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Literature Review

Development of dentists perceptions and knowledge of teledentistry

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ABSTRACT

Teledentistry is a dental health service that provides consultation, guidance, or education remotely using information technology. Perception and knowledge play an essential role in the implementation of teledentistry. The purpose of this study was to explore the development of dentists' perceptions and knowledge of the concept of teledentistry. This study used a scoping review method based on the Joanna Briggs Institute methodology. Screening and study selection were carried out using the Preferred Reporting Items of Systematic Reviews and Meta-Analysis Scoping Reviews (PRISMA-Scr). Literature searches were conducted through PubMed, Science Direct, and EBSCOHost with keywords and inclusion criteria, hand searching, and viewing the list of selected article references. There were 23 articles analyzed according to the inclusion and exclusion criteria. Changes in dentists' perceptions of teledentistry would help shorten waiting list, reduce costs for dental practice, additional visits to take photographs, and additional costs to provide facilities/ equipment for teledentistry before and during the COVID-19 pandemic. Three articles (2015-2016) state that most dentists did not know or have little knowledge about teledentistry. Nine articles published during the pandemic revealed that the majority of dentists had knowledge of teledentistry. The results of this study found that developments in dentists' perception, namely teledentistry would help shorten waiting list, reduce costs for dental practice, the need for additional visits to take photographs, and additional costs to provide facilities/ equipment for teledentistry. The level of knowledge of dentists about teledentistry increased during the COVID-19 pandemic.

Keywords: dentist; knowledge; perceptions; teledentistry

INTRODUCTION

Oral health is an essential component of health and a fundamental human right.[1] According to World Health Organization (WHO), oral health is a key indicator of overall health, well-being, and quality of life.[2] However, uneven distribution of oral health facilities remains a major public health challenge. Some of the problems associated with this can be found in developing countries and remote areas, such as lack of access to oral health facilities, expensive treatment, growing and aging population, labor migration, long distances from specialists, and shortage of dentists.[3] This problem also occurs in Indonesia. The 2018 Indonesian Basic Health Research (RISKESDAS) data shows that oral health problems affect 57.6% of the population, but only 10.2% receive treatment.[4] The distribution of dentists in Indonesia is also uneven. The distribution of general practitioners and specialists in Java is more significant than in other islands.[5]

Communication technology like phones, smartphones, social media, or the internet, has become a part of most people's lives.[6] Innovative technological advancements have led to changes in many sectors, including healthcare.[7] Oral healthcare is also evolving due to opportunities created by technology and telecommunications.[8] Teledentistry, a part of telemedicine, is an oral health care facility that provides consultation, guidance, or education remotely using information technology that can be an alternative option to face-to-face services.[9,10] Teledentistry is not a new concept and has emerged since it was started by the United States army to serve its soldiers in various parts of the world in 1994.[11] Teledentistry has proven helpful for remote oral examination, diagnosis, consultation, and making treatment plans.[9]

The COVID-19 pandemic has put dental practices at high risk because aerosols and droplets are often generated in dental procedures.[12] Various oral care protocols had been established to improve the biosecurity of public and private health services following the general guidelines for health workers and health services from WHO (2020).[13] Teledentistry services could be useful during the COVID-19 pandemic to avoid direct contact with patients without time and space restrictions.[12] Teledentistry examinations are valid, feasible, and comparable to in-person oral examinations.[14] Teledentistry has been studied and has shown to offer potential advantages to dentistry; however, there are several challenges and barriers that may impede its implementation, such as a lack of understanding among dentists, regulations, technology procurement, limited internet access, and country development.[13,15] Some studies have shown that only a few dentists in Rwanda practiced teledentistry and no dentists practiced teledentistry in Pakistan before the pandemic.[16,17]

The use of telemedicine, such as the HaloDoc and Alodokter health applications, has been recognized in Indonesia since 2015.[18] The Ministry of Health has been developing telemedicine since 2012 and developed the Telemedicine Indonesia (TEMENIN) platform, but it was constrained during the pilot project in 2017 due to a lack of understanding of the use of technology and the urgency of using telemedicine.[19,20] During the COVID-19 pandemic, the government issued a circular letter from the Minister of Health of the Republic of Indonesia Number HK.02.01/ MENKES/303/2020 of 2020 that allowed dentists and dental specialists to utilize information and communication technology in providing health services.[20] The implementation of teledentistry grew during the COVID-19 pandemic because it could be a solution for dental health services and government regulations.[12,20] Teledentistry has been implemented in Bandung City's health centers since the COVID-19 pandemic, but the implementation has not been optimal because the regulations have not been fully disseminated.[21]

From the explanation above, before the COVID-19 pandemic only a few dentists used teledentistry, but since the pandemic dentists have used teledentistry for dental practice. Dentists' perceptions and knowledge play an important role in the implementation of teledentistry. This study aims to determine the development of dentists' perceptions and knowledge of the concept of *teledentistry*. The perception studied in this study is the dentist's perception of the use of *teledentistry* in practice. This information could help health workers, policymakers, and service owners determine necessary steps for adopting *teledentistry* into practice.

MATERIALS AND METHODS

This study is a scoping review based on the Joanna Briggs Institute (JBI) scoping review protocol guidelines.[22] The research instruments used were a laptop, software such as Microsoft Word and Microsoft Excel, article search engines (PubMed, Science Direct, and EBSCOHost), and the Mendeley application. The variables of this research were perception and knowledge. Furthermore, the operational definition of perception is a process of interpreting, organizing and understanding the use of teledentistry as an outcome of a learning process and experience. This study looked into dentist's perceptions of teledentistry, such as teledentistry could help shorten waiting lists, reduce cost for dental practice, would need an extra appointment and additional cost to set up its equipment/ facilities, its ability to provide accurate diagnosis, and difficulty in using teledentistry. This study seeks to investigate whether dentists know about or are aware of teledentistry, know the definition of teledentistry, have knowledge about its regulations, and know how to prescribe drug through teledentistry.

The research procedure began with the determination the Population, Concept, and Context (PCC) framework according to the research topic, which helped determine the search strategy, inclusion criteria, and exclusion criteria. Articles were searched using keywords linked

with Boolean Operators ("AND" and "OR") and limit functions on PubMed, Science Direct, and EBSCOHost databases. Screening and selection of articles were done with Preferred Reporting Items of Systematic Review and Meta-Analysis Scoping Review (PRISMA-Scr).[23] Article searches were also conducted by viewing the reference lists of selected studies and hand searching. The inclusion criteria for this study were articles that addressed perceptions and/or knowledge of teledentistry with dentists being the study population and sample, all scopes of teledentistry, articles published from 2012-2022, available in full-text, and articles in English or Indonesian. Articles that included undergraduate dental students and interns as research sample and the data presentation was not separated by sample category were excluded. Narrative reviews, case series, and case reports were also excluded in this study.

RESULTS

A total of 4,203 articles were identified, with 27 articles in PubMed, 151 articles in ScienceDirect, 4,024 articles in EBSCOHost, and 1 unpublished article (grey literature). The first screening of articles began by removing duplicate articles, in which 155 articles were excluded and 4,047 articles were obtained. The second screening was carried out by checking the title and abstract of the articles. Twenty-nine articles were obtained and 4,018 articles were excluded.

After reading the full-text, 23 articles were included for data extraction. Six articles were excluded for several reasons. Due to unavailability of full-text, 1 article was excluded. Three articles were excluded because the research sample was not a dentist, and the other 2 articles were also excluded because dental students were the sample and data presentation was not separated between sample categories. The study selection flow was also presented in the PRISMA-Scr chart in Figure 1. The included articles were published from 2015-2022. Twenty-three articles were analyzed: eight articles discussed dentists' perceptions of teledentistry, fourteen articles discussed dentists' knowledge of teledentistry, and one article discussed dentist' perceptions and knowledge of teledentistry.

Based on the research method, twenty-one articles were cross-sectional study design,[13,16,24–39,40–43] one article was cross-sectional with a mixed method design,[40] and one article

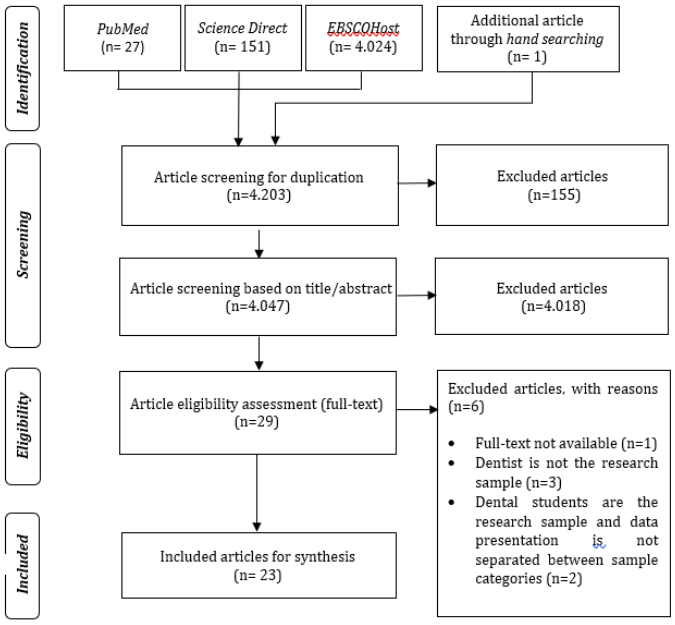

Figure 1. PRISMA scoping review study selection flowchart

Table 1. Characteristics of included studies

Author and Year	Country	Study design	Sample size (n)	Mean/Age range of participants	Perception towards teledentistry	Knowledge towards teledentistry
Boringi et al. (2015)[24]	India	Cross-sectional	406	20 –> 65 years		✓
Martin et al. (2016)[25]	America	Cross-sectional	384	N/A		✓
Estai et al. (2016)[26]	Australia	Cross-sectional	135	22 –≥ 60 years	✓	
Latif et al. (2016)[16]	Pakistan	Cross-sectional	155	Male = 29.57± 5.3 years Female = 29.2 ± 5.3 years		✓
Pradhan et al. (2019)[27]	India	Cross-sectional	77	30.9 years		✓
Almazrooa et al. (2020)[28]	Saudi Arabia	Cross-sectional	148	18 –> 36 years		✓
Al-Khalifa & AlSheikh, (2020)[29]	Saudi Arabia	Cross-sectional	286	N/A	✓	
Mathivanan et al.(2022)[30]	India	Cross-sectional	73	N/A		✓
Fatima et al. (2020)[31]	Pakistan	Cross-sectional	156	N/A		✓
Save et al. (2020)[32]	India	Cross-sectional	151	25.72 years		✓
Raucci-Neto et al. (2021)[33]	Brazil	Cross-sectional	575	N/A	✓	✓
Subhan et al. (2021)[34]	Pakistan	Cross-sectional	325	18 –> 65 years		✓
Maqsood et al. (2021)[35]	Global	Cross-sectional	506	20 - 64 years	✓	
Nassani et al. (2021)[36]	Saudi Arabia	Cross-sectional	603	28.8 ± 5.8 years		✓
Plaza-Ruiz et al. (2021)[13]	Colombia	Cross-sectional	5370	45 years		✓
Hazhar et al. (2021)[37]	Indonesia	Cross-sectional	103	20 –> 65 years	✓	
George et al. (2021)[38]	India	Cross-sectional	150	25 - 55 years		✓
Giraudeau et al. (2022)[39]	France	Cross-sectional	5056	46.3 years		✓
Tiwari et al. (2022)[40]	America	Cross-sectional, mixed-methods design	1642	18 –> 65 years	✓	
Khokhar et al. (2022)[41]	Malaysia	Cross-sectional	310	25 –> 65 years	✓	
Chaudhary et al. (2022)[42]	Saudi Arabia and Pakistan	Cross-sectional	190	20 – 64 years	✓	
Soegyanto et al. (2022)[43]	Indonesia	Cross-sectional	652	20 –≥ 65 years	✓	
Lin et al. (2022)[44]	Malaysia	Systematic Review	N/A	N/A		✓

Table 2. Dentists' perceptions of teledentistry

Perception Indicator	Estai et al. (2016)[26]	Al-Khalifa & AlSheikh, (2020)[29]	Raucci-Neto et al. (2021)[33]	Maqsood et al. (2021)[35,36]	Hazhar et al. (2021)[37]	Khokhar et al. (2022)[41]	Chaudhary et al. (2022)[42]	Soegyanto et al. (2022)[43]	Tiwari et al. (2022)[40]
Teledentistry would help shorten the waiting list	> 40% of respondents were doubtful	71% of dentists agreed and strongly agreed	N/A	79.64% of dentists agree	The majority of dentists agreed and strongly agreed (84.4%)	The majority of respondents agreed (77%)	75.2% of dentists in Pakistan and Arabia agree	The majority of dentists agreed (91.7%)	N/A
Teledentistry would reduce costs for the dental practices	54% of respondents were doubtful	54% of dentists agreed and strongly agreed	N/A	69.96% of dentists agree	58.2% of dentists agreed and strongly agreed	42% of respondents agreed	N/A	Most respondents agreed (63.6%)	N/A
Teledentistry would necessitate an extra appointment for taking photographs	52% of respondents felt no need for extra appointment for taking photographs	54% agree and strongly agree	N/A	59.28% of respondents agreed	72.8% agreed	65% agree	N/A	78.2% agreed	N/A
Additional costs incurred to provide facilities/equipment for teledentistry	More than a third of respondents felt that the cost to provide teledentistry equipment was too expensive	35% disagree and strongly disagree that procurement of facilities for teledentistry is expensive (34% neutral; 31% agree & strongly agree)	N/A	24.50% of respondents felt that the procurement of teledentistry equipment was expensive.	43.7% agreed and strongly agreed that setting up teledentistry for practices would not be costly	There was a mixed response to the procurement of teledentistry equipment being too expensive (36% neutral, 32% disagree, 32% agree).	Only 20% Saudi Arabian and Pakistani respondents agreed that teledentistry equipment is expensive	47.1% of respondents were skeptical that procurement of equipment for teledentistry was expensive (only 22.3% answered in the affirmative).	N/A

Teledentistry would provide an accurate diagnosis in a clinical setting	The majority of dentists (> 60% neutral and disagree) had mixed responses to teledentistry being able to provide a valid diagnosis like an in-person examination.	38% were neutral and 32% disagreed that teledentistry can produce an accurate diagnosis like a direct examination.	48.9% of respondents believed teledentistry would not be effective for diagnosis	50.6% of respondents did not want to use teledentistry for patient diagnosis.	89.3% of dentists were undecided, disagreed, and strongly disagreed that teledentistry can provide an accurate diagnosis similar to that of an in-person clinical examination.	42% of respondents doubted the accuracy of diagnosis using teledentistry	Only 23.7% of Pakistani and Saudi Arabian respondents agreed that teledentistry can produce accurate diagnoses	Only 1/3 of respondents agreed that teledentistry can provide an accurate diagnosis (37.8%).	N/A
Difficulty in using teledentistry	N/A	N/A		N/A	N/A	N/A	N/A	N/A	N/A
								There are two views of dentists towards teledentistry, namely positive perceptions and optimism towards teledentistry from dentists who have used teledentistry and doubts about the ethics and quality of care produced from dentists who have not used teledentistry.	

Table 3 Dentists' knowledge of teledentistry

Author and Year	Have knowledge/awareness of teledentistry	Know the definition of teledentistry	Knowledge of teledentistry regulations	Knowledge related to drug prescribing through teledentistry
Boringi et al. (2015)[24]	The level of teledentistry awareness and knowledge of post-graduate dental students is low (7.23%)	N/A	N/A	N/A
Martin et al. (2016)[25]	The majority of respondents knew little or nothing about teledentistry. (69.3%)	N/A	N/A	N/A
Latif et al. (2016)[16]	• 63% of respondents did not know about e-health • 96% of respondents did not know about the practice of teledentistry remotely	N/A	N/A	N/A
Pradhan et al. (2019)[27]	96.1% of respondents had heard of and knew about teledentistry.	96.2% of respondents knew that teledentistry is the practice of using computers, the internet, and technology for remote diagnosis and treatment planning.	N/A	N/A
Almazrooa et al. (2020)[28]	• The majority of dentists did not know teledentistry (71.6%) • 30.2% of dentists who were not familiar with teledentistry did not realize they had done teledentistry in the past	N/A	N/A	N/A
Mathivanan et al. (2020)[30]		• 95% of respondents agreed teledentistry is a practice that provides care advice remotely • 95% of dentists stated that teledentistry is not a face-to-face interview	N/A	N/A
Fatima et al. (2020)[31]	The majority of respondents (76.9%) had knowledge of teledentistry	N/A	N/A	N/A
Save et al. (2020)[32]	Only 55.6% of respondents were aware of the concept of teledentistry and only 43% of respondents were aware of the modalities that can be used for teledentistry.	N/A	N/A	N/A

Raucci-Neto et al. (2021)[33]	N/A	N/A	Most dentists had low knowledge of teledentistry resolution in Brazil (38.9%).	the majority of dentists do not know how to prescribe medication through *teledentistry* (63%)
Subhan et al. (2021)[34]	62.5% had no knowledge of teledentistry before COVID-19 but the majority of respondents (68.6%) became aware of teledentistry since the COVID-19 pandemic.	86.8% of respondents knew that teledentistry is the use of computers, internet, and technology to diagnose and provide care remotely.	N/A	N/A
Nassani et al. (2021)[36]	• Only 32.4% of general practitioners and 60% of specialists have heard of teledentistry • Only 32.7% of general practitioners and 53.7% of specialists know what teledentistry is.	70.1% of general practitioners and 83% of specialists agreed that teledentistry is the practice of using computers, the Internet, and technology for remote consultation and treatment planning.	N/A	N/A
Plaza-Ruiz et al. (2021)[13]	25.75% of respondents had heard of teledentistry before the COVID-19 pandemic and increased to 62.72% during the COVID-19 pandemic.	N/A	N/A	N/A
George et al. (2021)[38]	93.3% of orthodontists have knowledge of teledentistry	94.6% of respondents agreed that teledentistry is the use of computers, internet, and technology for remote diagnosis and treatment planning	N/A	N/A
Giraudeau et al. (2022)[39]	57.1% of dentists had never heard of or knew about teledentistry	N/A	The majority of respondents (90.5%, n = 4576) had no knowledge of current teledentistry regulations	N/A
Lin et al. (2022)[44]	Dentists' knowledge level of teledentistry is moderate during the COVID-19 pandemic (57.9%)	N/A	N/A	N/A

was a systematic review.[44] Based on the location of the study, five articles were conducted in India,[24,27,30,32,38] three articles in Pakistan,[16,31,34] three articles in Saudi Arabia,[28,29,36] two articles in Indonesia,[37,43] two articles in the United States,[25,40] and a few other articles in Australia,[26] Malaysia,[41,44] France,[39] Colombia,[13] and Brazil.[33] One article was conducted in two countries (Saudi Arabia and Pakistan)[42] and one article was a global study.[35]

A study by Estai et al in 2016 found that > 40% of dentists doubted that teledentistry would help shorten the waiting list.[26] By contrast, Al-Khalifa & AlSheikh, Maqsood et al, Chaudhary et al, Khokhar et al, Soegyanto et al, and Hazhar et al, whose articles were published between 2020 and 2022, showed the majority of dentists agreed that teledentistry could shorten waiting list (71%-84.4%).[29,35,37,41–43] However, the majority of dentists (52%) in a 2016 study by Estai et al did not agree that teledentistry required additional visits to take clinical photographs. On the other hand, dentists in the studies by Al-Khalifa & AlSheikh, Soegyanto et al, Hazhar et al, Maqsood et al, and Khokhar et al (2020-2022) revealed the need for additional visits to take clinical photographs (54%-78.2%). In addition, research by Estai et al in 2016 found that 54% of the respondents doubted that teledentistry could save operational costs of dental practices.[26] Several studies showed that the majority of dentists agreed that teledentistry could reduce the cost of dental practice (42%-69.96%).[29,35,37,41,43] Research by Estai et al in 2016 found that more than a third of the respondents found the procurement of teledentistry equipment too expensive.[26] In other studies, however, the majority of dentists did not find teledentistry equipment expensive.[35,37,42,43] There were mixed responses to this issue in the studies by Al-Khalifa et al and Khokhar et al.[29,41] In 2016, Estai et al stated that the majority of the respondents gave neutral responses to the statement that teledentistry could provide a valid diagnosis like an in-person examination.[26] A 2020-2022 study also found that the majority of dentists gave neutral responses and disagreed with the ability of teledentistry to produce accurate diagnoses as in in-person examinations.[29,35,37,41–43] Raucci-Neto et al in 2020 demonstrated that 48.9% of dentists found that teledentistry would not be effective for diagnosis.[33]

Research by Tiwari et al in 2022 showed that the group of dentists who had not adopted teledentistry found that teledentistry was a method adopted from medicine and was more useful in medicine than in dentistry due to the different hands-on nature of the two fields. These dentists found that virtual meetings could limit the value and scope of dentistry. In addition, this group of dentists did not seem to be aware of the potential benefits of teledentistry and seemed to be more reluctant to learn teledentistry. Some dentists stated that they were not comfortable billing patients for teledentistry because they were unsure of the quality of care provided. Different perspectives were offered by the group of dentists who had adopted teledentistry into their practice. This group revealed that teledentistry could provide patients care during the COVID-19 pandemic, be a valuable tool in dental health services, and play a significant role in the future of dentistry even after the pandemic. Some dentists said that teledentistry could improve access to oral health services for the nearby communities. Some dentists stated that patients were willing to access the virtual platforms, and a patient was found to be satisfied with the results of the virtual consultations.[40]

Dentists' knowledge of teledentistry were discussed in 14 articles. Research by Boringi et al conducted in 2015 found that only 7.23% of post-graduate students knew teledentistry.[24] Latif et al in 2016 in Pakistan also showed that 63% of dentists had no knowledge of e-health, while 96% did not know about the practice of teledentistry.[16] A study by Martin et al in 2016 also demonstrated the majority of dentists knew little or nothing about teledentistry.[25] A study by Plaza-Ruíz et al in 2021 found that only 25.75% of dentists had heard of teledentistry before the pandemic, and the figure increased to 62.72% during the pandemic.[9] Similarly, Subhan et al in 2021 found that only 37.5% of dentists knew about teledentistry before the COVID-19 pandemic, but since the pandemic

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the majority of dentists have become aware of teledentistry (68.6%).[34]

Dentists' knowledge in other studies during the COVID-19 pandemic showed different results. A study by Almazrooa et al in 2020 also demonstrated that the majority of dentists (71.6%) did not know the term teledentistry. Around 30% of dentists who were not familiar with teledentistry did not realize they had done teledentistry in the past.[28] Nassani et al in 2021 stated that 32.4% of general dentists and 60% of specialist dentists had heard of teledentistry, and only 32.7% of general dentists and 53.7% of specialist dentists knew what teledentistry was.[36] The results of research by Lin et al. (2022) showed that the level of knowledge of teledentistry among dentists was moderate (57%) during the COVID-19 pandemic.[44]

The majority of dentists are aware that teledentistry is the practice of dentistry that utilises computers, internet, and technology for remote consultation and treatment planning.[30,32,34,36,38] Almost all dentists (95%) in a study by Mathivanan et al. said that teledentistry was not a face-to-face interview.[30] Raucci-Neto et al. found that most dentists did not know how to prescribe drugs through teledentistry (63%).[33]

Two studies found regulations concerning dentists' knowledge of teledentistry in their countries.Most dentists in Brazil had minimum knowledge of the teledentistry resolution of 22 June 2020 which regulate teledentistry in Brazil (38.9%).[33] The majority of respondents (90.5%, n- 76) had no knowledge of the teledentistry regulations applicable in France, While only 0.7% (n = 35 respondents) had good knowledge of teledentistry regulations.[39]

DISCUSSION

The results of the study found that changes in dentists' perceptions of teledentistry could help shorten waiting lists. A study by Estai et al in 2016 found that > 40% of the respondents doubted that teledentistry would help shorten waiting lists.[26] However, the latest studies (2020-2022) have shown the majority of dentists agreed that teledentistry would help shorten waiting lists.[29,35,37,41–43] Long waiting lists, long consultation durations, and inappropriate referrals have been a concern to healthcare providers.[26] Teledentistry has the potential to reduce patient queues and facilitate a better referral system by looking at the information about patient condition submitted online.[45] Research using cloud-based store and forward teledentistry method in Australia suggests that teledentistry can reduce patient visits and reduce patient waiting times.[46] By using teledentistry, dentists can see a patient's oral health condition through clinical photos and then make a diagnosis and treatment plan.[47]

Based on a study by Estai et al in 2016, 54% of dentist respondents in Australia also doubted that teledentistry could reduce costs for dental practices.[26] The results of the latest studies (2020-2022), however, challenge this notion and show that the majority of dentists believe that teledentistry can reduce the cost of dental practice.[29,35,37,41,43] Several studies have shown that teledentistry can save costs compared to face-to-face examinations.[48,49] A study in Australia found that using teledentistry to screen children with low caries risk could potentially save up to 40 million dollars per year.[50] This study shows a change in dentists' perceptions of the need for additional patient visits to take clinical photographs. A study by Estai et al. in 2016 showed that the majority of dentists indicated that patients did not need additional visits for clinical photography, but the latest studies (2020-2022) have demonstrated the need for additional visits for clinical photography.[26,29,35,37,41,43] There is a need to understand how to take good photos for clinical examinations.[26] Lin et al. made recommendations to dentists on taking intraoral photographs for clinical examination remotely to produce good quality and interpretable photographs.[51]

One of the challenges in the adoption of teledentistry into practice is that additional costs are incurred to provide facilities/ equipment for teledentistry.[15] As reported by Estai et al,

dentists found the cost of acquiring teledentistry equipment too expensive.[26] Over time, the latest study (2020-2022) show that dentists found providing teledentistry equipment inexpensive. [29,35,37,41–43] This may be due to the fact that many people already have easy access to smartphones and the internet connection for teledentistry. Smartphones are affordable and easy to use by dentists and the public.[47] Smartphones are now a cost-effective and user-friendly option for screening caries through photos taken using the device.[52,53]

Most dentists still doubt the accuracy of diagnoses through teledentistry.[26,29,33,35,37,41–43] This result is in contrast to the systematic review articles which concluded that teledentistry has acceptable value for diagnosis.[54,55] This doubt may arise from the inability of teledentistry to perform a complete patient examination as in a direct examination, so a direct examination is still needed to establish an accurate diagnosis.[56] The interpretation and accuracy of teledentistry in the diagnosis depend on the quality of the equipment used, image quality, and training.[42]

Dentists' level of knowledge of teledentistry develops over time. The 2015-2016 studies revealed that the majority of dentists did not know teledentistry.[16,24,25] Different results were found in the latest studies (2019-2022) which showed that the majority of dentists knew or had heard of teledentistry. Several studies have found the influence of the COVID-19 pandemic on increasing dentists' knowledge of teledentistry.[13,34] The COVID-19 pandemic is a challenge for dental practices because aerosols and droplets are often produced in dental procedures, putting them at risk of transmitting the virus.[57] The recommendation to reduce interpersonal contact makes direct patient examination limited. Teledentistry can be a solution for dental health services during the COVID-19 pandemic because it can provide remote consultations.[12,58] National income, regulations, undergraduate education, or infrastructure may be contributing factors to dentists' low level of knowledge about teledentistry.[13,15] Several studies still found that the majority of dentists were not familiar with teledentistry during the COVID-19 pandemic.[28,36] A systematic review by Lin et al. showed that dentists' knowledge level of teledentistry was moderate (57%) during the COVID-19 pandemic.[44]

Training or education on teledentistry was found to be low both before and during the COVID-19 pandemic. Studies by Fatima et al, Latif et al, and Nassani et al revealed that the majority of dentists never received training/ education on teledentistry (87.4%, 69.7%, 79.4%).[16,31,36] Giraudeau et al stated that only 1.5% (n = 76) of dentists had attended telemedicine and/or teledentistry training during their studies. Among the dentists who had received such training, 75.2% (n = 57) said that the training was inadequate.[39] Lack of training/ education on teledentistry may be a factor influencing the low level of knowledge of dentists in the past. Adoption and practice of teledentistry are a gradual process involving education, training, and evaluation of the benefits and costs of using teledentistry.[40] Training and continuing education for dentists can be one way to increase awareness and knowledge of teledentistry and help prepare dentists to use it in clinical practice.[31] Providing training for dentists can have a positive change in attitudes after training and a positive impact on knowledge and competence about teledentistry.[59] The COVID-19 pandemic has impacted teledentistry, and teledentistry will continue to grow even after the pandemic.[60] Formal education in the application of teledentistry could prepare future dental students.

This study found that many dentists are not aware of teledentistry regulations in their country.[33,39] As a result, teledentistry practices may not be carried out according to applicable standards.[35] It is important that teledentistry services adhere to applicable regulations to ensure the privacy, and security of patient health information is maintained.[61] Teledentistry regulations can play a significant role in the adoption of teledentistry. Tiwari et al. said regulations are very important to the interest in using teledentistry for dentists who have adopted

and dentists who not yet adopted teledentistry.[40] Dissemination of information about teledentistry regulations for dentists is needed.

The level of knowledge about teledentistry among dentists may be influenced by age, experience, and the type of dental workplace.[13,31,36,38] Younger dentists may possess a higher level of knowledge compared to older dentists due to the use of technology such as smartphones in teledentistry.[13,16,24,38] Specialized dentists may also have a higher level of knowledge and awareness of teledentistry technologies than general dentists.[32,36]

The limitations of this study are the limited number of articles related to the research topic published before 2020, and some articles were not from highly reputable international journals. Despite these limitations, this study was conducted systematically according to Joanna Briggs Institute (JBI) guidelines for scoping review and PRISMA-ScR to ensure the quality was maintained at every stage. The inclusion and exclusion criteria have been set to reduce heterogeneity to a certain extent.

CONCLUSION

This study found development of dentists' perceptions. Before the pandemic, dentists were doubted/disagreed about some perceptions about teledentistry but they become agreed during the pandemic. Those perceptions were teledentistry would help shorten waiting lists, reduce costs for dental practices, the need for additional visits to take photographs, and additional costs incurred for providing facilities/equipment for teledentistry Dentists' knowledge of teledentistry has also evolved. Before the COVID-19 pandemic the level was low, but it increased during the COVID-19 pandemic.

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