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Research Article

Knowledge and Attitudes towards Light-Curing Units among Dental Professionals in Saudi Arabia

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Abstract

Background: Resin-based composites have become the most commonly used adhesive restorative materials in dentistry. However, insufficient polymerization can disrupt color constancy, affect strength, decrease hardness, and impact water sorption. This study aimed to measure the knowledge and attitudes toward light-curing units (LCUs) among dental professionals in Saudi Arabia.

Methodology: A cross-sectional study collected data from 249 dental professionals in Saudi Arabia using a self-administered questionnaire adapted from a previous study and hosted on Google Forms to assess the knowledge and attitudes about maintenance and infection control with LCUs among the dental professionals.

Results: A majority of the participants, around 67%, were currently using light-emitting diode type light curing, and most knowledge questions were correctly answered, with the exception of a question about the term used to define the amount of power of an LCU, which 40% incorrectly answered as radiant exposure. The mean score of knowledge and practice was calculated (mean = 14.00, standard deviation = 2.96), and significant differences were found between the professionals ($p = 0.025$), with specialists and consultants scoring higher (score = 15.24). Additionally, participants working in both governmental and private sectors had significantly higher scores than others (score = 15.86, $p = 0.041$).

Conclusion: The study revealed that dental professionals correctly answered most knowledge questions about LCUs, but half of the maintenance questions were answered incorrectly. Educational workshops and courses could improve LCU knowledge about maintenance.

Keywords: *LCU; Dental Professional; Maintenance; Knowledge; Attitude*

Introduction

In dentistry, resin-based composites (RBCs) have been the most frequently used adhesive restorative materials for posterior and anterior teeth for the last decade [1,2]. The majority of adhesive products available today contain photoinitiators, which require absorption of optical radiation in the form of light sources [3]. Exposing non-polymerized adhesive composites to a light source provides the energy for photoinitiators to initiate the polymerization process. However, the durability and clinical performance of RBCs are directly impacted by the efficiency and light quality of the light-curing unit (LCU) [4]. In particular, factors such as energy, irradiance, and radiation regularity, which have a direct influence on the final restoration, should be carefully considered when choosing an appropriate LCU [5]. Light-emitting diodes (LED), quartz-tungsten-halogen (QTH), argon laser, and plasma-arc curing (PAC) are the four LCU systems that are currently available on the market [6] LED-based curing lights are the most used light sources [3]. The newest advancement technology in LEDs is the polywave system, due to its numerous benefits over other LCUs, including minimal heat production and dissipation, rechargeability, wireless operation, and a less bulky, sturdy device with a long life span [7].

Ensuring the best physical and mechanical qualities of a composite is a satisfactory polymerization process, whereas insufficient polymerization can disrupt the color constancy, decrease hardness, and negatively impact the strength and water sorption of dental composites [8]. Light polymerization is the key to ensuring that these materials acquire their intended properties so that they function for the longest time [9]. Additionally, according to one study, placement of the light-curing tip close and at a right angle to the restoration is a crucial factor for maximizing the energy absorbed by resin-based light-cured materials [10]. Moreover, to achieve adequate polymerization, the irradiance value of the LCU is an essential factor, which refers to the amount of light that reaches a specific composite surface area, measured in mW/cm^2 [11]. The irradiance value can range from about 300 mW/cm^2 to more than 2000 mW/cm^2, with suggested cure times of 5 - 100 seconds [3]. Additional key elements for LCU practice are the maintenance procedures for the LCU device, appropriate cleaning, and adherence to safety guidelines. If these are ignored, the LCU's performance and quality are reduced, which in turn affects the restorations done using the device [12].

Looking at the body of literature, there are few studies that have been conducted in Saudi Arabia to measure knowledge and attitudes about LCUs among dentists, and all of those were conducted in Riyadh city. One such study conducted among general dentists and specialists concluded that the participants demonstrated a lack of knowledge with respect to the use of LCUs [13]. This result was in line with a study conducted among dental students and interns in Riyadh that had results showing low overall knowledge about the use of LCUs [14]. Similarly, a study conducted at different dental colleges in Riyadh city regarding dental students' knowledge about LCUs had results that supported earlier findings in concluding that the dental students had a lack of knowledge regarding LCUs [15].

Regarding LCU maintenance, a cross-sectional study conducted in Riyadh, Saudi Arabia, found that 73% of clinicians did not utilize radiometry to check the output of their LCUs [13]. This was similar to a study that aimed to assess the light intensity generated by LCUs in private clinics in Riyadh city noting that the majority of dentists did not monitor light intensity output [16].

However, it is important to note that Riyadh city may not be representative of the entire population of Saudi Arabia.

Aim of the Study

This study aimed to measure the knowledge and attitudes about LCUs among dental professional in all of Saudi Arabia.

Methodology

A cross-sectional study was used to collect data over a duration of two months, from August to September 2023, among dentists employed in both the private and governmental sectors in Saudi Arabia. A convenience sample was used to recruit dental students, general dental practitioners, residents, specialists, and consultants of different specialties as participants. Retired dentists were excluded

from the study. Ethical approval was obtained from the Research Ethics Committee of Taibah University College of Dentistry with the reference number TUCDREC/240823/IAbdouh.

A validated survey questionnaire from a previous study [14] was hosted on Google Forms and was self-administered in English after being distributed electronically via email to personal contacts or face-to-face with a paper copy. Written consent was obtained at the start of the questionnaire.

The questionnaire comprised three sections with a total of 18 questions. The first section gathered demographic data, including gender, age, qualification, name of university or hospital, city, region, nationality, and place of study or practice. The second section included six questions assessing the knowledge and attitudes about LCUs, such as the main type of LCU the respondent was using and the latest development technologies, proper light-curing techniques, and irradiance. Two questions were related to materials science, for example, the effect of inadequate irradiance on RBC characteristics and how to handle any decrease in power output. The third section consisted of four questions regarding infection control, safety, and maintenance of LCUs, such as monitoring light cure output by using a radiometer, inspection and cleaning of the light cure tips before use, how infection control measures affect the irradiance value, and the participant's use of eye protection during curing.

Data were entered into a spreadsheet using Microsoft Excel (Microsoft Corp., Redmond, WA, USA) and analyzed using SPSS V.28 software (IBM Corp., Armand, NY, USA). A chi-square test was performed to compare the categorical data between the groups. The level of significance was set at $p < 0.05$.

Results

This study had 248 participants, of whom 63.3% were male and 36% were female. The mean age was 28 years, with a standard deviation (SD) of 5. The majority of participants (53%) were graduates (general dentists), 33% were students and interns, and around 14% were specialists and consultants. Demographic data about the participants are provided in table 1.

Variable		n	%
Gender	Male	157	63.3%
	Female	91	36.7%
Qualification	Students and interns	81	32.7%
	General dentists	133	53.6%
	Specialists and consultants	34	13.7%
Place of study/practice	Governmental sector	162	65.3%
	Private sector	71	28.6%
	Both	15	6%
Region of Saudi Arabia	Western	197	79.4%
	Central	20	8.1%
	Southern	8	3.2%
	Eastern	19	7.7%
	Northern	4	1.6%
Nationality	Saudi	225	90.7%
	Non-Saudi	23	9.3%

Table 1: *Demographic data of study participants.*

Regarding the type of LCU used, 66.94% reported using LED, 10.89% used QTH, 1.21% used PAC, 1.61% used argon-ion lasers, and 19.35% did not know the type of LCU they used. Regarding knowledge and practice questions, the participants answered with great variability, as shown in table 2.

Question	Answer	N	%
Proper term to describe the amount of power used by the LCU.	Radiant energy	42	16.94%
	Radiant power	37	14.92%
	Irradiance*	69	27.82%
	Radiant exposure	100	40.32%
Insufficient radiant energy leads to poor mechanical physical properties of a restoration.	Yes*	177	71.37%
	No	28	11.29%
	I do not know	43	17.34%
Insufficient radiant energy leads to more bacterial colonization.	Yes*	92	37.10%
	No	87	35.08%
	I do not know	69	27.82%
Insufficient radiant energy leads to high bond strength.	Yes	77	31.05%
	No*	114	45.97%
	I do not know	57	22.98%
Insufficient radiant energy leads to better color stability.	Yes	60	24.19%
	No*	127	51.21%
	I do not know	61	24.60%
The dentist should hold the light-curing tip as close as possible to the restoration surface.	Yes*	214	86.29%
	No	18	7.26%
	I do not know	16	6.45%
The dentist should hold the light-curing tip up to 10 mm from the restoration.	Yes	45	18.15%
	No*	173	69.76%
	I do not know	30	12.10%
The dentist should position the light-curing tip at a 45-degree angle to the restoration.	Yes	43	17.34%
	No*	167	67.34%
	I do not know	38	15.32%
The dentists should position the light-curing tip at a 90-degree angle to the restoration.	Yes*	170	68.55%
	No	46	18.55%
	I do not know	32	12.90%
What is the newest advancement technology in LED LCUs?	It generates monowave lengths	40	16.13%
	It generates polywave lengths*	57	22.98%
	It has an advance filter and ventilation fan	18	7.26%
	I do not know	133	53.63%

What is done to overcome reductions in power output?	Store resin-based composite (RBC) material in a refrigerator before clinical application	92	37.10%
	Increase the curing time more than the manufacturer's recommendation*	52	20.97%
	Choose a darker shade of RBC	12	4.84%
	I do not know	92	37.10%
Do you inspect and clean the LCU before use?	Yes*	191	77.02%
	No	57	22.98%
Do you use a radiometer before a clinical session?	Yes*	64	25.81%
	No	184	74.19%
My protection from blue light is red laser safety glasses.	Yes*	76	30.65%
	No	172	69.35%
My protection from blue light is a light-curing shield.	Yes*	92	37.10%
	No	156	62.90%
My protection from blue light is a handheld light shield.	Yes	76	30.65%
	No*	172	69.35%
My protection from blue light is orange protective glasses.	Yes*	152	61.29%
	No	96	38.71%
My protection from blue light is having an assistant do the curing.	Yes	88	35.48%
	No*	160	64.52%
My protection from blue light is that I look away from the blue light.	Yes	211	85.08%
	No	37	14.92%
The least negative effect for LCU infection control.	Autoclaving	17	6.85%
	Use of disinfectant solution	58	23.39%
	Disinfectant with a clear barrier*	137	55.24%
	I do not know	36	14.52%
*Correct answer.			

Table 2: *Participant answers to proper knowledge and practice questions.*

When the total score for knowledge was calculated from 20 questions, the mean score of participants was 14.00 with SD of 2.96. Results of a comparison of the total knowledge score to the demographic data are shown in table 3.

Variable **M**		**Total knowledge and practice score**		**p-value**
		SD		
Gender	Male	14.16	3.07	0.278
	Female	13.75	2.76	

Qualification	Students and interns	14.01	2.92	0.025*
	General dentists	13.69	2.99	
	Specialists and consultants	15.24	2.7	
Region in Saudi Arabia	Western	14.04	2.91	0.495
	Central	13.95	3.24	
	Eastern	12.50	4.00	
	Southern	14.63	2.91	
	Northen	13.00	1.83	
Place of work	Governmental sector	13.85	3.05	0.041**
	Private sector	13.95	2.72	
	Both	15.86	2.50	
Nationality	Saudi	14.03	3.04	0.611
	Non-Saudi	13.78	2.11	
*According to Tukey's post hoc test, specialists and consultants scored significantly higher than general dentists (p = 0.025).				
**According to Tukey's post hoc test, the participants working in the governmental sector scored significantly lower than those who worked in both sectors (governmental and private) (p = 0.041).				

Table 3: *Total knowledge and practice score compared to the demographic variables of the participant.*

Discussion

This study aimed to measure knowledge and practices regarding LCUs among dental professionals in Saudi Arabia by using a validated questionnaire to assess knowledge about materials, how to use light curing, how to protect themselves from blue light hazards, their maintenance of LCUs, and infection control in LCU use.

A majority of the participants (around 67%) use LED type light curing. Most knowledge questions were correctly answered by participants, with the exception of a question about the term used to define the amount of power of an LCU, which most of the participants answered incorrectly as radiant exposure. Additionally, the majority of participants were unfamiliar with advanced LCU technology and how to solve light-curing issues that are related to power reduction. In terms of practice, half of the questions were answered correctly and the other half incorrectly. There were significant differences between the professionals regarding their knowledge and practices (p = 0.025), with specialists and consultants achieving higher scores (15.24). In addition, participants who worked in both sectors (governmental and private) had significantly higher scores than others (score = 15.86, p = 0.041).

A total of 67% of the participants used LED types of LCU. This result is consistent with studies conducted in Riyadh city, Saudi Arabia [13], and Edinburgh [17], and the reason for this preference may be related to LED units being smaller, lighter, and portable compared to other LCU types [18]. In contrast, a study conducted to measure the intensity output of LED LCUs in private clinics in Saudi Arabia evaluated 200 LED device intensity outputs using radiometers and found that 50% of the LEDs delivered adequate output, but 40% delivered only marginal output [16]. They explained their findings as the manufacturers of LED units creating them to deliver uniform performance over time [5], which supports that reasoning why the majority of dentists prefer using LED types.

Around 28% of participants in this study correctly answered the question regarding the proper term describing the power of LCUs, while 72% misunderstood the proper term. This is in agreement with previous studies conducted in Riyadh, Saudi Arabia [13,14]. It must

be noted that understanding irradiance is essential to ensuring a composite is properly cured and to avoid potential thermal injuries to tissues. This must be taken into consideration for proper training and education on the topic of irradiance among dentists in Saudi Arabia to eliminate the chance of dentists using inappropriate curing techniques. Additionally, adequate curing technique is a critical factor for achieving sufficient polymerization, and polymerization of the composite is achieved by converting a monomer-based composite into a polymer. This convergence is critical for improving the physical and mechanical properties, color stability, and biological properties of the RBC material [19,20]. In contrast, insufficient radiant energy will lead to poor mechanical and physical properties as well as bacterial colonization. Most of this study's participants understood the consequences of insufficient radiant energy, which is in agreement with the results from Al-Senan., *et al*. [13].

The greatest amount of energy in the RBC is achieved by placing the LCU tip as perpendicular and close to the restoration as possible [10], and 86% of this study's subjects were aware of this. These findings are consistent with a study that involved general dentists and specialists [13] and another study that involved dental students in Riyadh, Saudi Arabia [14].

Polywave systems are the latest technological advancement in LEDs. However, 53% of participants in the current study were unaware of this fact. This is in contrast to other studies conducted in Riyadh, where one study [13] showed that less than half of specialists and general dentists knew advanced LED technology and another study [14] that concluded the majority of dental students were up-to-date with the new generation of LED. This might be connected to the response of "I do not know" that was available in our study but that was not available on the questionnaires from the other studies.

Increasing the curing time as documented will guarantee that all surfaces were exposed to the energy output and lead to complete polymerization [21]. Only 20% of our participants agreed with this. Reduced power output can be resolved by extending the time for curing. However, 37% of respondents incorrectly stated that storing RBC material in a refrigerator before clinical application can overcome power output reduction, consistent with 44% of general dentists and 48% of specialists in Al-Senan., *et al*.'s study [22]. In fact, storing RBC in the refrigerator for overcome reduction of power output of LCU were recommended with self-curing RBC.

A dental radiometer is a device with an effortless and satisfactory method of evaluating the light intensity output of an LCU [16]. This method alerts the practitioner to the need to extend the duration of exposure in order to resolve an issue of decreasing output intensity [23]. Similar to participants in the studies from Al-Senan., *et al*. [13] and Alqabbaa., *et al*. [16], 74% of the participants in the current study did not use a radiometer prior to clinical sessions. This may be related to Saudi Arabian dentists having insufficient knowledge about the necessity of using a radiometer.

The only safe method of achieving both proper eye protection and simultaneously confirming that a restoration receives enough light is via eyewear [3]. In this study, 62% of the participants used orange protective glasses. However, on the other hand around 86% look away from a restoration when curing. This behavior causes the operator to frequently move the light away from the composite region, resulting in less exposure to the material. Consequently, it jeopardizes the quality of a restoration [24].

Significant differences were found between participants' qualifications in total scores for knowledge and practice, with specialists and consultants achieving higher scores. This may be related to years of experience; however, this finding is in contrast to one study [13] that found, in general, there was no significant relationship between years of experience and knowledge about LCUs. Conversely, in a study conducted in the United Arab Emirates (UAE) that contrasted dental interns and preclinical dentistry students regarding the utilization of LCUs in classes I and III, they found the internship group performed significantly better than the preclinical group after a training [25]. This can lead to the conclusion the training and years of experience will each have a large impact on knowledge, Additionally, being involved in clinical workshops and programs that are updated with the most recent developments in light-curing technology can improve non-expert dentists' comprehension and proficiency with LCUs.

The present study shows that those who work in both private and governmental hospitals had significantly better knowledge scores than those who work in just a governmental or private clinic. This finding may be related to the number of patients these participants are exposed to. Again, both experience and knowledge will grow as a result of this. One study conducted in Riyadh city measured the knowledge of dentists who work in private dental clinics concluded that dentists in private practices often lack the necessary information and practices regarding LCU maintenance [16].

The main limitation of the current study is due to the sampling method, which was convenience sampling. The results rely on self-reported responses, as with any questionnaire-based survey, and it is therefore possible that they may not accurately reflect the participants' actual knowledge and behaviors. It is advised that, in future studies, the sample size be increased in order to obtain more accurate results. Another recommendation is to conduct an experimental study among Saudi Arabian dentists to guarantee that LCUs are used with the required knowledge and experience.

Conclusion

The present study found that most of the knowledge questions were correctly answered by dental professionals, except for the term of irradiance. However, half of the LCU maintenance questions were answered incorrectly. Furthermore, most participants were unfamiliar with LCU advanced technology and the ways to overcome reductions of power output. Hands-on educational workshops and courses, in addition to topical additions to school curricula, would be helpful for increasing knowledge about LCUs among Saudi dental professionals.

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Conflicts of Interest

The authors declare that they have no conflicts of interest to declare.

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Ethics Statement

- The study was approved by Research Ethics Committee of Taibah University College of Dentistry with the reference number TUCDREC/240823/IAbdouh.
- Participants were required to agree to and sign the study's informed consent declaration before answering the questions.

Data Availability

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

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