Original Article

Awareness of, Beliefs about, Practices of, and Barriers to Teledentistry among Dental Students and the Implications for Saudi Arabia Vision 2030 and Coronavirus Pandemic

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ABSTRACT

Objectives: Saudi Arabia launched multiple initiatives to overcome the problem of health-care access. The recent coronavirus pandemic created urgent demand to deal with the problem using nonconventional venues such as telehealth and teledentistry. This study aimed to investigate teledentistry knowledge, attitudes, and practices, and barriers to its use among dental students and teaching staff in Makkah province, Saudi Arabia. **Materials and Methods:** A total of 314 dental students participated in this cross-sectional study. Data were collected using a validated self-reported questionnaire to measure teledentistry awareness, attitude, practices, and barriers to teledentistry. The study was approved by Umm Al-Qura University, Saudi Arabia. **Results:** Only 17.2% were aware of the term "teledentistry." However, after it was explained, participants were able to correctly answer 25.16%–62.42% of items about teledentistry. A total of 67.83% would practice teledentistry, and 70.7% support using teledentistry on a national scale for Vision 2030. Only 25.16% used teledentistry before, but 56.05% did dental consultations via smartphone. The most common barriers were patient satisfaction requiring a dentist's physical presence, violation of patient privacy, and low levels of population education. **Conclusion:** Dental students seem to know little about teledentistry. However, they are open to learning and using it. It is encouraged to include the topic in continuing dental education, including how to use it during health disasters such as the coronavirus pandemic.

KEYWORDS: *Teledentistry, telehealth, COVID-19, Vision 2030, attitude, barriers, dental students, knowledge, Saudi Arabia*

INTRODUCTION

Inadequate access to health care is a major challenge worldwide,[1] and the challenge includes access to oral health care.[2] In fact, the current coronavirus pandemic created an urgent demand to deal with the problem using nonconventional methods such as telehealth.[3-5] In the last 4 years, Saudi Arabia had launched multiple initiatives to overcome health-care access problems, including privatization of the health-care system;[6] however, a critical review of the body of literature indicated that privatization alone might not be sufficient to overcome the problem.[6] In fact, there is a shortage and uneven distribution of the dental workforce between the provinces of Saudi Arabia,[7] which accentuates the problem's complexity. Thus, it is important to pay attention to more innovative modalities and use technology such as teledentistry to overcome the oral health-care accessibility problem.

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Teledentistry, as a part of telehealth, can be defined as the use of telecommunications and technology in dental care and dental education interactions over a distance.[8-10] Teledentistry is still considered new, given that it was first used by the US Army in 1994.[11] Teledentistry seems to be a promising model because it overcomes social boundaries[12] and geographical gaps in the existing resources of developed countries.[13] It was found to be useful for underserved and remote areas of different countries around the world.[12,14,15]

Currently, the coronavirus pandemic (known as coronavirus disease 2019 [COVID-19]) has made more attention to the potential uses of telehealth,[3-5] including teledentistry.[16] In fact, the pandemic made high restrictions on elective medical and dental clinic visits, as visits were permitted to emergency cases in many countries.[16-18] The social distancing and movement restriction was taken as a measure to help controlling the spread of the disease[19] in many countries in the world. Also, the COVID-19 has a potential to paralyze the health system in the light of the basic health requirements to cope with the pandemic.[20] Thus, it was suggested that using telehealth might be a useful tool for "forward triage" before emergency cases reach the hospital and to facilitate medical professional–patient communication.[17] This was applied in China for tertiary dental cases in 48 dental hospitals.[16] Nevertheless, despite all of the promising studies in the literature about using the technology, it could be hindered by unexpected factors such as the resistance of dentists to using teledentistry.[21]

Therefore, to achieve a better implementation of teledentistry, it is important to understand the current state of knowledge, beliefs, and practices about it among current and future dentists. The comparison of results in the literature indicated that the knowledge about teledentistry differs by country, level of education, and years of experience.[22-26] For example, 74.4%–88.6% of dentists in India and Rwanda were aware of teledentistry,[22-25] as compared to 37.4% in Pakistan.[25] Dental students were found to be less knowledgeable and enthusiastic about teledentistry than dental faculty or practicing dentists.[25] In fact, years of experience had an inverse relationship with the level of knowledge about teledentistry.[24] Despite many studies showing that most dentists and dental students wished to practice teledentistry in the future,[23,26] approximately 26%–31.4% of dentists did not think that teledentistry was efficient in many respects.[24,26] Some studies found that no dentists had practiced teledentistry in Pakistan, and very few (6.8%) had in Rwanda.[22,27] The studies also highlighted some barriers

to teledentistry implementation that included the high cost of the technology, lack of available technology, lack of human resources,[26] lack of computer skills among dentists, and the need to perform manual work rather than online procedures.[27]

Currently, in Saudi Arabia, a major reform road map (Vision 2030) drives the country's initiatives into a new era in major domains such as health, economy, and technology.[28] Saudi Vision 2020 has three themes: vibrant society, thriving economy, and ambitious nation. These themes allocate into 96 strategic goals. Teledentistry seems to be a very important topic for investigation in Saudi Arabia because it can contribute greatly to three strategic goals of Vision 2030: "2.1. Improve healthcare service," "5.2.4. Develop the e-government," and "5.2.5. Improve the quality of services provided to citizens." [28] Furthermore, teledentistry can be useful in Makkah holy city, which hosts more than 6 million Muslim worshipers annually from around the world to perform Umrah and Hajj. This number is planned to be 30 million in Vision 2030, and Saudi Arabia is implementing many fast-paced initiatives to achieve this strategic goal. Thus, it is important to investigate such technology, and the levels of awareness, beliefs, and practices of teledentistry among Saudi dentists; dental students, as the future dental workforce; and dental faculty, who provide students with the latest about dentistry, for better implementation.

Yet, no other article was found that investigated the current levels of awareness about teledentistry in Saudi Arabia among dental students and faculty members. Thus, this study aimed to investigate the levels of knowledge, attitudes about, practices of, and barriers to teledentistry among dental students and teaching staff in Makkah province, Saudi Arabia.

MATERIALS AND METHODS

A cross-sectional study was conducted in November 2019 to assess the current levels of knowledge, attitudes about, practices of, and barriers to teledentistry among dental students at Umm Al-Qura University, King Abdulaziz University, Ibn Sina colleges, Albatatrji Medical colleges, and Alfarabi dental colleges in Makkah province, Saudi Arabia. The inclusion criteria included students from the second to the sixth year, in addition to dental intern. The exclusion criteria included graduate dentist or dropped dental students. The students were recruited to complete the study questionnaire during their breaks on workdays, and the inclusion criteria were dental students from second year to internship. Data were collected through a hard-copy

self-administered questionnaire in English, which took approximately 10 min to complete. All participants were required to sign a consent form before starting the questionnaire. All data were used anonymously, and all identifiable information was discarded.

The questionnaire had five sections comprising the following. Section One collected demographic information. Section Two consisted of 11 questions with true or false answers, designed to assess knowledge about teledentistry, with answers totaled for a score ranging from 0 to 11 (highest level of knowledge). Prior to those questions, the correct meaning of the teledentistry concept was explained, but because participants might be practicing teledentistry without being familiar with the term, the explanation included a note not to change previous answers. Section Three consisted of 10 questions regarding participant attitudes toward teledentistry, using a Likert scale from 1 to 5. Section Four included seven questions about practicing teledentistry. Lastly, Section Five included eight possible barriers to the use of teledentistry, and participants were to state whether or not they agreed that it was a barrier with a yes or no answer. The questionnaire was derived from previous literature,

with modifications.[22,23,26,27,29] A pilot test with 10 participants validated the questionnaire for logical flow, organization, language, syntax, and content. The questionnaire has good reliability as Cronbach α ranged between 0.67 and 0.82.

Data were analyzed by using the Statistical Package for the Social Sciences (SPSS) software program, version 21.0 (IBM, Armonk, New York). Descriptive data included mean (m), standard deviation (SD), frequency, and proportions. The research questions were tested with multiple regression and t test, and statistical significance was set at a P-value of 0.05. Data were entered via private computer with password protection and could be accessed only by the principal investigator. This study was approved by the Faculty of Dentistry Institutional Review Board of Umm Al-Qura University, Saudi Arabia (129-19).

RESULTS

A total of 314 dental students and interns with a mean age of 23.06 (SD = 1.63) completed the study questionnaire. Table 1 shows participant demographic data.

There were only 54 (17.2%) participants who had previously heard of teledentistry, but 44 (14%) were able to identify the true meaning of "teledentistry."

For the 11 questions regarding knowledge about teledentistry, the mean score for correct answers was 5.55 (SD = 2.56). Multivariable regression and backward elimination showed that the total knowledge score was not statistically significant with regard to gender, college, age, or previous knowledge. The percentages of correct answers for each item are shown in Table 2.

Participant practices of teledentistry activities are reported in Table 3. A significantly higher percentage of female respondents had conducted consultations via smartphone, and they were more willing to practice teledentistry, whereas a higher percentage of male

Table 1: Demographic data of participants

Variable	Category	N	%
Gender	Male	115	36.62
	Female	199	63.38
Academic year	Third year	33	10.51
	Fourth year	42	13.38
	Fifth year	73	23.25
	Sixth year	126	40.13
	Intern	40	12.74
Laptop	Yes	305	97.13
	No	9	2.87
Smartphone	Yes	312	99.36
	No	2	0.64
College	Governmental	152	48.41
	Private	162	51.59

Table 2: Percentage of participants correctly answering teledentistry knowledge items

Statement	N	%
Helps to monitor the patient's oral health	196	62.42
Used for dental education and continuing education in dentistry	193	61.46
Helps to consult with an expert on patient's problem	193	61.46
Useful in early and easy consultation on oral disease with specialists	191	60.83
Useful in diagnosis and management of oral disease	180	57.32
Used to educate and train dentists in primary dental care	167	53.18
Useful in improving access to oral health care	164	52.23
Can be applied in any branch of dentistry	139	44.27
Increases the number of dentists in areas where populations are scattered	107	34.08
Good tool for oral hygiene training	135	42.99
Decreasing the isolation of general practitioners apart from specialists	79	25.16

students had attended lectures about teledentistry. Also, a higher ratio of students from private dental colleges had conducted consultations using smartphones, attended lectures about teledentistry, and received hands-on training in teledentistry, as shown in Table 3. Participants' beliefs about teledentistry and their opinions on the barriers to its use are shown in Tables 4 and 5, respectively.

DISCUSSION

The level of awareness about teledentistry among participants in our study was lower than similar studies conducted in Pakistan, India, and Rwanda, which ranged from 37.4% to 88.6%[22-25,27] However, 25.16% of the participants mentioned in the first section that they had previously used teledentistry, which could be because students were unaware of term "teledentistry." Nevertheless, this percentage is still lower than the proportions in other studies. One of the reasons for the discrepancy with other studies is that most of those studies included graduated dentists, in contrast to our study, which included only students and interns. Another explanation is that this difference is due to the usage of telehealth in different countries. It was indicated that some countries, including Saudi Arabia, face many challenges with using telehealth in general, such as a general distrust of electronic business, privacy concerns, cultural factors, adoption by users,

Table 3: Participant teledentistry practices

Item		Total n (%)	Gender		College	
			Male n (%)	Female n (%)	Governmental n (%)	Private n (%)
In the future, will you practice teledentistry?	Yes	241 (76.75)	78 (67.83)	**163 (81.91)***	124 (81.58)	117 (72.22)
	No	73 (23.25)	37 (32.17)	36 (18.09)	28 (18.42)	45 (27.78)
Will you support an initiative to use teledentistry on a national level for Vision 2030?	Yes	222 (70.7)	74 (64.35)	148 (74.37)	107 (70.39)	115 (70.99)
	No	92 (29.3)	41 (35.65)	51 (25.63)	45 (29.61)	47 (29.01)
Do you think children and parents would like to have dental examinations by computer and camera to be sent to another dentist?	Yes	192 (61.15)	64 (55.65)	128 (64.32)	95 (62.5)	97 (59.88)
	No	122 (38.85)	51 (44.35)	71 (35.68)	57 (37.5)	65 (40.12)
Have you ever had a consultation with a patient using a smartphone and its camera?	Yes	176 (56.05)	53 (46.09)	**123 (61.81)***	67 (44.08)	**109 (67.28)***
	No	138 (43.95)	62 (53.91)	76 (38.19)	85 (55.92)	53 (32.72)
Have you ever used a teledentistry system before?	Yes	79 (25.16)	29 (25.22)	50 (25.13)	31 (20.39)	48 (29.63)
	No	235 (74.84)	86 (74.78)	149 (74.87)	121 (79.61)	114 (70.37)
Did you have hands-on training in using teledentistry?	Yes	65 (20.7)	30 (26.09)	35 (17.59)	20 (13.16)	**45 (27.78)***
	No	249 (79.3)	85 (73.91)	164 (82.41)	132 (86.84)	117 (72.22)
Have you attended a lecture/course about teledentistry?	Yes	55 (17.52)	**27 (23.48)**	28 (14.07)*	17 (11.18)	**38 (23.46)***
	No	259 (82.48)	88 (76.52)	171 (85.93)	135 (88.82)	124 (76.54)

* *P* < 0.05

Bold mean had higher prevalence

Table 4: Participant beliefs about teledentistry

Statement	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
Dental examinations via computers and intraoral camera are as accurate as dental clinic exams.	74 (23.57)	36 (11.46)	96 (30.57)	57 (18.15)	51 (16.24)
Teledentistry is a convenient form of oral care delivery that makes dental examinations easier.	82 (26.11)	74 (23.57)	94 (29.94)	45 (14.33)	19 (6.05)
Teledentistry can be in addition to regular dental care.	113 (35.99)	70 (22.29)	77 (24.52)	32 (10.19)	22 (7.01)
Teledentistry helps in reducing costs of dental practices.	55 (17.52)	65 (20.7)	93 (29.62)	56 (17.83)	45 (14.33)
Teledentistry saves dentists time.	108 (34.39)	77 (24.52)	74 (23.57)	32 (10.19)	23 (7.32)
Teledentistry can increase accessibility to dental specialists in rural and underserved communities.	100 (31.85)	81 (25.8)	81 (25.8)	39 (12.42)	13 (4.14)
I think teledentistry is useful.	133 (42.36)	73 (23.25)	70 (22.29)	26 (8.28)	12 (3.82)
I believe that teledentistry can be used to educate the population on a wide scale.	125 (39.81)	66 (21.02)	81 (25.8)	31 (9.87)	11 (3.5)
In the future, teledentistry will be a standard method of oral health-care delivery.	76 (24.2)	82 (26.11)	90 (28.66)	45 (14.33)	21 (6.69)
Teledentistry can violate the patient's privacy.	66 (21.02)	38 (12.1)	92 (29.3)	58 (18.47)	60 (19.11)

Table 5: Barriers to the use of teledentistry		
Barrier	**N**	**(%)**
Patient compliance and satisfaction require dentist's physical presence	153	(48.73)
Fear of violating patient privacy	152	(48.41)
Low level of population education	150	(47.77)
High cost of teledentistry infrastructure	132	(42.04)
The time required to learn and apply the technology for dentists	130	(41.4)
Inappropriate fees for teledentistry charged to patients	117	(37.26)
Resistance of dentists to new technology	110	(35.03)
Lack of current infrastructure	108	(34.39)

and technological infrastructure.[30] Also, a recent systematic review concluded that the e-health system in Saudi Arabia is growing thanks to the efforts of Vision 2030 and the goals planned for the year 2020, but the review also stated that these goals were not completely fulfilled.[31]

In fact, even after explaining the correct meaning of teledentistry, the participants in our study had only a moderate level of knowledge, with the mean equal to the midpoint. The percentages of correct answers for each item were not high, and more than three-fourths were not aware that teledentistry can help by providing better communication and decreasing the level of isolation between general practitioners and specialists. The level of knowledge was not related to gender, type of college, or age, which means that this lack of knowledge is generalized. This indicates that the students lacked significant amounts of information about the abilities and benefits that teledentistry could offer, if adopted, to improve dental services. This is supported by our finding that only 17.52% had ever attended a lecture about teledentistry.

It is surprising that in our study, 25.16% had previously used teledentistry, despite the low levels of knowledge about the term itself. This proportion is actually higher than that found in similar studies in Pakistan and Rwanda (0%–6.8%).[22,27] One reason for this might be the growing usage of e-health systems that accompanies Vision 2030.[31] However, our results are in line with other studies indicating that the majority of dental professionals are willing to practice teledentistry[23,26] and support such an initiative on a national scale.

It is interesting to note that more than half of the dental students in our study had used a smartphone for dental consultations, and one-fifth had received hands-on dental training using a teledentistry system. This might indicate that dental students are engaged in teledentistry as a part of the digital transformation of the country along with increased use of smartphone devices and social media in their personal and professional lives. A recent article indicated that 52.76% of dental students and dentists in Saudi Arabia use social media to communicate with their patients.[32] However, the same article highlighted that many dental professionals lack proper guidelines for using such devices in relation to patient privacy. Therefore, it might be important to augment teledentistry educational courses with proper guidelines for professional communication and privacy. Also, as opposed to students in governmental colleges, students in private dental colleges were found to have significantly higher smartphone use for consultations with patients and were also more likely to have attended workshops about teledentistry. This might reflect the variance in educational content between these types of colleges when it comes to modern trends.

With regard to opinions, the dental students in our study had good impressions of teledentistry in general. Two-thirds of the participants believed that teledentistry is useful, which is higher than similar studies (26%–31.4%).[24,26] In fact, around half the participants agreed that teledentistry is useful in education, saves time, and should be used in addition to regular dentistry for convenient oral care delivery. However, around one-third believed that teledentistry does not reduce the cost of a dental practice and that teledentistry might be less accurate than dental clinic consultations. It should be noted that a systematic review concluded that teledentistry had an acceptable level of accuracy in the diagnosis of dental caries,[33] but the investigated studies were not of high quality.

More importantly, one-third of respondents also think that teledentistry might violate patient privacy, and it was ranked by participants as one of the most significant barriers to teledentistry use. This perspective was shared by Turkish dental professionals.[34] A systematic review revealed that telehealth privacy in general differs depending on location and setting, and more studies should be implemented that focus on improving privacy and security, taking into account providers' preferences to keep data safe.[35] Thus, privacy is one of the important aspects that plans for Vision 2030 should carefully consider.

Participants reported several barriers to the use of teledentistry. Around half indicated that patient satisfaction is linked to the dentist's presence. A similar point was noted by a study in Pakistan, which indicated that dentistry requires manual work.[27] Also, around half of the participants do not trust the general population's level of education with regard to teledentistry. This claim can be refuted, however, thanks to many changes over the

last several years with e-government, which linked many services for citizens for vital personal services to electronic systems such as Absher,[36] in line with Vision 2030. In fact, recently, primary health-care appointments have been moved to the Absher platform. This indicated that teledentistry can be implemented on larger scale across Saudi Arabia fulfilling the strategic goals of improving healthcare service, the e-government, and improving the quality of citizen services.[28] Also, using teledentistry for Muslim visitors from around the world for Umrah and Hajj can be beneficial to overcome the relative shortage of dental workforce in Makkah city, in comparison to the high number of Muslim visitors annually, and reduces the burden of poor communication due to differences in languages used. Other barriers noted by this study's participants ranged from 34.39% to 42.04% and included the high cost of infrastructure, the time it takes to learn teledentistry, fees, and resistance to technology. These should be taken into consideration as well, especially as some were reported in other studies.[26] This indicates that teledentistry can be used, but some barriers should be tackled for better implementation.

One important aspect that should be discussed is the use of teledentistry during health crises such as the coronavirus pandemic. In fact, several studies highlighted the importance of using telehealth as an important alternative during such crises.[3-5] In the light of current social distancing, movement restrictions, and affected healthcare systems,[16-19] teledentistry might be very useful to help dental patients in many aspects including consultation, triaging, and prescribing dental emergency medication. Indeed, current information does not give conclusive expectation to the future permitted spaces between dentist and patient, so teledentistry might be crucial to help minimizing the amount of unnecessary dentist–patient contact. Recently in China, 48 dental hospitals offered teledentistry for tertiary dental cases to cope with COVID-19 pandemic.[16] Also, the American Teledentistry Association urged the use of teledentistry during the coronavirus pandemic;[37] however, very few articles discuss this important topic because the coronavirus pandemic is a current problem. In addition, the study did not collect participant opinions about using teledentistry during a pandemic because data were collected in November 2019, before the onset of the first case of coronavirus in December 2019.[38]

This study has a number of limitations. First, the self-administered questionnaire is prone to a self-reporting bias. Also, the external validity cannot be guaranteed because of the convenience sampling method that was used. Nevertheless, this study is likely one of only a few conducted in Saudi Arabia addressing this trending topic.

CONCLUSIONS

This study shows that, despite low awareness of the term "teledentistry" and a lack of knowledge about it, a considerable percentage of future dental professionals are using teledentistry in Saudi Arabia, just not systematically. Teledentistry can be a valuable venue for achieving Saudi Arabia's Vision 2030, and it is a suitable model for health crises such as the coronavirus pandemic. However, more education and greater efforts are needed to teach dental students how to use teledentistry properly. In addition, more efforts are required to overcome the barriers to teledentistry's use, including patient privacy.

CONFLICTS OF INTEREST

There are no conflicts of interest.

AUTHOR CONTRIBUTIONS

The author declare he is the only person who conduct the study idea, scientific study design, data analysis and interpretation and involved in manuscript writing.

ETHICAL POLICY AND INSTITUTIONAL REVIEW BOARD STATEMENT

This study was approved by Umm Al-Qura University Institutional Review Board (129-19).

PATIENT DECLARATION OF CONSENT

Not applicable.

DATA AVAILABILITY STATEMENT

Upon reasonable request, the data set analyzed during this study is available from the corresponding author (Dr. Khalid Aboalshamat, E-mail: ktaboalshamat@uqu.edu.sa).

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