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RESEARCH ARTICLE

Dentists' Self-perception on Teledentistry: The Changing Landscape Driven by Technological Booming in the 21st Century.

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Abstract:

Aim:

Teledentistry has gained popularity worldwide because it is cost-effective and increase accessibility to dental healthcare. This study assessed the self-perceptions of teledentistry among dental practitioners in Saudi Arabia and examined any gender-related differences.

Methods:

This cross-sectional study was conducted between January and December 2017 and recruited a convenience sample of dental practitioners, whose self-perceptions of the practice-related use of teledentistry were assessed via a teledentistry survey (TDS). The TDS consisted of four sections: efficiency in patient care, cost reduction, capabilities for improving practice, and security and confidentiality. Data analyses were conducted through descriptive statistics, internal reliability tests (Cronbach's alpha), and chi-squared tests of the TDS.

Results:

The response rate was 620/800 (78%). Most respondents were female (62%), and 58% of them worked in the public sector. The internal reliability of the TDS was 0.85 for the whole sample and 0.85 and 0.90 for males and females, respectively. Among the entire sample, 51% agreed that teledentistry reduced potential cost, and 65% reported shortened waitlists. More females (42%, $p < 0.001$) than males (22%) agreed that teledentistry could help monitor a patient's condition. More females (35%) than males (13%, $p < 0.001$) considered that teledentistry would require additional appointments for imaging. More females (29%, $p = 0.0001$) than males (22%) expressed great concern about potential violations of confidentiality.

Conclusion:

These findings suggest that teledentistry in dental practice is well perceived by practitioners in Saudi Arabia. Gender differences in perceptions are linked to certain aspects of teledentistry.

Keywords: Dentists, Self-perception, Technology, Teledentistry, Teledentistry survey, Sociodemographic characteristics.

Article History

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1. INTRODUCTION

In healthcare, the fields of Information Technology (IT) and telecommunication are continuously evolving. Terms, like "telemedicine," "teledentistry," and "telepharmacy" have emerged in recent decades [1]. The word "teledentistry" was first introduced in the year 1997 by Cook, who defined it as "the practice of using videoconferencing technologies to diagnose and provide advice about treatment over distance" [2, 3].

Teledentistry is being used with increasing frequency around the world – particularly in North America, Australia, South Africa, and the Scandinavian countries [4 - 7]. In addition, a growing body of literature has investigated the idea and efficacy of teledentistry. For instance, a qualitative and systematic review of 39 studies, which reported attitudes toward teledentistry and the implementation of teledentistry in practice, concluded that "there is a high acceptability for teledentistry amongst clinicians and patients alike" [8]. Teledentistry is also considered a practical and potentially cost-effective method, overcoming geographical time barriers, and increasing access to healthcare services. It has great potential

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for addressing challenges at both the patient and provider levels, especially when dental expertise is urgently required [9].

In some contexts, gender is a significant determinant of intentions to accept new technology, but there are cases in which gender differences cannot be discerned. For example, men are found to be more technologically adept than women in the context of IT use computers, email, web services, electronic data management systems, etc. In contrast, the gender difference is not observed with interactions on social media platforms, but males and females do have different agendas for using social networking sites. Females mainly use social media to maintain existing relationships, whereas males use it to make new friends [10].

Exploring gender differences in the adoption of teledentistry can identify techniques through which the gender gap in teledentistry acceptance if present can be addressed. Dental institutions, both private and public, can accordingly design specific programs aimed to understand the gender difference and enhance the skills of practitioners, who are more apprehensive about using emerging dental technological applications.

However, in the Saudi Arabian context, limited evidence is available on dentists' views of adopting tele dentistry and on the gender differences affecting technology adoption between male and female general practitioners. Thus, this study assessed dental practitioners' self-perceptions of teledentistry and searched for possible gender-related differences in Saudi Arabia. Since information and communication technology has been implemented in almost all modern daily tasks, including dental care delivery, the authors hypothesized that teledentistry would be generally well perceived by dentists in Saudi Arabia and that gender would have no role in this context.

2. MATERIALS AND METHODS

2.1. Study Design and Sampling

This cross-sectional study was conducted between January and December 2017, and the participants were recruited by convenience sampling. The research survey was distributed using social network sites, such as Twitter, Facebook, LinkedIn, WhatsApp, etc. The researchers' affiliation networks with their fellow dentists were also used as a strategy to recruit participants from different Saudi regions.

2.2. Measures and Data Collection

The sample size was calculated using Epi Info StatCalc, considering the population size of 16,887 licensed dentists [11] and a 99% confidence level, with expected frequency of 50%. The sample was 164 participants from registered general dental practitioners and dental specialists working in Saudi Arabia with an acceptable power of 80%. A total of 800 anonymous, electronic, self-administered questionnaires were sent to participants using a direct link to a Google form. Upon completion of the survey, respondents were instructed to submit the web form. The web server entered the data into an

Excel database created to store and retrieve data for analysis.

Additionally, the Teledentistry Survey (TDS) has become a well-known tool for assessing dental practitioners' self-perceptions of teledentistry [12 - 15].

The structured questionnaire was written in English and included two sections. The first was composed of eight questions relating to participants' sociodemographic characteristics (*i.e.*, age, gender, and nationality) and qualifications (*i.e.*, years of work experience in dentistry, location of the main job, the average number of hours/day spent on the internet for work-related matters and general use, and most common way of communicating with colleagues). The second section included the TDS, which comprised four subsections. Subsection 1 contained seven questions on the usefulness of teledentistry. Subsection 2 posed five questions on teledentistry efficiency. Subsection 3 presented seven questions on the benefits of teledentistry, and Subsection 4 included four questions on the practice-related use of teledentistry. Responses were rated on a five-point Likert scale (1 = strongly disagree, and 5 = strongly agree) [12].

2.3. Statistical Analysis

For analysis, the Excel database was exported into IBM SPSS software (ver. 24.0; IBM, Chicago, IL, USA). Descriptive statistics (frequency, percentage, and mean \pm standard deviation) were gathered to determine respondents' characteristics and dentists' perceptions and concerns in the teledentistry use. The internal consistency (Cronbach's alpha) of the TDS was also assessed. These analyses were conducted both for the entire sample and for each gender. Chi-squared tests were similarly used to examine the interaction between genders in the TDS item responses. The TDS responses were then collated into 'Agree and Strongly Agree,' 'Neutral,' and 'Disagree and Strongly Disagree' to ease interpretation. The statistical significance tests (*p*-values) were set to *p* < 0.05.

3. RESULTS

3.1. Sociodemographic Characteristics of the Sample

Out of the 800 survey questionnaires disseminated, 620 useful and completed surveys were analyzed. Surveys of dentists who were not licensed to practice dentistry in Saudi Arabia, dental practitioners not working in Saudi Arabia, and surveys with missing data were excluded. The internal reliability of the TDS was 0.85 for the whole sample and 0.85 and 0.90 for males and females, respectively.

Among respondents, 373 (62.2%) were aged between 20-34 years; 415 (66.9%) were Saudi nationals; and 383 (62%) were female. Over half of the participants (354 [57.1%]) were general dentists; 148 (23.9%) were dental specialists; and 118 (19%) were consultants (Table 1). 363 participants (58%) worked in the public sector, and 150 (24%) were engaged in dual practice by working in both the private and public sectors. 459 respondents (74%) had up to ten years' clinical experience, and 161 (26%) had 11 or more (Table 1).

Table 1. Socio-demographic characteristics of the whole sample (n=620) and chi-squared test results of comparisons between males (n=237) and females (n=383) responding dentists.

Variables	-	Whole N (%)	Males n (%)	Females n (%)	p-value
Age (Years)	20-34 years	373 (62.2)	107 (45.1)	266 (69.5)	0.001
	35-44 years	141 (22.7)	76 (32.1)	65 (17.0)	
	≥45 and older	106 (17.1)	54 (22.8)	52 (13.6)	
Nationality	Non-Saudi	205 (33.1)	98 (41.4)	107 (27.9)	0.001
	Saudi	415 (66.9)	139 (58.6)	276 (72.1)	
Qualification	General Dentist	354 (57.1)	104 (43.9)	250 (65.3)	0.001
	Dental Specialist	148 (23.9)	66 (27.8)	82 (21.4)	
	Dental consultant	118 (19.0)	67 (28.3)	51 (13.3)	
Work experience in dentistry	≤ 10 years	459 (74.0)	165 (69.6)	294 (76.8)	0.061
	≥11 years	161 (26.0)	72 (30.4)	89 (23.2)	
Work setting	Private	108 (17.4)	37 (15.6)	71 (18.5)	0.272
	Public	362 (58.4)	148 (62.4)	214 (55.9)	
	Both	150 (24.2)	52 (21.9)	98 (25.6)	

3.2. Internet Usage and Preferred Medium of Communication

As shown in Table 2, 406 (66%) participants spent more than five hours per day using the internet for general purposes unrelated to dentistry, and 453 (73%) used the internet for less than four hours per day for work-related issues. The participants reported their preferred methods of communicating with colleagues to be either email (64%) or phone (64.4%). Videoconferencing (9.2%) and forums (5.2) were less preferable medium of communication among practitioners.

3.3. Responses to the TDS Items and the Influence of Gender on Each Item

3.3.1. Efficiency in Patient Care

75% of the sample agreed that teledentistry could be useful for improving interaction and communication between dentists; 70% believed it could improve interaction and communication

between dentists and patients; and 69% thought it would be helpful for patients in distant or rural locations. A similar percentage (72%) either agreed or strongly agreed with the potential enhancement merits of teledentistry for providing guidance/advice, clinical training, continuous education, and efficient referrals. More females (42%, $p < 0.001$) than males (22%) agreed or strongly agreed that a teledentistry system would help monitor a patient's condition (Table 3).

3.3.2. Cost Reduction

A slim majority of respondents agreed that teledentistry could potentially reduce costs (51%) and had shortened waitlists (65%). Approximately two-thirds of participants (67%) indicated that teledentistry could help reduce unnecessary trips to hospitals. Females were significantly ($p < 0.001$) more likely to agree that teledentistry would reduce dental expenses (33.7%) and shorten their waitlists (42.7%) than males (17.3% and 22.3%, respectively).

Table 2. Internet usage and communication means of the whole sample (n=620) and Chi-squared test results of comparisons between males (n=237) and females (n=383) responding dentists.

Variables	-	Whole N (%)	Males n (%)	Females n (%)	p-value
Daily general internet usage (hours)	≤ 4 hours	214 (34.5)	95 (40.1)	119 (31.1)	0.027
	≥ 5 hours	406 (65.5)	142 (59.9)	264 (68.9)	
Daily work internet usage (hours)	≤ 4 hours	453 (73.1)	162 (68.4)	291 (76.0)	0.047
	≥ 5 hours	167 (26.9)	75 (31.6)	91 (24.0)	
Communication with colleagues at work					
In person	No	317 (51.1)	121 (51.1)	196 (51.2)	1.000
	Yes	303 (48.9)	116 (48.9)	187 (48.8)	
Phone	No	221 (35.6)	73 (30.8)	148 (38.6)	0.058
	Yes	399 (64.4)	164 (69.2)	235 (61.4)	
Email	No	223 (36.0)	86 (36.3)	137 (35.8)	0.965
	Yes	397 (64.0)	151 (63.7)	246 (64.2)	

(Table 2) cont....

Variables	-	Whole N (%)	Males n (%)	Females n (%)	p-value
Social media	No	443 (71.5)	166 (70.0)	277 (72.3)	0.541
	Yes	177 (28.5)	71 (30.0)	166 (27.7)	
Video conference	No	563 (90.8)	220 (92.8)	343 (89.6)	0.220
	Yes	57 (9.2)	17 (7.2)	40 (10.4)	
Forum	No	588 (94.8)	223 (94.1)	365 (95.3)	0.636
	Yes	32 (5.2)	14 (5.9)	18 (4.7)	

Table 3. Responses of the whole sample (n=620) to Teledentistry survey and both males (n=237) and females (n=383) dentists to Teledentistry survey.

Teledentistry sections	Sample	Disagree n (%)	Neutral n (%)	Agree n (%)
Efficiency in patient care				
Improve communications between dentists	Whole	27(4.4)	125(20.2)	468(75.5)
	Males	14(2.3)	44(7.1)	179(28.9)
	Females	13(2.1)	81(13.1)	289(46.6)
Make referral of new patients more efficient	Whole	38(6.1)	137(22.1)	445(71.8)
	Males	19(3.1)	46(7.4)	172(27.7)
	Females	19(3.1)	91(14.7)	273(44)
Enhance guidance and advice	Whole	36(5.8)	141(22.7)	443(71.5)
	Males	14(2.3)	65(10.5)	158(25.5)
	Females	22(3.5)	76(12.3)	285(46)
Enhance clinical training and continuing education	Whole	51(8.2)	122(19.7)	447(72.1)
	Males	24(3.9)	51(8.2)	162(26.1)
	Females	27(4.4)	71(11.5)	285(46)
Save time compared with a referral letter	Whole	51(8.2)	115(18.5)	454(73.2)
	Males	18(2.9)	47(7.6)	172(27.7)
	Females	33(5.3)	68(11)	282(45.5)
Help with patient information and education	Whole	31(5)	139(22.4)	450(72.6)
	Males	15(2.4)	52(8.4)	170(27.4)
	Females	16(2.6)	87(14)	280(45.2)
Provide adequate diagnostic information	Whole	76(12.3)	160(25.8)	384(61.9)
	Males	36(5.8)	67(10.8)	134(21.9)
	Females	40(6.5)	93(15)	250(40)
Helpful to monitor patient's condition ^a	Whole	44(7.1)	182(29.4)	394(63.5)
	Males	21(3.4)	81(13.1)	135(21.8)
	Females	23(3.7)	101(16.3)	259(41.8)
Useful for patients in distant or rural locations	Whole	56(9)	134(21.6)	430(69.4)
	Males	17(2.7)	56(9)	164(26.5)
	Females	39(6.3)	78(12.6)	266(42.9)
Improve interaction and communication with patients	Whole	36(5.8)	150(24.2)	434(70)
	Males	14(2.3)	60(9.7)	163(26.3)
	Females	22(3.5)	90(14.5)	271(43.7)
Cost reduction				
Reduce costs for the dental practices ^a	Whole	106(17.1)	198(31.9)	316(51)
	Males	32(5.2)	98(15.8)	107(17.3)
	Females	74(11.9)	100(16.1)	209(33.7)
Save money for patients	Whole	76(12.3)	192(31)	352(56.8)
	Males	28(4.5)	70(11.3)	139(22.4)
	Females	48(7.7)	122(19.7)	213(34.4)
Help reduce unnecessary travel to hospital	Whole	56(9)	151(24.4)	413(66.6)
	Males	19(3.1)	57(9.2)	161(26)
	Females	37(6)	94(15.2)	252(40.6)

(Table 3) cont.....

Teledentistry sections	Sample	Disagree n (%)	Neutral n (%)	Agree n (%)
Efficiency in patient care				
Convenient for patients and well received by patients	Whole	42(6.8)	217(35)	361(58.2)
	Males	17(2.7)	85(13.7)	135(21.8)
	Females	25(4)	132(21.3)	226(36.5)
Help shorten waiting lists ^a	Whole	47(7.6)	170(27.4)	403(65)
	Males	16(2.6)	83(13.4)	138(22.3)
	Females	31(5)	87(14)	265(42.7)
Capabilities to improve practice				
Increase surgery time spent with the patient	Whole	164(26.5)	206(33.2)	250(40.3)
	Males	61(11.5)	84(13.5)	82(13.2)
	Females	93(15)	122(19.7)	168(27.1)
Necessitate an extra appointment for taking photographs ^a	Whole	114(10)	207(33.4)	299(48.2)
	Males	62(8.4)	92(14.8)	83(13.4)
	Females	52(54.6)	115(13.4)	216(34.8)
Too expensive to set up	Whole	171(27.6)	254(41)	195(31.5)
	Males	66(10.6)	94(15.2)	77(12.4)
	Females	105(16.9)	160(25.8)	118(19)
Diagnosis is accurate of intra-oral images as in traditional clinical setting ^a	Whole	130(21)	182(29.4)	308(49.7)
	Males	79(12.7)	69(11.1)	89(14.4)
	Females	51(8.2)	113(18.2)	219(35.5)
Security and confidentiality				
Technical incompatibility ^a		Not concerned	Neither	Concerned
	Whole	102(16.5)	285(46)	233(37.6)
	Males	34(5.5)	97(15.6)	106(17.1)
	Females	68(11)	188(30.3)	127(20.5)
Reliability of Equipment	Whole	63(10.2)	192(31)	365(58.9)
	Males	24(3.9)	76(12.3)	39(6.3)
	Females	39(6.3)	116(18.7)	228(36.8)
Patient confidentiality when images are sent online to the hospital ^a	Whole	70(11.3)	237(38.2)	313(50.5)
	Males	24(3.9)	77(12.4)	136(21.9)
	Females	46(7.4)	160(25.8)	177(28.5)
Potential for tampering with computer images ^a	Whole	120(19.4)	181(29.2)	319(51.5)
	Males	25(3.9)	73(11.8)	140(22.6)
	Females	96(15.5)	108(17.4)	179(28.9)

^aPearson chi-Square significant at P < 0.05.

3.3.3. Capabilities to Improve Practice

Just under half of therespondents were unclear about their views concerning whether teledentistry is expensive to set up. More females (35%) than males (13%, *p*< 0.001) thoughtteledentistry would require additional appointments for imaging. Additionally, more females (36%) than males (14%, *p*< 0.01) were convinced that teledentistry could provide valid diagnoses comparable to those made in clinical settings (Table 4).

3.3.4. Security and Confidentiality

46% of the participants expressed uncertainty about technicalincompatibility. A series of chi-squared tests found that each item on the security and confidentiality ofteledentistry exhibitedgendered response patterns (*p*<0.05; Table 4). For example, 29% of female practitioners and 22% of male practitioners were very concerned about potential violations of confidentiality (*p*=0.0001), and 29% of females

and 23% of males were a little or very concerned about the reliability of equipment and potential image forgery (*p*=0.001).

4. DISCUSSION

Although teledentistry is widely implemented in various dental fields across many countries, limited evidence is availableconcerningdentists' perceptionsabout adopting it in Saudi Arabia. The most conspicuous general observation arising from the present data is that dentists acknowledge teledentistry for its potential to enhance patient care and improve oral health practices. This confirms the growing interest in adopting telemedicine services [16 - 18].These results are promising for future technological implications in dental screening and clinical diagnosis.Teledentistry is aimed to have a strategic importance in the future. In fact, this technology fits with other recently introduced improvements, such as CAD/CAM systems, which allow a digital workflow, with clinical reliability [18] and positive patients feedback [19].CAD CAM technology is easily linkable with telemedicine, and in dentistry, a completely digital workflow,

from impression to final framework, is already viable in restorative dentistry, prosthodontics, and orthodontics [20 - 21].

In Saudi Arabia, dental professionals prefer more traditional communication methods (*i.e.*, phone calls and emails), and their least preferred modes of communication are video conferencing and forums. However, the flexible, diverse modes of telehealth are essential for supporting communication at a distance, especially for patients in rural and remote communities where healthcare access is usually inadequate.

Although technology provides modern and time-efficient methods to improve knowledge or facilitate work tasks, in this study, dental practitioners used the internet for work-related purposes far less than for general information-seeking purposes. Further investigation is warranted to understand the possible reasons behind this finding.

Most participants agreed that teledentistry could optimize proper dental referrals. A high degree of accuracy was observed in several teledentistry studies when a digital intraoral photographic assessment method was compared with a direct visual examination in various clinical disciplines [23 - 26]. Thus, teledentistry has great potential to reduce inappropriate referrals and shorten the waitlist for senior consultations [27, 28].

Another factor associated with teledentistry modulation is the financial cost. Half of the sampled participants agreed that teledentistry could potentially reduce costs, and two-thirds indicated that it could reduce unnecessary expenses incurred when traveling to hospitals. Evidence indicates that the cost associated with a teledentistry model of dental screening is lower than that associated with conventional, face-to-face dental screening in both rural and urban regions [29]. The primary driver for net savings is linked to avoiding travel and accommodation and to the low salaries of dental therapists [30, 31]. Such savings could be redirected to improve infrastructure and provide much-needed oral health services to underserved patients.

The null hypothesis of this study was rejected, as gender was a significant variable influencing the acceptance and professional use of teledentistry. More female respondents agreed that teledentistry could help monitor patients' conditions, reduce cost, shorten waitlists, and prevent unnecessary travel to hospitals, especially in rural locations. Interestingly, female practitioners raised more concerns than male practitioners about patient confidentiality issues and the reliability of equipment associated with teledentistry practice. Females were also more convinced about the validity of diagnostic records, but, unlike the males, they believed teledentistry would necessitate additional appointments for photography. This confirms previous findings in the literature [10,32]. Although our results differ to some extent from those of Zhang [33], it could, nevertheless, be argued that the male gender imbalance ratio along with small sample size are the primary reasons for this rather contradictory result. Therefore, addressing gendered perceptions during teledentistry introduction may hasten the public and private adoption of the technology.

The main limitation of this study is that it did not address

thenon-technological, organizational, or political barriers associated with teledentistry. Self-selection into the study could also have biased the results; that is, those who were interested in teledentistry responded. More female practitioners were involved than males, and thus, conclusions drawn from the results must be made cautiously. The body of literature on teledentistry acceptance is also limited to the perceptions of its end-users and care providers. There is not enough conclusive data on the cost-effectiveness and long-term use of teledentistry to make evidence-based policy decisions [31]. Further in-depth research is required to examine patients' acceptance of teledentistry.

CONCLUSION

Applying teledentistry in dental practice was generally well perceived by dental practitioners in Saudi Arabia. Gender differences in perceptions were linked to certain aspects of the efficiency and cost reduction of teledentistry. Although most dentists expressed positive opinions on teledentistry, female practitioners raised concerns about security and confidentiality.

ETHICS APPROVAL AND CONSENT TO PARTICIPATE

Ethical clearance to conduct this study was obtained from the Research Ethical Committee of the Taibah University College of Dentistry, Saudi Arabia (TUCDREC2070209AL Harbi).

HUMAN AND ANIMAL RIGHTS

No animals were used in this research. All research procedures followed on humans were in accordance with the ethical standards of the committee responsible for human experimentation (institutional and national), and with the Helsinki Declaration of 1975, as revised in 2008.

CONSENT FOR PUBLICATION

A cover page was included in the questionnaire to summarize the study and provide the researchers' contact details for any research related queries. No personal information (names or telephone numbers) was required for participation. All data were collected into one database without differentiation, and information confidentiality was assured.

AVAILABILITY OF DATA AND MATERIALS

The data sets analyzed during the current study are available from the corresponding author [A.A.] upon request.

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CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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