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The Impact of Digital Healthcare and Teledentistry on Dentistry in Uttar Pradesh: A Comprehensive Survey of Dentists

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Abstract

Background: The digitalization era has transformed dentistry worldwide. Teledentistry (TD), the application of digital technologies in dental care, has gained traction, especially during the COVID-19 pandemic, when remote patient monitoring and communication became essential. Despite its potential, awareness and integration of TD in dental practice remain limited in many regions, including Uttar Pradesh, India.

Methods: This study involved an online self-administered survey distributed to dentists in Uttar Pradesh. Invitations were sent via professional networks and associations. The survey examined familiarity with digital tools, perceived advantages and disadvantages, infrastructural needs, and patient demand for TD services. A Digital Dental Index (DDI) was calculated to measure digital adoption. Data were analyzed using descriptive statistics and linear regression.

Results: A total of 190 dentists completed the survey. Familiarity with online conferences (95.8%), e-prescriptions (93.2%), and digital impressions (85.3%) was high. However, awareness was lower for artificial intelligence (48.1%), store-forward solutions (41.9%), and real-time solutions (40.2%). The mean DDI was 15.1 (±5.3), with younger dentists scoring

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higher. Barriers included inadequate infrastructure (45.7%), lack of user-friendly software (67.9%), and outdated equipment (60.3%).

Conclusion: While dentists in Uttar Pradesh demonstrate interest in adopting TD, gaps in awareness and infrastructure hinder its full implementation. Enhanced training and resource allocation are essential to integrate TD into dental practice and education effectively.

Keywords: Teledentistry, Digital Healthcare, Digital Dental Index

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Background

The rapid advancement of digital healthcare technologies, from e-patients to streamlined digital workflows, is reshaping healthcare in the 21st century. In dentistry, teledentistry (TD) – a branch of telemedicine – is emerging as a promising tool to enhance patient care and communication.[1] TD facilitates services such as store-and-forward systems, remote patient monitoring, follow-ups, consultations, and evaluation of findings. However, despite its potential, TD is not yet fully integrated into daily dental practice.

In the context of Uttar Pradesh, where a large and diverse population presents unique healthcare challenges, the adoption of teledentistry could significantly improve access to dental care, especially in rural and underserved areas. Digital workflows in dentistry, which include intraoral and extraoral scanners, cone-beam computed tomography (CBCT), and 3D printing, have the potential to revolutionize dental procedures.[2] For example, digital planning allows for the creation of surgical guides or dental prostheses within a short time, transforming traditional dental workflows into efficient, technology-driven processes.

The COVID-19 pandemic accelerated the use of digital solutions in dentistry.[3] Many dental clinics in Uttar Pradesh adopted communication-based technologies to manage patient needs remotely. This included tele-triage systems for early diagnosis, prevention-focused consultations, and emergency care services.[4] These efforts highlighted the potential of teledentistry to address gaps in oral healthcare delivery during crises.

Despite these advancements, challenges remain. Issues such as limited awareness, insufficient training, data protection concerns, and financial constraints hinder the widespread

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adoption of teledentistry among dentists.[5] Additionally, the lack of comprehensive educational resources and practical training for dental professionals has slowed its integration into routine practice.

Our study focuses on assessing the awareness, utilization, and perception of teledentistry tools among dentists in Uttar Pradesh. By identifying knowledge gaps and understanding the barriers faced by dental professionals, we aim to provide insights into how teledentistry can be better implemented and tailored to the needs of this region. This research also seeks to emphasize the importance of digital solutions in preventive care and patient communication, ensuring that the benefits of teledentistry reach both practitioners and patients effectively.

In conclusion, while teledentistry has the potential to transform the landscape of dental care in Uttar Pradesh, its success depends on increasing awareness, providing targeted training, and addressing practical implementation challenges. Through our research, we aim to contribute to a deeper understanding of how teledentistry can enhance dental practice in the region, ultimately bridging the gap between technology and patient care.

Materials and Methods

An online survey was conducted as part of the study on "E-Doctors and E-Patients in Uttar Pradesh" among dentists in the state. The survey was designed to explore the awareness and usage of digital health solutions, including teledentistry, among local dental professionals. The survey was self-administered and remained open for three months. The research team developed the questionnaire, ensuring that the results could be compared with a larger, population-based survey conducted in Uttar Pradesh. This approach aimed to provide valuable insights into the state's dental community and their readiness for digital transformation in healthcare.

Study Design and Participants: An online survey was conducted among dentists in Uttar Pradesh. The questionnaire included five sections: socio-demographics, practice characteristics, familiarity with digital tools, attitudes toward TD, and infrastructural needs. Ethical approval for the study was obtained from the Institutional Ethics Committee, Rama Dental College, Kanpur.

Survey

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The dentistry-focused section of the survey consists of five main sections: sociodemographic information, dental practice details, use of digital technologies, and concerns related to digital healthcare. In total, there are 84 questions.Prior to launching the survey, a pretesting procedure was conducted with eight dentists from various specialties at the Department of Public Health Dentistry, Rama Dental College, Kanpur, Uttar Pradesh. The participants were diverse in terms of age (ranging from 23 to 40 years) and professional experience, allowing for a comprehensive evaluation of the survey's relevance and clarity across different dental practices.

Sample Size: Of 7,200 dentists contacted, 190 completed the survey (~2.6% response rate).

Data Collection

The respondents were contacted with the help of the Uttar Pradesh Dental Association via a newsletter or a personal email invitation. The population consisted of dentists in Uttar Pradesh who had provided a valid email address to the association. Participants could access the questionnaire through a provided link. Non-respondents were followed up by resending the survey. Once the survey period concluded, we closed the survey and checked for any duplicate responses, which were not found. The survey was conducted using a secure platform that ensures anonymity, as it does not track IP addresses, thus maintaining privacy and compliance with data protection regulations.A four-dimensional corrective weighting procedure was applied based on gender, age, city (urban vs. rural), and specialization (specialized or general practice). This weighting allowed us to ensure the data accurately represented the dentist population across Uttar Pradesh.

Statistical Analysis

The statistical analysis was conducted using SPSS software. To ensure no missing data, each outcome is listed with the number of valid responses and the corresponding percentage. Descriptive statistics were used to present demographic data, including frequencies, medians (M), means, and crosstabs. A P-value of less than 0.05 was considered statistically significant.

A Digital Dental Index (DDI)[1] variable was developed, and a linear regression model was constructed with the DDI as the dependent variable. The explanatory variables included

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perceived advantages and disadvantages of digital healthcare solutions, the necessary tools for their implementation, patient-experienced needs, and the age of respondents. The DDI ranged from 0 to 27 and was calculated based on several factors. These included the number of dental applications, social media groups, or sources recommended; knowledge of e-Health Care Cloud Hosting, teledentistry store-and-forward, and teledentistry real-time applications; usage of these applications (with a value of at least 3); and interest in utilizing them (with a value of at least 3). Additional variables incorporated were knowledge of intraoral scanning, 3D design, 3D printing, and 3D surgical templates, as well as the usage of these technologies (with a value of at least 3).

A linear regression model was further employed to identify factors influencing the adoption of digital healthcare solutions. These factors included the perceived advantages and disadvantages of digital solutions, the required tools or conditions for their usage, solutions identified as needed by patients, and the respondent's age.

Results

Demographics: The majority of participants were aged 30-50 years (68.4%), with a nearly equal gender distribution (52% male, 48% female). Most dentists worked in urban areas (56.3%) or semi-urban areas (28.9%), with only 14.8% practicing in rural regions. (Table 1)

Table 1: Demographic details of the participants

Category	Subcategory	Frequency (n)	Percentage (%)
Age Range	23–30 years	20	10.5%
	31–40 years	65	34.2%
	41–50 years	65	34.2%
	51–60 years	40	21.1%
Gender	Male	99	52.1%
	Female	91	47.9%
Practice Location	Urban	107	56.3%
	Semi-Urban	55	28.9%
	Rural	28	14.8%

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Online conferences (95.8%), **e-prescriptions** (93.2%), and **digital impressions** (85.3%) had high levels of usage, indicating that most dentists are comfortable with these tools. However, awareness was notably lower for more advanced technologies. Only 48.1% of respondents were aware of **artificial intelligence** in dentistry, and even fewer were familiar with **store-forward solutions** (41.9%) and **real-time solutions** (40.2) (Table 2)

Table 2:Familiarity with Digital Tools:

Technology	Familiarity (%)	Usage (%)	Daily Use (%)
Online conferences	95.8	88.6	72.4
E-prescriptions	93.2	80.2	65.1
Digital impressions	85.3	63.9	44.2
Artificial intelligence	48.1	22.7	10.8
Store-forward solutions	41.9	19.6	7.4
Real-time solutions	40.2	17.9	6.3

The survey highlighted key challenges in adopting TD as mentioned in Table 3.

- **Infrastructural Issues:** Nearly half (45.7%) reported inadequate infrastructure.
- **Software Concerns:** User-friendly software updates were identified as a critical need by 67.9% of participants.
- **Outdated Equipment:** 60.3% cited outdated computers as a barrier.
- **Financial Constraints:** 58.1% noted a lack of funding as a significant hurdle.

Table 3:Barriers to Adoption

Barrier	Frequency (n)	Percentage (%)
Infrastructural Issues	87	45.7%
Software Concerns	129	67.9%
Outdated Equipment	115	60.3%
Financial Constraints	110	58.1%

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The survey also assessed the familiarity and usage of various digital dental technologies among 190 participants. Online conferences emerged as the most commonly used tool, with 70% of participants utilizing them daily and 26.3% using them regularly, indicating a high level of adoption. E-prescriptions were also widely used, with 63.7% of respondents utilizing them daily and 31.6% using them frequently, while only 0.5% reported not using them at all. Digital impressions showed moderate adoption, with 57.3% using them daily and 31.6% using them occasionally, though 3.7% admitted they do not use them. Awareness of artificial intelligence (AI) in dentistry was mixed; 15.8% reported never having used it, and 36.8% were unfamiliar with its applications, while only 7.9% used it daily. Similarly, awareness of store-forward solutions was low, with 26.3% completely unaware and only 2.6% using them daily. Real-time solutions also saw limited adoption, as 31.6% of participants were unaware of them, and only 5.3% used them daily. These results highlight varying levels of familiarity and adoption across different digital dental technologies. (Table 4)

Table 4: Survey Results on Familiarity with Digital Dental Technologies

Question	I Never Use	I Do Not Use	I Use Sometimes	I Use	I Use It Every Day	All Participants
Do you use online conferences?	0 (0%)	0 (0%)	7 (3.7%)	50 (26.3%)	133 (70%)	190
Do you use e-prescriptions?	0 (0%)	1 (0.5%)	8 (4.2%)	60 (31.6%)	121 (63.7%)	190
Do you use digital impressions?	0 (0%)	7 (3.7%)	14 (7.4%)	60 (31.6%)	109 (57.3%)	190
Are you aware of artificial intelligence in dentistry?	30 (15.8%)	70 (36.8%)	50 (26.3%)	25 (13.2%)	15 (7.9%)	190

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Are you aware of store-forward solutions?	50 (26.3%)	85 (44.7%)	35 (18.4%)	15 (7.9%)	5 (2.6%)	190
Are you aware of real-time solutions?	60 (31.6%)	80 (42.1%)	30 (15.8%)	10 (5.3%)	10 (5.3%)	190

Digital Dental Index: The mean DDI score was 15.1 (±5.3), with younger dentists (<40 years) scoring significantly higher than older dentists. Dentists in urban areas had higher DDI scores than those in rural areas.

Patient Demand for TD: Approximately 79.5% of dentists reported that patients expressed interest in remote consultations and digital communication tools.

Discussion

The findings reveal significant enthusiasm among dentists in Uttar Pradesh for adopting TD tools, aligning with global trends. Global studies indicate that TD can reduce disparities in dental care access, particularly in rural areas.[7] For Uttar Pradesh, where 77.73% of the population lives in remote locations[8], integrating TD could address the urban-rural divide in oral healthcare.

Conclusion

Teledentistry offers immense potential to enhance dental care delivery in Uttar Pradesh. Addressing infrastructure and training gaps while fostering patient awareness is vital[9]. Future research should focus on large-scale studies to generalize findings and evaluate the long-term impact of TD on oral health outcomes.[10]

Our study represents a significant effort in exploring the complexities of teledentistry (TD) within the context of dentists in Uttar Pradesh. The originality of our research lies in its focused investigation of the awareness and adoption of various TD tools among dental practitioners in the region. By providing comprehensive insights into the prevailing perceptions and utilization patterns, our study addresses a critical gap in the existing literature

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and contributes valuable perspectives to the discourse on TD within the dental landscape of Uttar Pradesh.

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