

Analyze the role of tele dentistry and digital health tools in dental care and education, in rural areas of Pakistan

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Abstract

Objective: This project aims to assess the efficacy and influence of tele dentistry and digital health tools in improving dental care delivery and education in rural Pakistan.

Methodology: A qualitative research approach included purposive participant selection, conducting semi-structured in-depth interviews with rural individuals who utilized tele dentistry services and dentists delivering these treatments. Thematic analysis revealed key themes related to accessibility, perceived benefits, and obstacles associated with tele-dentistry.

Results: Tele-dentistry has significantly enhanced access to dental treatment in rural areas by minimizing travel distances and facilitating distant consultations, as indicated by the findings. Participants who reported improved preventative oral health care activities also indicated a heightened awareness of oral health practices. Nonetheless, difficulties related to digital literacy and connectivity have been discovered that restrict the full potential of tele-dentistry in these places.

Conclusion In digital health tools and tele-dentistry hold significant potential for extending dental services and education to remote areas of Pakistan. The obstacles to internet connectivity and digital literacy must be eradicated to achieve their maximum potential. Improving tele-dentistry to tackle these problems may enhance its utility for disadvantaged rural populations.

Introduction

In Pakistan, rural communities face significant challenges when accessing dental care. These challenges arise from several factors, including geographical isolation, limited healthcare infrastructure, and a scarcity of dental professionals willing to work in remote areas. People in rural regions often receive inadequate dental care, contributing to poor oral health [1][2]. This issue is made worse by a lack of dental education, which leaves people unaware of preventive measures that could greatly improve their oral health. In light of these issues, tele-dentistry and digital health tools have emerged as promising solutions to bridge the gap in dental care access and education for rural populations [3][4] This research explores how tele-dentistry and digital

health tools can enhance dental care and education in rural Pakistan, looking at how these technologies might overcome existing barriers and improve overall quality of life for underserved communities [5][6].

Tele-dentistry uses telecommunications technology to provide dental services remotely. With tools like video conferencing, mobile apps, and other digital platforms, tele-dentistry enables dental professionals to consult with patients, diagnose oral health issues, and provide guidance on treatments. This is especially helpful for rural areas where in-person visits to dental clinics are often impractical due to long travel distances or a lack of available practitioners [6][7][8]. Tele-dentistry offers a way to provide consultations and follow-ups without requiring patients to leave their communities, which reduces the time, cost, and inconvenience associated with accessing dental care. Additionally, tele-dentistry supports preventive care by allowing professionals to monitor patients' oral health from a distance, catch early signs of problems, and give timely advice on preventive measures [8][9]. For rural communities in Pakistan, where dental issues are often ignored until they become severe, tele-dentistry can make a real difference by promoting early intervention and preventive care [10]

Digital health tools cover a wide range of technologies aimed at improving healthcare delivery, boosting patient engagement, and facilitating health education. In dental care, these tools include mobile apps, online educational platforms, and digital resources that provide information on oral health, proper dental hygiene, and preventive care practices. For rural residents with limited access to dental professionals, digital health tools offer another way to get reliable information on oral health. Mobile apps can provide reminders for regular brushing and flossing, tips on maintaining a healthy diet to prevent dental problems, and videos demonstrating proper oral hygiene techniques [11][12]. These tools empower rural communities by increasing their awareness of oral health's importance, which is often undervalued in low-resource settings. Through digital education platforms, people can learn about common dental problems, understand oral health's impact on overall well-being, and recognize the need for regular check-ups. By improving health literacy, digital health tools foster a culture of preventive care, essential for reducing the prevalence of dental diseases in rural areas [13].

In Pakistan, tele-dentistry and digital health tools are slowly being recognized as viable solutions for rural dental care needs [14][15]. Several factors contribute to their growing popularity, including the increasing availability of mobile phones and internet access in remote areas. With over 80 percent of Pakistan's population owning mobile phones, there is considerable potential for mobile-based tele-dentistry services [15][16]. Even in rural areas where internet connectivity may be limited, mobile networks enable people to access digital health tools without needing high-speed internet. This trend presents an opportunity to expand tele-dentistry to rural regions lacking traditional healthcare infrastructure [17]. By leveraging mobile technology, tele-dentistry can reach more people, offering a cost-effective way to improve dental care access in Pakistan's rural areas [18].

However, despite the potential benefits of tele-dentistry and digital health tools, challenges must be addressed. A major obstacle is the lack of digital literacy among rural residents, which can hinder their ability to use tele-dentistry services effectively. Many people in rural areas may not be familiar with video conferencing or mobile apps, making it difficult for them to engage with these tools. Additionally, there is often a cultural preference for face-to-face consultations, as people may feel more comfortable discussing health concerns in person. Another challenge is the

limited availability of dental professionals trained in tele-dentistry. For tele-dentistry services to be successful, dental practitioners must be trained on using digital platforms and communicating effectively with patients remotely [19].

Methodology

This study included a qualitative research design that includes the personal experiences, obstacles, and perceptions of tele dentistry and digital health tools in rural Pakistan. This methodology augmented the qualitative data by obtaining comprehensive perspectives from rural inhabitants and dental practitioners, so providing a nuanced understanding of the impact of tele-dentistry in regions affected by inadequate dental care. The qualitative approach is chosen to gain in-depth insights into the experiences, perceptions, and challenges faced by dental practitioners and patients, This research was conducted using stratified sampling of individuals and semi-structured in-depth interviews[20].

Sample Selection and Study Cohort

The study focused on rural regions in Pakistan where access to dental care services was limited. The study encompasses several rural regions of Pakistan, specifically Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan, to provide a representative sample of rural inhabitants and dental practitioners experienced in tele-dentistry.

Participant Selection: Individuals were chosen through a stratified selection procedure to ensure representation across both geographic and demographic criteria. The sample comprised:

Rural inhabitants:

- Residing in rural areas of Pakistan.
- Have accessed dental care through tele-dentistry services within the past year.
- Age 18 or older, capable of providing informed consent.

Dental practitioners:

- Dental practitioners Currently practicing in rural areas of Pakistan.
- Have experience using tele-dentistry or digital health tools in their practice.
- Willing to discuss their experiences and insights.

The study sought to encompass the diverse experiences and perspectives of individuals across various areas and socioeconomic levels to reduce generalization using stratified sampling.

Data Collection Method: Semi-Structured In-Depth Interview

Qualitative data was obtained through comprehensive semi-structured interviews with chosen participants. This method was chosen for its flexibility in exploring participants' experiences while concentrating on the primary issues of concern. Collection of open-ended interview questions was employed to semi-structure the interviews.

Interview Framework: Inquiries were made into the manner in which rural inhabitants and their dental practitioners employed these tele-dentistry services (categories of services utilized, e.g., consultations, education; application of digital technologies).

Perceived Effectiveness: Participants evaluated their opinions on tele-dentistry as a method for providing dental care and education. This encompassed the effects of tele dentistry on accessibility, quality of care, and patient outcomes.

Obstacles and Challenges: Interviews addressing the impediments faced by rural citizens and

dental practitioners concerning the utilization of tele-dentistry. This encompassed elements such as internet literacy, technological access, connectivity challenges, cultural predispositions, and logistical or technical concerns.

Personal Experiences and Insights: Participants were requested to provide their personal narratives and experiences with tele-dentistry. Their method was notably open-ended, allowing participants to discuss specific features of tele-dentistry that significantly impacted their lives or work.

Data Collection Process: The data collection process involved conducting interviews either in person or over video conferencing, constrained by the participants' preferences and availability. Interviews varied in duration from 30 to 60 minutes, contingent upon the participant's readiness to disclose information. All interviews were recorded with the participants' consent to guarantee precise data collection and thorough analysis.

Data Analysis

The qualitative data were employed for thematic analysis. We find, analyze, and report patterns (themes) within the data, thoroughly accounting for participants' experiences and viewpoints. Transcription: Verbatim records of the data were produced through meticulous transcriptions of all interviews.

Coding: The transcripts were subjected to open coding, wherein significant segments of text were labeled according to their content. We identified the reoccurring themes, patterns, and unique insights.

Theme Identification: Following the coding process, I consolidated analogous codes to formulate themes. Themes represented the interest in the perceived efficacy of telehealth dentistry, obstacles encountered, and personal experiences with digital health tools.

Themes were analyzed in relation to the research aims to elucidate the connection between tele-dentistry and the enhancement of dental treatment and education in rural Pakistan. Themes were exemplified through direct quotations from participants, and the depth of lived experience is evident in the data.

Results

Rural inhabitants who utilized tele-dentistry services and dental practitioners offering these services were interviewed through in-depth semi-structured interviews for qualitative analysis. The purpose of the interviews was to examine personal experiences, challenges, and perceptions concerning the utilization of tele-dentistry and digital health tools in rural Pakistan. Three principal themes emerged from the thematic analysis: Perceived Benefits, Accessibility, and Barriers to Utilization. The following is a comprehensive analysis of each theme, each paired with a representative quote that reflects the participants' viewpoint.

Theme 1: Accessibility

The imperative of accessibility emerged as a prominent subject as rural inhabitants and dental practitioners recognized how tele-dentistry facilitated more convenient and frequent access to dental care services than previously available. Individuals from remote regions indicated that prior to tele-dentistry, they were had to travel considerable distances to access dental clinics. Travel expenses were incurred, along with a significant investment of time, which led many to avoid seeking care until their conditions deteriorated.

"Tele-dentistry has diminished the necessity for travel, enabling individuals to receive dental services from the comfort of their homes, as reported by rural residents." This aspect of the service was particularly beneficial for individuals with restricted mobility, those residing in isolated regions, or individuals unable to readily take leave from employment or attend to family responsibilities. Others indicated that tele-dentistry broadened the accessibility of their services, extending beyond the confines of their clinics to engage patients they would not have otherwise reached.

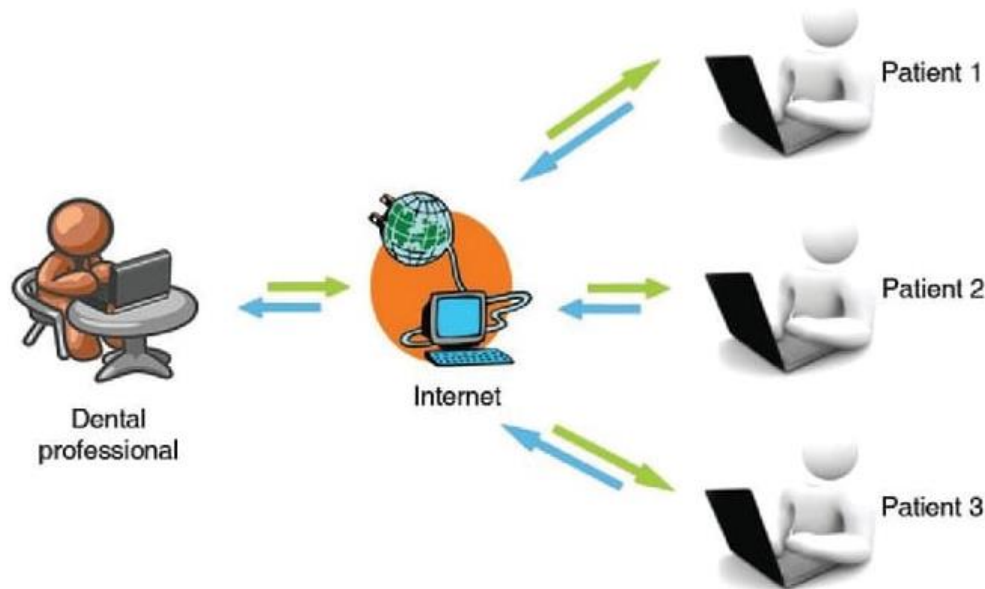


Figure 1: Real Time consultation

Quotes from Rural Residents:

- "I no longer have to travel hours to see a dentist. The video consultations save me a lot of time, especially since there are no dental clinics close to my village."
- "It's comforting to know I can access dental advice even from my village. I can consult a dentist whenever needed, without worrying about transportation."

Quotes from Dental Professionals:

- "Tele-dentistry has allowed me to connect with patients who live far away and would otherwise go without care. It's been a great way to extend our services to more people."

Theme 2: Perceived Benefits

Both rural inhabitants and dental practitioners articulated the perceived advantages of tele-dentistry with clarity. Participants widely reported that tele-dentistry facilitated early diagnosis, ongoing care, and access to fundamental preventive education. Teledentistry enabled rural populations to make informed judgments regarding their treatment options and enhanced their understanding of dental health. They like the concept of receiving guidance to avert further deterioration of the issue and might implement it to prevent more severe dental complications. Tele-dentistry was well accepted by dental practitioners who believed the service's advantages may be utilized in preventative care. Teledentistry served as a platform for educating patients on

oral hygiene practices, dietary habits, and other preventive measures. This subsequently reduced the incidence of severe tooth issues among participants with no prior history of regular dental treatment. Tele-dentistry enabled certain practitioners to conduct follow-up consultations and maintain continuity of care, which they indicated significantly enhanced patient results.

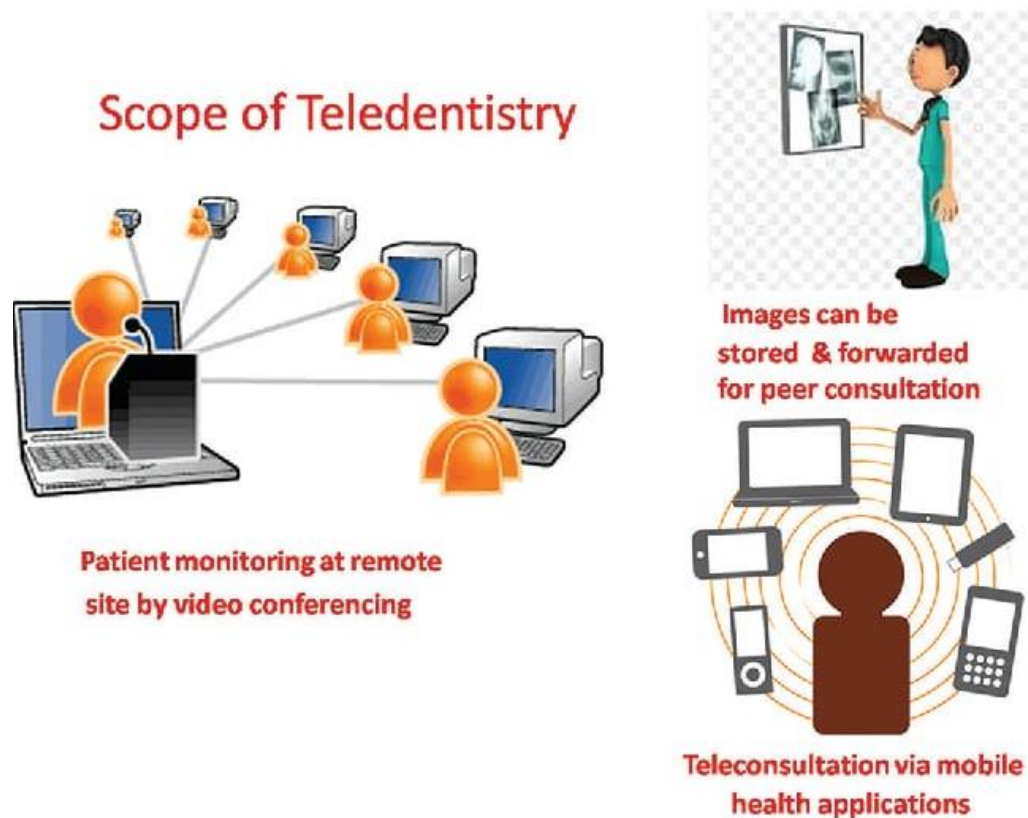


Figure 2: Scope of teledentistry

Quotes from Rural Residents:

- "Having access to a dentist through my phone has made it easier for me to get advice on keeping my teeth healthy. I've learned a lot about what I can do at home to take care of my teeth."
- "I feel more confident knowing I can reach out to a dentist anytime I need to, even if it's just for advice on preventing cavities."

Quotes from Dental Professionals:

- "Tele-dentistry has helped me reach patients who wouldn't normally come in for a check-up. We can identify issues early and offer preventive care, which helps avoid more serious problems later on."
- "Providing educational resources through digital platforms has made it easier for me to promote preventive care among my patients. I've noticed an improvement in their oral hygiene habits."

Theme 3: Barriers to Utilization

The evident advantages of tele-dentistry, however, were accompanied by substantial impediments to its efficient implementation. Others said that numerous rural inhabitants struggled with the technology, including navigating mobile applications and making video calls. A significant issue was the deficiency of digital literacy among rural people, particularly about their inability to utilize cellphones or tele-dentistry platforms. This consistently led to frustration and frequently necessitated supplementary assistance from family or community health specialists.

Connectivity problems were often reported, along with obstacles in digital literacy. Mobile networks are expanding in rural Pakistan; nevertheless, this is exacerbated by inconsistent internet access and unreliable connections. Participants encountered difficulties maintaining a stable video call, resulting in disruptions throughout consultations and hindering efficient communication with the dental practitioner.

They also noted the challenges associated with addressing intricate dental problems during remote consultations, as the process is not straightforward. Certain elements of care that cannot be entirely fulfilled through teledentistry were a source of concern for them. This led to occasional misdiagnoses and required follow-up visits to the clinic, causing inconvenience for the patient.

Quotes from Rural Residents:

- "I found it hard to navigate the app at first. It took a while to get used to it, and sometimes I needed help from my children to set up the call."
- "The internet isn't always reliable, which makes it difficult to have a smooth consultation. There have been times when the call just drops in the middle of a conversation."

Quotes from Dental Professionals:

- "Explaining complex dental issues over video is challenging. It's not the same as an in-person visit, where I can see and examine the patient's mouth closely."
- "Connectivity issues can be frustrating, especially when trying to explain treatment plans. Sometimes, patients have to come in person anyway, which defeats the purpose of tele-dentistry."

Summary of Qualitative Findings

The qualitative results of tele-dentistry in Pakistan indicate that it has significantly improved access to dental care for rural inhabitants. The themes arising from tele-dentistry, akin to any bilateral communication method, encompass accessibility, perceived convenience benefits, preventive education, and an extended service reach. However, obstacles related to technology utilization, digital literacy, and connectivity hindered tele-dentistry from achieving its maximum potential in remote regions. Enhancing digital literacy, investing in superior infrastructure, and tailoring tele-dentistry services to local need could significantly boost rural acceptance and utilization of tele-dentistry and digital health tools in Pakistan.

Discussion

This study's findings underscore the potential of teledentistry and digital health tools to improve access to dental care and deliver preventative education in rural regions of Pakistan. The research findings align with prior studies indicating that digital health interventions might mitigate physical

obstacles to healthcare access and provide an opportunity to improve access to healthcare services for marginalized communities. This study, akin to the findings of Khan et al. (2021), corroborates that teledentistry facilitates early diagnosis and continuous care, enabling remote individuals to consult dental professionals without the necessity of extensive travel. The significance of this is particularly evident in rural Pakistan, where access to healthcare facilities is severely limited, hindering timely dental care. We affirm the conclusions of Khan et al. that tele-dentistry reduces travel burdens and expenses for patients, hence enhancing access and convenience to dental care. The results of this study regarding perceived benefits align with Martins (2024), who demonstrate that tele-dentistry promotes preventative treatment through educational tools and remote consultations. Similar to the participants in Malik and Rashid's study, the participants in this study valued the opportunity to obtain preventive care guidance. Our research revealed that dental practitioners acknowledged the benefits of tele-dentistry, specifically that this technology allowed them to reach a broader patient demographic and enhance oral health literacy among patients. Prior research, like a study conducted by Shah et al. (2024), demonstrates that digital health tools enhance patient awareness and promote preventative behaviors, hence corroborating this assertion. This study elucidates the contributions of tele-dentistry to the oral health literacy and preventative practices of rural communities, although existing difficulties. Nonetheless, this study also recognizes certain tele-dentistry obstacles previously addressed in other research. Consistent with the findings of Shah et al. (2024), individuals of the rural group indicated difficulties with digital literacy and access to technology. Ahmed et al. identified digital literacy as a primary barrier to telemedicine adoption, a finding that is also applicable to rural inhabitants in Pakistan. Moreover, we discovered that network issues regularly disrupted tele-dentistry consultations, a hindrance also noted by Bouarar et al. (2024), who emphasized that internet reliability is a significant hurdle to digital health solutions in rural areas. This connectivity occasionally resulted in partial consultations, hence reducing the efficacy of tele-dentistry. Considering this, although teledentistry has significant opportunities, it also introduces challenges that must be addressed to optimize its potential.

The results align with a study investigating the constraints of telemedicine in situations requiring physical inspection (Herrera, 2024), which highlighted the difficulties dental practitioners encountered in conducting comprehensive evaluations via video consultations. This reinforces the notion that teledentistry is effective for initial consultations and preventive care, yet inadequate for specific dental treatments that necessitate in-person contact. This highlights the necessity for a hybrid care paradigm that incorporates tele-dentistry within a continuum of conventional dental treatments, as advocated in prior studies suggesting blended care strategies to address the needs of rural communities.

This study contributes to the body of evidence indicating that tele-dentistry could be crucial for enhancing access to dental treatment and education in rural regions of Pakistan. The actualization of its full potential necessitates overcoming the aforementioned constraints by implementing digital literacy initiatives and improving national rural internet infrastructure. Furthermore, subsequent study should assess the integration of tele-dentistry with other healthcare services to provide a comprehensive approach that meets the diverse needs of rural areas. To address these challenges and leverage the advantages of tele-dentistry, healthcare professionals and policymakers should endeavor to create a dental care system that is more accessible and equitable for the rural population in Pakistan.

Conclusion

This study illustrates that tele dentistry and digital health tools have effectively enhanced access to and education in dental care in rural regions of Pakistan. Qualitative findings indicate that tele-dentistry in rural areas is particularly effective in delivering preventative treatment, reducing travel burdens, and enhancing oral health knowledge among rural residents. Rural areas sometimes struggle to get dental treatments; nevertheless, tele-dentistry facilitates distant consultations and enhances access to dental specialists. However, the study also highlights difficulties of digital literacy and inconsistent internet connectivity that hinder the full potential of tele-dentistry in those areas. To achieve optimal outcomes in tele-dentistry, it is imperative to address these obstacles through enhanced infrastructure and digital literacy education. Teledentistry employs these advancements to better dental care and education for underprivileged rural people in Pakistan.

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