a potential limitation of the study.

Statistical analysis

Responses were entered into Excel (Microsoft Corp., Redmond, WA, USA) and analyzed using SPSS Statistics version 30.0 (IBM Corp. Released 2024. IBM SPSS Statistics for Windows, Version 30.0. Armonk, NY). Categorical variables are summarized as frequencies and percentages, and age as mean $\pm$ standard deviation. The analysis was purely descriptive; no inferential tests were performed, and the difference in ban awareness between male and female students is reported as observed percentages only. A response was classified as unclear if it was missing, internally contradictory (e.g., two mutually exclusive options selected), or could not be matched to any listed category; unclear responses are reported as a count and excluded from the percentage for that item only. Open-ended responses were analyzed thematically: themes were developed inductively, with each investigator independently proposing a preliminary set of recurring themes that were then reconciled into shared definitions, and each response was assigned to a single best-fitting theme to avoid double counting. A formal intercoder agreement statistic (e.g., Cohen's kappa) was not calculated; discrepancies were resolved by consensus, and the frequency of each identified theme was then counted. Percentages for each item use valid responses as the denominator.

Results

A total of 248 undergraduate dental students completed the questionnaire and were included in the final analysis. The mean age of participants was 21.0 ± 1.7 years (range: 18-25), with the largest group in the 20-year bracket (63 students, 25.4%). Of the 248 respondents, 180 (72.6%) were female, and 68 (27.4%) were male; none selected "prefer not to say" for gender. Regarding the year of study, fourth-year students constituted the largest proportion of the sample (85 students, 34.3%), followed by first-year students (64, 25.8%), second-year students (37, 14.9%), interns (36, 14.5%), and third-year students (26, 10.5%) (Table 1). This demographic profile is broadly comparable to similar cross-sectional surveys of dental and university students on vaping-related knowledge and attitudes [16,17].

Variable	n	%
Age (years)		
18	6	2.4
19	42	16.9
20	63	25.4
21	44	17.7
22	40	16.1
23	27	10.9
24	23	9.3
25	3	1.2
Gender		
Female	180	72.6
Male	68	27.4
Year of study		
First year	64	25.8
Second year	37	14.9
Third year	26	10.5
Fourth year	85	34.3
Intern	36	14.5

TABLE 1: Demographic characteristics of the study participants (N = 248)

Knowledge and awareness of the oral health effects of e-cigarette use

Most participants (238 of 247 valid respondents; 96.4%) believed that vaping can affect oral health, while nine (3.6%) did not; one response was unclear and was excluded from this item. When asked to compare the relative harm of smoking and vaping, 183 students (73.8%) felt that both habits were equally harmful to oral health, 39 (15.7%) considered smoking to be more harmful, and only 20 (8.1%) regarded vaping as the more harmful of the two; a small minority (6, 2.4%) either felt neither was harmful or were unsure.

Participants' knowledge of the potential mechanisms underlying vaping-related oral health effects was assessed. Regarding the risk of dental caries, 219 participants (88.3%) agreed that vaping can increase caries risk through dry mouth and certain e-liquid ingredients, 26 (10.5%) were not sure, and only three (1.2%) disagreed. When asked which e-liquid component contributes to tooth decay by supplying fermentable sugars, 207 students (83.5%) correctly identified sweeteners, while the remainder selected fluoride (31, 12.5%), calcium (7, 2.8%), or protein (3, 1.2%) (Table 2).

Item	Response	n	%
Do you think vaping can affect oral health?	Yes	238	96.4
	No	9	3.6
	Unclear response (excluded)	1	-
Which is more harmful to oral health?	Both equally harmful	183	73.8
	Smoking	39	15.7
	Vaping	20	8.1
	Neither/don't know	6	2.4
	Yes	219	88.3
Can vaping increase caries risk via dry mouth and e-liquid ingredients?	Not sure	26	10.5
	No	3	1.2
Which e-liquid component contributes to tooth decay via fermentable sugars?	Sweeteners	207	83.5
	Fluoride	31	12.5
	Calcium	7	2.8
	Protein	3	1.2
Can nicotine affect gum health and healing?	Yes	216	87.1
	Not sure	28	11.3
	No	4	1.6
Smoking can mask gingival bleeding despite periodontal disease	Yes	174	70.2
	Not sure	47	19.0
	No	27	10.9
Absence of smoke does not mean e-cigarettes are harmless	Yes	166	66.9
	No	50	20.2
	Not sure	32	12.9
Which substance in e-cigarettes causes addiction?	Nicotine	221	89.1
	Caffeine	22	8.9
	Fluoride	4	1.6
	Calcium	1	0.4

TABLE 2: Knowledge responses regarding the oral health effects of e-cigarette use (N = 248; percentages use valid responses, n = 247, for the first item)

Regarding gingival health, 216 participants (87.1%) agreed that nicotine in e-cigarettes can affect gum health and healing, and 174 (70.2%) correctly recognized that smoking can mask gingival bleeding despite underlying periodontal disease, with 47 (19.0%) unsure and 27 (10.9%) disagreeing. Most students (166, 66.9%) also agreed that the absence of tobacco smoke does not mean e-cigarettes are harmless to oral health, although a notable proportion (50, 20.2%) disagreed and 32 (12.9%) were not sure. Most participants (221, 89.1%) correctly identified nicotine as the addictive component of e-cigarettes (Table 2).

Attitudes toward professional responsibility and e-cigarette use

When asked how important it is, as future dental professionals, to routinely ask patients about e-cigarette use and counsel them on its oral health effects, 161 participants (64.9%) rated this as “very important,” and another 38 (15.3%) as “moderately important.” Only 20 (8.1%) considered it “slightly important,” while 29 (11.7%) reported that they did not believe vaping/e-cigarette use carries any side effects at all. This finding

warrants attention because it identifies a subgroup of students who may particularly benefit from targeted curricular reinforcement, echoing calls for more structured vaping-related education identified among medical and dental trainees in earlier pilot surveys [18,19].

Awareness of the legal status of e-cigarettes in India

“Legal awareness,” as used in this manuscript, refers to participants’ knowledge of the legal and regulatory status of e-cigarettes in India, i.e., whether they are banned and the year the ban was introduced (items 13 and 14). Regarding awareness of the e-cigarette ban in India, 149 participants (60.1%) were aware of the ban, 45 (18.1%) were not, and 54 (21.8%) were not sure (Figure 1). Among the 149 students who correctly identified that a ban exists, the specific year of the ban was less consistently known: 54 (21.8% of the total sample; 36.2% of the 149 students aware that a ban exists) correctly identified 2019 as the year of the ban, while smaller numbers selected 2020 (18, 7.3%), 2018 (17, 6.9%), or 2021 (10, 4.0%) (Figure 2).

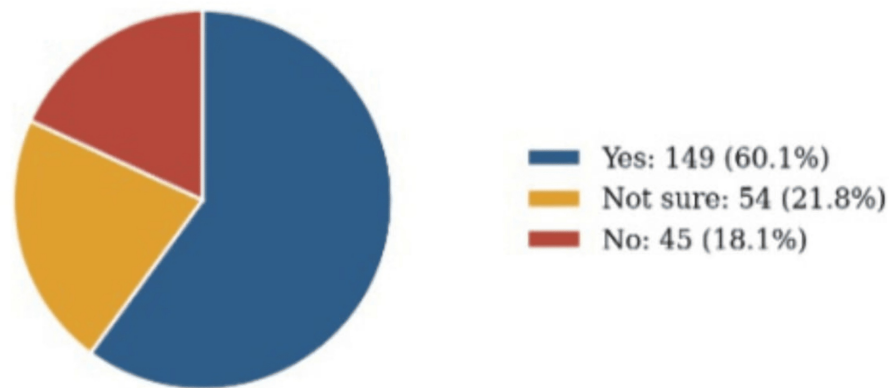


FIGURE 1: Awareness that e-cigarettes are banned in India

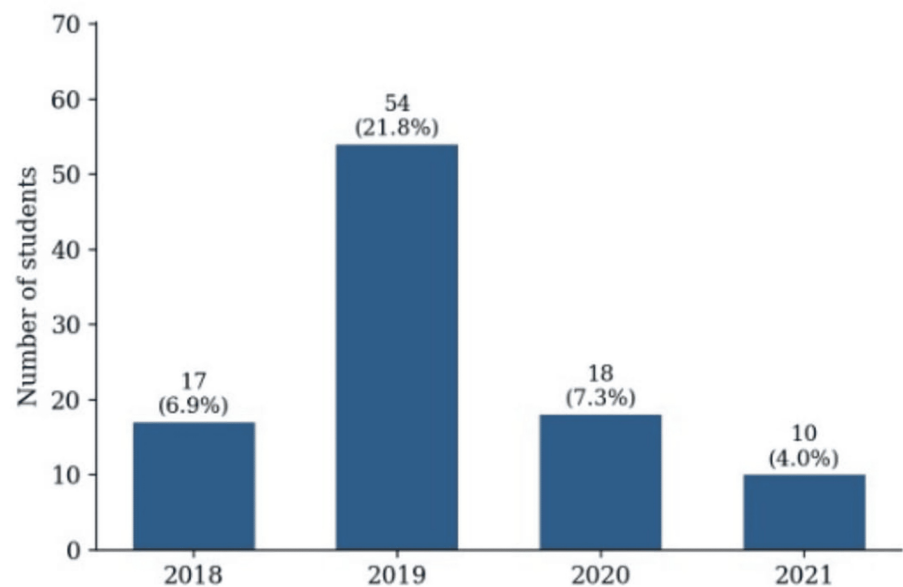


FIGURE 2: Perceived year of the e-cigarette ban in India

A descriptive comparison by gender revealed differences in awareness of the ban: 49 of 68 male students (72.1%) were aware that e-cigarettes are banned in India, compared with 100 of 180 female students (55.6%); 12 males (17.6%) and 42 females (23.3%) were unsure, and seven males (10.3%) and 38 females (21.1%) were unaware (Table 3). This gender comparison is descriptive; no statistical test was performed.

Awareness of ban	Male, n (%)	Female, n (%)	Total, n (%)
Yes	49 (72.1)	100 (55.6)	149 (60.1)
Not sure	12 (17.6)	42 (23.3)	54 (21.8)
No	7 (10.3)	38 (21.1)	45 (18.1)

TABLE 3: Awareness of the legal status of e-cigarettes in India by gender (N = 248; descriptive percentages only, no statistical test performed)

Perceived oral health concerns associated with vaping (open-ended responses)

When asked, in their own words, to name the oral health concern they considered most important in relation to vaping/e-cigarette use, periodontal and gingival problems constituted the most frequently reported theme, appearing in 59 responses (23.8%), closely followed by oral cancer or potentially malignant lesions, mentioned in 49 responses (19.8%). Dry mouth was raised in 31 responses (12.5%), and dental caries or tooth decay in 10 (4.0%). Smaller numbers of students referred to tooth staining or discoloration (5, 2.0%), halitosis (3, 1.2%), or systemic and extraoral effects such as respiratory or cardiovascular complications (4, 1.6%); together with several less frequently reported themes, these accounted for 15 responses (6.0%). Twelve students (4.8%) openly stated that they did not know. A further 22 responses (8.9%) were too brief or nonspecific to classify (e.g., “none,” “good”). The remaining 39 responses (15.7%) did not fit any single recurring theme. These primarily included responses mentioning multiple concerns of equal importance or general health concerns not captured by the main themes, and no further subcategories were created given their heterogeneity and small subgroup sizes. Representative responses, selected as typical examples of the two most common themes, included concerns about “dry mouth, increased risk of dental caries, and periodontal problems” and the view that vaping causes “heightened risk of periodontal disease combined with severe tooth decay” (Figure 3).

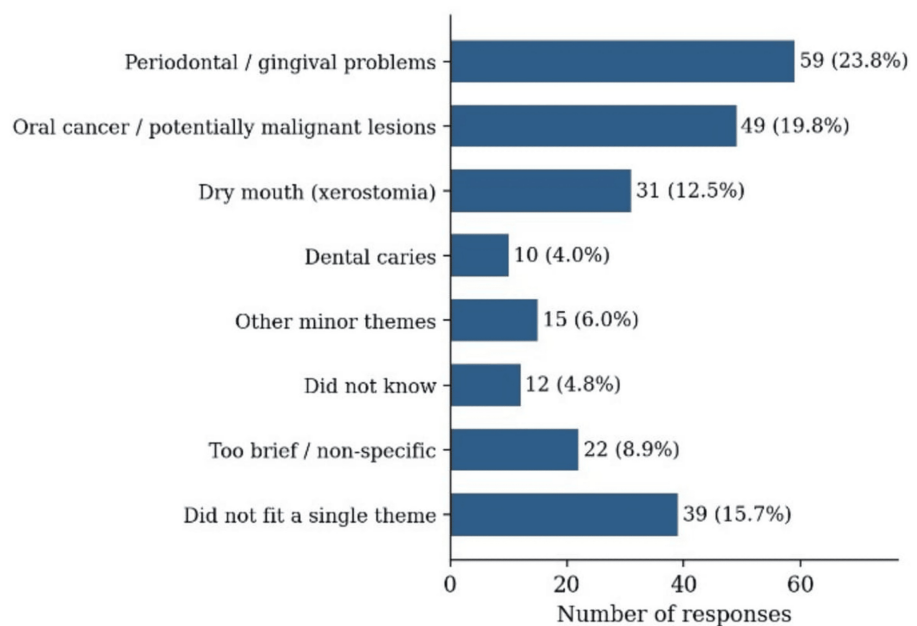


FIGURE 3: Perceived most important oral health concern associated with vaping (open-ended responses)

Participants were also asked what could be done to improve awareness among young people about the oral health effects of vaping. Social media and digital campaigns were the most frequently suggested strategy, cited in 69 responses (27.8%), followed by a general call for more “awareness” or “education” without specifying a particular medium (42, 16.9%). Awareness camps and workshops were suggested in 37 responses (14.9%), school- or college-based education programs in 18 (7.3%), dentist-led counseling during

clinical visits in 14 (5.6%), and regulatory measures such as bans or mandatory warning labels in 13 (5.2%). Eighteen responses (7.3%) were nonsubstantive, and a further 37 responses (14.9%) proposed other or combined strategies that did not fit a single category. Several students proposed combined, multi-pronged strategies, such as pairing short-form social media videos with interactive, visual teaching sessions in schools and colleges, and incorporating routine counseling and direct patient education into dental clinical visits (Figure 4).

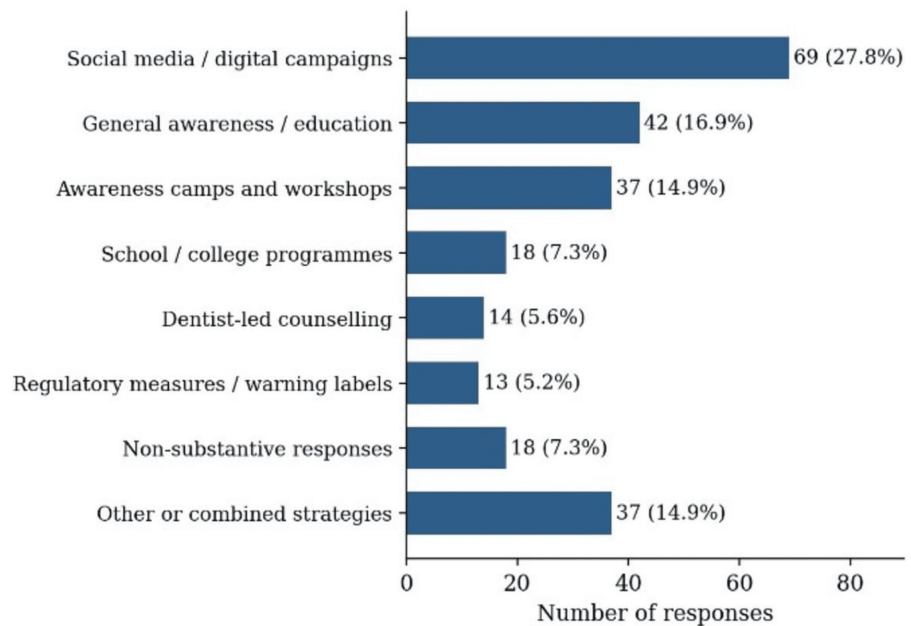


FIGURE 4: Suggested strategies to improve awareness of vaping's oral health effects (open-ended responses)

Discussion

This survey aimed to assess undergraduate dental students' understanding of the oral health consequences of vaping. Overall, awareness was high, with 96.4% of respondents who provided valid responses acknowledging that vaping can affect oral health. This finding aligns with the high familiarity with e-cigarettes reported among dental students in multinational and regional studies [11,12]. Most participants also recognized specific mechanisms, including a higher caries risk through dry mouth and sweetened e-liquids, impaired gum health and healing due to nicotine, and the role of nicotine in addiction. Important knowledge gaps remained. One in five students (20.2%) rejected the idea that a smoke-free product can still be harmful, about one in eight (11.7%) believed vaping has no side effects, and only 60.1% were aware of the e-cigarette ban in India. These findings highlight opportunities to reinforce targeted curricula and strengthen public health education among dental students.

The level of awareness we found is higher than that reported in some wider student populations. In a survey of college students in Chennai, 59.8% acknowledged that e-cigarette use affects oral health and 22.8% regarded e-cigarettes as absolutely healthy and safe [17], whereas only 3.6% of our respondents denied any effect on oral health. Clinical training in dentistry may help explain this, although this study did not directly measure curricular exposure and included no non-dental comparison group; differences in sampling and question wording between studies may also contribute. Among dental students, a multinational survey reported that most participants considered e-cigarettes harmful to health, yet a substantial minority regarded them as a better option for patients than tobacco products [11]. In Palestine, the average knowledge score of dental students was described as generally inadequate, and most rated the e-cigarette teaching they had received as insufficient [12]; a Saudi study likewise pointed to limited knowledge and confidence [10]. An earlier survey of dental students in Chennai reported that 77.3% were aware of e-cigarettes, but only 38% answered correctly about e-liquid composition [16], which suggests that awareness of the product does not guarantee knowledge of its contents or effects. Direct comparison between studies is difficult because questionnaires, populations, sampling approaches, and definitions of knowledge differ; our questionnaire was short and relied on prompted answers, so comparisons with those studies should be made cautiously.

The perceived relative harm of smoking and vaping warrants further consideration. Nearly three-quarters of students (73.8%) felt that smoking and vaping are equally harmful to oral health, while only 8.1% considered vaping more harmful than smoking. For comparison, in a January 2018 Chennai survey of dental students,

71.3% believed e-cigarettes were less harmful than conventional cigarettes [16]. The questions were worded differently, so the figures cannot be compared directly, but only 15.7% of our students judged smoking to be the more harmful habit. Greater publicity about vaping-related harms and the 2019 ban [13] may have shifted views, although our data cannot show this. Whether “equally harmful” is the right answer is not straightforward. The current literature suggests that, for smokers who switch completely, the benefits of stopping combustible tobacco may outweigh the oral risks of e-cigarettes, particularly in the short term, but that e-cigarettes are far from harmless in people who do not smoke [1]. Future dentists will need to hold both messages at once: vaping is not safe, and it is not identical to smoking. Our questionnaire did not separate these situations, and future surveys should address this.

Knowledge of specific mechanisms was encouraging. Most students identified sweeteners as the e-liquid component that provides fermentable sugars (83.5%) and agreed that vaping can raise caries risk (88.3%), which fits the laboratory evidence on sweet-flavored aerosols and the reviews linking e-cigarette use to dental and periodontal changes [3,4,6]; gaps in detailed knowledge of e-liquid composition of this kind have similarly been reported among young adults elsewhere [15]. Awareness of the periodontal effects of nicotine was similarly good (87.1%). A notable knowledge gap concerned the masking of gingival bleeding: nearly 30% of students were either unsure or disagreed that smoking can hide bleeding despite underlying periodontal disease. This is clinically important because nicotine users with apparently healthy, non-bleeding gingiva may still have active periodontal disease, which clinicians may fail to diagnose if they are unaware of this masking effect; another study concerns tobacco and nicotine products broadly, and combustible and noncombustible nicotine delivery may differ in their periodontal effects [7]. Dental students surveyed in Saudi Arabia and China have also shown incomplete recognition of this masking effect [10,20].

The open-ended responses provided additional insights. Although 88.3% agreed in the closed question that vaping increases caries risk, only 4.0% named caries as the single most important concern when asked in their own words. Periodontal problems (23.8%) and oral cancer (19.8%) came first, followed by dry mouth (12.5%). Although the study design cannot confirm this interpretation, the contrast suggests that spontaneous recall may be a more clinically relevant indicator than prompted recognition. The prominence of oral cancer as a perceived concern may reflect laboratory reports of the potentially genotoxic and carcinogenic effects of e-cigarette aerosol components [3]. However, clinical evidence in human users remains limited [1]. Therefore, students would benefit from learning to distinguish established risks from plausible risks. The range of concerns raised also reflects misconceptions and concerns about vaping-related harm documented among young adults elsewhere [2].

Awareness of the legal position was moderate and somewhat below the regulatory awareness reported among Indian adolescents in a qualitative study of e-cigarette perceptions and practices [14], and below the policy-specific knowledge gaps noted in a nationally representative Indian survey of related substance use [21]. Around 60% knew that e-cigarettes are banned, and only 54 of the 149 students who were aware of the ban (36.2%) chose 2019 as the year, a level of awareness broadly comparable to that reported among dental students surveyed outside India [22]. Part of the confusion may stem from how the prohibition was introduced: first through an ordinance in September 2019, then through an act passed in December 2019 [13]. Male students demonstrated greater awareness of the ban than female students (72.1% vs. 55.6%). However, no statistical significance testing or adjustment for potential confounders was performed. Furthermore, nearly three-quarters of the sample were female. Therefore, this observed difference should be interpreted descriptively and investigated in future studies. Differences in exposure to vaping culture or news about the ban may explain this, but our data cannot confirm them.

Attitudes toward professional responsibility were largely positive: 80.2% considered routine inquiry about vaping and counseling to be moderately or very important. This is reassuring, as dental teams can help patients stop using tobacco products [8]. When asked how to raise awareness among young people, students most often proposed social media and digital campaigns (27.8%), followed by general awareness and education efforts, camps and workshops, and college-based programs. Only 5.6% suggested dentist-led counseling during clinical visits. One possible interpretation is that students did not spontaneously identify the dental chair as a venue for this conversation. However, the question asked about awareness strategies for young people broadly, not specifically about clinical counseling settings, so this interpretation should be treated with caution. The suggested strategies broadly align with recommendations for multi-channel awareness campaigns made in comparable prevalence and perception surveys [23,24]. Interestingly, more than half of dental students in the Palestinian study reported social media as a source of information about e-cigarettes [12], supporting the idea that these platforms reach young people, including future clinicians.

Implications for dental education

Collectively, these findings suggest several opportunities for curricular improvement, although this study tested no educational intervention. Short, case-based educational content on the oral health effects of vaping could be incorporated into existing oral medicine, periodontology, and public health dentistry curricula, emphasizing nicotine-related masking of gingival inflammation and the differences between complete substitution for conventional smoking, dual use, and initiation among nonsmokers. Students could also be trained in brief tobacco and vaping cessation counseling and given a clear summary of the legal

status of e-cigarettes in India so that they can advise patients confidently.

Strengths and limitations

The study has several strengths, although these should be considered alongside its limitations. The sample of 248 students exceeded the calculated minimum, although this reflects convenience sampling rather than probability sampling, and the response rate (77.5%) should be considered alongside the sample size. Responses were anonymous, and the combination of closed- and open-ended questions, supported by an explicit coding framework, allowed us to examine both prompted knowledge and spontaneous concerns. The survey also covered legal awareness, which such studies rarely examine.

Several limitations should also be acknowledged. Convenience sampling at a single institution limits generalizability and introduces potential selection and nonresponse biases. Consequently, the reported percentages describe the study respondents and should not be interpreted as population prevalence estimates. Nearly three-quarters of respondents were female, and the year-of-study distribution was uneven. All data were self-reported and may be influenced by social desirability. The questionnaire used simple yes/no and multiple-choice items and did not include a validated knowledge score; we also did not ask about students' own tobacco or vaping habits, so we could not examine how personal use relates to knowledge. The investigators categorized the open-ended responses, which involves some subjective judgment, and did not calculate a formal intercoder agreement statistic. Formal questionnaire validation (e.g., a Content Validity Index) was not performed beyond expert review and pilot testing; a small number of items combine more than one construct, and the effects of personal tobacco or vaping history cannot be separated from those of curricular exposure with this design. The cross-sectional design cannot show whether awareness changes over the course of training. Future multicenter studies using validated instruments and follow-up after educational interventions would strengthen these findings.

Conclusions

Undergraduate dental students in this survey reported high awareness that e-cigarette use can harm oral health and recognized several of the mechanisms involved, including caries risk, impaired gum healing, and nicotine addiction. Most also considered routine questioning and counseling about vaping to be an important part of their future role. Important gaps remained, however: a minority believed that vaping is free of side effects or that the absence of smoke means the absence of harm; many were unaware that smoking can mask gingival bleeding; and awareness of the legal ban on e-cigarettes in India was incomplete.

These findings identify specific areas for curricular improvement. Brief, case-based content on the oral effects of vaping, the diagnostic pitfalls of nicotine exposure, and the legal status of e-cigarettes could be added to existing teaching, alongside practical training in tobacco and vaping cessation counseling. Future multicenter studies using validated instruments and follow-up assessments after educational interventions could help determine whether such changes improve student knowledge and confidence, potentially strengthening future patient counseling.

Appendices

Survey questionnaire

Table 4 presents the full survey questionnaire, including the demographic section and the 13 items assessing knowledge, awareness, and attitude described in the Materials and Methods section.

No.	Item	Response options	Domain
Section 1: demographic information			
1	Age (years)	Numeric entry	Demographic
2	Gender	Male/female/prefer not to say	Demographic
3	Year of study	First year/second year/third year/fourth year/intern	Demographic
Section 2: Knowledge, awareness, and attitudes			
4	Do you think vaping can affect oral health?	Yes/no	Knowledge
5	Which of the following do you think is more harmful to oral health?	Smoking/vaping/both are equally harmful/neither/don't know	Attitude
6	Can vaping increase the risk of dental caries due to dry mouth and certain e-liquid ingredients?	Yes/no/not sure	Knowledge
7	Which component of e-liquid may contribute to tooth decay by providing fermentable sugars?	Sweeteners/fluoride/calcium/protein	Knowledge
8	Can nicotine in e-cigarettes affect gum health and healing?	Yes/no/not sure	Knowledge
9	Smoking can mask gingival bleeding despite the presence of periodontal disease.	Yes/no/not sure	Knowledge
10	The absence of tobacco smoke does not necessarily mean that e-cigarettes are harmless to oral health.	Yes/no/not sure	Knowledge
11	Which substance in most e-cigarettes is responsible for addiction?	Nicotine/caffeine/fluoride/calcium	Knowledge
12	As a future dental professional, how important do you think it is to routinely ask patients about vaping/e-cigarette use and counsel them about its potential oral health effects?	I don't think there are any side effects of vaping/use of e-cigarettes/slightly important/moderately important/very important	Attitude
13	Are you aware that e-cigarettes are banned in India?	Yes/no/not sure	Awareness
14	If yes, in which year were e-cigarettes banned in India?	2018/2019/2020/2021/don't know	Awareness
15	In your opinion, what is the most important oral health concern associated with vaping/e-cigarette use?	Open-ended	Awareness
16	What could be done to improve awareness among young people about the potential oral health effects of vaping?	Open-ended	Attitude

TABLE 4: Survey questionnaire on knowledge, awareness, and attitudes regarding e-cigarette use and oral health

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Madhura Mahajan, Aarya A. Patil, Ashwinirani SR, Kamala KA, Nomaan A. Shamlik

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Disclosures

Human subjects: Informed consent for treatment and open access publication was obtained or waived by all participants in this study. Institutional Ethics Committee of Krishna Vishwa Vidyapeeth (Deemed to be University) issued approval 139/2026-2027. **Animal subjects:** All authors have confirmed that this study did not involve animal subjects or tissue. **Conflicts of interest:** In compliance with the ICMJE uniform disclosure form, all authors declare the following: **Payment/services info:** All authors have declared that no financial support was received from any organization for the submitted work. **Financial relationships:** All authors have declared that they have no financial relationships at present or within the previous three years with any organizations that might have an interest in the submitted work. **Other relationships:** All authors have declared that there are no other relationships or activities that could appear to have influenced the submitted work.

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