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Voices from the Village: Designing a CHW-Led Telemedicine Solution for Tribal India through a Participatory Approach

MAY 2025

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1. Abstract

The Nashik Arogya Sampada project is an innovative community health worker (CHW)-to-doctor telemedicine initiative designed to address the significant healthcare challenges faced by vulnerable tribal populations, especially women and elderly, in the Peth and Surgana talukas of Nashik district, Maharashtra. These regions are marked by geographic isolation, inadequate infrastructure, and a reliance on traditional healers due to the absence or limited access of nearby formal healthcare providers. A comprehensive needs assessment identified several bottlenecks, leading to the development of a tailored telemedicine program that leverages the existing health infrastructure and community resources via the Telemedicine Program Design Canvas framework. The program integrates CHWs, who are culturally and linguistically aligned with the community, to bridge the gap between remote tribal communities and healthcare providers located at secondary and tertiary health facilities.

Key elements of the program include training local CHWs, conducting household visits to identify patients, and establishing health kiosks for diagnostics and consultations. Additionally, the program ensures free doorstep medication delivery, reducing logistical and financial barriers to healthcare access. The program is expected to enhance health-seeking behavior, improve access to timely and effective care, and alleviate the economic burden on these low-income households.

Despite its promising design, the project faces several challenges, including preference for traditional healers over telemedicine. This can be attributed to the trust in traditional healers, limited digital infrastructure and a general unfamiliarity with telemedicine services. To address these, the program includes continuous community engagement, education campaigns, and the establishment of health kiosks with reliable internet access. Future evaluation research is necessary to assess the program's impact on health outcomes, cost-effectiveness, and patients' compliance with prescribed treatments.

In conclusion, the Nashik Arogya Sampada project represents a significant step toward improving healthcare access in remote tribal areas where there is no doctor through innovative community health worker led telemedicine solutions. Its success will depend on ongoing adaptation, rigorous evaluation, and the lessons learned will contribute to the broader discourse on telemedicine as a viable solution for last-mile healthcare delivery in similar contexts.

2. Introduction & Problem

India's tribal communities, comprising 8.6% of the national population, face significant healthcare challenges due to geographic isolation, economic hardships, health awareness and limited healthcare infrastructure¹. The Peth and Surgana talukas in Nashik district, Maharashtra, home to the Konkana tribe, are emblematic of these issues. Tribal communities in India face a unique "triple burden" of disease, encompassing high rates of malnutrition and communicable diseases, a growing prevalence of non-communicable conditions like diabetes and hypertension, and significant mental health challenges, including addiction². This complex health crisis is compounded by socio-economic disparities, geographic isolation, and insufficient healthcare infrastructure, highlighting the urgent need for targeted interventions and inclusive policy frameworks. These communities often face significant barriers to healthcare access, such as limited availability of primary healthcare services, specialized treatments, and essential medications. This makes the tribal population often resort to home remedies and traditional healers due to the inaccessibility and at times, absence of formal healthcare in their community³. Addressing these challenges requires innovative solutions that bridge gaps in accessibility, affordability, and quality of care.

Addressing these complex issues demands innovative, culturally inclusive solutions to bridge gaps in accessibility, affordability, and quality of care. Although telemedicine programs have shown promise, up to 75% fail during the operational phase due to design shortcomings⁴, often exacerbating the digital divide⁵. Therefore, designing a patient-centric, community health-worker-led telemedicine program is crucial for meeting local healthcare needs and accommodating cultural, linguistic, and digital literacy variations.

There are different tools and frameworks available through which patient-centric health care service design is possible. One of such frameworks is the Telemedicine Program Design Canvas that incorporates all the critical elements of implementing a telemedicine program from a system level and hence increasing the chances of a successful implementation⁴. The World Health Organization also has created an implementation plan for global strategy on digital health with four objectives including collaboration and knowledge transfer, digital strategy implementation, digital health governance and human-centered health system, which also aid in overcoming digital health intervention led digital divide ⁶.

Intelehealth, an NGO dedicated to bridging healthcare gaps through telemedicine, aims to deliver quality health services in regions with a shortage of medical professionals. Using the Telemedicine Program Design Canvas, it has developed a patient-centric, community health worker-led telemedicine platform to reduce geographical and financial barriers to primary healthcare access while promoting health awareness and health-seeking behaviors among tribal communities

3. Methods

To design the intervention effectively, Intelehealth conducted a qualitative needs assessment in the Peth and Surgana blocks of Nashik district from July to December, 2021 to identify unmet healthcare needs and service gaps. For the Arogya Sampada project, 30 villages were selected from 145 Gram Panchayats (GP), with a sample of 11 villages across these blocks included in the survey.

The needs assessment followed a qualitative approach guided by the Watkins et al. framework for assessing needs⁷, aiming to identify healthcare challenges, and understand the current health-seeking behavior, availability, access, and utilization of different healthcare services in these regions.

The tools used in this assessment included 11 transect walks (Fig:1), 8 focus group discussions (FGDs) with 32 participants (Fig: 2), and 18 semi-structured interview (SSI), drawing on methodologies from the Center for Disease Control's (CDC) Community Needs Assessment⁸ and Catholic Relief Services's (CRS) Rapid Rural Appraisal ⁹. A consent was taken from each participant at the beginning of the transect walks, focus group discussions and semi-structured interviews.



Figure 1: An example transect walk for one of the eleven villages involved in the Nashik Arogya Sampada project.

The assessment focused on 7 key constructs, identified through discussions with Intelehealth's Monitoring & Evaluation (M&E) team. These constructs were designed to capture a comprehensive view of the community's health landscape (Table 1):

Constructs	Transect Walks	Focus Group Discussion	Semi-structured Interviews
Demographic			√
Local Dynamics	\$	√	✓
Health Management	√	 Image: A set of the set of the	✓
Infrastructure	✓	1	✓
Government Welfare		~	✓
Nutrition	✓	✓	✓
Substance Abuse		✓	
Number	11 Transect Walks	8 FGDs; 32 Participants	18 Participants

Table 1: A summary of 7 constructs along with the tools used in the need assessment of Nashik Arogya Sampada project.



Figure 2: Focus group discussions conducted by the Nashik Arogya Sampada Telemedicine project field officer with women (15–45 years and 45+ years), Gram Panchayat members, and village elders to gather community insights.

4. Results

This needs assessment revealed several critical healthcare related challenges in the Peth and Surgana talukas:

4.1. Demographics

According to the secondary data source, across 11 villages, the male-to-female sex ratio is balanced at 1.027, with the population primarily from the Scheduled Tribes community and a literacy rate above 50% for both men and women. Secondary data sources (Management Information System data) suggests high school enrollment for children. Over 90% of adults live below the poverty line, with higher unemployment among adults compared to over 60% employment among youths.

The transect walks indicated that most households raise livestock, such as hens, buffaloes, oxen, cows and goats. While oxen and cows are clearly used for agricultural labor, it remains unclear whether hens and goats are kept for consumption, sale, or other purposes.

The region suffers from significant infrastructural deficiencies, including poor road conditions, inadequate health centers, and limited digital connectivity. These factors further exacerbate the challenges in accessing timely and effective healthcare services.

4.2. Local Dynamics

The transect walks revealed that while men and the elderly enjoy considerable freedom of movement, women in most villages are restricted in their mobility, with children's movement also limited to domestic tasks like fetching water. Community influencers include Mukhiyas, elders, ASHA workers, AMPs, educated individuals, and religious leaders, who play significant roles in health-related matters.

The semi-structured interviews revealed that women, particularly those aged 15 to 45, primarily handle household tasks such as cooking, cleaning, and childcare, often spending most of their day on these activities. Many women are also involved in unpaid domestic work alongside laboring in farms or urban settings, while older women generally avoid household tasks unless younger women are unavailable. Focus group discussions with women indicated that younger women are heavily involved in household work, while older women lead more sedentary lives. Women generally lack agency in family and social decision-making, with major influencers in the community being the Sarpanch, village leaders, and male family heads. Among Gram Panchayat members and elders, issues like

financial challenges, domestic disputes, and water scarcity were prominent, with elders advising against alcohol consumption in front of children and encouraging unity within families. The FGDs with the GP also revealed that women are discouraged from speaking in public meetings and need permission from men to do so.

Semi-structured interviews highlighted that women, regardless of age, typically defer to the household patriarch for decision-making. Interviews with Sarpanches and school principals showed that while attendance is generally high in schools, parental engagement remains low, making teachers and school principals less influential figures in the community.

4.3. Health Management

The disease profile of these regions includes waterborne diseases, addictions, asthma, high blood pressure, and joint/body aches. The transect walk revealed that the most prevalent illnesses are the common cold, cough, and fever, with skin diseases reported in 9 out of 11 villages. Hepatitis, diarrhea, and malaria are particularly widespread, while osteological diseases, anemia, chikungunya, and cancers related to betel nut and tobacco addiction are also common in several villages.

Findings from the transect walks, focus group discussions, and semi-structured interviews point to a lack of accessible healthcare facilities due to distance, limited staff, infrastructure gaps, and high costs. These barriers contribute to low health-seeking behavior, delayed care, and increased household medical expenses. Consequently, many residents resort to symptom suppression and consulting AMPs, who may offer herbal remedies or refer complex cases to allopathic care. In the SSIs conducted with AMPs, they reported that patients commonly seek their care for ailments such as bodily pains, jaundice, fever, and cough. The community demonstrated a strong reliance on home-based remedies and traditional healers as the first point of contact for healthcare, particularly for minor ailments and common infections. There was also a notable dependence on local health workers for basic healthcare needs, with formal healthcare being sought only when conditions worsened.

ASHA workers are frequently approached for medical advice, though some respondents also consult unlicensed informal practitioners. ASHA workers are well-received in the community, often acting as the main distributors of medicines, while primary health centers (PHCs) and hospitals are seen as last resorts due to their inaccessibility and cost. Although health camps are currently inactive, they tend to have high participation, especially among women, when conducted nearby. Health workers (HWs) and AMPs are open to collaborating with doctors via phone consultations, but both groups feel the need for better communication and mutual respect, with doctors encouraged to value AMPs' contributions.

4.4. Infrastructure

Transect walk data highlights significant water access issues for both drinking and domestic purposes. While connectivity challenges exist in many villages, it remains unclear if these affect Primary Health Centers (PHCs) and Sub-Centers (SCs). The nearest MBBS doctors were found to be located at the taluka/block level, with distances more than 20 kilometers away, making access to healthcare difficult, particularly during emergencies. The lack of local healthcare providers compounded the issue, leading many to rely on traditional healers or delay seeking care altogether. The considerable distance to healthcare facilities and underdeveloped transport systems further hinder access, and women's limited inclusion in public spaces like schools, temples, and Gram Panchayat (GP) offices restricts their participation in gatherings.

Focus group discussions and semi-structured interviews reveal that local healthcare centers provide only basic services, with limited doctor and nurse availability as they cover multiple villages. Health workers identified necessary infrastructure improvements and are open to remote collaboration with doctors to enhance healthcare delivery.

4.5. Government Welfare

Focus group discussions revealed that younger women typically obtain basic groceries from Public Distribution System (PDS) shops, while older women also purchase items like supari (betel nut) and tobacco. Awareness of health schemes or benefits appears low, with many residents unaware of available assistance programs. Due to COVID-19, home-cooked midday meals were halted, replaced by monthly grocery deliveries to households. Around one-third of senior citizens receive pensions, and families get a monthly ₹600 allowance. Although additional schemes exist, such as Shravan Bal¹⁰ and Krushi Sanman Yojana (Prime Minister's Farmer's Tribute Fund)¹¹, ¹², elders are largely unaware of them.

Semi-structured interviews indicated that most children attend an Anganwadi or school, but they now receive only monthly grains instead of midday meals. Women generally feel that Gram Panchayat (GP) members do not share information about health schemes, though opinions on Primary Health Centers (PHCs) vary. Sarpanchs believe that cost limits access to government health services, while health workers report that pregnant and lactating women, as well as malnourished children, receive nutrition and regular check-ups through government support, though specific schemes were not mentioned.

4.6. Nutrition

Food scarcity was not observed in any village; however, diets are limited mainly to staples like rice, dal, and ragi, with wheat reserved for special occasions. The assessment highlighted significant nutritional deficits within the community, particularly among women and children. The diet, primarily vegan and carbohydrate based, lacked adequate protein and

essential micronutrients, contributing to widespread malnutrition and related health issues. However, there was an intent to consume relatively more 'healthy' food among the young women in the community, but they face resource limitations, while older women are less focused on dietary health. Commonly consumed foods include rice, dal, and bhakri, with vegetables bought occasionally; rice is typically home-grown, while other staples are obtained from PDS shops or local markets.

4.7. Substance Abuse

Focus group discussions revealed prevalent substance abuse issues in the community, including the consumption of alcohol, tobacco, gutka, bidi, and betel nut. Men commonly drink alcohol in public, while married and older women prefer using tobacco at home, and adolescents tend to consume alcohol in secluded areas like nearby jungles. Substances are either purchased locally or prepared at home. Community members, including women, elders, and Gram Panchayat members, believe these habits lead to addiction, health issues, negative influences on children, domestic conflicts, and financial strain. Excessive use is also seen as potentially fatal, reducing appetite, and contributing to job loss.

4.8 The Need for Holistic and Appropriate Telemedicine Program

These findings underscore the urgent need for a tailored telemedicine intervention that addresses both the logistical barriers to healthcare and the broader socio-economic factors affecting health outcomes in these tribal communities.

The primary goals of the Nashik Arogya Sampada project are to:

- Demonstrate the model for improving the access to quality comprehensive primary healthcare for the tribal population through provider-to-provider telemedicine.
- Establish a learning and innovation site to advance primary healthcare through telemedicine.
- Demonstrate the reliable, quality comprehensive primary healthcare through robust telemedicine services.
- Reduce out of pocket expenses to access healthcare of healthcare access for the tribal population.
- Enhance health-seeking behaviors and health awareness within the community.

5. Program Description

5.1 Program design and implementation

The Nashik Arogya Sampada Telemedicine program was designed using the Telemedicine Program Design Canvas framework by Verma et al. This framework is a comprehensive tool

designed to guide the development and implementation of telemedicine programs, particularly in low-resource settings, emphasizes the importance of a holistic approach, integrating various components such as stakeholder engagement, patient-centered care, technology infrastructure, and sustainability. The program's design was shaped by the specific needs identified in the community needs assessment and baseline studies, focusing on enhancing healthcare access and delivery in the remote tribal regions of Peth and Surgana.

During the design process key stakeholders including community leaders like Mukhiya (village chiefs), community elders, school teachers/principals, religious leaders, local healthcare providers like ASHA workers and AMPs, government health officials, local government like gram panchayats, and the target population were involved. This engagement ensured that the program was tailored to the unique cultural, social, and economic context of the communities served. The program team consists of five Community Health Workers (CHWs), four Community Health Assistants (CHAs), one active doctor, and a Project Manager. The project is implemented in 30 remote villages of the intervention area, Peth and Surgana and are grouped into eight-clusters based on their proximity. Both CHW and CHA were recruited from the local areas and communities of each cluster to ensure cultural, religious and language inclusivity. Health kiosks were set up in five clusters where CHW resides to provide the community with access to diagnostics, virtual doctor consultation and medicine to act as an end-to-end care facility. These kiosks also act as an internet connection hub for the community. While the CHW conducts house visits, these kiosks give the community members an option of accessing primary care at a permanent health establishment as per their need.

5.2 Key Program Element and Program Workflow

The workflow of the Nashik Arogya Sampada Telemedicine program (Fig: 3) is designed to be simple and responsive to the healthcare needs of the community. Below is an overview of the step-by-step process:



Figure 3: Workflow of Nashik Arogya Sampada Telemedicine Program

Step 1: Recruitment and Training of Community Health Workers, Community Health Assistants and Doctors

The local 5 CHWs, 4 CHAs who serve as delivery personnels, and virtual doctors were recruited and trained on the usage of the NAS telemedicine platform and the clinical protocol guided symptom triage. The CHWs and CHAs were also trained on basic human physiology, patient history taking including vitals, patient communication and usage of rapid on point diagnostic test (RDT) kits like glucometer, digital blood pressure machine, and first aid kit. Every CHW and CHA are given a 'kit box' (Fig: 4) containing the RDTs, first aids and thermal printer. The training program also included pre-post assessment to understand the knowledge intake and retention by these health workers. Monthly refresher training for the CHW and CHA was provided to ensure continuity in providing high quality care. Additionally, we assumed that this refresher training would provide an opportunity for these frontline health workers to discuss the challenges they might encounter during the service delivery and become a steady feedback mechanism for tailoring the telemedicine service fit for the CHWs, CHAs, virtual doctors **a**nd patients.



Figure 4: Kit Box Contents Used by Community Health Workers in the Nashik Arogya Sampada Telemedicine Program.

Step 2: Village Empanelment and Awareness Campaign

Once the CHWs were trained, they enrolled villages into the program and initiated awareness campaigns to educate the community about the NAS telemedicine program and benefits of telemedicine. Community members' consent was obtained to register them in the software system and record their personal information. Additionally, CHWs create unique identifiers to each community member and household. These campaigns were conducted both by CHWs and CHAs, who used local languages and culturally appropriate materials to engage the target population. By empanelling the village beforehand and providing the community members and households with unique identifiers, we assumed that it would help in reducing steps like registering patients during teleconsultation, and hence increasing the time efficiency of the service. The CHWs also collected important household data on social determinants of health (eg: income, occupation, caste, availability of toilets, cooking fuel, water sources and water purification methods past pregnancy outcomes, current health seeking behavior, health issues experienced in last 6 months) to better inform service delivery, and identify underlying root causes of disease. Additional awareness and marketing campaigns might be needed for continuing the momentum of telemedicine usage in the community.

Step 3: Doctor-Patient Teleconsultation Facilitation by Community Health Workers (typical workflow)

Intake of patient vitals and patient history via Ayu

CHW opens up the patient's record created during the empanelment process using any of the following identifiers - the patient's unique ID, name, phone number or household ID. She takes the patient's consent to initiate a teleconsultation and explains the limitations and risks of teleconsultation including the types of diseases treated and treatment given through remote consultation. She creates a "new consultation", and collects patients' vitals, patient history, and family history (Fig: 5) prompted by evidence-based clinical protocol symptom triage in the Intelehealth app.

The app has a unique digital assistant called Ayu, integrated into the platform, enhances the clinical history-taking process by providing structured guidance and standardized protocols to semi-skilled community health workers¹³. By leveraging over 150 evidence-based protocols, Ayu ensures that essential clinical questions are systematically covered, thereby reducing the likelihood of missing critical information. This consistency in history-taking helps to maintain high standards of patient assessments, regardless of the health worker's education and experience level¹⁴.

Moreover, Ayu's intuitive interface prompts health workers to ask relevant follow-up questions based on patient responses, mimicking the approach of a skilled physician. This dynamic guidance helps to uncover symptoms and risk factors that may not be immediately obvious, leading to a more thorough and accurate understanding of the patient's condition¹³. Additionally, Ayu's decision-support capabilities flag any concerning responses or patterns, prompting health workers to escalate the case to a qualified doctor when necessary.

This approach not only improves the quality of patient interactions but also frees up doctors to focus on complex decision-making and direct patient care. By empowering local community health workers with the right tools and protocols, Ayu helps to bridge skill gaps and enhance the overall efficiency and accuracy of clinical assessments, ultimately improving patient outcomes¹³.

Uploading case to the telemedicine platform and facilitating teleconsultation

The CHW uploads the collected data to the telemedicine platform, where it is reviewed by the doctor. CHW also helps in collecting additional vitals such as temperature, SpO2, blood pressure, height and weight, etc., information needed by the virtual doctor. Once the CHW submits the patient information, the doctor calls the patient through their web app and collects more history if need be. This step also enhances the communication between patient and virtual doctors who might not come from the community they serve. The call may be using video or audio, depending on the available internet bandwidth. If the consultation is occurring at the patient's home and the internet connection may not be reliable, and if the doctor needs to see the patient on video, the health worker may request the patient to come to the kiosk at a scheduled time as per the patient's convenience.

Doctor's Prescription and Guidance

After a video or audio consultation, the doctor utilizes their dedicated portal to record the diagnosis, prescribe medications, provide medical advice, and issue referrals to diagnostic centers as necessary based on the patient's condition. Additionally, the portal enables the doctor to schedule follow-up appointments to reassess the patient's health progress or to make adjustments to the treatment plan if required. This process ensures continuous monitoring of the patient's health status and helps in timely intervention to improve health outcomes.



Figure 5: Community Health Worker Conducting Teleconsultations in the Nashik Arogya Sampada Telemedicine Project.

Step 4: Delivering doctor-signed prescription to the patient

At the end of the teleconsultation the prescription is received by the CHW. Then the doctor's signed prescription is downloaded and shared with the linked pharmacy and the CHA. The prescription is also printed using a thermal printer for the patient. The rationale behind using thermal printers is that they are less expensive and easy to carry in CHWs *kit boxes*. It is assumed that by providing the physical copy of the prescription would mark the end of the teleconsultation, keeping the patient experience the same when they visit doctor's chambers physically. At the end, the prescription is also shared with the patients via WhatsApp so that they could retrieve the prescription easily when needed.

CHWs charged small user fees for teleconsultations and diagnostic tests, using a sliding scale structure. At their discretion, CHWs could waive these fees based on the patient's socioeconomic status. The collected fees were retained entirely by the CHWs as an incentive and to support their self-sufficiency. Additionally, CHWs provided patients with an approximate cost of medicines. An itemized bill, including service and diagnostic fees, was generated by the software and given to the patient upon payment.

Step 5: Connection to Partner Pharmacy, Medicine Delivery and Patient Counseling

The pharmacy receives the digital prescription and dispenses the medicines by creating a packet with the patient's ID and name. CHAs play a crucial role in the logistics of collecting medicines from the partner pharmacy and delivering them to the patients via CHW daily. Once receiving the prescribed medication from the CHA, CHW delivers them to the patients at their doorsteps and counsels patients on the prescribed treatment including medication usage, dosage, lifestyle modifications and follow-up care. This step ensures that patients fully understand their treatment plan and any necessary next steps. The medicine delivery at the door-step is for free of charge and thus ensures that the patient saves time and lost wages that would have otherwise incurred if they visit the pharmacies by themselves. Furthermore, the local pharmacies might now have the opportunity to stock the common medications needed by their communities and manage their inventory accordingly.

Step 6: Follow-ups, Referrals, and Medicine Adherence

Regular in-person follow-ups are conducted by CHWs, typically within 3–7 days of the teleconsultation depending on patient conditions and needs. The application assists CHWs by providing automated reminders and generating lists of patients scheduled for follow-up visits, organized by date. This enables CHWs to efficiently manage interactions, ensuring timely check-ins and continuity of care. CHWs also fill out questionnaires to calculate patient-reported positive outcomes (PPRO), maintaining a consistent follow-up process, improving compliance, health outcomes, and medication adherence.

6. Discussion

The Nashik Arogya Sampada project, an innovative community health worker led telemedicine initiative, was designed to address the critical healthcare needs of the tribal populations in the Peth and Surgana talukas of Nashik district, Maharashtra. The comprehensive needs assessment conducted in these intervention areas revealed important contextual details such as significant barriers to healthcare access, including geographic isolation, inadequate infrastructure, and a reliance on traditional healers due to the absence of nearby formal healthcare providers. These findings informed the design of the Nashik Arogya Sampada telemedicine program, which specifically aims to overcome these barriers

by bringing healthcare services directly to the community through a CHW-led telemedicine program. By using the telemedicine program design canvas, the program's design is a direct response to the identified needs, leveraging telemedicine to bridge the gap between the remote tribal communities and healthcare providers. The involvement of CHWs, who are culturally and linguistically aligned with the community, ensures that the program is not only accessible but also acceptable to the population it serves by improving patient trust and engagement in telemedicine and formal healthcare in general. Additionally, using local CHWs and establishing health kiosks at the community level helps overcome the digital divide due to low digital literacy and low mobile phone ownership, especially among elders and women, which was revealed during the need assessment study.

The Nashik Arogya Sampada project is expected to yield several positive outcomes as a result of its tailored design. First, by reducing the distance and logistical challenges associated with accessing healthcare, the program is likely to enhance health-seeking behavior within the community. Second, the integration of CHWs into the program provides a critical link between the community and healthcare providers. Third, the use of telemedicine is anticipated to provide timely and effective care, particularly for conditions that require immediate attention but are currently left untreated due to the lack of accessible healthcare facilities. Fourth, the program aims to alleviate the financial burden on low-income households by offering reduced or free consultations and free medication delivery. This not only saves time and prevents lost wages for patients but also significantly eases economic strain. Additionally, the program empowers CHWs to achieve financial independence through consultation and RDT fees. Finally, it enhances the social recognition and respect for CHWs, who are often viewed as trusted health ambassadors within their communities.

Beyond its direct benefits to patients, free medication delivery may represent the most cost-effective approach to delivering quality healthcare, maximizing the impact of philanthropic organizations' missions—such as CSR initiatives, donor-supported programs, and partner-funded efforts. Furthermore, this model holds significant potential for government adoption due to its cost and outcomes related effectiveness.

Telemedicine offers significant benefits for women in remote or underserved communities by reducing barriers traditionally associated with seeking healthcare¹⁵. One of the primary advantages we foresee from this program is minimizing the need for long-distance travel, which is often challenging for women due to mobility restrictions, household responsibilities, lack of decision-making authoritites or cultural norms as revealed by the need assessment surveys. By allowing consultations from the safety and comfort of their homes facilitated by a trusted health worker, the model reduces the need for women to seek permission or arrange for a companion, which are often prerequisites in the patriarchal settings that were observed during the focus group discussions and semi structured interviews with the Gram Panchayat, elders and women.

This model will not only save time but also enhance privacy and autonomy in making healthcare decisions, leading to increased agency for every community member and women in particular. Furthermore, the flexible scheduling of consultations aligns with women's daily routines, enabling them to seek medical advice without disrupting their caregiving or work responsibilities. It also helps men who are generally involved in agricultural work, in not missing their work and can save money on lost wages. This approach could help in overcoming traditional gender norms and enable women to access timely and essential healthcare services without facing social or logistical hurdles. By eliminating these barriers, telemedicine can contribute to improved health outcomes for the community and especially women, particularly in addressing maternal health, reproductive health, and chronic diseases that often remain untreated due to these constraints.

Despite its promising design, the Nashik Arogya Sampada program may face several challenges during implementation. For example, quality control and maintenance of equipment- such as digital blood pressure machines, printers and tablets, and rapid diagnostic test kits like glucose strips- may be difficult, especially during the monsoon season. Another challenge is the potential resistance to the adoption of telemedicine due to deep-rooted trust in traditional healers. Despite the benefits of telemedicine, the program could face opposition from traditional healers and unlicensed medical practitioners, or "quacks," who hold significant influence in many rural communities. These individuals have established a sense of trust with the community and often provide immediate, familiar care. Research indicates that even if such providers are formally trained, they often continue to rely on traditional or outdated practices rather than adopting evidence-based medical guidelines¹⁶,¹⁷. This resistance arises from deeply ingrained beliefs, economic interests, and limited exposure to new medical knowledge.

To mitigate this, it is crucial to focus on educating communities limitations of traditional and unregulated care while highlighting the reliability and effectiveness of telemedicine can gradually shift patient preferences towards more scientifically validated treatment options. Establishing clear communication channels and engaging respected community leaders could help in gaining the trust of the population and reducing reliance on informal practitioners while also finding ways to integrate these informal practitioners into the program by supporting them in adopting evidence-based practices. Continuous community engagement and education campaigns by CHWs and CHAs can help in gradually shifting health-seeking behavior towards telemedicine usage.

Additionally, the reliance on digital infrastructure and need for internet connectivity, which is still underdeveloped in these regions, poses a risk. To mitigate this, the program has established health kiosks with reliable internet access in key locations to ensure consistent connectivity and should continue to increase the number of kiosks in the intervention clusters. In addition, driven by the findings from the needs assessment, the software was designed to support low bandwidth and offline use. Programs, in the future, could also

explore alternative ways of connectivity, including traditional short-wave or CB radio frequencies, signal boosters, small cost effective relay towers, or satellite based internet if and when they become cost effective.

Telemedicine poses risks of misdiagnosis, primarily due to the inherent limitations of remote consultations compared to in-person care. One key challenge is the restricted ability to conduct comprehensive physical examinations, which may lead to missing subtle but critical physical signs essential for diagnosis. Additionally, telemedicine heavily relies on visual and verbal cues, which can be compromised by low-quality digital tools, unstable internet connections, or outdated software, all potentially affecting the accuracy of the assessments. Another risk arises from an overreliance on self-reported symptoms, especially when patients struggle with health literacy or under report symptoms due to communication barriers. Complex cases that require tactile examination or specialized diagnostic maneuvers are particularly susceptible to misdiagnosis in a telemedicine setting. Although studies indicate that telemedicine can provide comparable outcomes for common, non-urgent conditions like respiratory infections and chronic disease management, it falls short in scenarios requiring physical assessments or specialized tests¹⁴. Therefore, achieving equivalence with in-person care necessitates clear triage protocols, access to comprehensive patient records, and the use of advanced diagnostic tools to supplement remote evaluations. Properly structured telemedicine programs can mitigate these risks, making them a safe and effective alternative for certain types of care. This is mitigated through proper design of the software solution using the digital assistant Ayu. For example, in rural Gujarat the use of Ayu to guide the teleconsultation has shown an overall diagnosis concordance of 74% between in-person and telemedicine consultations, and an 80% concordance in the treatment plans, showing that telemedicine can be a safe and effective alternative to in person care¹⁴.

In future, evaluation research is needed to assess the impact of the program on health outcomes, such as the cost of accessing healthcare services, patients' compliance to medicine, percentage of positive patient reported outcomes and improvements in health-seeking behavior. This research will provide valuable insights into the program's effectiveness and inform future scaling efforts.

In conclusion, the Nashik Arogya Sampada project represents a significant step towards improving healthcare access in remote tribal areas through innovative CHW-led telemedicine solutions. While challenges are anticipated, the program's design is well-aligned with the needs of the community, and its success will depend on continuous adaptation and rigorous evaluation. The lessons learned from this project will contribute to the broader discourse on telemedicine as a viable solution for last-mile healthcare delivery in similar contexts.

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