ORIGINAL ARTICLE

Laser Technology Utilization and Its Role in Restorative and Cosmetic Dentistry

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Abstract

Introduction: Since its introduction into dentistry in the 1960s, laser technology has evolved from experimental tools to advanced systems with applications in both soft- and hard-tissue procedures. In restorative and cosmetic dentistry, lasers are used for cavity preparation, gingival contouring, tooth whitening, and precise soft-tissue management, offering high precision, minimal invasiveness, and faster recovery. **Objectives:** The objective of this study was to evaluate the knowledge, attitudes, and practices (KAPs) of dental students, interns, and practicing dentists toward the utilization and clinical role of laser technology in restorative and cosmetic dentistry. **Methods:** This cross-sectional study was conducted between July 2025 and December 2025 to assess the KAPs regarding the utilization and role of laser technology in restorative and cosmetic dentistry among dental students, interns, and practicing dentists. Data were collected through a self-structured, anonymous, self-administered questionnaire in English. The questionnaire was developed after reviewing relevant studies conducted in Saudi Arabia and internationally to ensure content validity. **Results:** A total of 678 responses were analyzed. Participants were predominantly aged 17–24 years (48.4%) or 25–29 years (46.8%), and nearly half were undergraduate students (47.8%). Although 97.6% of participants reported knowing what a laser is, formal education was limited: 50.9% of participants received 0 h of laser education, and only 34.8% reported previous laser practice. Interest was high (78.2%), and most participants (70.4%) believed both theoretical and practical training are needed. Overall knowledge was low in 89.7% of respondents, with only 0.6% of participants achieving high overall knowledge. Knowledge was lowest in operative dentistry (86.6% low) and endodontics (79.4% low), whereas higher performance was observed in pediatric/orthodontics (16.5% high) and laser safety (17.6% high). Education/practice level was significantly associated with gender, age, education, workplace, and experience ($P < 0.05$). **Conclusion**: Despite high awareness and strong interest in laser dentistry, Saudi dental trainees and practitioners demonstrate insufficient formal education, limited practice exposure, and generally low knowledge, supporting the urgent need for improved curricular integration and structured continuing education.

Key words: Cosmetic dentistry, dentists, knowledge, attitude, practice, laser technology, restorative dentistry, Saudi Arabia

INTRODUCTION

The upcoming new technologies in all fields of science, including dentistry, are growing rapidly and luxuriantly day-by-day.[1] Dental lasers are one of the most significant developments in modern dentistry.[2] Today, dental lasers have gained wide attention for the use of both soft tissue and hard tissue dentistry. Lasers can be used on hard tissues for caries detection, caries

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prevention, cavity preparation, dentinal hypersensitivity, bleaching, restoration removal, laser Doppler flowmetry, and in digital radiography.[3] Laser dentists and patients frequently report that the application of mid-IR wavelengths during cavity preparation can be accomplished without any associated discomfort.[4] Finally, the effectiveness of dental lasers in detecting cavities has been confirmed by Brazilian dentists.[5]

The acronym LASER denotes light amplification through stimulated emission of radiation, a concept first articulated in a scholarly article published in 1959 by graduate student Gordon Gould at Columbia University.[6] In operative dentistry, certain laser wavelengths can induce the melting of dentinal surfaces through heat generation, which may be beneficial in addressing dental hypersensitivity.[7]

According to the study's findings, most dentists heard about lasers through continuing education courses. This suggests that the UG program needs to incorporate laser education. The main disadvantage of laser dentistry, even though many dentists are interested in it, is its high cost. When fully utilized, laser technology has the potential to transform dentistry in terms of diagnosis, prevention, and treatment planning, giving patients the best possible care. Reducing the production costs of lasers while maintaining acceptable standards should enable their exponential use in this technological age.[8]

The majority of dental students are interested in dental lasers and would like to learn more about them both theoretically and practically. Furthermore, most of them pursued specialized dental laser courses throughout their undergraduate studies. This further demonstrates that most of their dental laser knowledge came from undergraduate courses in oral surgery, periodontal therapy, and operative dentistry. Among them, diode and carbon dioxide (CO_2) lasers were the most well-known laser types.[2]

A total of 344 persons answered the online survey. Upon grouping the participants based on gender, it was discovered that 62% ($n = 214$) were men and 38% ($n = 130$) were women. In addition, 68% ($n = 233$) of the participants were general practitioners, 29% ($n = 100$) were specialists, and 3% ($n = 10$) were advisers based on their classification. In addition, it was discovered that 78% ($n = 266$) of the participants had 1–3 years of experience, 16% ($n = 54$) had 4–6 years, 5% ($n = 16$) had 7–10 years, and 2% ($n = 13$) had more than 10 years.[5]

The general level of laser utilization skill among dentists was found to be below average. The dentists' level of expertise was unaffected by their gender. In addition, the task designation had nothing to do with the level of skill, and dentists with less work experience had a higher level of laser usage expertise.[5]

A comprehensive understanding of laser physics, operation, various laser types, and their appropriate applications was essential for safe and effective clinical practice. This survey aims to assess the educational level and knowledge regarding laser applications among dental specialists, interns, students, and practitioners. It addresses the growing availability of new dental technologies and the corresponding need for enhanced education and training. This article also highlights the role of lasers in restorative and cosmetic dentistry, emphasizing their clinical value.

Objectives

The objective of this study was designed to determine the level of knowledge, attitudes, and practice (KAP) regarding the utilization and role of laser technology in restorative and cosmetic dentistry.

METHODS

Study design, setting, and participants

This cross-sectional study was conducted between July 2025 and December 2025 in Saudi Arabia using a structured questionnaire developed by the authors to determine the level of KAP regarding the utilization and role of laser technology in restorative and cosmetic dentistry among dental specialists, interns, students, and dentists who might be male or female with age most likely between 30 and 39 for specialist whereas general practitioners mostly between 25 and 29, and a range of 19 and 24 for students. A sample-acquiring approach was utilized on social media platforms (WhatsApp, Facebook, Snapchat, and Instagram) to recruit individuals from Saudi Arabia.

Sample size

The minimum required sample size for this study was calculated to estimate the overall awareness and application of artificial intelligence tools in prosthodontic treatment planning among dental students and practitioners in Saudi Arabia. The calculation was performed using the Raosoft sample size calculator (Raosoft, Inc., Seattle, WA, USA), assuming an indicator proportion of 50%, a 5% margin of error, and a 95% confidence interval. The formula applied was:

$$n = (Z^2 \times P[1\text{-}P])/E^2$$

Where $Z = 1.96$ for a 95% confidence level, $P = 0.50$, and $E = 0.05$. Substituting these values yielded a minimum required sample size of 384 participants. To compensate for a possible non-response rate of 10%, the final target sample size was increased to 422 participants.

Inclusion and exclusion criteria

The inclusion criteria were dental specialists, interns, students, and dentists who are currently working or studying. All respondents who neglected to execute the informed consent form were excluded from the study, as well as those people outside the dental field or living in a country other than Saudi Arabia.

Method for data collection, instrument

A structured questionnaire was used as a study tool. This tool was developed after consulting relevant studies conducted in Saudi Arabia and elsewhere. The final version of the questionnaire is classified into two main parts.

The first part of the questionnaire consisted of demographics, then 7 items regarding the students' dental laser education and practice.

The demographic part gave information about the respondents' backgrounds by including information on their gender, educational institution, years of work experience, and place of employment, then 7 items regarding the students' dental laser education and practice.

The second part consisted of 32 items in 5 sections. Each section contained several items related to the uses of lasers in 5 different dental specialties (operative dentistry [12 items], endodontic [5 items], periodontic [5 items], and pediatric dentistry/orthodontic [5 items], in addition to some items in laser protection [5 items]). With the goal of reaching as many eligible participants as possible, the survey was distributed through well-known channels such as Facebook, Instagram, WhatsApp, and email. The questionnaire's goal was explained in an introduction statement, and then participants were reassured that participation was voluntary and that answers would be kept anonymous in an informed consent section.[2]

Scoring system

Part 1: Level of education and practice

A survey with seven questions has been used to determine the level of education and practice. The total knowledge score was between 0 and 7.

The overall level of knowledge was calculated by applying Bloom's cutoff point. Those with a high level scored 80–100%, those with an intermediate level scored 60–79%, and those with a low level scored <60%.

Part 2: Assessment the level of knowledge

The level of knowledge was 32 questions divided into five subsections. The total level of knowledge score was assessed using the same Bloom's cutoff point as high awareness if the score was 80–100%, intermediate if the score was 60–79%, and low awareness if the score was <60%. Furthermore, a score should be calculated using the same cutoff percentages for each of the five knowledge areas or subsections.

Pilot test

The questionnaire was distributed to 20 people and asked them to complete it. This was done to assess the questionnaire's simplicity and feasibility for the study. The pilot study data were excluded from the final study results.

Analyzes and entry method

The gathered data were initially recorded using Microsoft Excel (2016 edition for Windows). Thereafter, the dataset was exported to the Statistical Package for the Social Sciences, version 20, for comprehensive statistical processing and analysis.

RESULTS

A total of 678 completed questionnaires were included in the analysis. Scores were categorized using modified Bloom's cutoffs as specified in the provided scoring sheet (high = 80–100%, intermediate = 60–79%, low <60%). As shown in Table 1, participants were almost evenly distributed by gender (52.1% females and 47.9% males). Most respondents were young adults: 48.4% of participants were aged 17–24 years, and 46.8% of participants were aged 25–29 years, with only 4.0% of participants aged 30–39 and 0.9% of participants aged ≥40. Nearly half of the sample were undergraduate dental students (47.8%), followed by interns (18.1%) and general practitioners (17.6%). The dominant workplace/affiliation was academic settings (67.6%), and most participants reported either no clinical experience (35.0%) or 0–5 years of experience (46.9%).

Table 2 indicates high self-reported awareness of lasers in dentistry, as 97.6% of participants answered that they know what a laser is. However, formal exposure was limited: 50.9% of participants reported receiving 0 h of laser education, 44.1% of participants reported 1–4 h, and only 5.0% reported >4 h. Only 34.8% of participants had previously practiced dental laser use, yet interest was high, with 78.2% of participants expressing interest in laser dentistry. Most respondents (70.4%) believed that both theoretical and practical education are needed. For the "select all that apply" items, the most frequently selected courses for laser education were periodontics (54.6%) and operative dentistry (50.1%). The best-known laser type was the diode laser (71.7%), followed by erbium, chromium-doped yttrium scandium gallium garnet (64.6%), and CO_2 (62.1%); option-level percentages overlap by design.

Table 1: Sociodemographic characteristics of study participants (*n*=678)

Parameter	No.	Percentage
Gender		
Female	353	52.1
Male	325	47.9
Age group		
17–24	328	48.4
25–29	317	46.8
30–39	27	4.0
≥40	6	0.9
Education		
Undergraduate	324	47.8
Intern	197	29.1
General practitioner	96	14.2
Resident	36	5.3
Specialties	25	3.7
Workplace		
Academic	458	67.6
Governmental	146	21.5
Private	74	10.9
Years of experience		
None	237	35.0
0–5	396	58.4
6–10	31	4.6
11–15	9	1.3
≥16	5	0.7

As detailed in Table 3, within operative dentistry applications, "caries removal" (63.0%) and "cavity preparation" (58.4%) were the most frequently selected uses, whereas fewer participants selected "tooth bleaching" (21.8%) or "dentin desensitization" (25.1%). For the operative true/false (or yes/no) statements, correct response rates varied widely; for example, 71.7% of participants correctly agreed that lasers can be used for cavity preparation; however, but only 19.8% of participants correctly rejected the statement that hard-tissue lasers are not suitable for enamel etching, and only 19.3% of participants correctly rejected the statement about higher microleakage. In the periodontics subsection, the most commonly selected clinical uses were "treatment of periodontal pockets" (52.4%) and "gingival depigmentation" (48.1%). Although 67.8% correctly agreed that laser use may promote better gingival healing and 66.2% agreed that laser surgery can reduce treatment time with faster healing, a major misconception was observed regarding flap surgery, with only 15.8% correctly rejecting the contraindication statement. Across multiple items, substantial "I don't know" responses indicate uncertainty in several knowledge areas.

Table 2: Frequency distribution of responses to the education and practice questionnaire items (*n*=678)

Parameter	No.	Percentage
Do you know what is laser?		
Yes	662	97.6
No	16	2.4
How many hours of dental laser education have you received?		
0	345	50.9
1–4	299	44.1
>4	34	5.0
Had previous dental laser practice?		
Yes	236	34.8
No	442	65.2
Are you interested in dental laser dentistry?		
Yes	530	78.2
No	148	21.8
What type of dental laser education do you think is needed?		
Theoretical	95	14.0
Practical	78	11.5
Both	477	70.4
No need	28	4.1
Which dental courses should have laser education included?		
Endodontics	257	37.9
Oral surgery	308	45.4
Pediatric dentistry/orthodontics	155	22.9
Periodontics	370	54.6
Operative dentistry	340	50.1
Others	108	15.9
Which types of dental lasers do you know?		
CO_2	421	62.1
Er: Cr: YSGG	438	64.6
Diode	486	71.7
Er: YAG	275	40.6
Nd: YAG	211	31.1
Argon	102	15.0
None	14	2.1

CO_2: Carbon dioxide, Er: Cr: YSGG: Erbium, chromium-doped yttrium scandium gallium garnet, Er: YAG: Erbium-doped yttrium aluminum garnet, Nd: YAG: Neodymium-doped yttrium aluminum garnet

Table 4 summarizes the remaining knowledge items. In endodontics, the most frequently selected laser application was disinfection of root canals (51.5%), followed by irrigant activation (31.6%) and root canal shaping (23.6%), whereas diagnosis of pulp vitality was less frequently selected (18.4%).

Table 3: Frequency distribution of responses to the first two knowledge items (operative dentistry and periodontics) (*n*=678)

Parameter	No.	Percentage
Operative dentistry: Dental laser can be used for/to		
Caries detection	216	31.9
Caries prevention	160	23.6
Caries removal	427	63.0
Composite	71	10.5
Dentin desensitization	170	25.1
Eliminate the noise of the handpiece	315	46.5
Enamel etching	123	18.1
Lessen the need for local anesthesia	342	50.4
Removal of the smear layer	146	21.5
Whitening the teeth	281	41.4
Lasers can be used for cavity preparation in restorative dentistry		
True	486	71.7
False	73	10.8
I don't know	119	17.6
Hard tissue lasers are not suitable for enamel etching		
True	210	31.0
False	134	19.8
I don't know	334	49.3
Laser use in restorative dentistry can reduce the need for anesthesia		
True	392	57.8
False	87	12.8
I don't know	199	29.4
Lasers can replace high-speed handpieces in all types of cavity preparations		
True	223	32.9
False	235	34.7
I don't know	220	32.4
Using lasers for caries removal is slower than using traditional rotary instruments		
True	308	45.4
False	147	21.7
I don't know	223	32.9
Er: YAG lasers are commonly used for hard tissue procedures		
True	272	40.1
False	61	9.0
I don't know	345	50.9
Laser-prepared cavities show higher microleakage compared to conventional methods		
True	187	27.6
False	131	19.3
I don't know	360	53.1
Lasers can modify the dentin surface to improve the bonding of restorations		
Yes	280	41.3
No	81	11.9
I don't know	317	46.8
Laser use in restorative dentistry is completely risk-free		
Yes	202	29.8
No	220	32.4
I don't know	256	37.8
Lasers can sterilize the cavity preparation site during restorative procedures		
True	313	46.2
False	63	9.3
I don't know	302	44.5
Periodontics: A dental laser can be used for		
Accelerating wound healing	279	41.2
Bleeding arrest	388	57.2
Bone recontouring	203	29.9
Eliminating suturing and dressing	257	37.9
Frenectomy	495	73.0
Reducing swelling and discomfort	180	26.5
Soft tissue curettage	254	37.5
Surgical treatment of large vascular lesions	245	36.1
Lasers can be used for the treatment of periodontal pockets		
True	394	58.1
False	74	10.9
I don't know	210	31.0
Laser surgery reduces treatment time and has faster healing		
True	449	66.2
False	78	11.5
I don't know	151	22.3
All laser types are equally effective in periodontal therapy.		
True	158	23.3
False	246	36.3
I don't know	274	40.4
Laser use in periodontics may promote better healing of the gingival tissues		
True	460	67.8
False	60	8.8
I don't know	158	23.3
Lasers are contraindicated for use in periodontal flap surgeries		
True	247	36.4
False	107	15.8
I don't know	324	47.8

Er: YAG: Erbium-doped yttrium aluminum garnet

Table 4: Frequency distribution of responses to knowledge items (endodontics, pediatric/orthodontics, and laser safety subsections) (*n*=678)

Parameter	No.	Percentage
Endodontics: A dental laser can be used for		
Diagnosis of pulp vitality	320	47.2
Direct and indirect pulp capping	176	26.0
Drying of the root canal	312	46.0
Root canal disinfection	374	55.2
Lasers can be used to disinfect root canals during endodontic treatment		
True	411	60.6
False	46	6.8
I don't know	221	32.6
Diode lasers are ineffective in endodontic procedures		
Yes	193	28.5
No	126	18.6
I don't know	359	52.9
The use of lasers in endodontics can improve the cleaning of complex canal anatomy		
Yes	344	50.7
No	47	6.9
I don't know	287	42.3
Laser-assisted irrigation eliminates the need for chemical irrigants entirely		
True	197	29.1
False	164	24.2
I don't know	317	46.8
Pediatric dentistry/Orthodontics: A dental laser can be used for		
Behavior management in children	382	56.3
Etching enamel for orthodontic bracket	374	55.2
Pulpectomy in primary teeth	206	30.4
Pulpotomy in primary teeth	220	32.4
Lasers can be used for gingival contouring in orthodontic cases		
Yes	507	74.8
No	46	6.8
I don't know	125	18.4
Laser procedures are more traumatic for pediatric patients compared to conventional methods		
Yes	231	34.1
No	213	31.4
I don't know	234	34.5
Lasers can assist in the exposure of unerupted teeth during orthodontic treatment		
Yes	369	54.4
No	60	8.8
I don't know	249	36.7
Children usually require general anesthesia when undergoing laser dental procedures		
Yes	233	34.4
No	210	31.0
I don't know	235	34.7
Laser protection and safety: Dental laser		
Cannot be used with alcohol based materials	203	29.9
Cannot be used with oil-based lip products	199	29.4
May damage the cornea and burn the retina	430	63.4
Skin and eyes should be protected when using a laser	513	75.7
Protective eyewear is mandatory for both patient and clinician during laser use		
True	536	79.1
False	49	7.2
I don't know	93	13.7
All dental personnel can operate lasers without specialized training		
True	222	32.7
False	326	48.1
I don't know	130	19.2
Laser safety protocols are optional if the laser is low power		
True	181	26.7
False	254	37.5
I don't know	243	35.8
Laser plume may contain harmful biological particles that require evacuation		
True	258	38.1
False	67	9.9
I don't know	353	52.1

While 60.6% of participants correctly recognized that lasers can disinfect root canals, only 18.6% of participants correctly rejected the misconception that diode lasers are ineffective in endodontics, and only 24.2% of participants correctly rejected the claim that laser-assisted irrigation eliminates the need for chemical irrigants. In pediatric dentistry/orthodontics, over half selected lasers for behavior management in children (56.3%) and etching enamel for orthodontic brackets (55.2%). The statement that lasers can be used for gingival contouring in orthodontic cases had the highest correct rate in this subsection (74.8%), whereas misconceptions persisted about trauma and anesthesia requirements (correct rates ~31%). Regarding protection and safety, most respondents selected that skin/eyes should be protected (75.7%) and that lasers may damage the cornea/retina (63.4%). Although 79.1% correctly affirmed that protective eyewear is mandatory,

fewer participants correctly rejected unsafe practices such as operating lasers without specialized training (48.1% correct) or treating safety protocols as optional at low power (37.5% correct).

As shown in Table 5, most participants demonstrated knowledge levels that were generally low across domains, particularly in operative dentistry (86.6% low) and endodontics (79.4% low). Relatively better performance was observed in pediatric/orthodontic knowledge and laser safety, where 16.5% and 17.6%, respectively, reached the high level.

Figure 1 shows an intermediate level of education and practice (53.4%), whereas 43.1% were classified as low, and only 3.5% as high.

Figure 2 indicates that all 32 knowledge items were aggregated into a single overall knowledge score. Based on this score, 89.7% of participants were classified as having low knowledge, 9.7% as intermediate, and only 0.6% as high. As expected, the proportion of participants with a "high" overall knowledge level is lower than those achieving a "high" score in individual subsections, as the overall classification requires consistently strong performance across all knowledge domains rather than high performance in a single domain.

Table 5: Distribution of participants by proficiency level for each scoring system (*n*=678)

Parameter	Frequency	Percentage
Level of education and practice		
Low level	292	43.1
Intermediate level	362	53.4
High level	24	3.5
Operative dentistry knowledge		
Low level	587	86.6
Intermediate level	77	11.4
High level	14	2.1
Periodontics knowledge		
Low level	527	77.7
Intermediate level	125	18.4
High level	26	3.8
Endodontics knowledge		
Low level	538	79.4
Intermediate level	95	14.0
High level	45	6.6
Pediatric dentistry/Orthodontics knowledge		
Low level	463	68.3
Intermediate level	103	15.2
High level	112	16.5
Laser protection and safety knowledge		
Low level	421	62.1
Intermediate level	138	20.4
High level	119	17.6
Overall knowledge (32 questions)		
Low level	608	89.7
Intermediate level	66	9.7
High level	4	0.6

Chi-square analysis [Table 6] demonstrated statistically significant associations between education/practice level and several sociodemographic characteristics. Education/practice level differed by gender ($P < 0.001$), with males representing 75.0% of the high category despite comprising 47.9% of the sample. Age group was also significant ($P < 0.001$), indicating progressively higher education/practice levels among older participants. Educational status showed a strong association ($P < 0.001$); for example, specialists exhibited the highest proportion of higher education/practice (28.0%), whereas only 0.9% of undergraduates fell into the high category. Workplace/affiliation showed a smaller but significant association ($P = 0.037$), with private-sector respondents having a relatively higher proportion of higher education/practice compared with academic respondents. Finally,

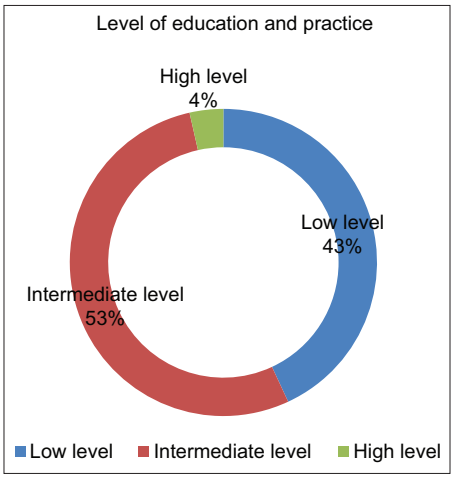

Figure 1: Distribution of education and practice level (*n* = 678)

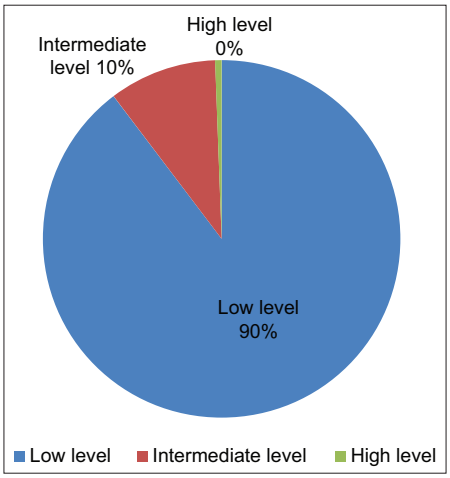

Figure 2: Distribution of overall knowledge level (*n* = 678)

Table 6: Association between sociodemographic variables and education/practice level (Chi-square test) (*n*=678)

Parameters	Category	Education and practice level			Total (*n*=678) (%)	*P*-value*
		Low (%)	Intermediate (%)	High (%)		
Gender	Female	182 (62.3)	165 (45.6)	6 (25.0)	353 (52.1)	0.0001
	Male	110 (37.7)	197 (54.4)	18 (75.0)	325 (47.9)	
Age group	17–24	185 (63.4)	137 (37.8)	6 (25.0)	328 (48.4)	0.0001
	25–29	99 (33.9)	207 (57.2)	11 (45.8)	317 (46.8)	
	30–39	6 (2.1)	16 (4.4)	5 (20.8)	27 (4.0)	
	≥40	2 (0.7)	2 (0.6)	2 (8.3)	6 (0.9)	
Education	Undergraduate	170 (58.2)	151 (41.7)	3 (12.5)	324 (47.8)	0.0001
	Intern	73 (25.0)	120 (33.1)	4 (16.7)	197 (29.1)	
	General practitioner	33 (11.3)	56 (15.5)	7 (29.2)	96 (14.2)	
	Resident	11 (3.8)	22 (6.1)	3 (12.5)	36 (5.3)	
	Specialties	5 (1.7)	13 (3.6)	7 (29.2)	25 (3.7)	
Workplace/ affiliation	Academic	206 (70.5)	240 (66.3)	12 (50.0)	458 (67.6)	0.037
	Governmental	57 (19.5)	84 (23.2)	5 (20.8)	146 (21.5)	
	Private	29 (9.9)	38 (10.5)	7 (29.2)	74 (10.9)	
Years of experience	None	112 (38.4)	125 (34.5)	0 (0.0)	237 (35.0)	0.0001
	0–5	160 (54.8)	219 (60.5)	17 (70.8)	396 (58.4)	
	6–10	15 (5.1)	14 (3.9)	2 (8.3)	31 (4.6)	
	11–15	3 (1.0)	1 (0.3)	5 (20.8)	9 (1.3)	
	≥16	2 (0.7)	3 (0.8)	0 (0.0)	5 (0.7)	

*$P \leq 0.05$ was considered statistically significant

years of experience were strongly associated with education/practice level ($P < 0.001$), consistent with increased exposure and training over time.

As presented in Table 7, overall knowledge level was significantly associated with age group ($P < 0.001$), educational status ($P < 0.001$), and years of experience ($P < 0.001$), suggesting that higher training and longer clinical exposure are linked with higher knowledge scores. In contrast, overall knowledge did not significantly differ by gender ($P = 0.410$) or workplace/affiliation ($P = 0.176$). Interpretation should consider that the "high" overall knowledge category was rare (0.6%, $n = 4$), which can reduce the stability of expected cell counts for Chi-square testing; nevertheless, the observed pattern consistently favored higher knowledge with greater educational attainment and experience.

DISCUSSION

The present cross-sectional study aimed to evaluate the KAPs of dental students, interns, and practitioners in Saudi Arabia regarding the clinical aspects of lasers in restorative and cosmetic dentistry. Although laser technology has been incorporated into dentistry for over 50 years, the adoption of the technology is very much reliant on clinician awareness and training. The purpose of our study was thus to check the awareness and self-reported competence of various professional groups, and to identify factors that correlate with greater or lesser competence. Findings were then contrasted against those of similar surveys and evidence on clinical outcomes of laser-assisted procedures.

Overall knowledge and practice were low despite almost universal awareness of lasers. Nearly all of the respondents were aware of the definition of a laser (97.6%); however, half of the respondents reported being educated in lasers for 0 h, and only about one-third had ever used lasers in practice. Only 0.6% had a high overall knowledge score, whereas 89.7% were classified as low. Nonetheless, there was high interest; 78.2% wished to incorporate lasers into their practice, and most felt that both theoretical and practical teaching were required. Moreover, comparable KAP studies reveal similar gaps. In a survey of 200 dentists in Saudi Arabia from the region of Al-Kharj, 80% were aware of laser dentistry; however, only 37.5% had received formal training; the most familiar type of laser was the diode laser, and the high cost of equipment and lack of training were the major barriers.[9] A survey of 263 dental students and professionals in Pakistan in 2025 revealed 61.6% were familiar with laser application; however, only 25.1% had practical experience. Most respondents reported lasers as enhancing precision and patient comfort, whereas 78.0% reported the cost of equipment, and 57.4% lack of training as a major barrier.[10] These results suggest that even in other parts of the world,

Table 7: Association between sociodemographic variables and overall knowledge level (Chi-square test) (*n*=678)

Parameters	Category	Overall knowledge level			Total (*n*=678) (%)	*P*-value*
		Low (%)	Intermediate (%)	High (%)		
Gender	Female	312 (51.3)	38 (57.6)	3 (75.0)	353 (52.1)	0.410
	Male	296 (48.7)	28 (42.4)	1 (25.0)	325 (47.9)	
Age group	17–24	297 (48.8)	29 (43.9)	2 (50.0)	328 (48.4)	0.0001
	25–29	286 (47.0)	29 (43.9)	2 (50.0)	317 (46.8)	
	30–39	23 (3.8)	4 (6.1)	0 (0.0)	27 (4.0)	
	≥40	2 (0.3)	4 (6.1)	0 (0.0)	6 (0.9)	
Education	Undergraduate	302 (49.7)	19 (28.8)	3 (75.0)	324 (47.8)	0.0001
	Intern	178 (29.3)	18 (27.3)	1 (25.0)	197 (29.1)	
	General practitioner	80 (13.2)	16 (24.2)	0 (0.0)	96 (14.2)	
	Resident	31 (5.1)	5 (7.6)	0 (0.0)	36 (5.3)	
	Specialties	17 (2.8)	8 (12.1)	0 (0.0)	25 (3.7)	
Workplace/affiliation	Academic	417 (68.6)	37 (56.1)	4 (100.0)	458 (67.6)	0.176
	Governmental	126 (20.7)	20 (30.3)	0 (0.0)	146 (21.5)	
	Private	65 (10.7)	9 (13.6)	0 (0.0)	74 (10.9)	
Years of experience	None	221 (36.3)	14 (21.2)	2 (50.0)	237 (35.0)	0.0001
	0–5	352 (57.9)	43 (65.2)	1 (25.0)	396 (58.4)	
	6–10	27 (4.4)	3 (4.5)	1 (25.0)	31 (4.6)	
	11–15	5 (0.8)	4 (6.1)	0 (0.0)	9 (1.3)	
	≥16	3 (0.5)	2 (3.0)	0 (0.0)	5 (0.7)	

*$P \leq 0.05$ was considered statistically significant

awareness is high; however, the capacity to use lasers is limited by training opportunities and cost.

Demographic factors had a great impact on knowledge and practice in the current study. Males and the elderly were more likely than others to be in the higher education/practice category, and knowledge levels were higher with professional rank and years of experience. These associations are similar to comments gathered from other surveys. The study of Al-Kharj found that older and more experienced dentists were much more familiar with lasers and more willing to incorporate them into practice.[9] Similar trends were observed for Pakistan, where dental professionals had much higher awareness and use of lasers compared to dental undergraduates.[10] Younger members of our group may thus have little exposure to laser technology while in dental school, which highlights the need for early curricular integration.

Knowledge gaps were specifically high in the area called operative dentistry. While a majority of respondents knew that lasers can be used in caries removal (63%) and cavity preparation (58.4%), only about one-fifth correctly rejected the statement that hard tissue lasers are unsuitable for enamel etching or that laser-prepared cavities have a higher microleakage rate. Participants were unclear on the effect of laser preparation on bonding and microleakage, indicating conflicting literature. Although some *in vitro* studies have shown that selective acid etching may still yield superior results in terms of the integrity of the margins than Er,Cr: YSGG laser etching. In a study comparing phosphoric acid with Er,Cr: YSGG laser conditioning, occlusal margins etched with phosphoric acid had less microleakage than those etched with lasers; laser conditioning enhanced the bonding of a universal adhesive but was less effective for self-etch adhesives.[11] The study concluded that phosphoric acid etching enhanced the performance of self-etch systems while laser conditioning had a positive effect for some universal adhesives.[11] These results support the results of the uncertainty of enamel etching in our participants. On the other hand, lasers provide advantages in operative dentistry, including precision caries removal, fewer vibrations and noises, and a reduction in the use of local anesthesia; in a review of clinical applications, laser procedures are reported to be less invasive and in many cases do not require local anesthesia, leading to a better patient experience.[12] The same review states that lasers sterilize the operative field, minimize collateral damage, and are particularly useful in minimally invasive cavity preparation.[12] Such advantages may be the reason why 57.8% of respondents correctly agreed that the use of lasers reduces the necessity of anesthesia, despite many not appreciating the differences in microleakage or etching.

Periodontics knowledge was somewhat higher: The answers were the most frequent choice of treatment of periodontal pockets and depigmentation of the gums. Two-thirds agreed that treatment time can be reduced with laser surgery and

that treatment outcomes and healing can be improved. However, only 15.8% correctly rejected that lasers are contraindicated for flap surgery, and many believed that all types of lasers are equally effective. There is evidence that lasers can be useful adjuncts to scaling and root planing, but are not universally interchangeable. A mini review on laser technology in the field of periodontal treatment in 2025 states that lasers provide the advantage of specific targeting of infected areas and the ability to penetrate deep pockets better than mechanical tools, the minimally invasive characteristic means less patient discomfort and faster healing, and the pre-photocoagulation of diode lasers helps to reduce the vascular component during surgery.[13] Randomized controlled trials have proven that adjunctive high-intensity diode lasers offer superior clinical results to scaling alone, and erbium-doped yttrium aluminum garnet (Er: YAG) and neodymium-doped yttrium aluminum garnet (Nd: YAG) lasers significantly reduce periodontal pathogens.[13] Therefore, lasers are not contraindicated in periodontal flap surgery; however, their usage should be according to appropriate protocols. Our participants' uncertainty in the efficacy of various types of lasers highlights the need for specific education in clinical indications, laser parameters, and adjunctive use with conventional therapy.

In endodontics, more than half of the participants knew that root canal disinfection would be an indication for lasers, but only one-fifth of them correctly rejected the statement that diode lasers have no effect. Furthermore, many held that the laser-assisted irrigation eliminates the need for chemical irrigants. Contemporary evidence is the opposite of these misconceptions. A systematic review focusing on Er: YAG laser-assisted irrigation of the tooth evaluated fifteen studies. It showed that the use of laser significantly improved root canal disinfection relative to the use of conventional or ultrasonic methods, laser-activated photoacoustic streaming and shock-wave enhanced emission photoacoustic streaming produced better bacterial reduction, and the use of lower sodium hypochlorite levels.[14] However, the authors did emphasize the fact that there are variations in laser disinfection protocols, and that lasers should be used in conjunction with, not in replacement of, chemical irrigants.[14] Moreover, diode and Nd: YAG lasers have bactericidal activity and are also effective in endodontic disinfection.[13] The stubbornness in which our sample felt that diode lasers do not work presents an educational gap that should be filled, especially because diode lasers are among the most widely recognized lasers.

Knowledge of pediatric and orthodontic applications present participants had mixed knowledge of pediatric and orthodontic applications. Most accurately identified laser applications for behavior management and gingival contouring in orthodontics, but about a third of them incorrectly thought that laser procedures are more traumatic to children and typically require general anesthesia. In fact, laser therapy has many benefits in pediatric dentistry: it is minimally invasive and therefore reduces pain and anxiety, it reduces the need for local anesthesia, and it reduces post-operative swelling and bleeding. A review on the use of laser technology in dentistry stated that lasers eliminate the need for anesthesia and reduce post-operative discomfort as they seal the nerve endings and blood vessels during cutting.[12] Clinical comparisons between traditional and laser surgery have revealed that patients undergoing laser treatments have fewer complications and quicker recovery.[12] Such benefits make lasers especially appropriate for behavior management in children, and this should be incorporated into the dental curriculum.

Safety awareness and training deficiencies were observed. Although 79.1% of the respondents agreed that protective eyewear is mandatory, almost one-third of them thought that all dental personnel can operate lasers without specialized training, and a similar percentage of the respondents considered safety protocols to be optional at low power. These perceptions go against known safety guidelines. Laser energy may cause serious injuries to the eye; retinal or corneal wounds may result from direct or reflected laser beams in the visible and near-infrared spectrum.[15] In addition, the laser plume contains dangerous particulate matter and biological contaminants, which require the use of sufficient suction and respiratory protection.[15] Comprehensive laser safety protocols include controlled areas, non-reflective surfaces, warning signs, and appropriate personal protective equipment.[15] Operators should be trained in the specific wavelength and power settings of their equipment, and a laser safety officer should be responsible for usage. The misconception that it is not necessary to perform training that is specialized training puts both patients and personnel at risk of preventable risks. Curriculum designers should, therefore, include laser safety education along with clinical education.

This study has a number of limitations. Its cross-sectional nature and ease of sampling through social media may affect generalizability, and self-reported knowledge may not be indicative of actual competence. The scoring system was based on modified Bloom's cutoffs, which, although useful in categorization, may be too simple a system for nuanced knowledge. Furthermore, the survey did not investigate the reasons for misconceptions among participants, and there were no assessments of the skill (which was more objective). Nonetheless, with 678 responses, this study presents one of the most comprehensive assessments of laser-related knowledge and practice among Saudi dental professionals and trainees.

CONCLUSION

Our findings show that the level of awareness of dental laser technology is good among Saudi dental students and practitioners; however, there is limited formal training and substantial knowledge. Comparison with other regional surveys highlights that this is not only seen within our own

cohort; however, it is apparent that a lack of training and high costs of equipment have consistently hindered a broader uptake. Targeted education should address misconceptions about etching of the enamel, microleakage, laser-assisted irrigation, and safety protocols. Integrating comprehensive education on operative, periodontal, endodontic, pediatric, and safety aspects of lasers into the undergraduate curriculum and in the continuing professional development programs will be crucial to maximizing the potential of lasers in dentistry.

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ETHICAL APPROVAL

The study was fully explained to all participants, and it was emphasized that participation was voluntary. Written informed consent was obtained from each participant before enrollment. All collected information was securely stored and used exclusively for research purposes.

INFORMED CONSENT

Written informed consent was obtained from all study participants.

DATA AND MATERIALS AVAILABILITY

All data generated or analyzed during this study are included in this published article.

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