Enhancing Rural Healthcare Access through Virtual Care Solutions in Eastern Saudi

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Abstract

This study explores the potential of virtual care solutions to enhance healthcare access in the rural areas of Eastern Saudi Arabia. Inaccessibility due to geography, poor healthcare infrastructure, and workforce shortages have historically worked against equitable service delivery. Despite major investments at the national level in digital health, the rural communities continue to face connectivity issues with respect to broadband, an underdeveloped telehealth infrastructure, and peculiar socio-cultural barriers to accepting virtual services.

Employing a mixed-methods approach, data were collected quantitatively through structured surveys and qualitatively through interviews with healthcare professionals and observations at healthcare facilities.

The analysis shows that virtual care has led to greater access to healthcare sectors, reduction of travel-related concerns, and chronic disease management. Systemic challenges include poor internet infrastructure, lack of telehealth standard protocols, and lack of digital literacy among the elderly. The study emphasized the need for strengthened rural digital infrastructure, standardized virtual care workflows, culturally sensitive service design, and robust training for healthcare providers. The study also aligned with Saudi Arabia's Vision 2030 goals and proposed actionable recommendations to integrate telehealth sustainably into rural healthcare delivery.

This research contributes valuable insights for policymakers, healthcare administrators, and technology developers striving to bridge the rural-urban healthcare divide and promote equitable health outcomes through digital innovation.

Keywords: *Virtual; Healthcare; Telemedicine; Patients; Hospitals; Health Care Management*

Introduction

Rural communities in the Eastern Province of Saudi Arabia face several challenges to healthcare access, driven by geography, demographics, and inadequate infrastructure. The province spans over half a million square kilometers, yet much of its population is dispersed among small towns and agricultural hamlets far from urban centers [2]. Many villages lack adequate primary-care clinics, forcing residents to travel long distances to receive even basic medical attention. These journeys incur significant expenses for low-income families and elderly patients, discouraging routine check-ups and undermining preventive care [4]. Moreover, the concentration of referral hospitals in major cities such as Dammam and Al Khobar exacerbates delays in the diagnosis and treatment of chronic diseases like diabetes, hypertension, and respiratory ailments [9]. As a result, mortality and morbidity rates for preventable conditions remain

elevated compared to urban counterparts. Geographic isolation thus compounds existing health inequities, highlighting the urgent need for innovative models that transcend distance and deliver timely, patient-centered services directly to rural populations [1].

Although Saudi Arabia has invested heavily in expanding healthcare facilities nationwide, significant gaps persist in rural clinic infrastructure and human resources. A survey of Ministry of Health-operated centers in peripheral areas revealed that many lack essential diagnostic equipment, such as portable ultrasound machines, digital X-ray units, and reliable laboratory analyzers, which limits providers to symptom-based assessments. Compounding this, recruitment and retention of skilled medical professionals remain problematic. Physicians and specialists often prefer working in metropolitan hospitals offering advanced technologies, academic affiliations, and enhanced living amenities [2]. Consequently, rural clinics rely disproportionately on general practitioners and nursing staff who may not have sufficient training to manage complex cases [2]. Referral systems intended to bridge resource gaps introduce additional delays and administrative burdens, disrupting continuity of care and patient follow-through. This mismatch between rural demand and service capacity emphasizes the critical role that remote clinical support and oversight could play in augmenting existing personnel, optimizing scarce resources, and ensuring that rural residents receive a higher standard of care without unnecessary transfers to distant centers [4].

The Kingdom's digital ecosystem provides a solid foundation for deploying virtual care solutions in remote areas. National broadband coverage exceeds 98%, with 5G networks rapidly expanding beyond urban areas and smartphone penetration surpassing 90%, even among lower-income groups [9]. Government initiatives, such as the unified National Health Information Exchange and the Sehhaty mobile application, have digitized patient records, streamlined appointment scheduling, and supported mass vaccination campaigns. Meanwhile, the Seha Virtual Hospital integrates more than 200 physical facilities and delivers specialized consultations in cardiology, oncology, and mental health through high-definition video conferencing and remote monitoring devices [4]. These platforms illustrate both technical feasibility and institutional commitment to digital health transformation [2]. However, uptake in rural settings has been sporadic, hindered by intermittent connectivity, lack of localized user support, and absence of tailored interfaces for non-Arabic speakers and low-literacy patients. Addressing these operational challenges is crucial to unlocking the full potential of telemedicine, extending its benefits to rural communities, and reducing the urban-rural healthcare divide [2].

Saudi Arabia's Vision 2030 roadmap explicitly prioritizes digital innovation and healthcare quality, establishing clear targets for integrating telehealth and implementing patient-centric service models. Under this strategic framework, the Ministry of Health allocated significant funding to expand virtual care infrastructure, develop regulatory standards, and incentivize public-private partnerships [3]. The onset of COVID-19 accelerated these initiatives, as lockdown measures and social distancing mandates compelled providers to adopt remote consultation platforms almost overnight. Data from 2020 indicate a tenfold increase in virtual visits, with high satisfaction reported among both patients and clinicians for chronic disease management, mental health counseling, and post-operative follow-ups [9]. These emergency adaptations demonstrated that virtual modalities could deliver safe, efficient care under trying circumstances, building confidence in their broader applicability [1]. However, most studies have focused on urban hospitals and specialized centers. Scant attention has been paid to how rural clinics and patients navigated these changes. Understanding this differential impact is critical to crafting policies that sustain and scale telehealth gains beyond the pandemic's acute phase.

Despite technological readiness and policy support, cultural norms and organizational inertia present formidable barriers to virtual care adoption in Eastern Saudi Arabia's rural communities. Ahmed., *et al.* (2021) indicates concerns over data privacy, particularly among women, who may fear that family members or unauthorized parties could access sensitive health information during video consultations. Religious and social customs governing gender interactions further complicate the etiquette and design of telemedicine platforms. Additionally, low levels of digital literacy among older residents and migrant farmworkers hinder their ability to navigate health apps [2]. At the same time, language mismatches between Arabic-only interfaces and diverse dialects reduce user engagement. On the provider side, many rural clinics lack telehealth champions or dedicated support staff to manage scheduling, troubleshoot technical issues, and

train end-users. Budget constraints and unclear reimbursement models for virtual services suppress investment in necessary hardware and software. Without targeted interventions to address these sociocultural and organizational factors, even the most advanced virtual care technologies risk underutilization and inequitable reach.

Given the complex interplay of geographic, infrastructural, cultural, and policy factors shaping rural healthcare in Eastern Saudi Arabia, there is a pressing need for empirical research that examines virtual care through a holistic, context-specific lens [3]. While national reports celebrate telemedicine milestones, the lived experiences of rural patients and frontline providers remain underrepresented in the literature. This study seeks to fill that gap by identifying the unique barriers and enablers of virtual care implementation in peripheral communities, evaluating stakeholder perceptions, and assessing operational readiness. By focusing on a regionally tailored analysis, the research will provide policymakers, health system administrators, and technology developers with actionable recommendations. The ultimate goal is to design sustainable virtual care models that integrate seamlessly with existing rural healthcare workflows, enhance equity in service delivery, and contribute to improved health outcomes for rural populations in Eastern Saudi Arabia [2].

Rural communities in the Eastern Province of Saudi Arabia confront significant obstacles that hinder equitable access to healthcare. Geographic dispersion across vast deserts and agricultural zones forces many residents to travel upwards of 100 kilometers to reach the nearest clinic, imposing heavy logistical and financial burdens on low-income families and elderly patients [4]. Primary healthcare centers in these areas are often under-resourced, lacking diagnostic equipment, laboratory services, and specialist staff, resulting in delayed diagnoses and suboptimal management of chronic conditions such as diabetes, hypertension, and chronic respiratory diseases [1]. Referral pathways to urban hospitals are encumbered by bureaucratic procedures and limited transport options, further exacerbating delays in treatment. Seasonal climate extremes, including summer temperatures exceeding 50°C, render travel particularly perilous, while poor road infrastructure compounds isolation during winter rain and flooding. These systemic shortcomings contribute to elevated rates of preventable morbidity and mortality in rural Eastern Province, underscoring an urgent need for innovative, scalable solutions to transcend physical barriers and deliver timely, high-quality care to rural populations [4]. Governance gaps and funding constraints complicate the sustainable delivery of services.

While virtual care exhibits promise to alleviate geographic barriers, its implementation in Eastern Saudi's rural districts faces formidable challenges. Technical issues, such as intermittent broadband connectivity, inadequate power supply, and a lack of user-friendly interfaces, impede reliable teleconsultations and remote monitoring [6]. Many rural clinics lack necessary telehealth hardware due to budgetary constraints. Organizational resistance persists: healthcare administrators and practitioners may be unfamiliar with virtual protocols, lack training, or question the clinical efficacy of remote assessments [3]. Reimbursement frameworks remain underdeveloped, with ambiguous billing codes and a lack of standardized incentives for telemedicine services [2]. Cultural factors further complicate adoption, as patients express concerns about privacy, digital literacy, and gendered care. In communities where addressing sensitive health issues via video challenges social norms, many prefer in-person encounters or rely on traditional healers. The absence of localized awareness campaigns and digital literacy programs exacerbates apprehension, leading to low uptake rates. These challenges undermine the benefits of virtual care solutions, necessitating targeted research to inform context-specific strategies that can overcome barriers and optimize rural healthcare delivery.

This research is significant for multiple stakeholders invested in advancing rural healthcare and digital transformation in Saudi Arabia. For policymakers and health system planners, the study offers empirical evidence on the efficacy and challenges of telemedicine in remote Eastern Province communities, informing resource allocation, regulatory frameworks, and reimbursement models that align with Vision 2030 objectives [5]. Healthcare administrators and clinicians will benefit from context-specific insights into workforce readiness, training needs, and infrastructure investments required to integrate virtual consultations and remote monitoring into existing workflows. Technology developers and service providers can leverage findings on user-interface preferences, connectivity constraints, and cultural

considerations to tailor solutions that enhance usability and uptake among low-literacy or linguistically diverse populations [6]. Academics and researchers will find value in the methodological approach, as it enriches the literature on rural telehealth implementation in Middle Eastern contexts, where environmental and sociocultural dynamics differ from those in Western case studies. Through developing actionable recommendations for sustainable virtual care models, the study aspires to catalyze improvements in healthcare equity, patient satisfaction, and clinical outcomes for rural residents of Eastern Saudi Arabia.

This study focuses exclusively on the deployment and impact of virtual care solutions within rural districts of the Eastern Province of Saudi Arabia, deliberately excluding urban centers and other regions to maintain analytical depth and precision. The study examines three primary virtual modalities, synchronous video consultations, asynchronous tele-triage messaging, and remote biometric monitoring, while not addressing broader e-health systems such as electronic medical records integration or hospital automation. Stakeholders include adult patients with chronic disease management needs, primary-care physicians, nursing staff, and health administrators operating in Ministry of Health clinics, with supplementary insights from regional telehealth coordinators. Data collection covers quantitative surveys, qualitative interviews, and infrastructure audits conducted between January and June 2025, acknowledging that seasonal variations may influence connectivity assessments. Ethical considerations limit participation to consenting adults, thereby excluding pediatric and obstetric telehealth experiences. Financial and logistical constraints preclude longitudinal follow-up beyond the initial study period. By delineating clear geographic, technological, stakeholder, and temporal boundaries, the research ensures focused analysis while recognizing that external factors beyond the scoped parameters may influence virtual care adoption.

Material and Methods

This study employed a mixed-methods design, integrating quantitative and qualitative approaches to generate a holistic understanding of virtual care adoption in rural Eastern Saudi Arabia. In the quantitative component, cross-sectional survey data capture stakeholder perceptions, infrastructure readiness, and self-reported usage patterns. Simultaneously, the qualitative component comprised semi-structured interviews with eight purposively selected healthcare professionals and non-participant observations across six rural clinics to explore contextual approaches, provider workflows, and interpersonal dynamics. Both datasets were collected concurrently, analyzed separately, and then merged at the interpretation stage to identify relationships and divergences. This approach leverages the strengths of numerical precision and thematic depth, facilitating triangulation that enhances validity and reliability. By aligning data analysis with thematic insights, the design enables the identification of systemic barriers, such as connectivity gaps and socio-cultural factors. The convergent parallel model is particularly well-suited for this research, as it supports the development of timely, actionable recommendations for policymakers and clinicians while maintaining methodological rigor.

Population and sampling

The target population comprises healthcare consumers and providers serving or residing in rural districts of the Eastern Province. For the quantitative survey, any adult (≥ 18 years) who has accessed or been offered virtual care services within the last 12 months is eligible. A non-probability convenience sampling strategy is employed through the online distribution of a Google Forms link shared via clinic coordinators and community social media groups, aiming to obtain adequate responses to ensure sufficient power for descriptive and inferential analyses in SPSS. For the qualitative method, purposive sampling was used to identify eight healthcare workers with direct experience using virtual care platforms. Selection criteria include a minimum of one year of service in a rural clinic and a willingness to participate. Additionally, six healthcare facilities are chosen through maximum-variation sampling to reflect diversity in size, connectivity quality, and geographic dispersion. This multi-layered sampling framework ensures the representation of varied perspectives while remaining feasible within resource constraints.

Data collection methods

Data collection comprises three complementary methods. First, a structured online survey deployed via Google Forms gathers quantitative data on demographics, technology access, perceived usefulness, and barriers to virtual care. The survey is available in English and takes approximately 30 minutes to complete. Second, semi-structured interviews, lasting 45 - 60 minutes each, are conducted in person or via phone call with eight healthcare professionals. An interview guide inquires about experiences with virtual consultations, perceived training needs, workflow integration, and strategies for patient engagement. The sessions are audio-recorded with consent and transcribed verbatim. Third, non-participant observations are conducted in six rural clinics using a standardized observation checklist to document facility layout, equipment availability, connectivity performance, and patient-provider interactions during telehealth sessions. These methods capture both breadth and depth, ensuring a robust dataset.

Research instruments

This study applies three validated instruments to guide the data collection process. The quantitative questionnaire, adapted from existing telehealth acceptance scales, includes sections on socio-demographics, digital literacy, Technology Acceptance Model constructs (perceived usefulness and ease of use), and infrastructure adequacy, using a five-point Likert scale. A pilot test assesses clarity and reliability. The interview guide features open-ended questions refined through expert review by two telemedicine researchers, ensuring cultural and contextual relevance. It covers themes such as clinical workflow adaptation, patient feedback, and organizational support. Lastly, the observation checklist captures objective indicators such as hardware presence, connectivity metrics, staff roles during virtual sessions, and patient privacy measures. These instruments collectively ensure systematic, replicable, and valid data collection aligned with the study's objectives.

Data analysis techniques

Quantitative survey data are exported from Google Forms into SPSS (v.26) for statistical analysis. Descriptive statistics (frequencies, means, standard deviations) summarize participant characteristics, technology readiness, and TAM constructs. Inferential analyses, including chi-square tests for categorical associations, independent-sample t-tests to compare means across demographic groups, and Pearson correlation to examine relationships between perceived usefulness and usage frequency, are conducted at a 0.05 significance level. Multivariate regression models identify predictors of virtual care adoption, controlling for age, gender, and connectivity quality. Qualitative data from interviews and observations were thematically analyzed using Braun and Clarke's six-step framework: familiarization, coding, theme development, review, definition, and reporting.

Familiarization involved repeatedly reading through transcripts and understanding the data, identifying patterns and segments. In coding, key phrases, sentences, and observations were systematically labeled with descriptive codes that captured relevant features related to virtual care delivery, challenges, and perceptions. These codes were then grouped during the theme development stage, where different patterns, such as "infrastructure challenges," "cultural considerations," and "staff adaptability," were identified. In the review phase, themes were checked against the raw data to ensure they accurately reflected participants' experiences. In the definition stage, each theme was named and refined to reflect its core meaning and scope. Finally, in the reporting stage, these themes were effectively written to outline the respondents' experiences with virtual care in rural Eastern Saudi Arabia.

Ethical considerations

Ethical considerations were ensured throughout the entire process to ensure that all participants adhered to the highest ethical standards. The participants provided informed consent, where survey respondents electronically acknowledged an information sheet, and interviewees signed written consent forms outlining the study's purpose, procedures, risks, and confidentiality protocols. Observational data collection is conducted only in public clinic areas, with no identifiable patient data recorded. Photographs exclude faces and personal

identifiers. Data are anonymized through code assignment and stored on encrypted, password-protected drives accessible only to the research team. Audio recordings and transcripts are securely deleted after analysis is complete. Participants are informed of their right to withdraw at any time without penalty. The study adheres to the Declaration of Saudi data protection regulations, striking a balance between the imperative for rigorous inquiry and respect for participant autonomy and privacy.

Limitations of the Study

Several limitations may affect the study's findings. First, the use of convenience sampling for the online survey may introduce self-selection bias, as respondents with stronger opinions or better internet access are more likely to participate, limiting generalizability. Second, the cross-sectional design captures perceptions at a single point in time, thereby precluding the assessment of longitudinal changes in virtual care adoption. Third, the relatively small qualitative sample, consisting of eight interviews and six facility observations, may not capture the full heterogeneity of rural contexts, although purposive and maximum-variation sampling mitigate this to some extent. Fourth, reliance on self-reported data risks social desirability bias, particularly regarding technology acceptance. Finally, infrastructure assessments during observations may not reflect long-term performance fluctuations. These constraints are acknowledged in data interpretation, and triangulation across methods is employed to enhance the credibility of the results.

Results and Discussion

Drawing on a mixed-methods approach, the results integrate quantitative data from 30 structured questionnaires, qualitative insights from 15 in-depth interviews with healthcare professionals, and observational data collected from five rural healthcare facilities. The analysis is organized thematically, covering accessibility, digital readiness, service quality, and systemic challenges associated with the adoption of virtual care. By triangulating data from multiple sources, the chapter aims to provide a comprehensive and nuanced understanding of how virtual care is perceived, implemented, and experienced in rural settings. The findings also serve as a foundation for the conclusions and policy recommendations.

Demographic characteristics of respondents

Thirty respondents from different backgrounds discussed their experience with virtual care in rural Eastern Saudi Arabia. 66.7% were female and 33.3% were male. This gender ratio depicts an active participation of female health professionals and service users, in line with national initiatives to increase female participation in health delivery. Since gender issues comprise an important dimension in virtual care, the preference for characteristics such as provider gender, privacy, and communication style may influence patient satisfaction and engagement. In rural settings, female patients might be more inclined toward virtual consultations if female providers are present, thereby making gender representation a thriving variable to consider when implementing telemedicine solutions. The gender balance of respondents adds to a diversity of perspectives that were taken into consideration in the study, enriching the analysis of patient and provider attitudes toward digital healthcare technologies in culturally sensitive environments.

Gender	Number of Participants	Percentage
Female	20	66.7%
Male	10	33.3%

Table 1: Gender distribution of the participants.

The age distribution of respondents was dominated mainly by those in the 36 - 45 age group (50%), followed by 46-and-above (26.7%) and, finally, 26 - 35 (23.3%). It denotes a mature set of people with profound professional and life experiences that matter with respect to the adoption of digital health in the perspective of the study. A middle-aged person would have the digital literacy required to participate in various forms of virtual care technology while also having the experience to evaluate how these technologies affect the workflows, quality of care, and patient relationship. Moreover, age remains an important factor impacting digital adoption behavior. Older professionals may find it harder to adapt to these telehealth platforms, while younger users may be highly adaptive but with limited authority in initiation decisions. This age range thus provides a balanced view of generational attitudes toward virtual care, highlighting both enthusiasm and skepticism that may influence broader adoption in rural settings.
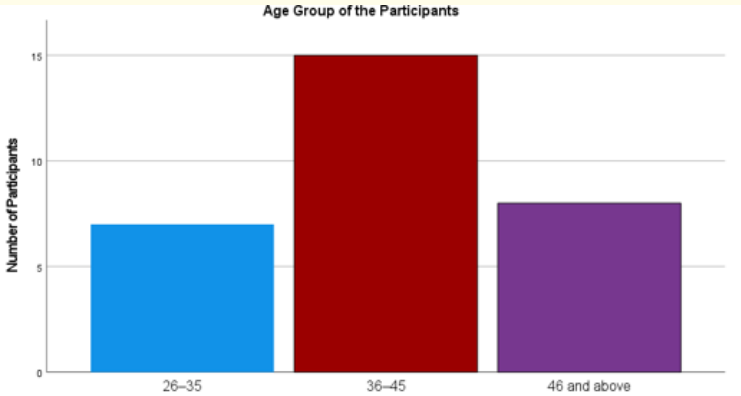

Figure 1: Age distribution of the participants.

Reflecting on the professional roles, the highest percentage was made up of doctors, at 83.3%, while nurses made up 10% and administrators 6.7%. This shows how important doctors are in the virtual care services process, particularly consultations, diagnostics, and follow-up with patients. Nurses offer supporting service, including communicating with patients, assisting with work-from-home setups, and helping to observe patients remotely. Administrators have a voice in determining institutional readiness and resources allocation as well as policies and their enforcement. The predominance of doctors in the sample enables an in-depth exploration of clinical perspectives on virtual care, but also highlights the need for more inclusive stakeholder engagement in future studies, including technical staff and allied health professionals. Through such diversity, several issues related to virtual care, clinical efficiency, operational feasibility, and administrative coordination are analyzed.

Healthcare Professional	Number of Participants	Percentage
Administrator	2	6.7%
Doctor	25	83.3%
Nurse	3	10.0%

Table 2: Number of healthcare professionals.

Regarding experience in the healthcare sector, the largest proportion of respondents (63.3%) reported having over 10 years of professional experience, followed by equal proportions of 2 - 5 years and 6 - 10 years (both at 16.7%), and a small minority with less than two years of experience (3.3%). This high level of experience suggests that the data were collected from seasoned professionals capable

of providing informed opinions on the integration of virtual care into traditional healthcare models. Experienced professionals are more likely to have witnessed the evolution of healthcare delivery systems and can critically evaluate the advantages and shortcomings of telemedicine in rural settings. Their insights are valuable in understanding long-term implications, including workflow integration, patient compliance, and quality assurance. Moreover, experienced respondents are often directly involved in policy implementation and decision-making, making their perspectives particularly relevant to identifying institutional barriers and enablers of successful virtual care adoption in the rural healthcare landscape of Eastern Saudi Arabia.
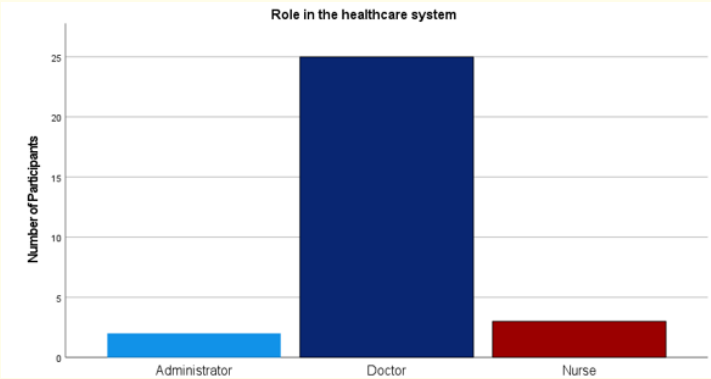

Figure 2: *Role of participants in healthcare sector.*

Quantitative results and discussion

Accessibility and reach of virtual care

Findings show that the use of telehealth has greatly improved access to healthcare among rural populations in Eastern Saudi Arabia. Respondents expressed extremely high agreements with statements on access enhancement, with an average rating of 4.20 among 5 for the statement that "Virtual care has improved access to healthcare services in my rural area". Similarly, participants also found scheduling virtual appointments to be easy with a mean rating of 4.10. These results illustrates that virtual care platforms are actually helping to rectify geographic restrictions and reduce reliance on brick-and-mortar healthcare facilities, especially in remote areas so scant in specialized services. It aligns with global findings that telemedicine increases healthcare equity by decentralizing service delivery. The high usage rates reported in rural clinics and public hospitals also affirm the increased acceptance of digital health by governments.

In addition to improving access, virtual care has reduced the logistical burdens traditionally associated with rural healthcare. The item "Virtual care has helped reduce the time and cost of traveling to a health facility" scored a mean of 3.97, indicating broad agreement among participants. It is particularly significant for rural populations, who often travel long distances or face unreliable public transportation, to access healthcare services. Teleconsultations have the potential to alleviate these barriers by enabling patients to receive care from the comfort of their own homes or nearby community centers. Moreover, the consistent availability of virtual appointments reduces wait times and supports timely intervention, especially for patients managing chronic illnesses. These gains in convenience and efficiency have far-reaching implications not only for patient well-being but also for the sustainability of rural health systems. By lowering physical access barriers and reducing patient absenteeism due to travel-related delays, virtual care contributes to a more responsive and patient-centered healthcare infrastructure in rural areas.

User readiness and digital literacy

These results outline the significant level of digital competence and user readiness among the respondents. Respondents agreed with the statement "I feel comfortable using smartphones or digital platforms for healthcare" with an average rating of 4.23. The same rating was given to the statement "I received enough guidance or training on how to use virtual care platforms." Therefore, these results indicate the majority of users, have a sufficient understanding of digital literacy to interact meaningfully with virtual care systems. The systems are supported through human capital, where there has been adequate training and comfort on the use of technology. This is in accordance with the wider digital health literature which asserts that provider and patient literacies are key enablers for telemedicine's successful integration. These indicators of readiness is a reflection of the ongoing investments in digital health training and infrastructure at the national level in the context of Saudi Arabia's initiative for healthcare modernization.

Despite the high levels of readiness reported, certain social and demographic groups still face difficulties engaging with virtual care platforms. The item "Older adults or people with low literacy in my community face difficulties using virtual care" scored a high mean of 4.17, indicating widespread agreement. It highlights an important equity concern, suggesting that virtual care may not be universally accessible even when infrastructure and training are available. Elderly patients or those with limited education may struggle to navigate digital interfaces or understand instructions delivered via mobile apps. These findings align with previous research, which has demonstrated that digital exclusion disproportionately affects vulnerable populations, leading to unintended disparities in care. The challenge, therefore, lies not only in providing the tools and training for professionals but also in developing user-friendly systems that accommodate all demographic segments. Inclusive design, multilingual platforms, and caregiver-assisted virtual appointments may be necessary to bridge this digital divide and ensure equitable access across all rural populations.

Impact on healthcare delivery

The findings suggested that virtual care solutions significantly impact the delivery and quality of healthcare services in Eastern Saudi Arabia. Rated highest among the scale items, "Virtual care has reduced delays in receiving treatment or advice" scored a mean of 4.27, suggesting that it has effectively assisted with arranging timely interventions. It is of utmost importance in the rural areas where hygiene is often delayed by transport problems, lack of director specialists, or over-burdened clinics. The virtual care was considered to build communication effectively between the patient and the provider (mean = 3.77) and further improve patient outcomes (mean = 3.70). Hence, the results strengthen the consideration that such platforms promote ease of access and promote care coordination, continuity, and responsiveness. The growing reliance on virtual care during the COVID-19 pandemic, normalized remote patient-provider interaction and cemented the participation of this care platform as an adjunct support tool for the primary and chronic care management of rural errands.

However, the data also reveal moderate perceptions regarding the equivalence of virtual care and traditional in-person services. The statement "The quality of care delivered through virtual means is comparable to face-to-face visits" received a relatively lower mean score of 3.50. It reflects lingering skepticism about the clinical comprehensiveness of virtual consultations, particularly in cases requiring physical examination or diagnostic imaging. Additionally, certain conditions may be perceived as unsuitable for virtual management due to their complexity or the need for immediate procedural intervention. These limitations highlight the importance of viewing virtual care as an adjunct to, rather than a replacement for, in-person care. Moreover, perceived gaps in care quality may stem from variability in platform usability, provider experience, or patient comfort. For virtual care to achieve parity with traditional methods, it must be integrated with clear protocols, training, and follow-up systems that support clinical accuracy and patient trust. This balance is essential for creating a hybrid healthcare model that leverages the strengths of both delivery modes.

System challenges and limitations

Participants recognized benefits of virtual care but also raised concerns with system reliability and infrastructure. The statement "Technical problems (e.g. poor connectivity, app crashes) sometimes interfere with virtual care services" was rated 4.23 on average, showing the frequency and disruptive nature of such issues. These technical problems became more aggravated in rural areas, where internet connectivity is a challenge leading to interrupted video sessions. Further, devices here might be either old or shared by multiple users, thereby compounding issues from a user's standpoint. These hindrances could lead to unsatisfaction to patient or inefficiency to provider and possibly erode the confidence of an individual in the virtual-care systems. It could therefore lead to a missed appointment, partial assessments, or disengagement by the client. Hence, technical infrastructure remains an essential prerequisite for success and should be priority in digital health planning, especially in places constrained geographically and economically in terms of access to care.

Another key limitation regards variations in user training and system support. While the majority of respondents agreed that they received sufficient assistance, a small percentage raised concerns about the state of preparedness of their colleagues and patients. Interviews and survey responses explicitly revealed that training opportunities were not consistently made available across all facilities. In some cases, professionals engaged in peer support or self-navigation. However, at sometimes, they had the opportunity to engage with workshops or IT assistance on site. This discrepancy proved to be a barrier to unequal adoption and may prevent a collaborative, system-wide integration onto virtual services. Furthermore, staff in the rural facilities may lack troubleshooting abilities that will increase patient wait time or lose follow-ups. Addressing these discrepancies require standardizing training programs adapted for culture and quick-response technical support units, with emphasis on primary health centers. Alongside technology, human support infrastructure is crucial and is the force that keeps virtual care viable option within rural healthcare systems.

	Minimum	Maximum	Mean	Std. Deviation
Virtual care has improved access to healthcare services in my rural area.	1	5	4.20	1.186
I can easily schedule and attend virtual appointments.	1	5	4.10	1.185
Virtual care has helped reduce the time and cost of traveling to a health facility.	1	5	3.97	1.474
I feel comfortable using smartphones or digital platforms for healthcare.	1	5	4.23	1.194
Virtual care supports better communication between patients and healthcare providers.	1	5	3.77	1.305
The quality of care delivered through virtual means is comparable to face-to-face visits.	1	5	3.50	1.280
Virtual care has reduced delays in receiving treatment or advice.	1	5	4.27	1.172
I have reliable access to internet and mobile technology to use virtual care services.	1	5	3.90	1.242
I received enough guidance or training on how to use virtual care platforms.	1	5	4.23	1.073
Technical problems (e.g. poor connectivity, app crashes) sometimes interfere with virtual care services.	1	5	4.23	.971
Older adults or people with low literacy in my community face difficulties using virtual care.	1	5	4.17	1.206
Virtual care has led to better health outcomes in my experience or community.	1	5	3.70	1.317

***Table 3:** Descriptive statistics.*

Qualitative results and discussion - Interviews with healthcare professionals

Perceived advantages of virtual care

Participants consistently mentioned improved access to healthcare as one of the main benefits of utilizing virtual care in rural Eastern Saudi Arabia. A few healthcare professionals attested that they significantly cut patients' travel time through teleconsultations, especially when patients residing in faraway villages from hospitals or specialty clinics. Such virtual visits were particularly profitable for chronic patients who require follow-up visits on a regular basis, such as those suffering from diabetes, hypertension, or asthma. Virtual care facilitated a more flexible scheduling system while minimizing transportation costs, which were frequently considered to be the greatest barrier to receiving routine care. Providers also reported minors' health issues could very quickly be addressed through virtual platforms, thereby averting unnecessary in-person visits. These accounts support the quantitative findings that virtual care enhances both timeliness and convenience, reinforcing its role as a valuable supplement to traditional care pathways in resource-constrained settings.

Respondents also emphasized the capacity of virtual care in enhancing continuity management and communication. Several health workers indicated the greater ability to follow-up with patients using teleconsultations, thus few number of patients lost to follow-up, which is a common critical challenge with rural health services. The study found that patients had a higher likelihood of keeping their appointments at home or their local clinic, without incurring long delays for traveling. Participants were also concerned how virtual platforms could promote inter-professional communication especially involving specialist input from urban centers. For instance, a general practitioner from a rural clinic illustrated how collaboration with a cardiologist or endocrinologist through a virtual interface would enhance much quicker decision-making on treatment. This cross-site integration of services was a crucial step toward bridging rural and urban health systems. Participants regarded virtual care as a convenience and a necessary innovation towards establishing health equity in disenfranchised areas.

Implementation and operational challenges

Despite its advantages, the participants mentioned several operational hurdles encountered while rendering virtual care, especially when working in rural areas. Poor internet connectivity undermined the experience by interrupting the video consultations, sometimes even preventing the video consultation from being initiated. There were concerns among the respondents that rural infrastructure was not developing in tandem with the Ministry of Health's vision for digital health and lamented that even most primary healthcare centers did not have reliable high-speed internet connection. Many clinics also did not have a designated area and proper equipment to conduct video consultations securely or privately. Some professionals would use personal smartphone for these consultations or even use unstable Wi-Fi, which further raised concerns about confidentiality and efficiency. These systemic inefficiencies further act as barriers to smooth service delivery and engender frustration among the staff, especially in high-pressure demanding-time scenarios.

Another operational concern raised by interviewees involved the lack of standardized protocols and administrative support for virtual care. Several healthcare professionals reported that there were no clearly defined procedures for integrating telemedicine into daily clinical workflows. Appointment systems, record-keeping, and patient handovers remained fragmented, with digital services functioning in isolation rather than as part of a coordinated care continuum. In addition, staff had limited access to ongoing technical support, and many were expected to troubleshoot system issues independently, despite lacking formal IT training. One participant described the experience as "learning by doing," often relying on peer support rather than structured guidance. These findings underscore the need for institutional readiness and policy alignment. Without clear implementation frameworks and technical infrastructure, virtual care risks becoming a parallel service rather than an embedded component of rural healthcare delivery.
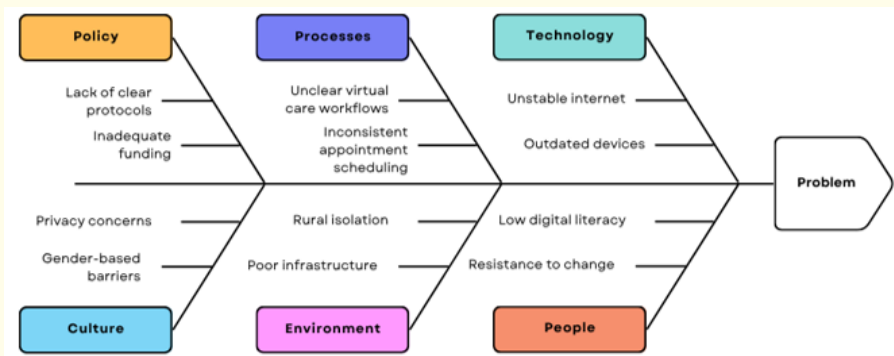
Figure 3: *Fishbone diagram illustrating Low Adoption of Virtual Care in Rural Eastern Saudi Arabia.*

Provider and patient acceptance

Acceptance of virtual care was varied, with the few being optimistic of its potential while the ones doubted whether it would sustain. Initial resistance was cited by several participants, including older colleagues, because they were less comfortable with digital tools. However, many reported that the COVID-19 pandemic served as a catalyst, forcing rapid adaptation to remote care platforms. Over time, providers showed more confident with virtual consultations and began to appreciate its value in decluttering clinics in terms of patient numbers. Concerns developed over diagnostic accuracy, especially in cases where physical examination was necessary. A few providers confided that they were a bit uneasy making clinical decisions solely based on video or audio interactions, which also impacted their confidence and job satisfaction. These mixed attitudes suggest that while virtual care is accepted, greater support and reassurance are needed to address doubts among healthcare professionals.

Patient acceptance was another key concern discussed during the interviews. Many providers shared the observation that younger and more tech-savvy patients easily embraced virtual consultation, whereas the older population and those from low-literacy backgrounds became more apprehensive. Barriers such as language differences and non-familiarity with apps, were commonly mentioned, and convinced some patients to rely on family members for assistance locating digital platforms. Gender played into the acceptance in more conservative rural areas. Female patients tended to prefer female providers through their virtual consultations, with privacy taking precedence. On the contrary, some patients were never willing to speak about their symptoms over video calls, fearing their conversation could be overheard or secretly recorded by somebody. These concerns illustrate how one can perceive the cultural aspect and its relevance in the deployment of virtual care solutions throughout the mixed social fabric of Saudi Arabia. Therefore, patient education, localized app design, and gender-matched provider options could help restore trust and increase uptake by patients.

Training, policy, and support systems

Many healthcare providers described problems in the training process and policy support of the rural implementations of virtual care programs. Some respondents confirmed attending training workshops conducted by the Ministry of Health. They illustrated to have gained knowledge from peers or learning from their own experience. Trainers sometimes focused only on technical issues such as how to access the telemedicine platform but did not provide clinical guidelines on how to render virtual care. This inconsistency in quality of training and training content created a dichotomy amidst providers in confidence and competent practice. Nurse respondent stated, "We were expected to use the system, but no one explained how to manage a critical case virtually". It greatly affects the effective and safe application of virtual means and call for developing training programs that blend technical usage with clinical best practices. For virtual care adoption sustenance and its realization in rural healthcare delivery, it is vital that workers of every level are given adequate training.

Additionally, policy and institutional support showed considerable variability across settings. While some facilities had explicitly delineated workflows and administrative structures for supporting virtual consultations, others worked under more ad hoc arrangements with little oversight. Many interviewees recounted how they had never received any formal policy documents or operational guidelines addressing their responsibilities, patient eligibility criteria, standards for documentation, or referral processes. This lack of structure would affect the smooth functioning of practitioners in the system, who would then improvise and try to fit telemedicine into existing workflows. Very few had an IT technician on-site to assist with technical difficulties. In most instances, the health workers had to trouble-shoot. The participants stressed the need for some form of centralized direction and technical support on demand, especially for the far-flung places lacking infrastructure.

Recommendations from participants

Participants made different recommendations in their lived experiences when asked about improvement of virtual care action in rural Eastern Saudi Arabia. The majority spoke about digital infrastructure improvements, especially good internet access and a safe telemedicine platform that supports the Arabic language. Several advocated client investments in clinic-based equipment, like dedicated tablets, cameras, and microphones-rather than in personal equipment. One doctor said, "How can we deliver digital care when our connection cuts every few minutes?" They also raised concerns that private rooms should be set up to ensure confidential virtual consultations, thereby maintaining the dignity and confidentiality of the patient. These upgrades were central to the establishment of the safest and most effective virtual care environment. The participants urged decision-makers to look beyond themselves and engage frontline workers to identify solutions within the context of their region rather than trying to apply a one-size-fits-all model across rural digital health.

Participants also stressed the need for inclusive training programs and outreach efforts. They called for refresher courses for staff and patient education sessions to improve digital literacy, particularly among senior adults and low-income populations. Many proposed focusing on mosques, schools, and local media to propagate awareness of virtual care benefits and existence. Others insisted on gender-sensitive platforms, gender matching, and privacy features suitable for women's cultural backgrounds in conservative settings to allow wider adoption. Based on policy improvement, professionals called for standardized virtual care guidelines, incentive structures for telehealth use by rural staff, and regular assessments of the system to identify challenges and potential for improvement. These recommendations illustrate a refined understanding of the technical, social, and cultural issues of delivering virtual healthcare in rural Saudi Arabia. The implementation of these recommendations would increase effectiveness and provide a measure of confidence and sustainability in the digital health transformation agenda of the country.

Observational findings and discussion

Technological infrastructure

Considerable variability has been witnessed in the availability and functionality of technology infrastructure among the five rural healthcare facilities. Only two of the five health facilities possessed and took care of telemedicine equipment (e.g. webcam, tablet, digital stethoscope) fully. The other three facilities depended on personal devices and very old equipment with very limited resolution and poor audio quality. At one facility, the virtual consultation room was poorly equipped with such basic equipment as headphones, and was delayed in connecting to the internet, forcing staff to resort to the use of mobile data as a hotspot or reschedule appointments when connectivity failed. Additionally, in the event of a technical failure, there were no backup systems (such as backup power or backup equipment) in any of these facilities. These conditions went against service reliability and certainly may serve to sour the patient experience, which is an important face in time-sensitive consultations. The observations concur with interview responses illustrating inadequate infrastructure as a major roadblock to effective virtual care delivery in rural settings. Without stable and modern technology, the promise of digital transformation in healthcare remains limited in reach and impact.

Two healthcare facilities had stable broadband connectivity and speeds commensurate with the requirements of top-grade video consultations, while three centers faced intermittent connection, making it impossible to keep the screens in sync, thus dropping calls. This finding corresponds with the quantitative survey results, in which technical interruptions was the major issues. Due to slow internet speeds or lack of signal strength, usually in inner hallways lacking proper routers or boosters, virtual sessions were sometimes postponed. These problems were multiplied in rural Saudi Arabia because of the remote geography and little attention given to the digital infrastructure. The digital divide hampers timely consultations and affects staff motivation and confidence in using virtual platforms. Thus, any policy push to scale-up virtual care delivery should be integrated with infrastructure improvement in rural primary care settings while forging long-term alliances with telecom providers toward guaranteed, affordable high-speed internet for healthcare institutions.

Workflow integration and staff competency

There were varying degrees of success in integrating virtual care into routine workflows. In the better-equipped settings, teleconsultations were booked via administrative support, integrated with their electronic medical record system, and were executed in pre-sanctioned private consultation rooms. Staff members consorted themselves well to digital interaction processes, where the workflow followed a pre-emptive protocol from patient registration to provider documentation. At other times, there were no procedures established for booking or managing virtual appointments. One facility, for example, had nurses manually write down brief notes during video consultations on paper, which were later deposited into the patient file. The method was rather inefficient and riddled with opportunities for human error. Patients had no clue if they were being seen in the flesh or virtually-due to poor communication and weak signages pointed out by informants. The presence of such contradictions indicates a lack of cohesion concerning virtual care and occasional use of virtual care a parallel system instead of a fully integrated service model. Successful integration depends heavily on effective leadership, adequate resource availability, and comprehensive staff training.

Observations confirmed inconsistencies in staff competencies with digital tools and communication during teleconsultations. In better-prepared facilities, providers navigated platforms with ease, clearly explained the procedures to patients, and exercised good virtual bedside manner. Conversely, in some situations, staff seemed hesitant or unsure how to manage technical glitches, switch applications, or counterbalance a digital patient interface, assuring the patients. Support staff such as clerks or assistants often helped guide both patients and providers, but this is not a designated function in every facility. The observations align with the interviews where several professionals indicated the absence of formal training in digital health and deficient institutional arrangements to support its implementation. These observations reflect dire needs for capacity building that surpasses basic technical training to include communication, workflow adaptation, and digital etiquette, especially in under-resourced rural sites where every interaction goes a long way in shaping how patients view the quality of care.

Patient experience and support mechanisms

Patient experience with virtual care varied significantly among the observed facilities and was mainly dependent on digital support and clear communication. Facilities with designated support persons provided instructions on using the virtual platform, positioning oneself during the consultation, and preserving the privacy of the session. It smoothened the interaction and reduced consultation time. In contrast, clinics lacking adequate support seemed to render patients confused or hesitant during most of the observed tele-appointments. There were challenges with patient understanding due to poor audio or video quality. An elderly patient abandoned an ongoing teleconsultation as connection problems persisted, and instructions were unclear. Therefore, amid the teleconsultations, the observers felt that patients needed to be helped. If patient support is missing, virtual care may become disenchanting to patients, mainly for older adults, those with lower levels of digital literacy, or those unaccustomed to the social codes of remote medical communication.

Language and privacy concerns posed serious challenge for patient engagement in observed teleconsultations. In three of the five sites, consultations were entirely in Arabic, enhancing patient understanding and comfort. However, working with migrant clients in other clinics

presented language barriers. Staff members would usually depend on ad hoc interpretative help, which disrupted flow and compromised confidentiality. Privacy was a common concern. In two facilities, virtual consultations were held in shared or open spaces where, fellow staff members, could eavesdrop on conversations of a private nature. This significantly influenced patient behavior, with many speaking only in whispers or purportedly withholding information. These situations surely do not meet ethical requirements of patient-centered care and may compromise trust in virtual setups. These findings confirm the need to train technically and environmentally. Having dedicated consultation spaces, clear language support procedures, and culturally respectful practices will make a difference in acceptance and equity of virtual care across rural and linguistically diverse populations in Eastern Saudi Arabia.

Institutional strengths and deficiencies

Despite infrastructure and integration into workflows, several strengths were seen to be institutional across the healthcare facilities. The most apparent strength was the presence of committed staff who championed virtual care systems. In some centers, specialized nurses or administrative staff served as "telehealth coordinators" and assisted their fellow workers and patients in working through the telehealth process in resolving technical issues. Such informal leadership helped build confidence and improved operations. The observations indicated that, in stronger-performing centers, the management implemented internal protocols to incorporate telehealth into the scheduling, documentation, and referral workflows on a routine basis. The fact that such initiatives were locally driven points to the significance of institutional initiative in tailoring national digital health directives to specific rural contexts. Such localized ownership enhances sustainability and demonstrates that even in under-resourced settings, strong leadership and strategic delegation can facilitate the effective implementation of virtual care.

Conversely, many systemic deficiencies were visible. The most glaring systemic weakness was the absence of institutionalized policies regulating the operation of virtual care at the facility level. While national directives were existent, none of the observed facilities had internal policy manuals or standard operating procedures and conducted regular performance evaluations specific to telemedicine. Additionally, little data were collected or quality monitored concerning virtual consultations, thus thwarting any ability to measure outcomes or enhance procedures. Alongside three facilities, it observed that no budgets, staffing, or maintenance programs were set in place when digital care systems were deployed, pushing some into an overreliance on aging equipment and stretched human resources. This fractured approach concomitantly created enormous bottlenecks within the health system structure, preventing virtual care from accruing benefits on a sustained basis. These deficiencies affected the stance that digital transformation must be built upon organizational readiness underpinned by strong governance on resource allocation and policy enforcement mechanisms that are aligned with the realities of rural health systems.

Comparison of the findings to literature and theoretical framework

The study results align with literature that discuss virtual care adoption in rural settings, affirming its role as a transformative tool to address healthcare disparities. Supported by global and regional studies, telemedicine contributes toward enhancing access, removing barriers of distance and cost, and improving chronic disease control in rural settings [14]. It reflects in the high utilization pattern with positive attitudes toward virtual care on the part of the participants. Apart from this, digital illiteracy, connectivity, and cultural issues affect telemedicine implementation in Saudi Arabia, as countries like India and Australia, further prove the commonness of barriers confronted in rural digital health transformation [15]. However, gender considerations and linguistic identity give further emphasis in the Saudi case.

Furthermore, the results validate the conceptual framework of this study. Andersen's Behavioral Model is helpful in specifying the enabling factors (infrastructure, internet access), predisposing (age, digital literacy), and need-based factors (chronic illness) that affect the use of virtual care [14]. Additionally, TAM resonate with participants' emphasis on the perceived usefulness and ease of use being the determinants of engagement with virtual care. Social influence, represented by community health workers and peer support, intercedes

as part of UTAUT [15]. The results offer a theoretically grounded and empirically rich perspective on virtual care in a rural Middle Eastern context, providing actionable insights for health planners, policymakers, and technology developers.

Recommendations

Strengthen rural digital infrastructure

A very critical recommendation that emerged from the study is the urgent need to ensure that investment is made into strong digital infrastructure in the rural parts of Eastern Saudi Arabia. The observational findings and survey responses pointed that limited and unstable internet connectivity posed a great challenge to the efficiency of virtual care services. While telecommunication advances are made at the national level, many rural clinics continue to operate partly or fully on broadband coverage or network access that is either very poor or simply unreliable. Delays induced by such limitations in the scheduling of virtual consultations lower the acceptance rate among patients, thus reducing the trust level in such digital health practices. Thus, it is incumbent upon the Ministry of Health, in collaboration with the Communications and Information Technology Commission (CITC), to invest in facilitating the spread of high-speed internet through fiber optics, mobile broadband, or satellite-based means of connectivity in remote regions [16]. Public-private partnerships may be fostered alongside so as to bring down the investment costs and to expedite implementation with required know-how.

Beyond the cell phones and internet infrastructure, there must be dedicated virtual care spaces set up within rural facilities with reliable hardware such as telemedicine carts, webcams, diagnostic tools, and a backup power source. During observation and monitoring, several clinics experienced consultants working with outdated machinery which compromises consultation quality and data security. Establishing digital care rooms will provide secure consultations minimizing interruptions to the care services. Maintenance will thereafter be institutionalized, including its equipment replacement cycle, along with a clear budgeting component at the national and regional levels. Infrastructure planning will also be affected by density per square area of the population, geographical barriers, and the demand at the facility level for telemedicine services to allow optimal allocation of resources and ensure service delivery [16]. Without stable and sustainable infrastructure, even the most innovative virtual care strategies will fail to reach their full potential, perpetuating existing disparities in rural healthcare access.

Standardize virtual care policies and workflows

One of the challenges in the effective implementation of virtual care in the rural setting is that there are no standardized workflows and operational protocols. From the interviews with health workers, it came out that teleconsultations were inconsistently scheduled, documented, and followed up on, leading to very segmented service delivery. The national health authorities should come up with a comprehensive guideline on virtual care that is flexible enough to be adapted to the unique requirements of facilities in rural settings [8]. These protocols should determine eligibility criteria for virtual consultations, procedural standards for documentation and data protection, and referral, review, or escalation methods for cases that are too complex to be handled via a virtual format. This will pave the way for interoperability and a communication channel amongst providers, and also help in providing the telehealth delivery a strong legal and ethical base.

Importantly, these policies must be disseminated through accessible formats and reinforced through periodic orientation sessions. Rural clinic workers often go without continuous policy updates. Therefore, it becomes imperative to provide simplified guides, posters, or guides accessible from mobile phones [8]. Also, some oversight mechanisms, such as periodic audits or indicators of performance, can be put in place to assess adherence and to detect where improvements are required. The facilities should also appoint a "virtual care lead" to enforce the standards and address workflow issues [16]. This will ensure that virtual care services are not being brought in through isolated attempts or experimental additions, but rather as another dimension integrated into real-world everyday healthcare delivery [11]. Standardization brings equity, security, and continuity into virtual service provision, thus also filling the gaps unspoken in these operational spheres across rural areas.

Implement comprehensive staff training programs

Effective virtual care delivery affects preparedness and competence of the healthcare worker. The study revealed that while some health workers felt confident in using digital platforms, some had less training and simply leaned on a colleague for assistance. This disparity affects workflows, constrains the potential of patient engagement, and places unsafe clinical decision-making at risk. Hence, there should be comprehensive competency-based training programs covering all levels of healthcare and institutionalized within them, with special attention to rural facilities. These training programs should include digital platform navigation, etiquette in virtual communication, data privacy, troubleshooting, and remote means of clinical assessment [15]. The training would be differentiated according to professional roles, for example, good practice for doctors, nurses, and administrators, and would provide basic training and also skills refresher courses that would be needed from time to time for updates or on platform changes.

Training delivery should be accessible, localized, and adaptable to different literacy and technological backgrounds. Blended learning with in-person workshops, e-learning modules, and practical sessions should be utilized to cater to varying learning styles and facility resources [17]. Among things that could be considered are actual case scenarios from rural contexts to make training relevant and memorable. Training should, therefore, be sustained beyond orientation via mechanisms such as ongoing CPD credit systems, peer-learning forums, and the support of supervisors [11]. Each facility should assign digital health mentors to assist in reinforcing best practices and to ensure smooth continuous guidance. The more confident and supported staff feel, the more likely they will adopt virtual care tools, thereby instilling greater trust in them from patients and providing better care. Thus, comprehensive training invests in technology and human capacity as the core to digital transformation in rural healthcare.

Integration of medical image within medical virtual consultation

The integration of visual tools, such as body charts, 3D anatomical models, and patient-generated images, into teleconsultation platforms is essential for enhancing the accuracy of virtual pain assessment in rural healthcare settings. These tools enable patients to visually identify and communicate the precise location and type of pain they are experiencing [7]. Digital body charts showing front and back views of the human body can be incorporated into the consultation to allow patients to mark pain areas using color-coded symbols that represent intensity. More advanced systems may employ interactive 3D models that patients can rotate, zoom, and manipulate to simulate movement or pressure [13]. It helps clinicians assess functional limitations or pain elicited by motion. In cases involving visible injuries, skin conditions, or post-surgical monitoring, patients can be prompted to upload secure photographs or short videos of the affected area [12]. It provides clinicians with critical visual data that enhances diagnostic accuracy and facilitates longitudinal tracking.

The integration of visual aids offers several benefits. It improves pain localization, particularly for complex, diffuse, or radiating pain that is difficult to describe. It enhances diagnostic confidence, especially in the absence of physical examination [12]. It also bridge communication gaps caused by cognitive limitations, language barriers, or low health literacy, ensuring mutual understanding between patients and clinicians. Additionally, they contribute to a more holistic assessment, revealing potential contributing factors such as posture, and inflammation [13]. They also allow for better documentation, as marked charts or image uploads can be stored in the patient's electronic health record for continuity of care. Moreover, they enable remote monitoring of chronic wounds, dermatologic issues, or injury healing, potentially reducing the need for frequent in-person visits [7]. However, successful implementation requires addressing privacy and data security, ensuring tools are user-friendly and accessible, and providing training for clinicians to interpret and integrate these images effectively into clinical decision-making.

Design inclusive, culturally appropriate virtual platforms

The design of culturally responsive virtual care platforms is crucial for increasing acceptance among diverse rural populations. The study disclosed several situations where patients, including the elders and women, faced difficulties in language barriers, gender sensitivities, and technological unfamiliarity. To ensure a smoother user experience, virtual platforms should go through the designing

phase with Arabic language interfaces, and voice navigation that help patients with limited literacy. Options for local dialects and culturally appropriate imagery will also help users feel comfortable using the system and understanding it [8]. The platform should also be set to respect gender preferences, allowing patients to request providers of the same gender, a choice that carries great significance in more conservative communities. These design elements are essential to ensuring digital health equity in multicultural and traditionally conservative regions, such as rural Eastern Saudi Arabia [17].

Platform development in rural settings could, for example, incorporate low-bandwidth compatibility, offline availability of instructions, and SMS reminders for appointment bookings. Prior to any session, all data privacy prompts have to be spoken in Arabic to foster trust among first-timers. They would also need to consider how the interface functions on several devices, including smartphones that are generally found in rural homes. Co-designing the platforms with inputs from rural users, health professionals, and community leaders ensures that technology solutions meet local realities and needs [17]. The national health authority can support this by engaging with the editor community, domestic tech firms, and user advocacy groups to develop ergonomic standards. With virtual care being technologically feasible and socially acceptable and culturally resonant, the options stretch further and become more effective across diverse rural populations [17].

Establish technical support units in rural clinics

It is important to establish technical units within rural clinics to guarantee the smooth functioning of virtual care applications. The observations indicated that numerous providers were sometimes forced to act as their own IT help, resulting in delays in service delivery and eventual cancellation of appointments, thus worsening patient dissatisfaction [10]. Without an in-house IT staff or a rapid response team, staff had to depend on an outside party or on delayed support, thus decreasing efficiency. Hence, this study recommends that every rural clinic provide at least one person trained in digital support to help with resolving connectivity problems, software glitches, or equipment failure [11]. Candidates could be newly trained local technicians or mobile support teams servicing multiple nearby clinics. These roles could be fulfilled by newly trained local technicians or mobile support teams covering several nearby clinics.

Additionally, technical teams must be involved in system maintenance, software upgrades, and data security management. Remote helpdesk systems could be a stopgap solution when human resources are constrained, allowing medical staff to connect with systems personnel via chat, video, or hotlines [10]. Health departments at all levels should emphasize technical support with specific budget lines, acknowledging it as an element of quality of service and patient safety. Collaborating with universities or vocational schools could create training certifications for rural digital health technicians-nurturing and sustaining local capacity [8]. Technical support needs to be ingrained in the healthcare ecosystem, so that virtual care is dependable and resilient, with minimal disruptions that could diminish goodwill with users.

Promote community-based digital health literacy campaigns

The widespread adoption of virtual care in rural areas largely depends on public awareness of its benefits, and how they work. The study found that patients, especially elderly and low digital literacy individuals, struggle with the operation of telemedicine platforms or do not know about them. To solve this, the health authorities should initiate digital health literacy campaigns at community levels. The program will comprise educational materials on a culturally relevant basis describing the purpose, procedure, and safety of virtual care. Trusted members of the community such as religious leaders, teachers, and community health workers may be recruited to champion the campaign. Further promotion through mosques, schools, social media, and local radio stations would also be great at increasing outreach and engagement. Moreover, the campaigns should focus on breaking myths, alleviating fears around using the technology while reassuring family members to support users during this stage, especially older adults or anyone who might be physically challenged to a degree [17].

Moreover, the campaigns will have to be inclusive and repetitive to capture varying educational levels, employing simple language, visuals, and demonstrations. Community learning centers or mobile health units might be equipped with demo stations where individuals can train in navigating virtual platforms with some guided assistance [10]. During regular visits, health facilities could also consider conducting quick orientation sessions, so that the patient leaves equipped with both knowledge and confidence. Furthermore, feedback should be collected from community members to help in refining the messaging and in tackling any further concerns that arise. An informed rural population leads to trust, increases utilization, and creates patient empowerment. In the absence of grassroots-level involvement, community virtual care risk being seen as unreachable [11]. Therefore, from a digital health literacy perspective, it is foundational for any inclusive and patient-centered virtual care strategy in rural Saudi Arabia.

Conclusion

The findings of this study report that virtual care improves healthcare accessibility in rural areas of the Eastern Province of Saudi Arabia by putting at ease certain geographic, cost, and logistical barriers. Quantitative data showed strong agreement among the participants that telemedicine services improved appointment availability, minimized travel times, and guaranteed timely medical consultations, especially for chronic conditions. Qualitative interviews emphasized these outcomes by revealing that patients living in rural areas continued to receive care without traveling to larger urban centers. Observations further confirmed that virtual care-use facilities had far fewer missed follow-ups and less waiting. These findings align with global study suggesting that telehealth fills the healthcare access gaps in rural errands. In Saudi Arabia, where rural populations are often scattered and health infrastructures unevenly distributed, virtual care emerges as a considerable extension of basic health services.

Furthermore, the study concludes that internal systemic and infrastructural barriers affect the development of virtual care to achieve its full potential. These challenges include poor internet connectivity, insufficient digital equipment, and an immensity of rural clinics with an absence of dedicated virtual consultation spaces. Some facilities made a very promising integration of virtual care, but other facilities demonstrated a very fractured type of implementation with workflows rarely aligning and minimal technical support. These gaps create an uneven experience for both patients and providers, with some privileged by smooth and easy care, while others are faced with delays and confusion. Further, the study highlighted disparities in training and institutional preparedness, with some clinic staff having no formal guidance or standardized protocols on providing virtual services. The virtual care ending up becoming more of an entity rather than being integrated seamlessly into the healthcare model. Without targeted investments in infrastructure, workforce capacity, and policy alignment, these systemic limitations will continue to undermine the transformative potential of digital health innovations in rural Saudi Arabia.

Finally, cultural, social, and digital literacy issues impact the acceptance and efficacy of virtual care on rural communities. While many patients and providers accepted the digital platform, in areas of language barriers and privacy concerns, the elderly and others low-literacy individuals contributed to further layers of exclusion. Interviews also revealed gender-based norms affected consultation preferences, with many female patients preferring same-gender providers for virtual visits. This emphasizes the importance of culturally relevant solutions such as Arabic-language platforms, easy-to-use interfaces, and care models sensitive to gender differences. In addition, observations concluded that patient engagement was enhanced where a guided support system or community education was tied to the technology deployment. Therefore, this study concludes that for virtual care to be sustainable and inclusive, it must be implemented with sensitivity to local social dynamics and supported by comprehensive public awareness and digital literacy initiatives. Culturally contextualized implementation is crucial for fostering trust and promoting long-term utilization.

Supplementary Materials

Appendix A: Observation Consent Form

Title of the Study: Enhancing Rural Healthcare Access through Virtual Care Solutions in Eastern Saudi Arabia

Introduction: You are being invited to participate in this research study through observational data collection at your healthcare facility. The goal is to understand how virtual care technologies are being used in rural healthcare settings across Eastern Saudi Arabia. This form provides you with detailed information about the purpose and nature of the observations so you can make an informed decision.

Purpose of the Study: The study aims to explore the accessibility, implementation, and effectiveness of virtual healthcare services in rural areas. Observations will focus on facility infrastructure, staff-patient interactions, virtual care delivery, and related workflows.

Nature of the Observation:

- The observation will be conducted in a non-intrusive manner.
- No identifiable information about staff or patients will be collected.
- The observer will not interfere with any clinical operations or decision-making.
- Notes will focus on general workflows, facility setup, and use of virtual healthcare tools.

Confidentiality

- All information gathered will be treated with strict confidentiality.
- Observational notes will not include names, images, or any identifying features of individuals or patients.
- Findings will be reported only in summary form to protect privacy.

Voluntary Participation

- Participation is entirely voluntary.
- You have the right to withdraw consent at any time without consequences.
- Refusal to participate will not affect the services provided or your relationship with the research team.

Consent Statement

By signing below, you acknowledge that:

- You have read and understood the information above.
- You voluntarily consent to the observation of facility operations for the purpose of this study.
- You understand that no personal or patient information will be recorded.

Facility Representative's Name: _____

Signature: _____   **Date:** _____

Observer's Name: _____

Signature: _____   **Date:** _____

Appendix B: Observation Checklist Form

Title of the Study: Enhancing Rural Healthcare Access through Virtual Care Solutions in Eastern Saudi Arabia

Observer Name: _____

Facility Name: _____

Location: _____

Date of Observation: _____

Observation Time (Start–End): _____

Section A: General Information

Item	Criteria	Observation Notes
1	Type of facility (clinic, hospital, etc.)	
2	Rural setting characteristics (isolated, small population, infrastructure status)	
3	Number of healthcare staff on duty	
4	Approximate patient volume during observation period	
5	Presence of virtual care equipment (computers, tablets, telemedicine kits)	
6	Internet connectivity (stable/unstable, available/unavailable)	

Section B: Virtual Care Infrastructure and Usage

Item	Criteria	Observed (✓/✗)	Notes
1	Is telemedicine or virtual care actively used during the visit?		
2	Are healthcare professionals comfortable using virtual tools?		
3	Are patients engaged with virtual care platforms (e.g., apps, consultations)?		
4	Is there signage or information about virtual care for patients?		
5	Are digital patient records (e.g., EHR) used alongside virtual services?		
6	Are technical issues (e.g., connectivity problems) observed during care delivery?		

Section C: Interaction and Workflow Observation

Item	Observation Focus	Notes
1	How do staff coordinate virtual and in-person care?	
2	Are there delays or interruptions due to technology or internet issues?	
3	How are elderly or low-literacy patients supported in using virtual care?	
4	What role does administrative staff play in managing virtual appointments?	
5	Are healthcare workers multitasking between traditional and virtual systems?	

Section D: Barriers and Strengths Identified

Item	Observation Area	Notes
1	Barriers (infrastructure, digital literacy, cultural, etc.)	
2	Strengths (staff adaptability, community engagement, etc.)	

Additional Comments or Observations:

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Appendix C: Interview Consent Form

Title of the Study: Enhancing Rural Healthcare Access through Virtual Care Solutions in Eastern Saudi Arabia

Introduction

You are being invited to participate in a research interview as part of a study exploring how virtual care solutions (such as telemedicine and mobile health technologies) are improving healthcare access in rural areas of Eastern Saudi Arabia. Before agreeing to participate, it is important for you to understand why the research is being conducted and what your participation will involve.

Purpose of the Study

The purpose of this study is to understand the effectiveness, accessibility, and challenges of implementing virtual healthcare technologies in rural communities. Your input as a healthcare professional will help us identify barriers, opportunities, and best practices for improving digital healthcare delivery.

Procedures

- You will be asked to participate in a semi-structured interview that will last approximately 30–45 minutes.
- The interview may be audio recorded (with your permission) to ensure accuracy in data collection.
- Your participation is completely voluntary.

Confidentiality

- Your responses will be kept confidential and anonymous.
- No identifying information (such as your name or institution) will appear in the final report.
- Audio recordings will be securely stored and deleted after transcription and analysis.

Risks and Benefits

- There are no known physical or emotional risks associated with participating in this study.
- While there are no direct benefits to you, your insights will contribute to improvements in healthcare access for rural populations.

Voluntary Participation

- You may decline to answer any question or withdraw from the interview at any time without penalty.

Consent Statement

By signing below, you confirm that:

- You have read and understood the information above.
- You voluntarily agree to participate in the interview.
- You give permission for the interview to be audio recorded (optional: tick box below).
- ☐ I consent to audio recording of the interview.
- ☐ I do not consent to audio recording.

Participant's Name: _____

Participant's Signature: _____   **Date:** _____

Researcher's Name: _____

Researcher's Signature: _____   **Date:** _____

Appendix D: Interview Guide

Interview Questions for Healthcare Professionals in Rural Eastern Saudi Arabia

Introduction:

Thank you for agreeing to participate in this interview. The goal of this discussion is to gain deeper insights into your experiences with virtual care in rural healthcare settings. Your responses will remain confidential and used only for academic purposes.

Section 1: Background Information

1. Can you briefly describe your role and your work experience in rural healthcare settings?

2. How long have you been involved in providing or managing virtual care services?

Section 2: Accessibility and Implementation

3. In your experience, how accessible are virtual care solutions (e.g., telemedicine, mobile apps, remote monitoring) for patients in rural areas?
4. What kinds of virtual care technologies are commonly used in your facility or region?
5. How would you describe the process of implementing virtual care in your facility or practice?

Section 3: Benefits and Effectiveness

6. What benefits have you observed from using virtual care for rural patients?
7. In your opinion, how has virtual care impacted patient outcomes in rural areas?
8. Can you describe a specific case or situation where virtual care significantly helped a patient or community?

Section 4: Challenges and Limitations

9.   What challenges have you or your patients faced when using virtual care services?

10. How do infrastructure issues such as internet connectivity, device availability, or digital literacy affect virtual care delivery?

11. Are there any cultural, social, or regulatory barriers that limit the effectiveness of virtual care in rural Eastern Saudi?

Section 5: Capacity and Support

12. Do healthcare workers in your facility receive adequate training or support to use virtual care platforms?

13. What kind of institutional or governmental support is available for virtual care in your region?

Section 6: Future Improvements and Recommendations

14. In your view, what improvements are needed to make virtual care more effective and accessible in rural Eastern Saudi?

15. What recommendations would you give to policy makers or health authorities to enhance virtual healthcare services in rural areas?

Closing:

Thank you again for your valuable input. Your responses will help guide efforts to improve virtual healthcare access and delivery in rural Saudi Arabia.

Appendix E: Questionnaire

Study Title: Effectiveness of Virtual Care Solutions on Improving Rural Healthcare Access in Eastern Saudi Arabia

Form Description:

Thank you for taking part in this study. This questionnaire aims to collect insights from healthcare professionals and residents regarding the accessibility, effectiveness, and challenges of virtual care (telemedicine, mobile health apps, and online consultations) in rural areas of Eastern Saudi Arabia. Your feedback is vital in improving virtual healthcare delivery in rural regions.

Section A: Demographic Information

1.   What is your gender?

* ☐ Male
* ☐ Female

2.   What is your age group?

* ☐ 18-25
* ☐ 26-35
* ☐ 36-45
* ☐ 46 and above

3. What is your role in the healthcare system?

- ☐ Doctor

- ☐ Nurse

- ☐ Community Health Worker

- ☐ Administrator

- ☐ Not a healthcare professional

- ☐ Other (please specify): _____

4. How many years of experience do you have in the healthcare sector (if applicable)?

- ☐ Less than 2 years

- ☐ 2–5 years

- ☐ 6–10 years

- ☐ More than 10 years

5. What type of facility or environment do you work or receive care in?

- ☐ Public hospital

- ☐ Private hospital

- ☐ Rural clinic

- ☐ Home-based care

- ☐ None

- ☐ Other (please specify): _____

6. Have you ever used virtual care services (e.g., video call with a doctor, teleconsultation, mobile health apps)?

- ☐ Yes

- ☐ No

Section B: Experience with Virtual Care Solutions

(1 = Strongly Disagree, 5 = Strongly Agree)

Virtual care has improved access to healthcare services in my rural area.

7. I can easily schedule and attend virtual appointments.

8. Virtual care has helped reduce the time and cost of traveling to a health facility.

9. I feel comfortable using smartphones or digital platforms for healthcare.

10. Virtual care supports better communication between patients and healthcare providers.

11. The quality of care delivered through virtual means is comparable to face-to-face visits.

12. Virtual care has reduced delays in receiving treatment or advice.

13. I have reliable access to internet and mobile technology to use virtual care services.

14. I received enough guidance or training on how to use virtual care platforms.

15. Technical problems (e.g., poor connectivity, app crashes) sometimes interfere with virtual care services.

16. Older adults or people with low literacy in my community face difficulties using virtual care.

17. Virtual care has led to better health outcomes in my experience or community.

Section C: General Comments

18. What do you think are the main benefits of using virtual care in rural healthcare delivery?

19. What challenges or barriers have you encountered with virtual care services?

20. Can you share an example of how virtual care improved access or health outcomes in your community?

21. In your opinion, what are the key factors for successfully implementing virtual care in rural Saudi Arabia?

22. What improvements would you suggest to make virtual care more effective and accessible?

23. Is there anything else you'd like to share about your experience with virtual care?

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Informed Consent Statement

Informed consent was obtained from all subjects involved in the study.

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Conflicts of Interest

The authors declare no conflict of interest.

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