

Enhancing Primary Healthcare Access in Brazil: An UBS+Digital Telehealth Initiative

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Submitted to: Journal of Medical Internet Research
on: November 05, 2024

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Abstract

Background: Brazil faces significant inequities in healthcare access, particularly in remote communities. The Brazilian Unified Health System grapples with challenges in delivering adequate healthcare to its vast population. To address these issues, the Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP), a leading institution in Latin America, established the Digital Health Program. This initiative aims to enhance healthcare coverage and reduce disparities through technological innovation. In collaboration with the United Kingdom Government's Better Health Program, HCFMUSP developed a Digital Primary Care proof of concept in Santarem, Pará, Brazil. This initiative successfully conducted over 220 teleconsultations with higher patient satisfaction. Building on this success, the UBS+DIGITAL project was created, in partnership with the Agência Brasileira de Apoio à Gestão do Sistema Único de Saúde, to expand and test the model of telehealth services in different scenarios in primary healthcare across Brazil.

Objective: Describe the results of the UBS+DIGITAL project, a telehealth initiative focused on training healthcare professionals, teleconsultation, and KPIs monitoring, on primary healthcare units (PHU) in Brazil.

Methods: The study comprehended fifteen Brazilian PHUs by a multi-centric prospective design. Brazilian regulations for service improvement studies do not require ethics approval. Data were collected through anonymous surveys of patients and physicians, recorded in the RedCap® database. PHUs were selected based on criteria such as the absence of an on-site physician and existing technological infrastructure. Synchronous and asynchronous training was provided, focusing on digital health and teleconsultation skills. In loco training included workshops and community events to share experiences and foster local engagement. A community of practice facilitated ongoing knowledge exchange. Teleconsultations followed the Person-Centered Clinical Method and Calgary-Cambridge methodology. KPIs were monitored by a dashboard to guide continuous improvement. The transition of operations was managed based on physician availability and project duration. Microcosting analysis assessed the project's economic impact using Brazilian guidelines, with statistical analysis performed using Jamovi® software.

Results: From March to November 2023, the project conducted 6,312 teleconsultations. Training goals were met, with over 70% of targeted professionals trained. The Net Promoter Score (NPS) for teleconsultations was 97, indicating excellent service quality. Of the teleconsultations, 66% were pre-scheduled, and 34% were on-demand, depending on family health team organization. Teleconsultations resolved 85% of cases, with 15% requiring in-person referrals or emergency care. The average absenteeism rate was 15%, and consultation durations were between 15 to 20 minutes, suggesting potential adjustments in scheduling.

Conclusions: The results highlight the effectiveness of telehealth programs in primary care settings with limited medical professionals. The UBS+DIGITAL project demonstrated that telehealth can enhance healthcare access, presenting a pioneering model within the Brazilian Unified Health System for digital primary care.

(JMIR Preprints 05/11/2024:68434)

DOI: <https://doi.org/10.2196/preprints.68434>

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Original Manuscript

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Abstract

Background: Brazil faces significant inequities in healthcare access, particularly in remote communities. The Brazilian Unified Health System is struggling to deliver adequate healthcare to its vast population. Telehealth, regulated in Brazil in 2022, emerged as a solution to improve access and quality of care. Thus, the *Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP)*, in partnership with the *Agência Brasileira de Apoio à Gestão do Sistema Único*

de Saúde created the *UBS+Digital* project, that aimed to mitigate the lack of medical care in remote areas of Brazil by providing teleconsultation in Primary Health Units (PHU) across the country. Through teletraining and digital health strategies, the initiative enabled healthcare professionals to provide remote assistance, improving access to medical care.

Objective: Describe the implementation and results of the *UBS+Digital* project, a telehealth initiative focused on training healthcare professionals, teleconsultation, and KPIs (Key performance indicator) monitoring, on primary healthcare units in Brazil.

Methods: The study comprehended fifteen Brazilian PHUs by a multi-centric prospective design. Brazilian regulations for service improvement studies do not require ethics approval. Data were collected through anonymous surveys of patients and physicians, recorded in the RedCap® database. PHUs were selected based on criteria such as the absence of an on-site physician and existing technological infrastructure. Synchronous and asynchronous training was provided, focusing on digital health and teleconsultation skills. *In loco* training included workshops and community events to share experiences and foster local engagement. A community of practice facilitated ongoing knowledge exchange. Teleconsultations followed the Person-Centered Clinical Method and Calgary-Cambridge methodology. KPIs were monitored by a dashboard to guide continuous improvement. The transition of operations was managed based on physician availability and project duration. Microcosting analysis assessed the project's economic impact using Brazilian guidelines, with statistical analysis performed using Jamovi® software.

Results: From March to November 2023, the project conducted 6,312 teleconsultations. Training goals were met, with over 70% of targeted professionals trained. The Net Promoter Score (NPS) for teleconsultations was 97, indicating excellent service quality. Of the teleconsultations, 66% were pre-scheduled, and 34% were on-demand, depending on family health team organization. Teleconsultations resolved 85% of cases, with 15% requiring in-person referrals or emergency care. The average absenteeism rate was 15%, and consultation durations were between 15 to 20 minutes, suggesting potential adjustments in scheduling.

Conclusion: The results highlight the effectiveness of telehealth programs in primary care settings with limited medical professionals. The *UBS+Digital* project demonstrated that telehealth can enhance healthcare access, presenting a pioneering model within the Brazilian Unified Health System for digital primary care.

Keywords: telehealth, public health service, innovation, primary healthcare

INTRODUCTION

Universal and free access to healthcare is constitutionally guaranteed by Brazil's Federal Constitution of 1988 and its *Sistema Único de Saúde (SUS)* (English: Unified Health System), established in 1990. Over its three-decade history, *SUS* has demonstrated significant advancements in promoting the Brazilian population's right to healthcare, annually attending over 190 million people at no cost and striving for higher quality service [1].

Healthcare services within *SUS* are organized according to the complexity needed to meet population demands: Primary Health Care (PHC), medium complexity, and high complexity services. In this regard, the Primary Health Unit (PHU; *Portuguese: Unidade Básica de Saúde - UBS*) is a fundamental structure within the Brazilian healthcare system, designed to provide PHC and accessible, high-quality health services to the population. The *Estratégia Saúde da Família* team (*ESF*; English Family Health Strategy) is a central component of this structure, emphasizing health promotion and disease prevention, treatment and management through a community-based approach. The *ESF* is composed of a multidisciplinary team of healthcare professionals. This team, which is the minimum required, consists of a physician, a nurse, a nursing technician, and at least a community health agent [2, 3].

The National Primary Care Policy determines that each *ESF* team should oversee no more than 4,000 individuals, with an ideal average of 3,000. This allocation should adhere to equity standards, as the number of individuals per team reflects the vulnerability levels of families in the region [4]. The PHC coverage in Brazil was reported at 78.56% as of September 2023, with more than 50 thousand accredited *ESF* teams [5]. Considering that approximately 71.5% of Brazilians lack private health insurance, *SUS* remains fundamental in medical treatments, health assistance, and comprehensive healthcare services [6]. In addition, the PHC serves as the primary gateway for patients, addressing more than 85% of the health needs expressed by the population [7]. Due to Brazilian geography, economic disparities, and diverse population densities, healthcare faces the challenge of offering higher quality health services [7]. Thus, telehealth initiatives have emerged to enhance healthcare accessibility by facilitating rapid diagnosis and early disease detection [8].

Telehealth, defined as the use of information and communication technologies to deliver healthcare services remotely, has been recognized as a crucial tool to enhance healthcare accessibility and quality [9]. In Brazil, telehealth was formally regulated in 2022, establishing guidelines for its practice (Brazilian Law, N° 14.510, December 27th, 2022). Since its regulation, telehealth has been increasingly implemented across various healthcare domains, particularly in PHC settings, where it is utilized for remote consultations, monitoring of chronic conditions, and facilitating specialist referrals [10]. Several studies highlight the potential of telehealth to bridge healthcare gaps, especially in underserved regions, by providing timely access to medical professionals [10]. A study conducted in Australia [11], examined healthcare professionals' experiences with the rapid upscaling of telehealth during the pandemic. The study found that telephone consultations were the predominant method of telehealth delivery, while video consultations were less frequently used. Although telehealth improved access to care for vulnerable populations and those in rural areas, it

posed challenges for patients with language barriers and limited digital literacy. Despite these limitations, most participants supported the continuation of telehealth with appropriate funding and improvements in care models.

In this context of telehealth expansion in Brazil, the *Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (HCFMUSP)* has established itself as a leading reference in the implementation of digital health services. The *HCFMUSP* is the top public hospital in Brazil and is considered a reference hospital in Latin America [12]. *HCFMUSP* plays a significant role within the SUS, which serves over 200 million people and is one of the largest public health systems in the world. To expand healthcare coverage for the Brazilian population and reduce disparities in medical care, *HCFMUSP* developed the Digital Health Program which has become a leading reference for telehealth services in Brazil. Although teleconsultation was only regulated in Brazil after the COVID-19 pandemic, *HCFMUSP* had already been conducting studies in digital health, which facilitated the swift integration and provision of teleconsultations as soon as this modality was officially authorized. Additionally, other telehealth projects have been developed by the *HCFMUSP* Digital Health Program based on its expertise, such as the Tele-ICU and the Smart ICU [13]. From a broader perspective, the *HCFMUSP* Digital Health Program projects have been based on three pillars: training healthcare professionals, providing teleinterconsultation (consultations conducted by two or more professionals to discuss clinical cases) or teleconsultation (consultations performed between physicians and patients), and managing key performance indicators (KPIs).

The digital health initiatives of the *HCFMUSP* in PHC began in 2021, driven by the need to address persistent challenges in this healthcare sector. A collaborative initiative between *HCFMUSP* and the United Kingdom Government's Better Health Program developed a Digital PHC proof of concept. This initiative focused on implementing telemedicine service in Santarem, Pará - Brazil, due to the lack of healthcare services in remote areas. This included teletraining medical and multi-professional teams to independently operate in telemedicine service, adapting to the specific challenges and realities of the Brazilian context [8].

Between September and December 2021, as part of the Digital PHC proof of concept, we conducted over 220 teleconsultations, providing medical care to 111 patients. The results demonstrated high patient satisfaction, with approximately 95% of participants expressing satisfaction with the service, and 76.6% reporting that their medical needs were fully met [8]. Based on the Digital PHC proof of concept results, we expanded the project to include 15 additional PHU. This expansion was carried out in partnership with the *Agência Brasileira de Apoio à Gestão do Sistema Único de Saúde (AgSUS)*. It is an entity created to provide operational support for the

implementation of public health policies formulated by the Brazilian Ministry of Health) and the *HCFMUSP*. The initiative was named *UBS+Digital* (English: *PHU+Digital*) and focused on assisting different regions across Brazil. Therefore, the *UBS+Digital* project aimed to provide medical care through teleconsultations for patients seeking assistance at PHU, but who were not attended due to the absence of an on-site physician. Additionally, the project sought to demonstrate that patients who received care were satisfied with the service and that its implementation was feasible and accessible across different regions of Brazil. Thus, the objective of the present study was to describe the implementation and results of the *UBS+Digital* project, a telehealth initiative focused on teletraining of healthcare professionals, teleconsultation, and KPIs monitoring, on PHU in Brazil.

METHODS

Study Design

This study, conducted between March and November 2023, represents a multi-centric prospective study that describes the implementation of a telehealth program at fifteen Brazilian PHUs. The Brazilian National Health Council resolution number 466/12, and 510/16 established that it is not necessary for the ethics committee to review studies with the sole objective of evaluating implementation and service improvement. In this study, we conducted an anonymous survey with physicians to gather technical information about the provided service, ensuring that no clinical or sensitive patient data was collected. All information was anonymously recorded in the RedCap® database.

Human Resources Structure

Family and Community Medicine physicians were scheduled for 18 hours per week. Each physician was responsible for attending one PHU, ensuring continuity of care. The physicians' weekly schedule included one hour for PHU team meetings, one hour for educational upgrading, and 16 hours for patient care (including teleconsultations, patient reception, prescribing and sending referral requests, and reviewing guidance with the patient).

The project team also included project managers, project coordinators, project analysts, research coordinators, data analysts, and information technology technicians, all of whom dedicated 40 hours per week to the project. In addition, a medical project coordinator and a nurse teletraining analyst dedicated 20 hours per week to the project. All professionals underwent a structured

onboarding program developed by the Human Resources of Digital Health at *HCFMUSP* and completed a 20-hour “Digital Health at Primary Healthcare” (The course description is in the item 2.4.2).

The selected project manager and project coordinators should have experience in primary healthcare, both of whom were responsible for the overall management of the project. Their duties included financial planning, monitoring and improving collected KPIs and serving as the interface with stakeholders at the PHUs. The medical and project coordinators were responsible for selecting the operational team for the *UBS+Digital* project. Two key criteria guided the selection process: expertise in PHC and soft skills, such as decision-making, problem-solving, and leadership. The research team, including the research coordinator and the data analyst, was responsible for preparing reports, writing scientific materials, and managing the collected data. The teletraining team, composed of nurses, engaged with the PHU teams to design the lectures delivered during *in loco* visits and synchronous training. Finally, the information technology team was responsible for implementing the platform used for teleconsultations and training the PHU teams on the technology used.

Selection criteria of Primary Health Units

Initially, a mapping of Brazil's regions with available vacancies in the *Médicos pelo Brasil* Program (a Brazilian Federal Program that aims to address the significant need for healthcare professionals in municipalities with high vulnerability, promoting a better distribution of physicians in remote areas of Brazil) was carried out using the reports provided by *AgSUS*. Next, we identified *ESF* teams with open positions in municipalities within these regions by utilizing the *e-Gestor APS* system (*e-Gestor APS*= web-based platform that facilitates access to PHC systems and provides strategic information to support the management of programs and services available at the state and municipal levels).

The first selection criterion was that the municipality must have at least one approved *ESF* team with 50% suspension of resources registered. This *ESF* team should be without a physician, in accordance with the registration in the *Cadastro Nacional de Estabelecimentos da Saúde* (CNES= an operational base for health information systems, responsible for managing the SUS). Furthermore, the municipality should utilize the *e-SUS APS*⁵ (*e-SUS APS*= it consists of a citizen electronic medical record system, which integrates patient care and follow-up data), based on data from the PHC Information System. Priority was given to municipalities classified as remote rural areas, which

have open physician vacancies.

The following criteria were used for PHUs selection flow for inclusion in the project:

- Availability of a computer with audio and video capabilities, as well as a printer for printing medical prescriptions and issuing certificates;
- Stable internet connection with sufficient speed for video calls;
- Utilization of the videoconferencing platform provided by the project, which was installed in advance and for which professionals were trained in its use;
- Availability of a private room for teleconsultations;
- Support from a local technology team to address infrastructure and system-related issues.

Training program

Synchronous teletraining

The synchronous teletraining aimed to train the PHU professionals in using the technological tools necessary for teleconsultation operations, clarify the project's objectives and expected results, and demonstrate the patient's journey within the PHU in the context of teleconsultation. The training process was structured into: (1) technical-operational training, encompassing all aspects of teleconsultation; (2) alignment meetings to assess partial results and identify strategic areas for improvement; and (3) capacity-building for professionals involved in the digital PHC service. The teletraining synchronous sessions were scheduled according to the availability of each PHU. Initially, the project team introduced the *IConf*®, the institutional videoconference platform used for teleconsultation. It facilitates communication between patients and physicians, physicians and *ESF* team, and physicians and the management team, following Brazil's General Data Protection Law (*Lei Geral de Proteção de Dados - LGPD*). The *IConf*® features included audio and/or video sharing, screen sharing, presentations with whiteboard and document functions, as well as public and private chat options. Health agents, physicians, dentists, nurses, nursing technicians, PHU managers, and other professionals participated in the synchronous teletraining using the Google Meet platform. At the end, the participants provided anonymous feedback using the Net Promoter Score (NPS) system to assess their satisfaction and likelihood of recommending the service [14].

Asynchronous teletraining

The asynchronous teletraining aimed to provide basic qualifications on "Digital Health at

Primary Healthcare”. The 20 hours course was available on the HCX e-learning platform of the *HCFMUSP* and covered the following topics: introduction to Digital Health in PHU, regulatory aspects of telemedicine and telehealth, ethical considerations in Digital Health, legal aspects of Brazilian data protection law, effective patient communication, humanization and media training, humanization of teleconsultations, telepropaedeutics, telepediatrics, teleorthopedics, challenges in teleconsultation in mental health, telerehabilitation, and simulation of teleconsultations. Participants took a test at the end and provided anonymous feedback using the NPS [14] system to assess their satisfaction and likelihood of recommending the course.

***In loco* training**

In loco training was offered to PHU professionals to increase engagement, facilitate the sharing of experiences, and exchange scientific knowledge. The *in loco* training included a workshop to discuss common clinical scenarios encountered in PHU, encompassing clinical issues, work processes, and community-specific aspects. The PHU participants first addressed the case from their respective roles, followed by a theoretical presentation based on their comments and the development of a personalized therapeutic plan for the case. Additionally, the *in loco* training included a community event aimed at promoting the project, strengthening relationships, and obtaining patient feedback. This event featured a real-time or recorded speech from the PHU physician, emphasizing the importance of medical follow-up. At the end, the participants provided anonymous feedback using the NPS [14] system to assess their satisfaction and probability of recommending the training.

Communities of practice

A community of practice was established for professionals involved in the *UBS+Digital* project to share their knowledge and experiences related to their telehealth experiences. Through discussing successful cases, participants were able to enhance their understanding of telehealth and identify challenges and opportunities that emerged throughout the project. In order to facilitate this process, an instant group at a messaging app was created for *ESF* team professionals and local managers to forward their questions. Additionally, synchronous meetings were organized to discuss telehealth experiences from the *UBS+Digital* project, allowing teams from different PHUs to present their successful cases, meet external speakers, and further engage in collaborative learning.

Difficulties and obstacles encountered during the implementation were shared through this group and further discussed at the end of synchronous meetings. Promotion and dissemination of the event occurred through communication channels targeted at professionals within the PHU, emphasizing the importance of this learning opportunity and the exchange of experiences among participants.

Technical visits

The technical visit itinerary included a meeting at the Municipal Health Department aiming to strengthen relationships, update project stakeholders, and promote discussions about the project's impact on the population and potential action plans. Additionally, the project management team observed the routine of PHU professionals to map out the patient and professional journeys.

Teleconsultation setting

In general, teleconsultations were conducted with patients at the PHU, where the professionals from the *ESF* team provided on-site assistance. In exceptional cases, home-based teleconsultations were arranged to assist not only bedridden or mobility-impaired patients but also those living in remote areas or who had not sought care at a PHU. The home visits were conducted using a mobile phone or tablet to enable teleconsultation.

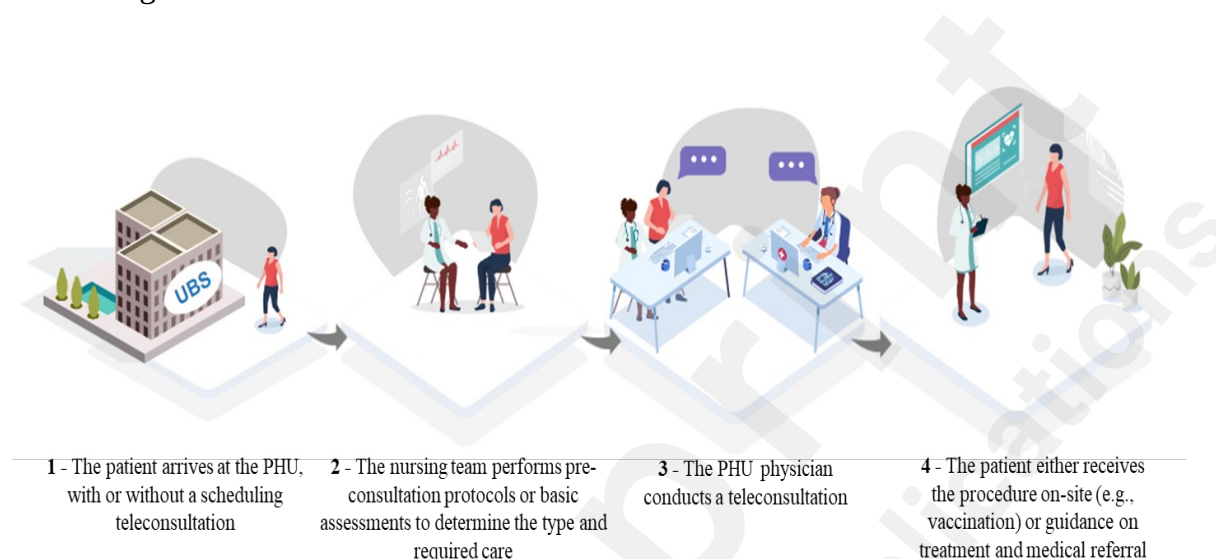
Medical teleconsultation was scheduled either in advance or on the same day, based on the physicians' availability. If a patient did not attend the appointment, the slot was offered to another patient at the PHU.

The teleconsultations followed the Person-Centered Clinical Method and were guided by the Calgary-Cambridge methodology (a structured framework for teaching and assessing medical communication skills, focusing on effective doctor-patient interactions) [15]. When receiving the patient at the online platform, the physician confirmed the patient's full name and birth date. The initial few minutes of interaction were dedicated to establishing clear communication and building a connection.

The projection indicated that teleconsultations would have an average duration of 30 minutes. With 16 hours allocated to this service, the PHU would offer approximately 32 teleconsultations *per* week. Although a time estimate for consultations was established, physicians had the autonomy to manage the teleconsultation according to the patient's needs, which could result in a duration shorter or longer than initially projected. **Figure 1** illustrates the teleconsultation process.

At the end of each teleconsultation, patients provided anonymous feedback using the NPS system to assess their satisfaction and probability of recommending the service. The physicians completed an on-line form documenting relevant metrics such as consultation duration, number of sessions, unavailability service rate, patient no-shows, and the need for further medical referral.

In addition, teleconsultations and other telehealth care services were categorized, such as clinical case discussion, prescription renewal, reception, teleconsultation at patients' houses, and counseling.



Source: HCFMUSP, 2023.

Figure 1. Patient's journey in PHU during the telehealth service delivery. PHU = Primary Health Unit.

Key Performance Indicators (KPIs) and project management

To ensure effective monitoring and management of the *UBS+Digital* project, a set of predefined KPIs was used to track and evaluate progress. These KPIs were selected based on their relevance to the project's objectives and were continuously monitored throughout the project's lifecycle. The KPIs assessed the performance of both training sessions and teleconsultations, with data collected from both patients and healthcare professionals via structured online surveys. All collected data were securely stored in the RedCap® database, maintaining participant anonymity. A dynamic dashboard, developed on the Power BI platform, was employed to present real-time updates on key metrics. This allowed the project team to perform continuous monitoring and make informed decisions about the project's direction. Weekly reviews of the KPIs took place with the project

management team to evaluate trends, identify areas needing improvement, and refine strategies. In addition, biweekly meetings with the full project team facilitated deeper discussions and comprehensive data analysis. A resolution rate goal of 50% was set, ensuring the project's ability to address a substantial proportion of medical cases remotely. Table 1 presents the KPIs that were tracked throughout the project.

Table 1. Key Performance Indicators evaluated during the *UBS+Digital* project.

Key Performance Indicators analyzed	Description
Number of participants on asynchronous, synchronous and in loco training	Tracks participation rates in various training formats
NPS for asynchronous, synchronous and in loco training	Measures satisfaction with training sessions.
Total number of teleconsultations	Tracks the overall volume of teleconsultations performed.
Percentage of service type (teleconsultation, teleinterconsultation, and other services ^b)	Measures distribution of service types provided.
Number of patients attended via teleconsultation	Tracks the number of patients served remotely.
Percentage of absenteeism	Indicates the rate of missed appointments.
Resoluteness rate	Percentage of cases resolved through teleconsultation without the need for in-person referrals.
Average duration of teleconsultation	Average length of teleconsultations.
NPS for teleconsultations ^a	Measures satisfaction with the teleconsultation experience.
Appointment occupancy rate ^c	Percentage of available appointment time utilized.

^a NPS = Net Promoter Score; ^b Appointment occupancy rate = Occupancy rate (%) = (total time occupied/total available time)x100; ^c Others services = clinical cases discussion, prescription renewal, reception, teleconsultation at patients' home, and counseling.

Closure of Operations at PHUs

The closure of operations at the participating PHUs occurred gradually, with a reduction in the number of teleconsultations by the physician to ensure the continuity of care. The transition period lasted an average of 3 weeks, until the total cessation of the service. This process occurred in three possible situations: the arrival of a full-time on-site physician, the end of the project's execution period, or the lack of participation of essential PHU professionals and managers.

The closure of operations at the PHUs phase started with a meeting between the project team and the municipal health management team to present the transition operation process. During this meeting, data and progress of the specific PHU were reviewed. When applicable, the new physician serving the PHU in person was involved in the process and invited to access the online course “Digital Health at Primary Healthcare”, to understand telehealth practices implemented prior to their arrival, thereby highlighting the importance of operational procedures and the quality of patient care.

Microcosting analysis

A comprehensive microcosting analysis was conducted to evaluate the economic impact of the *UBS+Digital* project. The goal was to provide a detailed cost assessment that aligns with the Social Return on Investment (2019) framework, facilitating a clear understanding of the financial sustainability of the project [16]. Data was collected retrospectively, as it was necessary to consolidate productivity data for accurate cost mapping.

The analysis adhered to the Brazilian Economic Evaluation Guidelines of the Ministry of Health [17], following a structured three-step process:

1. Identification of Relevant Costs: This involved determining all cost components necessary for the implementation and operation of the project.
2. Measurement of Resources Used: We quantified the resources consumed by the project at both the implementation and operational stages.
3. Valuation of Resources: Each resource was then assigned a monetary value to estimate the total project cost.

The analysis differentiated between implementation costs (one-time costs incurred during project setup) and operational costs (recurring costs associated with ongoing activities). For the implementation phase, cost components included human resources (personnel involved in project setup), infrastructure (physical and technological requirements), e-learning platform (development and deployment costs), and marketing services. The operational phase considered ongoing personnel

costs, platform maintenance, and travel expenses for *in loco* training sessions. To estimate human resource costs, we calculated the number of hours dedicated by each professional, categorizing them into either the implementation phase or the operational phase.

To facilitate decision-making, several key economic metrics were calculated to assess the project's cost-effectiveness:

- **Total Cost:** The sum of both implementation and operational costs, divided by the total number of teleconsultations performed.
- **Actual Cost:** The real cost per service provided, focusing only on operational expenses.
- **Effective Cost:** The operational costs divided by the number of scheduled teleconsultations, providing insight into cost reductions from improved scheduling.
- **Optimized Cost:** The operational costs divided by an expanded number of teleconsultations, projecting potential efficiency improvements with increased utilization.
- **Break-even Time (T):** The time required for the accumulated operational costs to equal the initial investment costs.

This comprehensive microcosting approach allows for the reproducibility of the cost analysis by clearly outlining the steps taken in cost identification, measurement, and valuation. It also provides a transparent framework for estimating the economic impact of similar telehealth initiatives in other regions or countries.

Statistics analysis

The data collected anonymously and recorded in the RedCap® databases were extracted into Microsoft Excel 2023, where raw values were organized for analysis. Descriptive analysis of the data was performed using Jamovi® software.

The results were expressed both in absolute values and percentages to provide a clear overview of the data distribution. The descriptive analysis involved evaluating frequencies and proportions, allowing for the identification of patterns and general trends within the dataset. All results were reviewed to ensure the accuracy and reliability of the conclusions presented in the study.

RESULTS

Mapping and Selection of Brazil's Primary Health Units

All professionals from the project team completed the “Digital Health at Primary Healthcare” course, which explored digital health, including its historical development, definitions, regulatory law, and current challenges, aiming to standardize the knowledge among the professionals regarding the fundamental principles of telehealth services.

After searching for *ESF* teams with open positions in municipalities within the regions mapped for available vacancies in the *Médicos pelo Brasil* Program, 322 teams met the first selection criterion: having at least one approved *ESF* team with a 50% suspension of resources. Of these, 135 municipalities proceeded to a pre-selection based on additional inclusion criteria outlined for the project. Among these, 39 expressed interest in taking part in the project, and 25 municipalities representatives attended an online meeting to discuss the project and its requirements. Ultimately, 11 municipalities agreed to participate in the project. From January to December of 2023, the *UBS+Digital* project served 15 PHU from four regions of Brazil (North, South, Northeast, and Southeast) (Figure 2). The median duration of PHU participation in the project was 5 (IQR 1,50-6) months, with the shortest and longest durations being 1 and 7 months, respectively. Figure 3 illustrates the flowchart of the *UBS+Digital* project implementation at the selected PHUs.



Figure 2. Brazil's map showing the localization of the 15 selected PHUs.

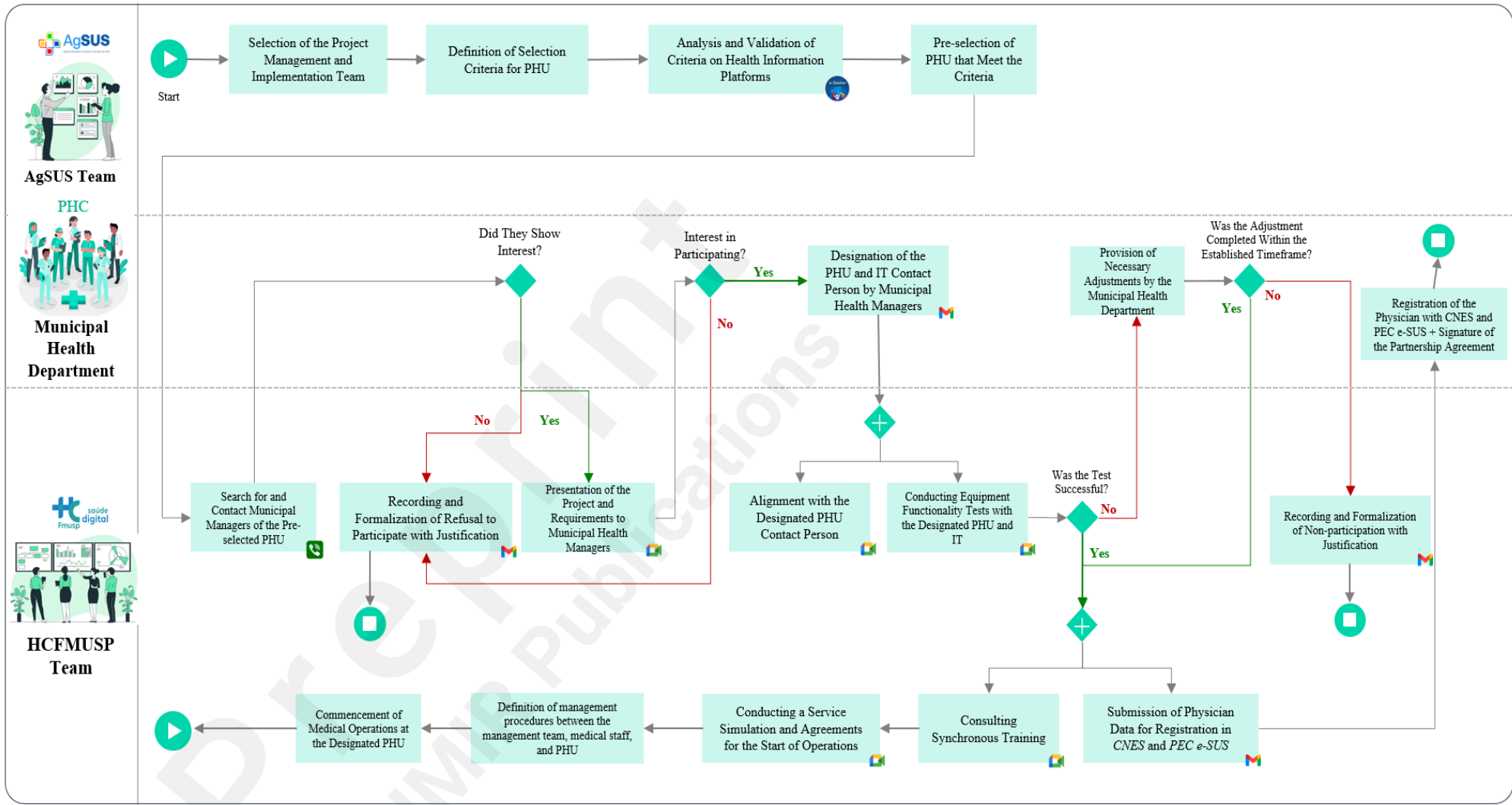


Figure 3: Project implementation workflow. PHU = primary health unit; PHC = Primary Health Care; CNES = *Cadastro Nacional de Estabelecimentos de Saúde* (National Registry of Health Establishments); PEC e-SUS = *Prontuário Eletrônico do Cidadão* (Electronic Citizen’s Medical Record).

Monitoring of the Primary Healthcare Units' training program

A total of 153 professionals were synchronously teletrained to use the technological tools necessary for teleconsultation operations. The majority of the professionals were community health agents, community health coordinators, and nursing technicians (Table 2). Approximately, 40% of professionals responded to the NPS questionnaire, and the NPS score achieved was 100, classified as excellent.

Asynchronous teletraining was offered to a total of 91 professionals, consisting mainly of community health agents' coordinators, as well as nursing technicians, nurses, managers, and other professionals (buccal health agents, secretaries, administrative and information technician, community health agent, and dentist) (Table 2). Approximately, 19% of professionals responded to the NPS questionnaire. The NPS score for this training was 84, classified in the zone of excellence.

Additionally, nine *in loco* training were conducted between July and September 2023. Of the 15 PHUs participating in the project, two withdrew before the *in loco* training, three joined the project without available time to undergo this training and one preferred to complete the training online. These training sessions educated 87 professionals, including community health agents, community health coordinators, and nursing technicians (Table 2). The NPS score for this training was 99, classified as excellent.

Table 2. Categories of the healthcare professionals that participated in the synchronous,

asynchronous, and *in loco* training.

Percentage Professional	Synchronous	Asynchronous	<i>In loco</i>
Health community agent, N (%)	76 (50)	48 (53)	48 (44)
Nursing technician, N (%)	21 (14)	17 (19)	17 (17)
Nurse, N (%)	16 (10)	10 (11)	9 (9)
Managers, N (%)	14 (9)	1 (1)	19 (19)
Dentist, N (%)	3 (2)	2 (2)	2 (2)
Physician, N (%)	1 (1)	1 (1)	3 (3)
Others, N (%)	22 (14)	12 (13)	5 (5)
Total, N (%)	153 (100)	91 (100)	98 (100)

*Others: buccal health agents, secretaries, and administrative and information technicians.

The communities of practice strategy were implemented to increase the visibility of the *UBS+Digital* project and to establish an environment where the professionals involved in the project could share their knowledge and experiences related to telehealth services. To facilitate this, a group was created on an instant messaging app, and virtual meetings were held, with the presence of external speakers. Four meetings were conducted, addressing topics identified by participants as relevant for enhancing teleconsultation practices, such as telemedicine for integrated logistics and telehealth, digital empathy, home care services, hybrid practices linked to health care delivery, and project closure. The first twenty minutes of each session were dedicated to university professors or *ESF* team professionals who shared successful teleconsultation cases or theoretical topics related to digital health. Following the presentations, a discussion was opened to all participants. It was noted that participants preferred topics related to PHC over more technological subjects. The communities of practice involved PHC managers, healthcare professionals, the project manager, the teletraining team, the medical project coordinator, physicians, and the project team.

Monitoring of the Implementation and impact of teleconsultation

Initially, the teleconsultation schedule began with a limited offering, and after evaluating the PHU participant adaptation to the teleconsultation system, it was expanded to full capacity (100%). The methodology applied was designed to implement

the solution gradually, reducing the necessity for major changes to existing workflows and minimizing the risk of resistance from the local team and patient adherence challenges.

During the telehealth program, a total of 6.312 sessions were conducted. Of these, 6.140 were teleconsultations (97.3%), 96 were teleinterconsultations (1.5%), and 76 were other services such as home visit, renew medical prescription, and medical advice (1.2%). The teleconsultations served 4,279 patients, out of which 1.842 patients (43%) returned for follow-up treatment. The teleconsultations had a resolution rate of 85%, and a 15% absenteeism rate. Teleconsultations majoritarily lasted 10 to 20 minutes and were previously scheduled. This service achieved the NPS score of 97, classified as excellent. These results are summarized in Table 3.

During the teleconsultation program, nine technical visits were carried out simultaneously with the *in loco* training. Initial findings were presented to local stakeholders as health department managers, PHU coordinators, and PHU focal points, providing a project overview and a brief on outcomes from other PHU locations involved.

The operation transition plan was implemented at the end of the teleconsultation operations. Among 15 participating PHUs, 7 ended their operation due the arrival of the physician in person, 4 concluded their participation due to the project's finalization, and 4 lacked engagement. During the teleconsultation transition and arrival of the physician in person, the 7 physicians joining PHUs for in-person activities were able to participate in a teleconsultation and access the online course “Digital Health at Primary Healthcare”. The transition process also involved the project physician transferring complex cases, detailing interventions, and setting patient care expectations.

Table 3. Results of telehealth service offered on the *UBS+Digital* project.

Telehealth service	
Teleconsultation % (n/N)	97.3 (6140/6312)
Teleinterconsultation % (n/N)	1.5 (96/6312)
Others service* % (n/N)	1.2 (76/6312)
Average teleconsultation time	
0-10 min % (n/N)	7.5 (461/6140)
10-20 min % (n/N)	66.1 (4054/6140)
>20 min % (n/N)	26.4 (1623/6140)
Previous or same-day teleconsultation	
Previously scheduled teleconsultation % (n/N)	65.3 (4009/6140)

Same-day scheduled teleconsultation % (n/N)	34.7 (2130/6140)
Teleconsultation resoluteness rate % (n/N)	85 (5219/6140)

The results were presented as percentages (%), case counts (n), and the total number of samples for each metric (N). *Other services: clinical cases discussion, prescription renewal, reception, teleconsultation at patients' house, and counseling.

UBS+Digital project microcosting analysis

To determine the costs of teleconsultations, we considered a total of 6,312 telehealth services provided during the study period. The effective cost was calculated based on the total availability of 4,752 hours allocated for teleconsultation scheduling, with a maximum operation capacity of 9,504 teleconsultations. To estimate the optimized cost, we assumed a 15 minutes teleconsultation time, which would allow for an increased capacity of 19,008 teleconsultations within the 4,752-hours timeframe. This estimate was based on the observed distribution of teleconsultation durations, where 66.1% of the teleconsultations lasted between 10 and 20 minutes. The implementation cost was determined using the actual expenses incurred during the setup phase, factoring in an average of 23.6 telehealth services per day. This analysis provides a comprehensive view of cost variations depending on teleconsultation duration and system efficiency, allowing for potential cost optimizations if consultation times are effectively managed. The results of the microcosting evaluation are described in Table 4.

Table 4. Project microcosting analysis in different scenarios.

Microcosting Indices	Value (USD/teleconsultation)	Time (Days)
Total Cost	137*	-
Real Cost	85*	-
Effective Cost	57*	-
Optimized Cost	28*	-
Time	-	161.5

*These results were presented in dollars based on the exchange rate at the time of the project's implementation.

DISCUSSION

This study describes the *UBS+Digital* project, which assessed the

implementation and feasibility of a telehealth program in PHUs of the Brazilian Unified Health System, specifically in facilities lacking physicians. The results indicate a high-resolution rate of teleconsultations, with a relatively low medical infrastructure cost *per* consultation. This approach showcased the project's capability to surmount geographical and economic barriers, particularly in remote areas with limited medical care, physical infrastructure, and internet.

The data showed high patient satisfaction, demonstrated by their return for continued treatment, reinforcing the importance of digital care in building a more resolute PHC system. One of the main challenges of the *UBS+Digital* project was establishing the physician-patient relationship that could be enhanced despite geographical distance and the use of technology to access services. Additionally, the project faced the challenge of training and engaging healthcare professionals, including physicians, nurses and nursing technicians. This focus on teleconsultation technology and training in specific clinical themes was crucial to the project's success. Studies have shown that inadequate training for healthcare professionals can lead to reduced adoption and effectiveness of digital health initiatives [18, 19]. The *UBS+Digital* project mitigated these issues through extensive synchronous, asynchronous, and in loco training, achieving high satisfaction rates among participants.

Moreover, the resolution rate of teleconsultations was high, with minimal referrals, indicating that the majority of health issues were effectively addressed. Accordingly, a study showed that implementing telehealth strategies to support referral management enhanced resolution in primary healthcare (PHC) and improved care coordination [20]. When combined with professional training and KPI monitoring, teleconsultations have proven effective in other fields, such as tele-ICU, yielding better outcomes than initiatives that do not follow this structured approach. These findings suggest adopting well-structured telehealth models—emphasizing proper training and KPI monitoring—in improving consultation resolution and reducing the need for referrals.

A study on the evolution of PHC from 2014 to 2018 documented the increasing implementation of Information and Communication Technologies (ICT) in healthcare services [21]. The study described the role of internet access in enhancing care quality and process efficiency. The introduction of these technologies has improved professional practice and healthcare management. The study also highlighted significant disparities, with a higher concentration of ICT usage in areas with better Human

Development Index (HDI) and stronger PHC coverage. However, the North and Northeast regions, which face more challenging economic and social conditions, continue to struggle with inadequate infrastructure and a lack of technological resources. These regional disparities, along with the complexity of implementing telehealth solutions at scale, underscore the need for increased investment in ICT to bridge gaps and ensure equitable healthcare access. Additionally, the availability of physicians in remote regions remains a challenge, often linked to HDI-M (Human Development Index by Municipality). The HDI-M measures longevity, education, and income, with values ranging from 0 to 1, where values closer to 1 indicate better development. In the present project, the HDI-M of the assessed PHU ranged from 0.565 to 0.778, indicating a need for increased medical resource allocation [22]. Previous studies have demonstrated that physician availability is directly linked to HDI-M, reinforcing the necessity of innovative solutions like telehealth to bridge gaps in healthcare access [23].

The *UBS+Digital* project showcased the potential of telehealth in addressing healthcare access challenges in remote areas with limited infrastructure. High resolution rates and positive patient feedback illustrate the effectiveness of telehealth in overcoming geographical and economic barriers, improving access, and ensuring continuity of care. Despite ongoing regional disparities and the need for increased investment in ICT, the project underscores telehealth as a viable solution for underserved areas. However, its scalability is currently limited, and successful implementation requires a balanced approach integrating technological advancements with targeted public policies and strategic investments to reduce regional inequalities and ensure equitable healthcare coverage. Furthermore, the involvement of human resources and team engagement, including municipal managers and family health teams, were critical to the project's success.

A comparison between Canada and Brazil highlights shared challenges in healthcare access due to their vast geographic areas. In both countries, residents of remote areas must travel long distances at significant costs to reach urban centers where medical specialists are concentrated. In Canada, 19% of the rural population faces restricted access to specialized care leading to high socioeconomic burdens and travel-related risks, along with lower availability of medical services [24]. Similar constraints exist in Brazil, particularly in regions with low physician density, further emphasizing the role of telehealth as an essential tool in healthcare equity [25].

Value-based healthcare strategy aims to improve patient outcomes by enhancing capacity, comfort, and calm, aligning with the Institute for Healthcare Improvement's "triple aim" of improving patient and clinician experiences, population health, and reducing per capita costs [26]. Evidence supports telehealth as a cost-effective model within this framework, as seen in China's telemedicine program for eye disease screening, which achieved an incremental cost-effectiveness ratio of 34% for traditional methods. In England, telemedicine for acute stroke care led to \$500,000 in cost savings compared to conventional services [26]. Microcosting analyses in other studies align with our findings, showing that optimized teleconsultation workflows reduce costs while maintaining quality of care [27].

While the initial investment in implementation is significant, evidence indicates that the cost *per* teleconsultation tends to decrease, reflecting increasing efficiency [28]. Beyond the economic benefits, the project brought significant social value to various stakeholders, including patients, the community, *ESF* team, the *AgSUS* and *HCFMUSP* Digital Health team, and health department managers. For patients and the community, the project raised awareness of the importance of teleconsultations and promoted digital inclusion, enhancing healthcare access and equity. The project improved the skills of teams at PHUs, *AgSUS* and *HCFMUSP*, particularly in telehealth, applied to PHC, project management, and data analysis. The medical team enhanced their telemedicine skills through courses in Digital Health for PHC, while also increasing their acceptance of telehealth for medical consultations. For the teams at both *AgSUS* and *HCFMUSP*, the project provided valuable insights into the local realities of primary care, enabling more informed decision-making regarding the implementation of telehealth services. Moreover, for municipal health managers, the project offered learning opportunities and insights into training professionals in digital health care. This knowledge significantly strengthens the municipal health system's ability to effectively adapt to and integrate telehealth solutions.

The implementation of the *UBS+Digital* project at a PHU in an isolated riverside district exemplifies a significant advancement in healthcare accessibility with environmental benefits. Previously, a single patient faced a 236 km journey, taking up to 12 hours in one day, to receive in-person medical care in another city. Within just seven months, the telehealth initiative facilitated 872 teleconsultations at this PHU, achieving a NPS of 96 and resulting in savings of 205,792 km in travel that these individuals would have otherwise needed to undertake by boat and car. The high resolution rate

(85%) observed at this PHU indicates that the majority of health issues were effectively addressed, thereby preventing the need for additional travel for follow-up appointments and potentially reducing the carbon footprint associated with such journeys. By minimizing commuting, the project also led to reductions in transportation costs, environmental impact, and risks related to transport accidents. These findings are consistent with global research showing that telehealth initiatives contribute to carbon footprint reduction by decreasing the need for patient travel [29].

This study has certain limitations that should be acknowledged. One key limitation is that we did not conduct a specific analysis of regional differences, which may impact the generalizability of our findings across Brazil's diverse healthcare settings. To mitigate this, we established standardized inclusion and exclusion criteria for PHUs to participate in the project. However, despite these criteria, we still encountered significant challenges in infrastructure, internet connectivity, and resource availability, which varied across different units. Additionally, the relatively limited number of PHUs included in the study may not fully capture the wide variability in healthcare infrastructure, patient demographics, and local healthcare policies. These factors highlight the complexity of implementing telehealth solutions at scale and underscore the need for future studies to explore strategies to overcome these structural and logistical barriers. Another study limitation is the low NPS response rate, reducing the representativeness of the data. Another study limitation is the low NPS response rate, reducing the representativeness of the data. The low response rate may lead to a biased interpretation, as the individuals who chose to respond may not fully represent the broader population of teleconsultation users. Factors such as lack of incentive, time constraints, or unawareness of its importance may contribute to this issue. Consequently, the findings on patient satisfaction and service quality, based on the NPS, should be interpreted with caution, as they might not reflect the experiences of all participants. To mitigate this problem, strategies such as simplifying the questionnaire, sending reminders, and offering incentives have been implemented. Despite these challenges, our findings provide valuable insights into the feasibility and impact of telehealth in primary care settings, contributing to the ongoing development of digital health strategies in Brazil.

CONCLUSION

The *UBS+Digital* project exemplifies how telehealth initiatives can effectively address healthcare disparities, particularly in underserved regions with limited medical infrastructure. By offering teleconsultations, this project has improved access to healthcare services, demonstrated a high-resolution rate, and achieved notable patient satisfaction that could be considered similar to the model in-person PHC. The training of healthcare professionals further ensured the sustainability and quality of these services. These findings highlight the potential for telehealth to mitigate geographic and economic barriers, enhancing healthcare access in regions where traditional medical resources are scarce. The findings from this study also provide a solid foundation for future research on optimizing telehealth to meet the diverse needs of the Brazilian population. The experience acquired can inform health policies and telehealth implementation strategies in similar global contexts. The microcosting approach used in this study is particularly useful for future evaluations of digital health projects and supports the development of public policies aimed at expanding access to quality healthcare. Given Brazil's vast territorial area and significant socioeconomic disparities, telehealth relevance highlights the ongoing need for innovative solutions to improve healthcare access and quality of the services. This highlights the importance of expanding our study in the future to investigate regional disparities, aiming to understand the specific demands and needs of each area.

Funding Statement

None declared.

Acknowledgments

We thank the *Agência Brasileira de Apoio à Gestão do Sistema Único de Saúde* for the financial support

This manuscript was fully drafted by the authors. OpenAI's ChatGPT was used during the revision process to enhance language clarity and readability. The authors take full responsibility for the content and interpretation of the manuscript.

Author contributions:

CAL, CRRC, PGS, PGSA, ABSP, ACC, LMA, LNA, and ALAM contributed to the study design CAL, CRRC, PGSA, TSY, LNA and CPS contributed to data collection

and analysis, and wrote the first draft of the manuscript. All authors read and approved the final manuscript.

Conflict of interest

None declared.

Data Availability

The datasets generated or analyzed during this study are available from the corresponding author on reasonable request.

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Supplementary Files

Untitled.

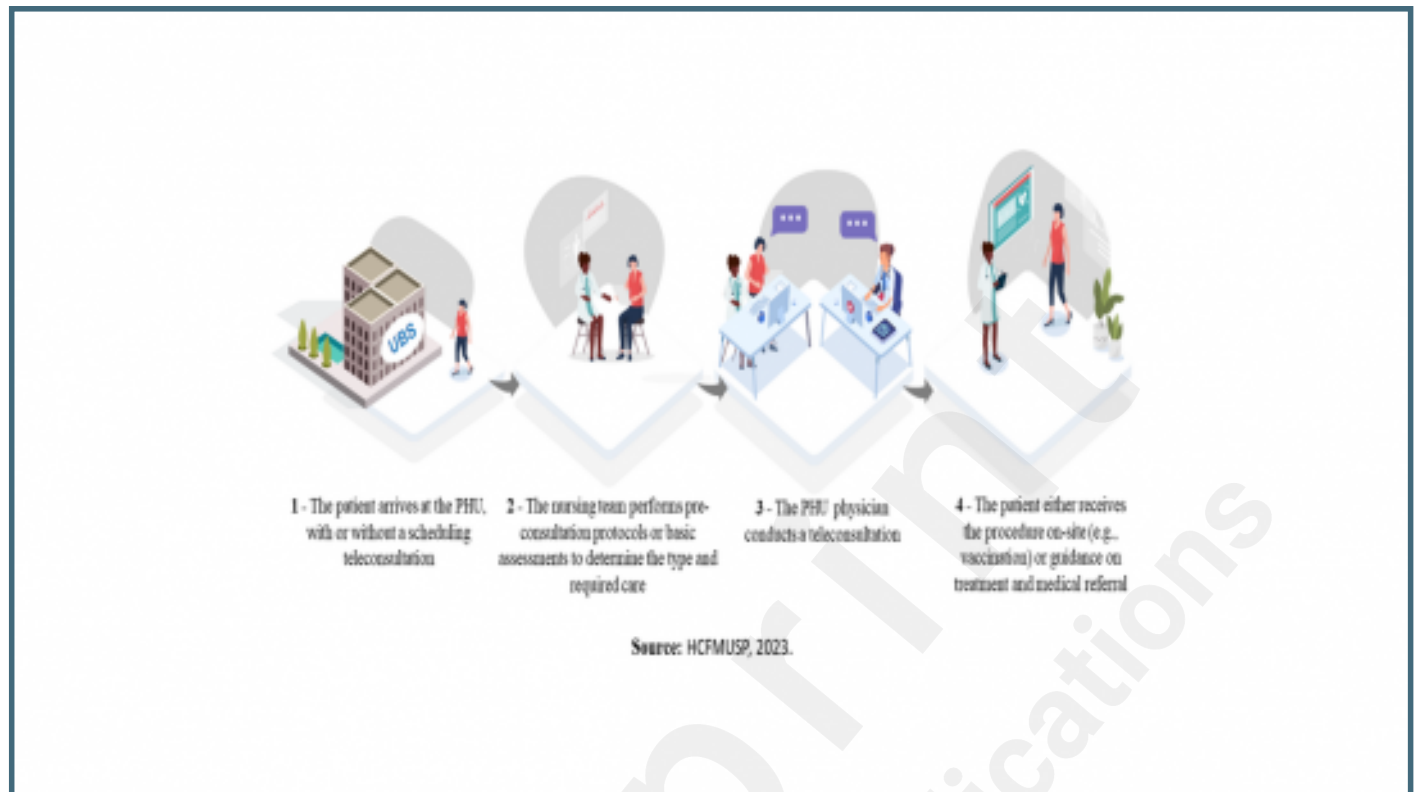
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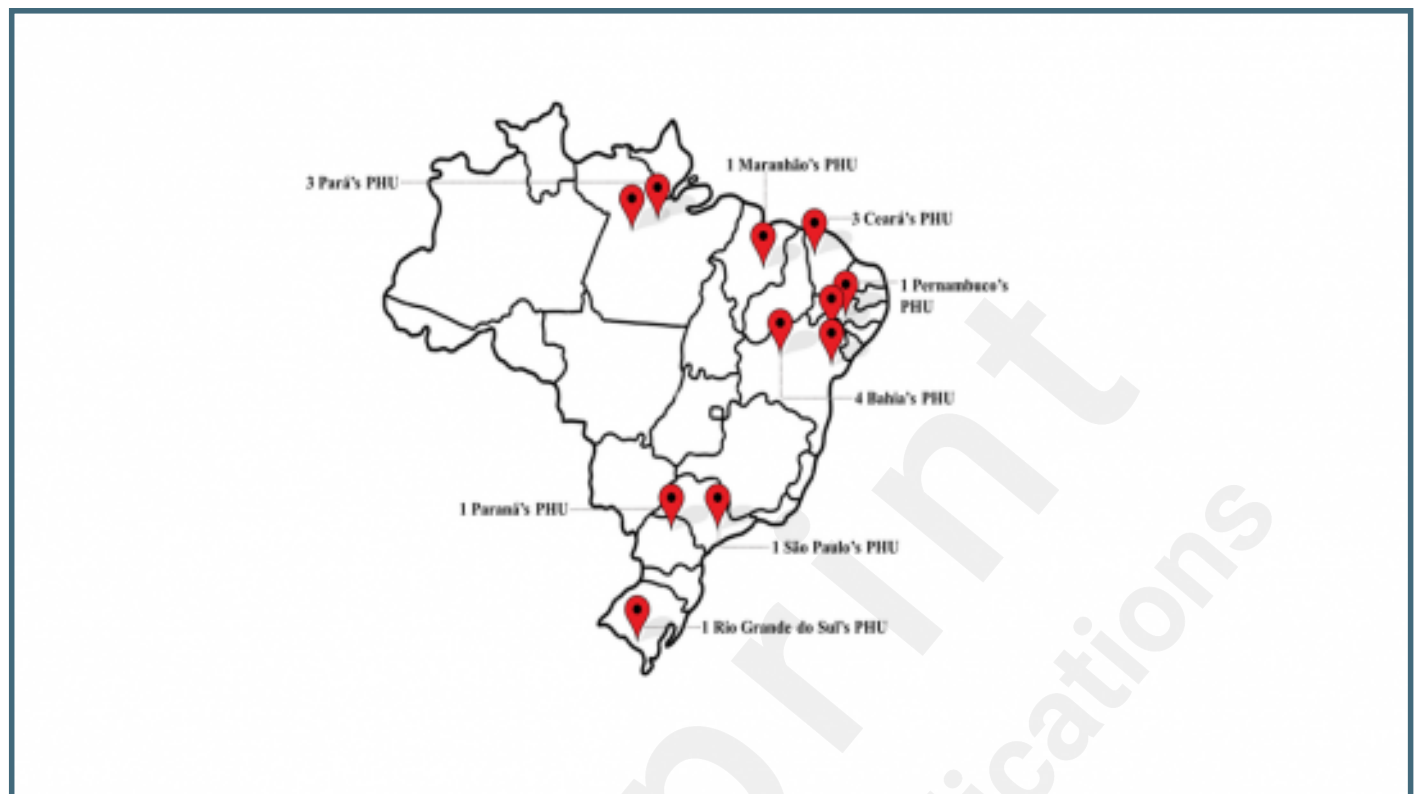
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Figures

Patient's journey in PHU during the telehealth service delivery. PHU = Primary Health Unit.



Brazil's map showing the localization of the 15 selected PHUs.



Project implementation workflow. PHU = primary health unit; PHC = Primary Health Care; CNES = National Registry of Health Establishments (Cadastro Nacional de Estabelecimentos de Saúde); PEC e-SUS = Electronic Citizen's Medical Record (Prontuário Eletrônico do Cidadão).

