Telehealth Center of the Faculty of Medicine at UFMG: Experiences and Perspectives

Maria do Carmo Barros de Melo	Professor and member of the Telehealth Center of the School of Medicine, Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mail: mcbmelo@gmail.com
Mariana Abreu Caporali de Freitas	PhD candidate in the Graduate Program in Public Health at the School of Medicine, Federal University of Minas Gerais. Researcher at the Health Technology Center, School of Medicine, Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mail:caporalimariana@gmail.com
Rosangela Durso Perillo	Researcher at the Health Technology Center, School of Medicine, Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mail rosangeladurso.perillo@gmail.com
Rosália Morais Torres	Associate Professor and member of the Telehealth Center of the School of Medicine, Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mail:rosaliamoraistorres@gmail.com
Gustavo Cancela e Penna	Professor at the School of Medicine and member of the Telehealth Center of the School of Medicine, Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mial: gustavocpenna@gmail.com
Rogeli Tiburcio Ribeiro da Cunha Peixoto	Associate Professor at the School of Dentistry, Federal University of Minas Gerais. Coordinator of Tele-dentistry at UFMG. Belo Horizonte (MG), Brazil. E-mail: rogelipeixoto@gmail.com
Carlos Eduardo Menezes Amaral	Adjunct Professor in the Department of Preventive and Social Medicine, Federal University of Minas Gerais (UFMG). Researcher at the Health Technology Center, School of Medicine, Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mail: caduamaral@gmail.com
Solange Cervinho Bicalho Godoy	Professor at the School of Nursing and Coordinator of Telenursing at the Federal University of Minas Gerais. Belo Horizonte (MG), Brazil. E-mail:solangecgodoy@gmail.com
Alaneir de Fátima dos Santos	***Corresponding author:*** Adjunct Professor in the Department of Preventive and Social Medicine, School of Medicine, UFMG, and General Coordinator of the Telehealth Center of the School of Medicine, Federal University of Minas Gerais. https://orcid.org/0000-0002-7674-0449 e-mail: laines@uol.com.br

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Abstract

Introduction: Digital Health is expanding worldwide, fostering collaboration among professionals and the development of new interdisciplinary skills to improve healthcare. The Telehealth Center of the School of Medicine at the *Universidade Federal de Minas Gerais* (NUTEL FM/UFMG) was created in 2006. It has a historical record of successful experiences, overcoming geographical barriers and supporting public health services to overcome challenges and act in a more decisive and organized manner. **Objective**: To describe the experience and trajectory of NUTEL/FM/UFMG, especially those related to public telehealth services and technological innovations. **Method**: Experience report with a descriptive and exploratory approach, based on the trajectory of NUTEL/FM/UFMG and in documents, articles, and records of the coordinators' actions. **Results**: The findings allow for an update and reflection on the importance of investing financial and human resources in the area. Between July 2015 and April 2025, 51,232 teleconsultations were conducted with specialists in various areas, in addition to web conferences and distance learning courses. Projects focused on technological innovation are also being developed. **Conclusion**: NUTEL/FM/UFUFMG has a broad scope of activity, conducting teleconsultations, web conferences, distance learning courses, and technological innovation projects, with the participation of experienced professionals, professors, and undergraduate and postgraduate students from UFMG. Digital Health specialists are crucial to overcome barriers, meeting challenges, and promoting advancements.

Key-words: Telehealth, Digital Health, Technological Innovation, Teleconsultation, Distance Education

Resumen

Centro de Telesalud de la Facultad de Medicina de la UFMG: Experiencias y Perspectivas

Introducción: La Salud Digital se está expandiendo a nivel mundial, fomentando la interacción entre profesionales y la creación de nuevas habilidades interdisciplinarias para mejorar la atención médica. El Centro de Telesalud de la Facultad de Medicina de la Universidad Federal de Minas Gerais (NUTEL FM/UFMG) fue creado en 2006. Posee un historial de experiencias exitosas, superando barreras geográficas y apoyando a los servicios de salud pública para superar desafíos y actuar de manera más decidida y organizada. **Objetivo**: Describir la experiencia y trayectoria de NUTEL/FM/UFMG, especialmente las relacionadas con los servicios públicos de telesalud y las innovaciones tecnológicas. **Método**: Informe de experiencia con un enfoque descriptivo y exploratorio basado en la trayectoria de NUTEL/FM/UFMG, contando con documentos, artículos y registros de acciones de los coordinadores. **Resultados**: Los hallazgos permiten una actualización y reflexión sobre la importancia de invertir recursos financieros y humanos en el área. Entre julio de 2015 y abril de 2025, se realizaron 51.232 teleconsultas con especialistas en diversas áreas, además de conferencias web y cursos a distancia. Cada vez se desarrollan más proyectos centrados en la innovación tecnológica. **Conclusión**: NUTEL/FM/UFMG cuenta con un amplio campo de acción, realizando teleconsultas, conferencias web, cursos a distancia y proyectos de innovación tecnológica, con la participación de profesionales, profesores y académicos con amplia experiencia de programas de grado y posgrado de la UFMG. La presencia de especialistas en Salud Digital es crucial para superar barreras, afrontar desafíos e impulsar el progreso.

Palabras clave: Telesalud, Salud Digital, Innovación Tecnológica, Teleconsulta, Educación a Distancia

Resumo

Núcleo Telessaúde da Faculdade Medicina da UFMG: Experiências e Perspectivas

Introdução: A Saúde Digital está em expansão em todo o mundo, propiciando a interação de profissionais e a criação de novas competências interdisciplinares para a melhor assistência à saúde. O Núcleo de Telessaúde da Faculdade de Medicina da *Universidade Federal de Minas Gerais* (NUTEL FM/UFMG) foi criado em 2006. Possui um registro histórico de experiências exitosas, transpondo barreiras geográficas e apoiando os serviços públicos de saúde a superar os desafios e atuar de forma mais resolutiva e organizada. **Objetivo:** Descrever a experiência e a trajetória do NUTEL/FM/UFMG, em especial os relacionados aos serviços públicos de telessaúde e em inovações tecnológicas. **Método:** Relato de experiência com abordagem descritiva e exploratória baseado na trajetória do NUTEL/FM/UFMG, baseado em documentos, artigos e registros das ações de coordenadores. **Resultados:** Os achados permitem uma atualização e reflexão sobre a importância de investimentos de recursos financeiros e humanos na área. Entre julho de 2015 e abril de 2025, foram realizadas 51.232 teleconsultorias com especialistas em diversas áreas, além de webconferências e cursos à distância. De forma crescente, também vêm sendo desenvolvidos projetos voltados à inovação tecnológica. **Conclusão:** O NUTEL/FM/UFMG tem uma atuação ampla, realizando teleconsultorias, webconferências, cursos EaD, projetos de inovação tecnológica, contando com a participação de profissionais experientes, professores e acadêmicos dos cursos de graduação e pós-graduação da UFMG. A presença de especialistas em Saúde Digital é crucial para superar barreiras, vencer os desafios e promover avanços.

Palabras-chave: Telessaúde, Saúde Digital, Inovação Tecnológica, Teleconsultoria, Educação a Distância

INTRODUCTION

Telehealth is a complement to in-person care and overcomes geographical barriers, demanding new professional, ethical, and data security skills, a context driven by technological advancements in the post-COVID-19 pandemic era[1]. Remote care not only expands access but also improves health outcomes[2]. Also, artificial intelligence enhances clinical practice, from diagnosis to therapeutic management and monitoring[3].

Brazil is a country of continental dimensions with socioeconomic and cultural contrasts, and differences in infrastructure and professional qualifications. The Family Health Program (PSF-Programa da Saúde da Família) has changed the distribution of services, and the Ministry of Health has been investing resources to reduce these disparities. The Brazilian Unified Health System (SUS-Sistema Único de Saúde) has prioritized primary health care (PHC), and since 2006, telehealth has been seen as a national strategic action to expedite responses and increase effectiveness, aiming for equity in healthcare[4].

In Belo Horizonte, the capital of the state of Minas Gerais, Brazil, the BH-Telehealth Program was initially created in 2004[5], connecting primary healthcare units with teaching units of the Universidade Federal de Minas Gerais (UFMG), with effective participation in the areas of medicine, nursing, dentistry, nutrition, and health management, constituting at the time the broadest and most consistent project in our country. It was considered a model for the implementation of the Project, and subsequently, the National Telehealth Program [6], which gave rise to the "Telehealth Brazil Networks" Program to support Primary Health Care (PHC), being a component of the Program for the Requalification of Basic Health Units (UBS) that aims to expand the problem-solving capacity of PHC and promote its integration with the entire Health Care Network[7]. This latter program underwent several changes, and currently the Secretariat of Information and Digital Health – SEIDIGI coordinates the digital transformation of the SUS (Brazilian Unified Health System) to expand access, promote comprehensiveness, and continuity of health care. It works in collaboration with the secretariats of the Ministry of Health, with

health professionals, and with SUS managers in the use of digital solutions, such as electronic medical records, telehealth, the dissemination of strategic health information, and data protection[8].

The Telehealth Center of the School of Medicine at the Universidade Federal de Minas Gerais (NUTEL FM/UFMG) uses tools in the process of qualifying healthcare professionals for continuing education of teams through tele-education, teleconsultations, and telediagnosis, contributing to the improvement of healthcare in health units and cooperating in the ongoing training of professionals linked to the Brazilian Unified Health System (SUS). NUTEL FM/UFMG actively participated in the implementation of the BH-Telehealth Program and subsequently in the stages of implementing telehealth in primary healthcare in Brazil. Also, it has produced scientific materials (journals, books, chapters, articles, and documentary records), educational materials, and technological innovation projects. This study aims to describe the trajectory, the actions developed, and the main results achieved by the Telehealth Center of the School of Medicine at UFMG between 2006 and 2025, encompassing healthcare, educational, technological innovation, and national and international cooperation activities.

METHODOLOGY

This is an experience report with a descriptive and exploratory approach, developed from the trajectory of the Telehealth Center of the School of Medicine at the Universidade Federal de Minas Gerais (NUTEL/FM/UFMG). The period considered ranges from 2006 to April 2025, encompassing everything from the implementation of the center to the most recent projects.
The information sources used to construct the narrative were based on three main sets:

1. Institutional documents – annual reports, work plans, internal regulations, technical materials, operational records, and documents used in the management of the core activities.

2. Administrative and healthcare databases – data consolidated in the SMART/Ministry of Health and NUTEL/FM/UFMG platforms, including teleconsultation production, tele-education records, and information from telediagnosis projects.

3. Reports from core staff – information provided by coordinators and specialists who directly participated in the organization and execution of the activities, selected for their strategic role over the years. Documents containing complete, institutionally validated information related to the activities developed by the core were included. Preliminary or unreviewed materials were excluded.

The data collection and organization process began with the search for documents gathered from institutional archives and the electronic platforms used by the center. Quantitative data were extracted from official reports and standardized by the system. The information was organized by year, type of activity (teleconsultation, tele-education, telediagnosis, technological innovation), and professional area. The professionals' reports were systematized in a narrative format, considering operational aspects, challenges faced, changes observed over time, and perspectives for expanding the activities.

The analysis followed two complementary stages: descriptive and narrative. The descriptive analysis of the quantitative data organized information into tables and relative frequencies, allowing to visualize the evolution of the actions and the participation of the municipalities. The thematic analysis of the documents and reports sought to identify historical milestones, advances, operational challenges, and innovations incorporated throughout the work of the center. The findings were integrated into a narrative synthesis, structured according to the main areas of activity of NUTEL/FM/UFMG.

The ethical aspects were respected. Because this study is based on aggregated administrative data and institutional documents, without nominal identification of professionals or users, it does not fall under the category of research involving human beings, according to CNS Resolution number 510/2016.

PRESENTATION OF THE EXPERIENCE AND DISCUSSION

Overview

Beheshti et al. (2022) stated that the use of telemedicine as a viable means of providing quality services is constantly increasing at various levels of the healthcare system[9]. Despite the growing use of telemedicine in secondary and tertiary healthcare services, there is still a long way to go in using this technology in public health and primary healthcare. On the other hand, the

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beginning of NUTEL/FM/UFMG's activities was marked by investment in public health, and especially in primary healthcare, having been one of the pioneering services in Brazil in this area. Initially, it covered the municipality of Belo Horizonte (BH-Telehealth Program), the capital of the state of Minas Gerais (MG), Brazil. The Brazilian National Telehealth Project began with the experience gained in the BH-Telehealth program, which changed over time, passing through "Telehealth Brazil Networks," and today its actions are coordinated by SEIDIGI.

NUTEL FM/UFMG has been actively involved, especially in the areas of telenursing, telemedicine, and teleodontology, by offering distance learning courses, web conferences on relevant topics, and formative teleconsultations as a form of continuing education and support for primary health care in the municipalities of the state of Minas Gerais. It has supported the structuring of telehealth in other Brazilian states, such as Piauí and Maranhão, and in Latin American countries. Its scope has been increasingly expanded to other areas of health, such as management, nutrition, and psychology. Students and preceptors of undergraduate health courses at UFMG receive support from specialists for decision-making during their rural internship, a mandatory curricular stage. In a survey conducted using data from SMART, a national platform that consolidates teleconsultation production, accounting for each interaction (within a single teleconsultation, there may be more than one question and/or answer), 48,119 interactions were recorded between 2016 and 2024. The survey also shows the number of active municipalities, that is, those that performed at least one teleconsultation each year. Currently, 140 municipalities in Minas Gerais are affiliated with NUTEL/FM/UFMG (Table 1).

Table 1 - Number of teleconsultations performed by NUTEL/FM/UFMG (combination of the BH, Contagem, Brumadinho and FM/UFMG centers) – 2016 to 2024

Year	Active Municipalities	Teleconsultations*
2016	77	2610
2017	105	4059
2018	102	6779
2019	106	6794
2020	70	3000
2021	107	3249
2022	91	2679
2023	85	7837
2024	90	11,112

Source: SMART/MS.

* Interactions within the same teleconsultation are recorded.

Table 2 shows the number of teleconsultations answered in various areas, conducted within the Primary Health Care/SUS system in Minas Gerais over the past ten years (July 2015 to March 2025), totaling 51,232. Unlike the consolidated SMART data presented above, these data reflect each teleconsultation performed, without counting interactions within the same teleconsultation.

Table 2 - Number of teleconsultations registered at NUTEL/FM/UFMG, across all specialties, between 2015 and 2025.

Year	Nº Teleconsultations
2015	1783
2016	5087
2017	4073
2018	5144
2019	5400
2020	2206
2021	2410
2022	2137
2023	6838
2024	10630
2025	5524
Total	**51232**

Source: Data extracted from the NUTEL/FM/UFMG Platform. Prepared by the authors.
Period: July 2015 to March 2025.

Of this total, 45,201 recorded information about the prior intention to refer the patient. In approximately 40% of these cases, the healthcare professional tried to send the patient before the teleconsultation took place (Table 3).

Table 3 - Record of prior intention to send in teleconsultations at NUTEL/FM/UFMG, in all specialties, between 2015 and 2025.

Intention to send the patient		
	N	**%**
Yes	18026	39.88%
No	27175	60.12%
Total	45201	100.00%

Source: Data extracted from the NUTEL FM UFMG Platform. Prepared by the authors.
Period: July 2015 to March 2025.

The NUTEL FM UFMG Platform includes an optional field where healthcare professionals can report their course of action taken after discussing a case during a teleconsultation. By analyzing a sample of 28,626 teleconsultations with this field accurately filled out, we were able to evaluate the impact of teleconsultation on reducing referrals (see Table 4). The results highlight the potential of teleconsultation to enhance the effectiveness of primary healthcare and optimize referral flows within the health system.

Table 4 - Record of clinical case management after teleconsultations at NUTEL/FM/UFMG, across all specialties, between 2015 and 2025.

Action		
	N	%
Keep in the unit.	20,864	72.73%
Forwarding secondary levels	7350	25.62%
Forwarding to tertiary levels	472	1.65%
Total	28,686	100.00%

Source: Data extracted from the NUTEL/FM/UFMG Platform. Prepared by the authors.
Period: July 2015 to March 2025.

The teleconsultations offered cover 108 specialties. The most requested were Dermatology (19%), followed by Cardiology (9.5%), Orthopedics and Traumatology (5.7%), Endocrinology and Metabolism (4%), Internal Medicine (4%), and Gynecology (3%). It is noteworthy that the responses provided constitute a formative second opinion, while simultaneously supporting clinical practice and contributing to the training of Primary Health Care professionals in the topics covered.

Teleodontology

The “Teleodontology” extension project of the School of Dentistry at UFMG has been operating in primary health care since 2005. It organizes, coordinates, and supports extension activities related to oral health in Minas Gerais. The project's main activities involve tele-education and teleconsultations, especially aimed at SUS health professionals, dentistry students, and other members of the service[10].
The web conferences are contextualized to promote continuous professional development and evidence-based practice. They consider the

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questions and needs identified by the public service professionals. These broadcasts are streamed live on the NUTEL/FM YouTube channel at UFMG and can be accessed later on both that channel and the project website: https://www.odonto.ufmg.br/teleodontologia/[11]. In 2023 and 2024, 18 web conferences were held in various areas, totaling 13,410 views.

The teleconsultations, conducted through the Minas Gerais (MG) Telehealth platform, cover 140 municipalities in Minas Gerais and serve professionals who request a second opinion. These requests are answered by professors from the School of Dentistry at UFMG across 13 specialties. In 2023, 216 teleconsultations were conducted, and in 2024, 178. During this period, the most requested specialties were Pathology (32.23%) and Surgery (18.27%). These responses have contributed to significantly reducing the need for referrals to specialized care and increasing the effectiveness of primary health care[12].

Since 2016, the project has had a website dedicated to Teleodontology, which provides information about its activities, including the schedule of web conferences and access instructions. The web conferences are stored in a video library organized by specialty, facilitating searching. The website also offers didactic and educational materials, access to the Virtual Health Library, produced in projects developed at the School of Dentistry of UFMG, as well as published articles in the field. In addition to the website, the project is promoted on Instagram, where it shares its activities and currently has 1,220 followers. This is an educational, interdisciplinary, political, and scientific project that promotes a transformative interaction between the university and society, contributing to the quality of care and the strengthening of digital health in the Brazilian public health system (SUS).

Telenursing

The School of Nursing at UFMG, through the “Telenursing Project,” is part of the NUTEL/FM/UFMG team, developing professional training activities in a distance learning format, involving faculty, students, and nursing staff from health units. From 2022 to 2024, 60 web conferences were held, with the most prominent thematic areas being women's health, nutrition, mental and psychiatric health, wound treatment, and health management. The web conferences reached 20,737 views, indicating that the use of technology is an important tool that can positively impact the quality-of-care practices in the SUS service network, contributing to research and the promotion of health education.

The professionals of the Family Health Program refer their requests to any specialty as needed, whether in the areas of nursing, medicine, dentistry, nutrition, and health services management. Specifically for nursing, between 2015 and 2025, a total of 2,612 teleconsultations were requested for the following specialties: nursing, health education, fundamentals of nursing, health management, health work processes, child and adolescent health, women's health, adult and elderly health, cardiovascular assessment, family health, mental health and psychiatry, systematization of nursing care, and wound treatment. Among the specialties requested for Telenursing, the most prominent were wound treatment (36%), women's health (19%), nursing (15%), child and adolescent health (9%), family health (6%), and health education (3%).

The data show a thematic convergence between teleconsultations and web conferences. Questions regarding wound treatment are more frequent in teleconsultations, and the topics discussed in web conferences focused on the field of nursing in general, covering various subjects, including issues related to wound treatment. The study demonstrates that professionals use telehealth resources to discuss the healthcare reality experienced in primary health care units, reaffirming the importance and benefits for professional development, improving patient care, reducing costs, and increasing the effectiveness of primary health care.

Telemedicine

The field of Telemedicine constitutes an important area of activity for NUTEL/FM/UFMG, with an emphasis on teleconsultations, and initiatives such as web conferences, support for rural internships, and continuing education activities for students, preceptors, and professionals in Primary Health Care. The project has a website that gathers information about the activities developed, a calendar of virtual meetings, and educational materials and access to the Virtual Health Library.

Telemedicine is also included in the schedule of web conferences, in conjunction with other areas. Relevant topics for Primary Health Care (PHC) are addressed, and the sessions are conducted by faculty, residents, or external guests. The sessions are broadcast live on YouTube, but

can also be accessed later through the YouTube library.

Regarding teleconsultations, the demands directed to the medical field are increasing and represent approximately 89.0% of the total, with 45,609 teleconsultations performed between July 2015 and April 2025. Cases are referred by Family Health Strategy teams, and responses, provided asynchronously, are given by specialist faculty members, covering up to 67 distinct subareas of different specialties in the case of Telemedicine (Table 5), within an ideal timeframe of up to 72 hours.

Table 5 - Number of teleconsultations in the medical area at NUTEL/FM/UFMG performed between 2015 and 2025

Specialty	Number of teleconsultations answered
Allergy and Immunology	6
Angiology	846
Anorexia and Bulimia	7
Cardiology	4860
Pediatric Cardiology	18
General Surgery	463
Gynecological Surgery	73
Pediatric Surgery	66
Vascular Surgery	213
Internal Medicine	2054
COVID-19 Epidemiology - Coronavirus	16
COVID-19 Infectious Diseases - Coronavirus	29
COVID-19 Medical Questions - Coronavirus	21
COVID-19 Mental Health - Coronavirus	3
COVID-19 Tests, Clinical Analyses, and Diagnostics	6
Dengue, Chikungunya, Zika, Microcephaly/Guidance	48
Dermatology	9809
Dermatology - Hansen's Disease	26
Endocrinology and Metabolism	2065
Pediatric Endocrinology	162
Gastroenterology	1604
Gastroenterology/Hepatology	557
Pediatric Gastroenterology	87
Geriatrics	368
Gynecology	1870
Gynecology/Human Reproduction	148
Gynecology and Obstetrics	1567
Gynecology and Obstetrics/Dengue, Chikungunya, Zika...	11
Hematology	1762
Hematology and Hemotherapy	17
Pediatric Hematology and Hemotherapy	113
Infectious Diseases	963
Infectious Diseases/Dengue, Chikungunya, Zika, Microcephaly	38
Pediatric Infectious Diseases	32
Mammography	8
Mastology	328
Family and Community Medicine	186
Adolescent Medicine	9
Fetal Medicine	3
Nuclear Medicine	4
Palliative Medicine	18

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Preventive and Social Medicine	13
Nephrology	830
Pediatric Nephrology	55
Neurofibromatosis	1
Neurology	2170
Neurology/Dengue, Chikungunya, Zika, Microcephaly	8
Pediatric Neurology	335
Pediatric Neurology/Dengue, Chikungunya, Zika	1
Ophthalmology	331
Oncology	106
Orthopedics and Traumatology	2934
Pediatric Otolaryngology	152
Otolaryngology	689
Pediatrics	1289
Pediatrics/Dengue, Chikungunya, Zika, Microcephaly	6
Pediatrics/Follow-up of Newborns with Microcephaly	9
Pulmonology/Tuberculosis	111
General Pulmonology	1014
Pediatric Pulmonology	86
Psychiatry	1121
Conventional Radiology and Computed Tomography	767
Magnetic Resonance Imaging - Musculoskeletal	1
Rheumatology	1695
Pediatric Rheumatology	1
Ultrasound - Internal Medicine	1
Urology	1399

Source: Data extracted from the NUTEL/FM/UFMG Platform. Prepared by the authors.
Period: July 2015 to March 2025.

Analyzing only the sample related to the medical field, the most requested specialties were dermatology and cardiology (Table 6).

Table 6 - Number of teleconsultations by most requested specialties in the field of medicine at UFMG (2015-2025)

Specialty	Number of teleconsultations N / (%)
Dermatology	9809 (26.4%)
Cardiology	4860 (13%)
Orthopedics and traumatology	2934 (7.9%)
Neurology	2170 (5.8%)
Endocrinology and metabolism	2065 (5.6%)
Internal medicine	2054 (5.5%)
Gynecology	1870 (5%)
Hematology	1762 (4.7%)
Rheumatology	1695 (4.6%)

Source: Data extracted from the NUTEL/FM/UFMG Platform. Prepared by the authors. Period: July 2015 to March 2025.

SES/MG Project

The project “Incorporation of Teleconsultations into the Healthcare Flow of Specialized Care within the SUS in Minas Gerais” was launched in 2024. It is coordinated by the State Secretariat of Health (SES) of Minas Gerais and implemented by NUTEL/FM/UFMG, the Telehealth Center of the University Hospital of UFMG, and the Lucas Machado Educational Foundation (FELUMA-Fundação Educacional Lucas Machado), seeking to overcome the challenges of poor distribution and insufficiency of specialists, promote better interaction between primary and secondary healthcare professionals, and optimize referrals to secondary care. It covers 465 municipalities and has the potential to benefit 18.61 million inhabitants. Initially, distance learning training was provided for primary care professionals, followed by the implementation of teleconsultations, the development of a specialized

care flow, and the monitoring of the actions developed. The main focus is maternal and child health, but teleconsultations in various specialties are offered: cardiology, endocrinology, nephrology, gynecology and obstetrics, mastology, orthopedics, pulmonology, dermatology, pediatrics, urology, proctology, rheumatology, and gastroenterology.

The goals were developed by each participating municipality. The initial results in 2024 showed the participation of 174 municipalities with the completion of 5,970 teleconsultations. The referral rate to secondary care was 23.6%. The satisfaction of primary care professionals with the results obtained was 94%.

NUTEL/FM/UFMG is responsible for 77 municipalities in 3 macro-regions of the State. (Do we have teleconsultation data from our center?)

Expansion of Telehealth in Latin America

The center plays a key role in expanding regional telehealth through the Latin American Telehealth Laboratory (2006), a collaborative network that has integrated specialists from 14 countries for almost 20 years. Its contributions include professional training, dissemination of best practices, and reference publications, such as “Development of Telehealth in Latin America: Conceptual Aspects and Current Status” (2014) and the forthcoming work “Telehealth in Latin America: A Legacy in Motion”. Since 2024, the group has been conducting the research “Quality of Telehealth Services in Latin America,” based on the ISO 13131:2021 standard. The study evaluates the knowledge and implementation of international quality standards focused on service planning, risk management, and technology in the region.

Scientific Journal

Created in 2009 by UFMG, with the support of the National Center for Technological Excellence of Mexico, the Revista Latino-Americana de Telessaúde is a quarterly open-access publication focused on digital health, AI, and distance education. The journal accepts articles in Portuguese, Spanish, and English, and has adopted the Ahead of Print model since 2023 for faster dissemination. Affiliated with ABEC, it has ISSN 2175-2990 and uses the abbreviation Latin Am J Telehealth for citations.

Teleophthalmology in Minas Gerais (MG)

The implementation of teleophthalmology in primary healthcare in Minas Gerais aims to strengthen care for diabetes and hypertension, the main causes of preventable blindness[13,14]. In accordance with Law 13.895/2019[15], the strategy seeks to overcome the scarcity of specialized services in the Brazilian public health system (SUS)[16]. The project, a partnership between NUTEL FM/UFMG and municipalities, uses portable retinography and, since December 2023, Artificial Intelligence for screening, with medical reports issued within 72 hours.

Between March 2023 and September 2024, 2,158 examinations were analyzed, prioritizing patients with diabetes (72%) and hypertension (82.5%). The predominant profile was female (67.7%), between 60 and 69 years old. Of the total, 45.1% (973) presented normal results, eliminating the need for referral, while 39.1% (843) had alterations, with a prevalence of hypertensive retinopathy (44.8%) and diabetic retinopathy (27.5%).

In 2025, the initiative was expanded through the UFMG Rural Internship program, integrating teaching and service. The results confirm the effectiveness of telehealth and AI in reducing waiting lists, improving screening quality, and optimizing referral flows in the SUS/MG.

Telehealth during the COVID-19 pandemic

During the COVID-19 pandemic, NUTEL/FM/UFMG strengthened its support for Primary Health Care (PHC) by expanding the offer of teleconsultations, training, and information channels[17,18,19]. The impact of this integration was analyzed in a cross-sectional study[20] with 260 PHC teams in 2020. Although the telehealth infrastructure was mostly rated as poor (43%) and fair (40%), a significant positive correlation was evidenced ($p < 0.001$): the greater the availability of telehealth resources, the better the unit's structure for facing the pandemic, proving its contribution to a more robust healthcare response.

Teleconsultations and Synchronous Teleconsulting

A pilot project for synchronous teleconsultations and teleconsulting is in the initial stages of implementation. A platform is under construction to enable the provision of these services. Within the scope of teleconsulting, the service will allow healthcare professionals in the Minas Gerais SUS (Brazilian Unified Health System) network to discuss clinical cases with specialists in real time through scheduled appointments. Regarding teleconsultations, the project aims to enable SUS Minas Gerais users who have been referred for a specialist

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consultation to schedule and receive the consultation remotely. The specialties initially offered in both services will be endocrinology, pulmonology, and gastroenterology, with the possibility of incorporating new specialties based on demand assessment.

Telepharmacy for Selexipag titration in patients with pulmonary arterial hypertension

Developed by SECTICS in partnership with SEIDIGI, UFMG, UFG, Conass, and state health departments (ES and PR), the telepharmacy pilot project focused on the management of patients with pulmonary arterial hypertension (PAH) using selexipag. The initiative involved rigorous monitoring of dose titration in 16 patients through weekly telepharmacy consultations and specialized medical consultations. The experience validated telehealth as an effective tool to ensure pharmacotherapeutic safety and comprehensive care in serious diseases, establishing a scalable model for other complex clinical conditions within the Brazilian public health system (SUS).

Technological Innovation

Technological innovation is fundamental for the country's development, and universities, especially public ones, play a crucial role in fostering interaction among professionals to create solutions and products that ensure the best possible healthcare for the population. Strengthening primary healthcare is crucial for improving the quality of life of the population and promoting equity in healthcare access. However, challenges such as organizing access to health units and the early identification of individuals at risk compromise the effectiveness of this level of care.

AI in Primary Healthcare

The NUTEL FM/UFMG has been working on several technological innovation projects, including a project applying AI models for access management and risk prediction in primary healthcare in the municipality of Belo Horizonte. The project aims to develop and implement AI-based solutions to optimize access management and predict the risk of serious outcomes in primary healthcare. The idea is to adopt a longitudinal, quantitative study design structured in four stages: (1) development and application of AI models for risk prediction in adult individuals;

(2) construction of an AI system for access management;

(3) integrated implementation of the systems in a health unit; and

(4) performance and impact evaluation of the applied solutions. A database of consultations conducted between 2014 and 2023 will be used, in addition to primary data collected from the implementation of the models. Among the techniques planned in this research are decision trees, random forests, Support Vector Machines (SVM), and deep neural networks. The methodological analysis will include exploratory data analysis, pre-processing, cross-validation of the models, and evaluation using metrics such as accuracy, sensitivity, specificity, AUC-ROC, and F1-score. Additionally, comparative statistical analyses will be conducted to evaluate the impact of AI on waiting time and service rate. It is expected that the implementation of AI solutions will result in the improvement and expansion of access to primary healthcare by optimizing patient flow, reducing waiting times, and allowing for the prioritization of higher-risk cases. Accurate prediction of serious outcomes can support timely preventive interventions, which will contribute to increasing the efficiency, equity, and quality of the services offered. This study therefore reinforces the strategic role of primary healthcare in the Brazilian health system and establishes a basis for technological innovation and scalability of AI solutions in primary care.

Digital Otoscopy

This project aims to incorporate telehealth resources for the assessment of children's hearing health within the context of Primary Health Care (PHC), in conjunction with the SUS (Brazilian Unified Health System) health care network in Minas Gerais. The project aims to implement clinical teleconsultation services in PHC, especially in the field of otolaryngology, focusing on the hearing needs of children treated within the SUS. Furthermore, it seeks to provide training for Family Health Team physicians in this area.

The plan is to adopt the use of a Virtual Otoscope, which will allow for examinations with the possibility of issuing reports remotely, and to conduct training activities for professionals through training courses and web conferences. These activities will qualify family health team physicians to perform clinical auditory examinations, otoscopy, and ear cleaning and cerumen removal.

Telehealth will then act more effectively as an important tool to avoid waiting lists for a medical specialty (otorhinolaryngology) and at the same time to contribute to tele-education.

Telemonitoring of Neonatal Intensive Care Units

From December 2012 to September 2014, NUTEL FM/UFMG developed a successful Telemonitoring project for Neonatal Intensive Care Units for the Minas Gerais State Health Secretariat (SES/MG) (21), creating a central hub with nurses and neonatologists available seven days a week, from 7 am to 7 pm, connected to 33 municipalities in Minas Gerais. Twelve web conferences were held, approximately 6,700 teleconsultations were conducted, and care flowcharts and an ebook on relevant topics in the field were developed. The project included virtual bed allocation and teleconsultations with specialists, as well as interaction with the state's bed regulation center. The project was discontinued due to a lack of resources, but at the time, the development of a national project to support neonatal care was considered.

LLMs

An emerging area of machine learning technology called large language models (LLMs) is considered a technological disruptor of this decade, similar to ChatGPT. They will be integrated into search engines (Bing and Google) and Microsoft products in the coming months. Therefore, they will fundamentally change how patients and doctors' access and receive information. Digital health literacy needs to remain a priority, both for doctors and consumers, as interactions with LLMs become part of the routine.

Asynchronous telehealth services involving digital communication, such as remote monitoring, store-and-forward systems, or electronic consultations, have the greatest potential for expansion using LLMs. Physicians who use these models to enhance clinical practice need to understand their generative nature and verify all information obtained to ensure its clinical accuracy[22].

NUTEL's perspective is to incorporate into teleconsultations a search system also based on LLMs.

Educational Technology Transfer

Our center has been developing digital health literacy for healthcare professionals and related fields of information and communication technology. Undergraduate students have been trained in the use of telehealth tools before their internships in rural areas of the state (UFMG rural internship) and in postgraduate studies through the telehealth discipline and in various areas of postgraduate studies at UFMG. We act as partners in the Professional Postgraduate Program in Digital Health, Distance Learning Network, which is coordinated by the Oswaldo Cruz Foundation (FIOCRUZ) in Brasília and the UNA-SUS/FIOCRUZ Network.

Our center has experience in training professionals from various Brazilian states and Latin America. In Latin America, it acts as a point of convergence between countries to seek solutions to problems and alternatives.

Future Perspectives

Based on the experience of our core team, the perspective is to expand the services offered and implement technological innovation projects, strengthening the implementation of digital health in order to provide equitable access to healthcare services for the population.

Projects in retinography, digital otoscopy, the use of LLMs, telemedicine consultations, and synchronous teleconsulting are in their initial stages with a promising future. Another area that has been widely addressed is tele-education, both for training human resources in the use of digital health and for improving healthcare quality.

The telemonitoring project for neonatal intensive care units has achieved excellent results and is being discussed at the state and national levels.

CONCLUSION

The trajectory of the Telehealth Center of the Faculty of Medicine at UFMG demonstrates how digital health can be consolidated as a structuring tool for the Brazilian Unified Health System (SUS).

Over the years, the center has expanded its areas of activity, incorporated different technologies, and integrated teaching, research, and assistance, always in dialogue with the needs of health services. This combination of actions has contributed to strengthening the problem-solving capacity of Primary Care, supporting professionals in their daily care, and bringing users closer to specialized services. The results presented show that telehealth, when organized in a planned manner and integrated into care networks, produces concrete effects: it reduces unnecessary referrals, improves clinical decision-making, and expands access to specialized examinations and guidance. Furthermore, the continuing education

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initiatives and technological innovation projects show that NUTEL/FM/UFMG has assumed an important formative role, capable of preparing professionals for a scenario of digital transformation that is no longer the future, but a daily reality.

Even with significant advancements, challenges persist that cannot be ignored, such as the need for continued investment, ongoing training of teams, system updates, and the expansion of information security strategies. The rapid evolution of artificial intelligence also imposes new demands, requiring services to incorporate these tools in an ethical, secure, and qualified manner.

Given this trajectory, it is evident that strengthening digital health in Brazil depends on the maintenance and expansion of initiatives like those of NUTEL/FM/UFMG. The center combines accumulated experience, innovation capacity, and institutional articulation, placing it in a strategic position to support public policies and develop solutions that address regional inequalities. Thus, its actions point to a future in which telehealth will continue to contribute to greater equity, access, and quality of healthcare.

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