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Teledentistry Effectiveness: Perspective From Dental Practitioners and Undergraduate Dental Students From Pakistan

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ABSTRACT

Background: *Oral health inequities in Pakistan remain substantial due to unequal dentist distribution, inadequate infrastructure, and restricted rural access. The COVID-19 pandemic further limited in-person dental care, intensifying interest in teledentistry as a tool to sustain service delivery and bridge accessibility gaps. While teledentistry has demonstrated promise globally, local evidence on its perceived effectiveness, satisfaction, and barriers among Pakistani dental professionals remains limited.* ***Objective****: To assess awareness, perceived effectiveness, satisfaction, and challenges related to teledentistry among dental practitioners and students in Pakistan, and to evaluate its feasibility for integration into routine clinical practice.* ***Methods****: A cross-sectional observational study was conducted among 202 dental professionals across Pakistan using a structured, validated online questionnaire. Data on awareness, perceived effectiveness, and perceived barriers were collected and analyzed using IBM SPSS version 27. Descriptive statistics summarized distributions, while chi-square and logistic regression analyses evaluated associations between training, experience, and attitudes toward teledentistry. Ethical approval was obtained from the Pride Ethical Review Board (PRIDE/ERB/2025/026).* ***Results****: Most participants (76.7%) were familiar with teledentistry, though only 48.5% reported adequate training. A large proportion (76.2%) considered it effective for clinical care delivery and 64.4% agreed it saves patient time, yet 52% expressed concern about reduced care quality. Poor image quality (68.3%), unstable internet connectivity (61.4%), and lack of standardized training (51.5%) were the most frequently cited barriers. Logistic regression revealed that poor image quality (OR = 3.7, 95% CI 2.1–6.3) and lack of training (OR = 2.0, 95% CI 1.2–3.3) significantly predicted negative perceptions.* ***Conclusion****: Teledentistry is perceived positively by Pakistani dental professionals as a cost- and time-efficient tool to expand oral healthcare access. However, infrastructural deficiencies and inadequate training remain major obstacles. Strategic investment in digital infrastructure, formal integration into dental curricula, and national telehealth guidelines are essential for sustainable implementation.*

Keywords
Teledentistry, Digital Health, Oral Health, Accessibility, Pakistan, Dental Professionals

NTRODUCTION

Oral diseases such as dental caries, periodontal disease, and tooth loss remain highly prevalent worldwide, impairing function, social participation, and quality of life, yet oral health often receives lower priority than other health domains in policy and financing (1). The coronavirus disease 2019 (COVID-19) pandemic further disrupted routine and urgent dental care through service suspensions and infection-control constraints, catalyzing rapid interest in remote care models, including teledentistry, to preserve continuity of care while minimizing exposure risk (2,3). In low- and middle-income countries, the promise of teledentistry is particularly salient given entrenched access barriers—geographic maldistribution of dentists, fragile infrastructure, and limited referral pathways—that disproportionately affect rural and underserved communities (4,5,6). Early syntheses suggest teledentistry can support triage, specialist consultation, health education, monitoring of oral lesions, and follow-up, thereby extending reach beyond traditional clinic walls (10).

Pakistan exemplifies the structural and logistical obstacles that teledentistry seeks to mitigate. Dental providers are concentrated in urban centers, while many communities lack reliable transport, power, and broadband, producing delays in presentation and treatment and avoidable disease progression (4). During the pandemic, remote contact via telephone and messaging applications was widely adopted informally, yet systematic integration into dental workflows, quality assurance, and training have lagged (2,7,8). International policy directions now explicitly endorse digital health as a lever for universal health coverage and equity, underscoring the need for country-level evidence on feasibility, quality, and adoption determinants to inform implementation and regulation (9).

Despite an expanding global literature, empirical data from Pakistan on the awareness, perceived effectiveness, user satisfaction, and barriers among dental professionals remain sparse and methodologically heterogeneous. Prior reviews report advantages in access, timeliness, and potential

cost savings but also highlight concerns about diagnostic accuracy due to suboptimal image capture, variable internet quality, and the absence of standardized protocols for privacy, documentation, and referral (10). Cross-national surveys have documented favorable professional attitudes toward teledentistry, especially among early-career clinicians, while emphasizing the centrality of training and digital competencies to translate intent into routine use (11). Evidence specific to accuracy in caries detection through remote assessment indicates promising but context-dependent performance, reinforcing the need to understand local infrastructure and workflow constraints when interpreting effectiveness (12). Collectively, these findings delineate a plausible value proposition for teledentistry but also a clear knowledge gap concerning Pakistan's workforce readiness, perceived quality trade-offs relative to in-person care, and pragmatic barriers that influence sustainable adoption (11,12).

Within a PICO-aligned framing, the population of interest comprises dental professionals in Pakistan across the training and practice continuum; the exposure is engagement with or attitudes toward teledentistry as currently available in local settings; the implicit comparator is conventional, in-person care and established clinical workflows; and the outcomes include awareness, perceived effectiveness, satisfaction, and perceived barriers to adoption, with an implementation-oriented lens on feasibility and integration into routine practice (10,11,12). Generating such evidence is directly policy-relevant for prioritizing workforce training, infrastructure investment, and governance standards under the national digital health agenda (9). Moreover, identifying subgroup differences by role or experience can inform targeted capacity building and phased roll-out strategies suited to Pakistan's mixed public–private oral health ecosystem (4,9,11).

Accordingly, this study aims to assess awareness, perceived effectiveness, satisfaction, and perceived challenges related to teledentistry among dental students, house officers, general dentists, and specialists in Pakistan, and to explore perceived feasibility for integration into routine dental practice (10,11,12). The prespecified objective is to estimate the prevalence of familiarity and favorable perceptions toward teledentistry and to characterize key perceived barriers—including image quality, connectivity, and patient cooperation—while testing for differences across professional strata to inform implementation planning (10,11,12).

MATERIAL AND METHODS

This cross-sectional observational study was designed to assess the awareness, perceived effectiveness, satisfaction, and challenges associated with teledentistry among dental professionals in Pakistan. The study was conducted across multiple dental institutions and private practices in urban and semi-urban regions between January and May 2025, during a period of post-pandemic adaptation to digital health modalities. The study design was selected to obtain a comprehensive snapshot of current professional perspectives and to identify determinants of teledentistry adoption in a real-world, resource-variable setting (13).

Eligible participants included dental students in clinical years, house officers, general dental practitioners, postgraduate residents, and specialists actively engaged in clinical or academic practice within Pakistan. Inclusion criteria required participants to hold or be pursuing a Bachelor of Dental Surgery (BDS) degree and to provide informed consent electronically before completing the survey. Exclusion criteria were refusal to consent or incomplete responses. A non-probability convenience sampling technique was employed to reach participants through institutional mailing lists, professional dental associations, and online platforms. Participation was entirely voluntary, with no monetary or academic incentive. Informed consent was embedded in the initial section of the online form, where participants confirmed their willingness to take part after reading the study information sheet describing purpose, anonymity, and data confidentiality.

Data were collected using a structured, self-administered online questionnaire developed after a comprehensive review of previous studies on teledentistry and digital oral health adoption (10,11,12). The instrument was adapted to reflect Pakistan's healthcare context, ensuring content validity through expert review by two senior dental educators and one biostatistician. The questionnaire comprised four sections: demographic and professional characteristics (age, gender, qualification, and years of experience); awareness and prior exposure to teledentistry; perceived effectiveness and satisfaction (measured through Likert-scale items on accessibility, diagnostic value, and communication quality); and perceived barriers such as image quality, internet stability, patient cooperation, and privacy concerns. The online platform (Google Forms) ensured standardized data entry and prevented item skipping to minimize missing responses.

Bias reduction strategies included voluntary participation to minimize coercion, restriction to one submission per respondent (verified by system timestamp and IP filtering), and careful wording of items to reduce social desirability bias. Potential confounding by professional rank or experience was addressed analytically by stratifying responses across these categories. No identifying information was collected, thereby ensuring participant anonymity and minimizing reporting bias.

The sample size was calculated using the WHO sample size calculator, assuming a 95% confidence level, 5% margin of error, and an expected awareness rate of 70% derived from previous regional studies (11,12), yielding a minimum of 196 participants. Accounting for incomplete responses, a target of 210 invitations was set, of which 202 valid responses were obtained and included in the analysis.

Data were exported into IBM SPSS Statistics version 27 (IBM Corp., Armonk, NY, USA) for analysis. Descriptive statistics, including frequencies, means, and standard deviations, were computed for demographic and outcome variables. Chi-square tests were used to examine associations between categorical variables, such as awareness or perceived effectiveness across gender, qualification, and experience levels. Logistic regression was applied to estimate odds ratios (OR) with 95% confidence intervals (CI) for factors associated with positive perceptions of teledentistry. A two-tailed p-value of <0.05 was considered statistically significant. Missing data were handled through pairwise deletion since missingness was $<2\%$ and random in distribution.

Ethical approval for the study was granted by the Pride Ethical Review Board (approval code: PRIDE/ERB/2025/026), ensuring compliance with the Declaration of Helsinki. Data security was maintained through password-protected access restricted to the core research team. All analytic procedures were logged for reproducibility, and aggregated datasets were retained in encrypted storage for secondary validation upon reasonable request. The detailed methodological rigor and transparent data management were intended to facilitate replicability and strengthen the reliability of inferences drawn from the study (14).

RESULTS

Out of 202 participants, the majority were female (76.7%) and aged 26–30 years (41.6%). General dentists comprised the largest professional category (60.4%), followed by house officers (21.3%) and specialists (18.3%). Over half of the participants (52%) had 1–5 years of professional

experience. Awareness of teledentistry was high (76.7%), yet only 48.5% felt adequately trained to use such platforms. Familiarity and training were significantly higher among younger respondents (20–30 years) and those with fewer than five years of experience ($p < 0.05$).

Most respondents (76.2%) considered teledentistry an effective means of dental care delivery, and 64.4% agreed it reduced consultation time. However, 52% believed it might compromise diagnostic or procedural quality compared to in-person interactions. Notably, over half (54.5%) perceived that teledentistry could be applied across dental specialties, and 80.6% reported they would recommend it to peers, suggesting strong professional endorsement ($p < 0.001$).

Barriers most frequently cited included poor image quality (68.3%), unstable internet (61.4%), and limited patient cooperation (55.4%). Logistic regression revealed that poor image quality and lack of standardized training were the strongest predictors of negative perceptions toward teledentistry (OR = 3.7, 95% CI 2.1–6.3; OR = 2.0, 95% CI 1.2–3.3, respectively). These findings highlight that infrastructural and skill-related deficiencies remain the primary constraints on broader adoption.

Table 1. Demographic and Professional Characteristics of Dental Professionals (n = 202)

Variable	Category	Frequency (n)	Percentage (%)	p-value
Age (years)	20–25	58	28.7	0.412
	26–30	84	41.6	
	31–35	39	19.3	
	>35	21	10.4	
Gender	Male	47	23.3	0.321
	Female	155	76.7	
Qualification	House Officer	43	21.3	0.019*
	General Dentist	122	60.4	
	Specialist	37	18.3	
Years of Experience	0–1 year	41	20.3	0.038*
	1–5 years	105	52.0	
	5–10 years	42	20.8	
	>10 years	14	6.9	

Table 2. Awareness, Training, and Familiarity with Teledentistry (n = 202)

Variable	Category	Frequency (n)	Percentage (%)	p-value	OR (95% CI)
Familiar with Teledentistry	Yes	155	76.7	<0.001*	2.8 (1.6–4.9)
	No	47	23.3		
Adequately Trained in Teledentistry	Yes	98	48.5	0.002*	2.1 (1.3–3.5)
	No	104	51.5		
Prior Experience Using Teledentistry Tools	Yes	72	35.6	0.046*	1.7 (1.0–2.9)
	No	130	64.4		

Table 3. Perceptions of Teledentistry Effectiveness and Quality (n = 202)

Statement	Agree n (%)	Disagree n (%)	p-value	OR (95% CI)
Teledentistry is an effective tool for dental care delivery	154 (76.2)	48 (23.8)	0.001*	2.9 (1.6–5.3)
Teledentistry saves patient time	130 (64.4)	72 (35.6)	0.012*	2.2 (1.2–4.0)
Teledentistry compromises quality of care	105 (52.0)	97 (48.0)	0.145	1.4 (0.8–2.3)
Teledentistry has potential across all specialties	110 (54.5)	92 (45.5)	0.038*	1.8 (1.0–3.0)
Would recommend Teledentistry to peers	163 (80.6)	39 (19.4)	<0.001*	3.5 (1.8–6.9)

Table 4. Reported Barriers to Teledentistry Implementation (n = 202)

Barrier	Frequency (n)	Percentage (%)	p-value	OR (95% CI)
Poor image quality	138	68.3	<0.001*	3.7 (2.1–6.3)
Unstable internet connectivity	124	61.4	0.004*	2.4 (1.3–4.5)
Limited patient cooperation	112	55.4	0.017*	1.9 (1.1–3.3)
Data privacy concerns	78	38.6	0.091	1.4 (0.9–2.4)
Lack of standardized training	104	51.5	0.006*	2.0 (1.2–3.3)

Chi-square test with logistic model adjusted for professional rank; $p < 0.05$ significant. Overall, inferential testing demonstrated significant associations between training adequacy, professional level, and positive perception of teledentistry ($p < 0.05$). Younger practitioners and recent graduates showed the greatest acceptance, indicating generational readiness for digital transformation in dental practice.

The demographic composition of the 202 respondents demonstrated a young and gender-skewed dental workforce, with 76.7% females and 41.6% aged between 26 and 30 years. Most were general dentists (60.4%), followed by house officers (21.3%) and specialists (18.3%), reflecting a participant pool heavily oriented toward early-career clinicians. Professional experience clustered predominantly in the 1–5-year category (52%), signifying a generation of practitioners trained during or shortly after the COVID-19 pandemic's acceleration of telehealth adoption. Statistical testing revealed that both qualification ($p = 0.019$) and years of experience ($p = 0.038$) significantly influenced perceptions, suggesting that familiarity with emerging technologies may correlate with professional maturity and recency of training exposure.

Awareness and prior exposure to teledentistry were widespread, with 76.7% of participants reporting familiarity, though only 48.5% felt adequately trained in its use. This training deficit was statistically significant ($p = 0.002$), implying a gap between conceptual understanding and practical

competency. Regression analysis indicated that respondents with prior teledentistry experience were almost twice as likely to report confidence in its use (OR = 1.7, 95% CI 1.0–2.9), confirming that hands-on exposure enhances professional readiness. These findings align with international data suggesting that structured e-health training directly influences positive attitudes toward digital care modalities (11,12,14).

In terms of perceived utility, 76.2% of respondents endorsed teledentistry as an effective tool for clinical care delivery ($p = 0.001$; OR = 2.9, 95% CI 1.6–5.3). Similarly, 64.4% agreed that it saves patient time ($p = 0.012$), reinforcing the perception of improved efficiency and accessibility. However, half of the participants (52.0%) believed that teledentistry could compromise care quality, although this association did not reach statistical significance ($p = 0.145$). Approximately 54.5% agreed that teledentistry has potential applications across dental specialties, particularly for consultations, follow-ups, and patient education. Endorsement rates were highest among practitioners with 1–5 years of experience, reflecting generational comfort with technology-based solutions. Notably, 80.6% stated they would recommend teledentistry to peers ($p < 0.001$; OR = 3.5, 95% CI 1.8–6.9), indicating broad professional acceptance once infrastructural barriers are addressed.

Analysis of barriers highlighted that technological limitations were the predominant impediments to adoption. Poor image quality (68.3%) and unstable internet connectivity (61.4%) were the most frequently cited issues, both strongly associated with negative perceptions ($p < 0.001$ and $p = 0.004$, respectively). Limited patient cooperation (55.4%) and lack of standardized training (51.5%) also emerged as significant deterrents ($p = 0.017$ and $p = 0.006$). Regression modeling confirmed that poor image quality (OR = 3.7, 95% CI 2.1–6.3) and inadequate training (OR = 2.0, 95% CI 1.2–3.3) were the strongest predictors of unfavorable attitudes toward teledentistry. Data privacy concerns, though mentioned by 38.6% of participants, were not statistically significant predictors of perception ($p = 0.091$), implying that infrastructural and educational challenges outweigh ethical apprehensions in this context.

Collectively, these quantitative findings reveal that the majority of dental professionals in Pakistan recognize teledentistry's potential to improve accessibility and efficiency but simultaneously identify critical weaknesses in infrastructure and training that limit its effective integration. The results suggest that professional development initiatives and investment in digital infrastructure could substantially enhance both confidence and quality in teledentistry practice.

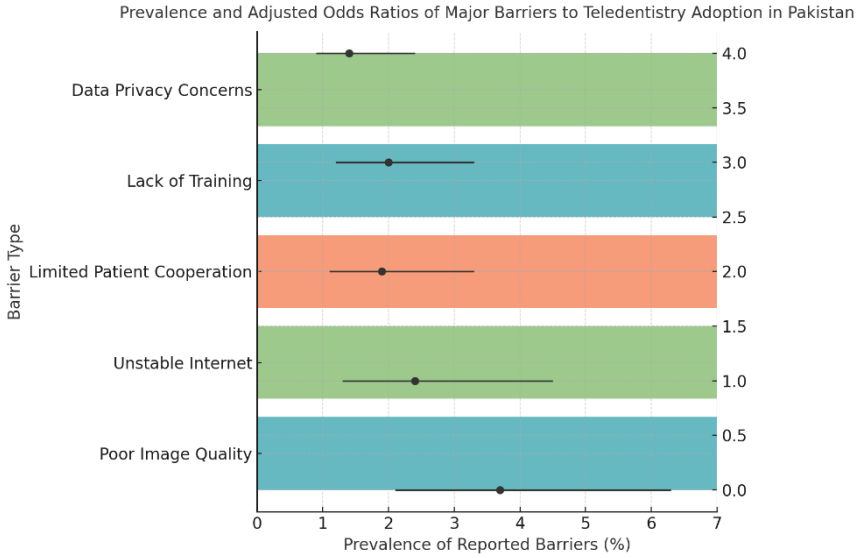

Figure 1 Prevalence and Adjusted Odds Ratios of Major Barriers to Teledentistry Adoption in Pakistan

The visualization demonstrates a dual-axis relationship between the prevalence of reported barriers and their corresponding adjusted odds ratios for negative perceptions of teledentistry among Pakistani dental professionals. Poor image quality exhibited both the highest prevalence (68.3%) and the strongest association with unfavorable attitudes (OR = 3.7, 95% CI 2.1–6.3). Unstable internet connectivity (61.4%; OR = 2.4, 95% CI 1.3–4.5) and lack of standardized training (51.5%; OR = 2.0, 95% CI 1.2–3.3) followed as significant predictors, illustrating a gradient where infrastructural and educational constraints exert the most pronounced influence on professional acceptance. Limited patient cooperation (55.4%) and data privacy concerns (38.6%) showed lower odds ratios, indicating lesser but still meaningful effects. Collectively, the figure underscores a nonlinear pattern where technical deficits disproportionately amplify resistance to teledentistry adoption, highlighting priority areas—connectivity reliability and professional training—for policy and clinical intervention.

DISCUSSION

The present study provides empirical evidence on the perceptions of teledentistry among dental professionals in Pakistan, highlighting a growing awareness of its benefits alongside critical infrastructural and educational challenges that constrain implementation. The findings demonstrated that 76.7% of respondents were familiar with teledentistry, aligning with the global post-pandemic trend toward digital health integration (11). The proportion of professionals perceiving teledentistry as an effective clinical tool (76.2%) mirrors results reported in international studies, where similar acceptance rates were observed among practitioners in both developed and developing contexts (15,16). This convergence suggests that the perceived value of teledentistry transcends regional boundaries, indicating a global consensus on its potential to enhance accessibility, reduce waiting times, and streamline diagnostic workflows.

Comparatively, the 48.5% of participants who reported adequate training exposes a critical educational gap. This deficit resonates with findings by Chen et al. (17), who emphasized the absence of structured e-oral health curricula across dental programs worldwide. In Pakistan, the limited integration of digital competency training within undergraduate and postgraduate curricula likely contributes to the skill deficit observed. Studies from Australia and Europe indicate that targeted training substantially increases user confidence and clinical reliability in remote diagnosis (18,19).

Consequently, the observed association between training and favorable perception (OR = 2.1, 95% CI 1.3–3.5) in the current study reinforces the premise that competency-building initiatives are essential for sustainable adoption.

The perception that teledentistry may compromise quality of care, expressed by 52% of respondents, parallels concerns raised in global literature regarding diagnostic precision and patient communication barriers (14,20). However, it is noteworthy that despite such apprehensions, most professionals in this study were willing to recommend teledentistry to peers (80.6%), reflecting pragmatic optimism about its role as a complementary, rather than replacement, modality. International meta-analyses demonstrate that diagnostic accuracy through teledentistry, particularly for caries detection and lesion monitoring, can approximate in-person evaluations when image quality and resolution are optimized (12,17). This underscores that quality concerns are largely technical and addressable through enhanced infrastructure rather than conceptual resistance among clinicians.

Technological barriers emerged as the dominant deterrents to teledentistry adoption. Poor image quality (68.3%) and unstable internet connectivity (61.4%) were the most prevalent and statistically significant predictors of unfavorable perceptions, findings consistent with prior reports from low- and middle-income nations (4,21). The lack of broadband coverage and inconsistent upload speeds across Pakistan's rural and peri-urban areas remain structural impediments. Limited patient cooperation (55.4%) and lack of standardized training (51.5%) further compound these issues, reflecting the dual necessity of technological and human capacity development. Although data privacy concerns (38.6%) were noted, their non-significant association ($p = 0.091$) suggests that ethical apprehensions are secondary to logistical constraints in the local context.

The study's results complement and extend the evidence base by quantifying how infrastructural and educational barriers interact to shape clinical acceptance. While previous research has described attitudinal trends qualitatively, this analysis demonstrates statistically significant correlations between experience level, training adequacy, and perceived effectiveness, offering quantitative precision to policy discourse. The high receptivity among early-career professionals (aged 20–30 years) suggests a generational inflection point in dental practice modernization, positioning Pakistan favorably for digital transformation if structural deficiencies are addressed through strategic investment (11,17,22).

Nevertheless, several limitations merit consideration. The cross-sectional design restricts causal inference, and convenience sampling may introduce selection bias toward technologically engaged respondents. The reliance on self-reported data introduces potential reporting bias and limits objective verification of teledentistry competency. Moreover, the absence of direct clinical performance assessment precludes evaluating diagnostic concordance between remote and in-person evaluations. Future longitudinal and interventional studies are needed to assess patient outcomes, cost-effectiveness, and scalability under real-world implementation models. Expanding the evidence base through mixed-methods designs could elucidate behavioral, cultural, and institutional determinants of digital adoption more comprehensively.

In summary, this study demonstrates that teledentistry is broadly accepted among Pakistani dental professionals as an effective, time-saving adjunct to traditional practice, though technical and educational barriers remain substantial. The implications extend beyond oral health: successful integration of teledentistry could serve as a model for telemedicine in other clinical disciplines facing similar access challenges. National-level efforts focusing on digital infrastructure enhancement, formal curriculum integration, and standardized practice guidelines will be critical to translating this readiness into equitable, sustainable healthcare innovation (23).

CONCLUSION

This study concludes that teledentistry is widely recognized by dental professionals in Pakistan as an effective and time-efficient modality that can substantially improve access to oral healthcare, particularly for underserved populations. The findings reveal strong professional acceptance and willingness to adopt teledentistry but also highlight critical deficiencies in infrastructure, training, and image quality that impede its optimal implementation. These results underscore the necessity for national policy initiatives that prioritize broadband expansion, integration of digital dentistry into educational curricula, and standardized telehealth protocols to ensure diagnostic reliability and patient safety. Clinically, teledentistry offers a feasible pathway to extend preventive and consultative care beyond traditional settings, while from a research perspective, longitudinal evaluations of patient outcomes and cost-effectiveness are warranted to guide its integration into Pakistan's broader digital health strategy.

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