

Digital health in Primary Health Care in Brazil: Experiences developed within the Unified Health System from 2018 to 2022

Saúde digital na Atenção Primária à Saúde no Brasil: experiências desenvolvidas no Sistema Único de Saúde entre 2018 e 2022

Gustavo Soibelman¹, Marcelo Fornazin¹, Mariana Vercesi Albuquerque¹

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ABSTRACT Digital health has advanced worldwide since the COVID-19 pandemic. Brazil has developed valuable digital health experiences over the past decade. However, comprehensive studies on the use of digital health in Primary Health Care (PHC) in the country remain limited. This study aims to map digital health experiences in PHC within the Unified Health System (SUS) from 2018 to 2022. This exploratory study was based on a bibliometric and spatial-temporal analysis of publicly available municipal experiences in the 'Virtual Catalog – Brazil, here there is SUS' of the National Council of Municipal Health Secretariats. The analytical categories were defined through a literature review. SUS is undergoing a diverse, accelerated, and complex digital transformation process, with substantial potential for new applications in PHC. There was a significant increase (668%) in reports of digital health experiences related to PHC between 2018 and 2021, with notable representation in the Northeast (85), South (69), and Southeast (68) regions. The most discussed terms included specific types of technologies, primarily related to telehealth. Significant digital transformations in SUS are expected to occur through PHC, necessitating policies to ensure their implementation strengthens and upholds SUS principles.

KEYWORDS Digital health. Primary Health Care. Unified Health System. Spatio-temporal analysis. Bibliometrics.

RESUMO A saúde digital avançou mundialmente desde a pandemia da covid-19. O Brasil possui experiências importantes em saúde digital ao longo da última década. Ainda são poucos os estudos abrangentes sobre o uso da saúde digital na Atenção Primária à Saúde (APS) no País. O objetivo deste estudo foi mapear as experiências em saúde digital na APS no Sistema Único de Saúde (SUS) entre 2018 e 2022. O estudo exploratório foi baseado em análise bibliométrica e espaçotemporal das experiências municipais disponíveis publicamente no 'Catálogo Virtual – Brasil, aqui tem SUS' do Conselho Nacional de Secretarias Municipais de Saúde. As categorias de análise foram definidas mediante a revisão da literatura. Há um processo diverso, acelerado e complexo de transformação digital do SUS, com grande potencial de novos usos a partir da APS. Houve aumento significativo (668%) de relatos de experiências de saúde digital em interface com a APS entre 2018 e 2021, destacando-se as regiões Nordeste (85), Sul (69) e Sudeste (68). Os termos mais abordados foram tipos específicos de tecnologias relacionados com a telessaúde. Importantes transformações digitais no SUS ocorrerão a partir da APS, sendo necessário políticas para garantir seus usos no sentido de fortalecer e alcançar os princípios do SUS.

PALAVRAS-CHAVE Saúde digital. Atenção Primária à Saúde. Sistema Único de Saúde. Análise espaço-temporal. Bibliometria.

¹Fundação Oswaldo Cruz (Fiocruz), Escola Nacional de Saúde Pública Sergio Arouca (Ensp) – Rio de Janeiro (RJ), Brasil.
gustavo.soibelman@gmail.com



Introduction

Digital health has been proposed by governments¹ and international organizations² as a way to overcome the challenges faced by health systems. In the case of the Unified Health System (SUS), some of these challenges are: underfunding, compared to similar health systems³; precariousness and dismantling related to necropolitics and neoliberalism⁴; regional inequalities in coverage, access, and availability of services and technologies⁵, also represented by the lack of care for general practitioners and specialists in certain regions of the country⁶.

Digital health can be defined as:

[...] the systematic application of Information and Communication Technologies, Computer and Data Sciences to support informed decision-making [...] with the aim of strengthening resilience against disease and improving health and well-being⁷⁽⁸⁾.

It is materialized through digital health interventions, which are specific functionalities or resources developed to solve challenges in the health system⁷. What has become known as digital health encompasses various technologies and potential uses in healthcare, financing, planning, management, and surveillance. It includes, for example, direct care for individuals through telehealth and telecare; digital platforms for interaction between professionals; information systems and electronic medical records. In addition, new applications are emerging, such as those based on Artificial Intelligence (AI) and the Internet of Things (IoT). Due to these innovations and the challenges and solutions caused by the COVID-19 pandemic – which drove a paradigm shift –, the world has experienced, in recent years, a significant change in the use and development of these tools in healthcare^{5,8}.

The benefits promised by the adoption of digital technologies are numerous. Among them, expanded access to healthcare services

and potential improvements in the quality of care and resolution are highlighted. An increase in the system's cost-effectiveness is also expected. Another potential benefit is the improvement in the quality of collected data, which can be used in public policy formulation and decision-making. Furthermore, these technologies tend to contribute to improvements in the management of Healthcare Networks (RAS) and healthcare regulation, as well as in the optimization of healthcare professionals' work processes^{1,9}.

Within the Unified Health System (SUS), there is great expectation regarding the potential of digital health to overcome historical limitations and bottlenecks, as well as the potential for progress in addressing current challenges, including those related to Primary Health Care (PHC). PHC is essential to enabling the principles of the SUS, but it faces widely recognized challenges to its implementation, such as: access barriers, lack of resolution/professional qualifications, care coordination issues and delays in referrals to other levels of care, incomplete teams, overload of users per team, difficulties in staffing/retention, and setbacks in the financing and care model^{4,10-14}.

It is important to emphasize, however, that the incorporation of digital technologies into the SUS, including PHC, must be critically considered given the context of structural socio-spatial inequalities that characterize Brazil⁵. Otherwise, digital health may also pose risks of further exacerbating health inequities if they act as access barriers for vulnerable populations and regions¹⁵. In this sense, the Lancet¹⁶ highlights that digital technologies can be considered a new dimension of health inequities, and their development and implementation in services and systems are essential from the perspective of equity, as well as other principles of the SUS.

It is essential to analyze the phenomenon of digital health from different perspectives, such as the uses and meanings of technology application in relation to the challenges of the

SUS (Unified Health System) and how this aligns with its principles and guidelines. To do so, it is first necessary to understand which technologies have been applied over time in different Brazilian regions and which terms are used to address them in studies, considering that digital health is an emerging field that does not yet include sufficient standardized descriptors.

According to Penteado et al.¹⁷, there has been an increase in publications on digital health and medical informatics, driven by emerging technologies such as big data, AI, and mobile devices. There are still few studies on digital health in PHC, although publications involving care, education, and management have increased during the pandemic¹⁸. Most digital health experiences in PHC appear in gray literature databases, that is, those that are not indexed¹⁹. For example, the National Council of Municipal Health Departments (CONASEMS)'s repository— 'Virtual Catalog – Brazil, here there is SUS'—stands out, compiling hundreds of successful initiatives from Brazilian municipalities. This initiative highlights the importance of mapping and valuing innovative practices, contributing to addressing SUS challenges and strengthening PHC strategies.

Therefore, this work aimed to map municipal digital health experiences in interface with PHC in the SUS, from 2018 to 2022, with the intention of valuing knowledge based on local experiences and cooperation actions between professionals, users and managers, to overcome the main challenges faced in the daily life of services, involving the application of digital technologies and PHC²⁰.

Material and methods

This is an exploratory, analytical-descriptive study focusing on the temporal and spatial bibliometric analysis of successful SUS experiences published in the 'Virtual Catalog – Brazil, here there is SUS', which relate to

digital health in conjunction with PHC. The Catalogue is publicly accessible, unrestricted, and is available on the CONASEMS website²¹.

CONASEMS represents all municipal health departments in Brazil and was officially established in 1988 as a result of the social movement in defense of health. Established as a political force within the Unified Health System (SUS), it works to strengthen municipal management, supporting the formulation of strategies and the sharing of information among local entities, based on technical cooperation and the principles of decentralization and municipalization. Its work is especially significant in the field of PHC, the main gateway to the Unified Health System (SUS), whose management is the responsibility of municipalities²².

The 'Virtual Catalog – Brazil, here there is SUS'²¹ is a repository of successful experiences presented at the 'Brazil Exhibition, here there is SUS' held during CONASEMS congresses. The platform brings together initiatives developed by SUS professionals, managers, and users at the municipal level, covering different areas of public health and all regions of the country. Since 2018 (except 2020), it has regularly mapped municipal initiatives for the purpose of recording, valuing, and disseminating them. It thus constitutes one of the most comprehensive repositories of successful health experiences from various regions of Brazil, and is extremely relevant for PHC.

For the purposes of this study, the period 2018 to 2022 was defined as comprehensive to capture the digital health initiatives carried out in the municipalities, considering the material available in the CONASEMS Catalog. At the time of collection (October 2024), the data from 2023 and 2024 were in the process of being cataloged in the repository, making it impossible to use them in the study. The proposed time frame also encompasses two important moments. First, the emergence of digital health as a central theme for public policies and for the work of the World Health Organization (WHO)

(publication of the digital health toolkit), encouraging the adoption of digital health strategies by various countries²³. Brazil, for example, launched its Digital Health Strategy for 2020–2028¹. According to the time frame, it includes the first two years of the COVID-19 pandemic, which were the most critical and ultimately drove the adoption of Information and Communication Technologies (ICT) in healthcare and digital health actions and strategies worldwide⁸.

In this way, the catalog presents itself as a good approximation to the national reality and diversity of experiences while also encompassing the growing interest in digital health as a field of research and public policy.

The research was conducted in four stages. The first analyzed the structure of the Catalog and of the experience reports contained within. Based on this information, a script was created to collect data from the platform through automated web scraping using the Python programming language (version 3.12.4) and the BeautifulSoup⁴ (version 4.12.3) and Pandas (version 2.2.2) libraries. Web scraping is the automated process of systematically extracting and combining content from web pages, simulating human navigation²⁴. This process has been applied in scientific studies that utilize secondary data^{25–27}.

The collected data were processed and organized in Excel[®] spreadsheets in JSON and CSV formats. The information extracted included fields relating to the experience reports (title, introduction, objectives, methodology, results, conclusions, keywords), authorship, municipality, Federative Unit of the experience, year and electronic address (link) of the experience report.

In the second stage, the works were selected using two processes: 1) filtering of experiences that contained at least one search term related to digital technologies in health; 2) applying inclusion and exclusion criteria. The search terms chosen to be used as filters were based on an initial search of the Virtual Health Library (VHL) and Scientific Electronic

Library Online (SciELO) databases. The literature review allowed us to identify the types of digital technologies and their uses to define the study's analysis categories. In addition to the terms found in this review, concepts present in Cetic.br and TIC Saúde²⁸ research were used, as they are references in the field of digital health, and other common-sense terms listed by the researchers—such as the names of programs/applications most commonly used in the daily lives of healthcare professionals. The list of search terms used is explained in the results of this research (*box 1*).

Inclusion and exclusion criteria were defined and applied to select the experiences. The inclusion criteria consisted of: 1) addressing the use of digital technologies in healthcare; 2) related to PHC and the SUS; and 3) full text available on the CONASEMS website. The exclusion criteria for the experiences included: 1) not involving the use of digital technologies in health; 2) no interface or explicit mention of PHC; 3) exclusively related to managerial or technical aspects, with no connection to health care services; 4) restricted to other levels of care within the RAS, or linked exclusively to universities, private institutions, or non-governmental organizations, with no direct interaction with PHC; and 5) addressing health technologies other than digital ones, such as medical devices and medications.

All 1,813 experiences available in the CONASEMS Virtual Catalog were collected, regardless of whether they were related to digital health or not, with 346 from 2018, 500 from 2019, 630 from 2021 and 337 from 2022. Of the total experiences, 814 (45%) had the occurrence of at least one of the search terms used in the code to filter data on digital health in PHC. After applying the inclusion and exclusion criteria, 271 experience reports were selected, corresponding to 15% of the total experiences in the Catalog.

In the third stage of the research, data categorization and analysis were performed. Initially, the occurrences of each search term in the experience reports were identified.

From this, the unique frequency of the terms in each work was counted, grouping them into themes and performing descriptive analysis using tables and graphs. Sequentially, the studies were classified by geographic region, using the criteria of the Brazilian Institute of Geography and Statistics (IBGE), by cross-referencing information on the municipality and state of the reports with data from the Application Programming Interface (API) of IBGE locations. Spatial analysis was performed using maps generated in Python, using the Geopandas (version 1.0.1) and Matplotlib (version 3.9.2) libraries, and tables—also available in the study results.

All collected and generated data, as well as the search terms and scripts used, are available in a GitHub repository²⁹, in compliance with open science. Considering that the study used only public secondary data, no submission was made for consideration by the Research Ethics Committee, as provided for in Resolution No. 510/2016³⁰.

It is worth noting that one of the secondary objectives of this study was to develop and test an automated data scraping methodology in the field of public health, using web scraping techniques, as well as the application of automated filters by key terms, as described above.

Results and discussion

As mentioned, 271 digital health experience reports were selected from the CONASEMS Virtual Catalog. In 2018, 25 reports were selected (7.2% of all CONASEMS experiences); in 2019, 32 (6.4%); in 2021, 167 (26.5%); and in 2022, 47 (13.9%) were selected. Thus, there was a significant 668% increase in experiences addressing digital health and PHC, jumping from 25 reports in 2018 to 167 in 2021. This finding corroborates several studies that point to a shift in the growth of digital health since the COVID-19 pandemic, demonstrating that PHC has also been affected by this phenomenon.

There has been an increase in the number of publications related to digital health experiences in PHC across all Brazilian regions over time (*figure 1*). The highest concentration (average number of publications per state) occurred in the states of the South and Southeast regions in 2021 and 2022, accounting for more than half of the reported experiences. However, the largest absolute number of publications, combined across all years, came from the Northeast region (85), followed by the South (69) and Southeast (68). A digital health expansion axis in PHC in Brazil has emerged, encompassing these three regions—South, Southeast, and Northeast—over the years. Among the states in the North region, Pará stands out in first place and Amazonas in second, leading the region's digital health experiences in PHC (*figure 1*).

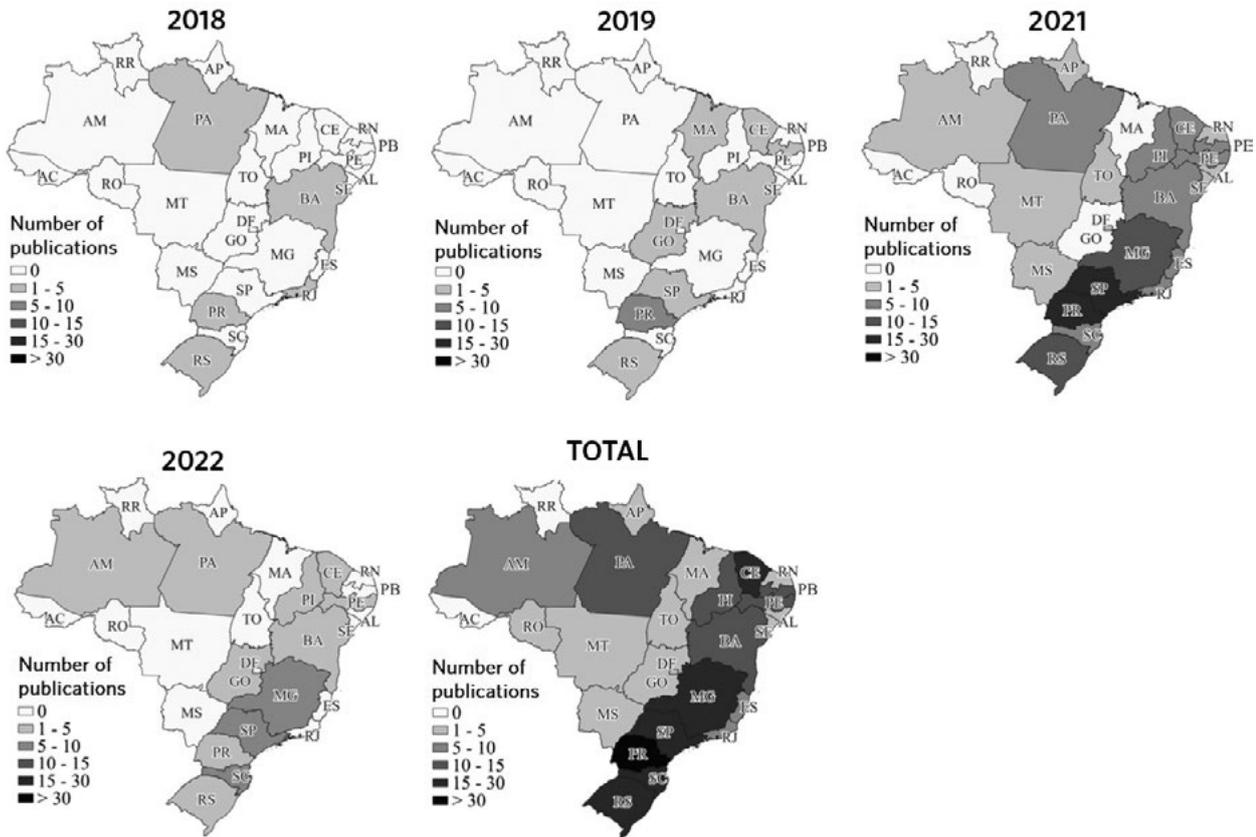
Since 2019, the Northeast region has had the highest percentage of reported experiences per year, ranging from 29.8% to 37.5% of the total experiences in Brazil during the analyzed period (*table 1*). The states in this region have become a reference in Brazil, presenting important experiences in digital health, including for PHC³¹⁻³⁵, albeit with significant limitations in use and access^{36,37}. The percentage of reported experiences from the North region in the total Brazilian experiences surpassed that of the Central-West region from 2021 onward, maintaining a level of around 11.8%. The significant growth in experiences is accompanied by inequalities in their distribution among Brazilian states and regions during the analyzed period. The average number of publications per state in the South region (23 per state) is significantly higher than in the Northeast (9.4 per state), North (4.6 per state), and Central-West (4.3 per state) (*table 1*).

The concentration of digital health experiences in PHC, especially in the South and Southeast regions, can be understood in light of Milton Santos's concept of Concentrated Region³⁸. According to the author, the technical-scientific-informational environment

tends to become denser in certain parts of the territory, deepening the selective use of space and widening regional inequalities. This helps explain why, despite significant absolute numbers in other regions, such as the Northeast, the distribution of experiences

is still marked by significant asymmetries. The diffusion of digital health innovations continues to be conditioned by available infrastructure, the concentration of resources and qualified professionals, and the capacity for insertion into higher information circuits.

Figure 1. Distribution by State of digital health experiences in PHC/SUS, according to the CONASEMS Catalog - Brazil, 2018-2022



Source: Prepared by the author based on the 'Virtual Catalog - Brazil, here there is SUS' from CONASEMS²¹.

Table 1. Studies related to digital health in conjunction with PHC in the CONASEMS Virtual Experience Catalog by Region, State, and Year (2018-2022)

Region	2018		2019		2021		2022		Total		Average by State	Number of states by region
	n	%	n	%	n	%	n	%	n	%		
Center-west	0	0.0%	4	12.5%	10	6.0%	3	6.4%	17	6.3%	4.3	4
Northeast	7	28.0%	12	37.5%	52	31.1%	14	29.8%	85	31.4%	9.4	9
North	5	20.0%	3	9.4%	18	10.8%	6	12.8%	32	11.8%	4.6	7
Southeast	5	20.0%	3	9.4%	46	27.5%	14	29.8%	68	25.1%	17	4
South	8	32.0%	10	31.3%	41	24.6%	10	21.3%	69	25.5%	23	3
Brazil	25	100.0%	32	100.0%	167	100.0%	47	100.0%	271	100.0%	10	27

Source: Prepared by the author based on an analysis of the CONASEMS Catalog, 2024²¹.

Regarding the themes and terms used in the experience reports selected from the CONASEMS Catalog, 65 distinct search terms were found. It is worth noting that some of these were similar terms, such as ‘technology’ and ‘technologies’, or spelling variations of the same concept, such as ‘telehealth’ and

‘tele-health’. The main categories for analyzing digital health experiences in PHC were identified according to ten themes correlated with terms related to digital technology use (box 1) and analyzed according to frequency over time (figures 2 and 3).

Box 1. Occurrence of themes and terms related to digital health in interface with PHC in the CONASEMS Virtual Catalog of Experiences from 2018 to 2022

Theme	Terms 2018	Terms 2019	Terms 2021	Terms 2022	Total Terms
Specific types of digital technology	Plataforma (4), planilha (3), aplicativo (2), software (2), web (2), site (1)	Aplicativo (10), planilha (5), plataforma (4), web (4), software (3), site (1)	Aplicativo (55), plataforma (40), planilha (31), site (15), vídeo (11), web (6), software (3), vídeos (3)	Planilha (11), aplicativo (10), plataforma (8), site (7), web (5), software (4)	Aplicativo (77), plataforma (56), planilha (50), site (24), web (17), software (12), vídeo (11), vídeos (3)
Telehealth	Telemedicina (2), teleassistência (1), teleconsultoria (1), telessaúde (1)	Teleconsultoria (4), telessaúde (4), telediagnóstico (2), telemedicina (2), telefônica (1)	Teleatendimento (42), telemonitoramento (31), telefônica (29), teleconsulta (17), telemedicina (17), teleorientação (9), telessaúde (4), teletriagem (2), teleassistência (1), teleconsultoria (1)	Teleatendimento (2), teleconsultoria (2), telefônica (2), telemedicina (2), telemonitoramento (2), tele-saúde (1), teleconsulta (1)	Teleatendimento (44), telemonitoramento (33), telefônica (32), telemedicina (23), teleconsulta (18), teleorientação (9), telessaúde (9), teleconsultoria (8), teleassistência (2), telediagnóstico (2), teletriagem (2), tele-saúde (1)

Box 1. Occurrence of themes and terms related to digital health in interface with PHC in the CONASEMS Virtual Catalog of Experiences from 2018 to 2022

Theme	Terms 2018	Terms 2019	Terms 2021	Terms 2022	Total Terms
Social media	Facebook (1), mídia social (1), mídias sociais (1), rede social (1), redes sociais (1)	Redes sociais (4), Whats (2), rede social (1)	Whats (54), redes sociais (39), rede social (13), Facebook (11), mídias sociais (10), Instagram (9), mídia social (2), Watts (1)	Whats (9), redes sociais (7), Facebook (1), Instagram (1), mídias sociais (1), rede social (1)	Whats (65), redes sociais (51), rede social (16), Facebook (13), mídias sociais (12), Instagram (10), mídia social (3), Watts (1)
Unspecified technology	Tecnologia (2), tecnologias (1)	Tecnologia (13), tecnologias (3), e-saúde (1)	Tecnologia (47), tecnologias (25), e-saúde (1)	Tecnologia (18), tecnologias (7), e-saúde (2), transformação digital (1)	Tecnologia (80), tecnologias (36), e-saúde (4), transformação digital (1)
Health information systems	Prontuário eletrônico (5), E-SUS (4), sistema de informação (3), sistema de informações (3), PEC (1), esus (1), sistemas de informações (1)	Prontuário eletrônico (6), PEC (4), sistema de informação (4), E-SUS (2), esus (2), sistema de informações (2)	Prontuário eletrônico (15), E-SUS (10), sistema de informação (7), sistemas de informação (4), sistemas de informações (1)	Prontuário eletrônico (12), E-SUS (9), sistema de informação (6), sistemas de informação (6), PEC (4), esus (2), PEC-SUS (1), sistemas de informações (1)	Prontuário eletrônico (38), E-SUS (25), sistema de informação (20), sistemas de informação (10), PEC (9), esus (5), sistema de informações (5), sistemas de informações (3), PEC-SUS (1)
Device types	Telefone (4), celular (2), celulares (2), <i>smartphone</i> (1), <i>smartphones</i> (1)	Celular (4), <i>smartphone</i> (2), celulares (1), <i>mobile</i> (1), telefone (1)	Telefone (51), celular (22), celulares (8), <i>smartphone</i> (2), <i>smartphones</i> (1)	telefone (5)	Telefone (61), celular (28), celulares (11), <i>smartphone</i> (5), <i>smartphones</i> (2), <i>mobile</i> (1)
Connectivity	Virtual (2), conectividade (1)	Internet (5), virtual (3)	Virtual (25), internet (21), 4G (1)	Internet (10), virtual (5), conectividade (3)	Internet (36), virtual (35), conectividade (4), 4G (1)
Emerging technologies	painel de indicador (2), painel de indicadores (2), <i>dashboard</i> (1), interoperabilidade (1), nuvem (1)	automação (1), <i>big data</i> (1), nuvem (1)	<i>dashboard</i> (2), <i>chatbot</i> (1), inteligente (1), nuvem (1)	nuvem (2), automação (1), <i>dashboard</i> (1)	Nuvem (5), <i>dashboard</i> (4), automação (2), painel de indicador (2), painel de indicadores (2), <i>big data</i> (1), <i>chatbot</i> (1), inteligente (1), interoperabilidade (1)
Geographic information systems	Geoprocessamento (2), SIG (1)		Georreferenciamento (4)	Georreferenciamento (1)	Georreferenciamento (5), geoprocessamento (2), SIG (1)
Teaching technologies	EAD (1)		EAD (2), ensino à distância (1)		EAD (3), ensino à distância (1)

Source: Prepared by the author, 2024, based on a literature review, Cetic studies and analysis of the CONASEMS Catalogue^{21,28}.

In general, throughout the analyzed period (*figure 2*), three main uses of digital technologies in interface with PHC/SUS can be identified: 1) Telehealth; 2) Social networks, especially associated with the use of new mobile devices and connectivity; and 3) Health information systems, which remain an increasingly strategic use for PHC. On the other hand, uses related to emerging technologies, geographic information systems, and teaching technologies were less prevalent among the reported experiences. In the broader context, these uses intensified during the COVID-19 pandemic, especially with regard to distance learning technologies, which had already been gaining traction in the health sector between 2017 and 2020³⁹. However, this movement was not reflected in the experiences reported in PHC during the analyzed period.

Regarding the main uses of digital technologies for PHC, according to data obtained for the years 2018 to 2022, there was a significant use of telehealth in 2021 (*figure 3*). There was an increase in all terms related to telehealth, such as telecare, telemonitoring, telemedicine, and teleguidance. This finding corroborates studies that show the importance of telehealth in Brazil over the years and the significant inflection that the COVID-19 pandemic caused in the use of telehealth in Brazil^{8,40,41}.

In this regard, in 2022, Furlanetto et al.⁴² conducted a study analyzing the responsiveness of 159 primary care units in Brazil, highlighting telehealth as an important strategy for addressing access barriers imposed by the COVID-19 pandemic. Despite this importance, they found that only 57.2% of units offered telehealth support. Although the telehealth program was implemented in Brazil in 2011, more than 40% of the health units analyzed had insufficient telephone equipment and computer networks. This demonstrates that, despite the positive increase in the development of telehealth experiences in primary care, there are still a number of necessary investments in equipment infrastructure and

connectivity for this care modality to be effectively incorporated into the SUS.

Electronic Health Record and Information Systems were mentioned and have shown a growth trend over the years. e-SUS appears as a prominent technology in this category. It is also noticeable that, although national information systems have been used for decades in Brazil⁴³, apart from e-SUS, other information systems rarely appear in the experiences. Therefore, it is worth reflecting on how digital health policies are promoting the use and integration of information systems and e-SUS to improve PHC care. Thus, it is necessary to consider ways of using and integrating systems that consider the diversity and local capacity of PHC.

There was a significant increase in experience reports in 2021 for all categories analyzed (*figure 2*). These findings corroborate the study by Penteado et al.¹⁷, which demonstrated a significant growth in international publications on digital health from that same year onward. Thus, it is clear that the practices of Brazilian PHC services have aligned with the global appreciation of digital transformation. As highlighted by the WHO in the Global Strategy for Digital Health 2020-2025, the digitalization of health systems has become a strategic priority, encouraging the adoption of national policies that integrate digital solutions into health care, management, and information processes².

Some terms have become more relevant in experiences over the last two years, such as: apps, platforms, spreadsheets, WhatsApp, social media, telephone, mobile, virtual, and internet. Topics such as connectivity and mentions of device types (cell phone, smartphone, etc.) also increased. The use of personal cell phones has become essential for contacting patients during the COVID-19 pandemic, especially in the North and Northeast regions³⁶. The use of social media and messaging apps such as WhatsApp has been widely adopted across different areas of PHC, both for communication between professionals

and for health education, as shown by recent studies^{44,45}. Guedes et al.⁴⁴ highlight the daily use of WhatsApp and Instagram in organizing care and addressing the infodemic. Aragão and Farias⁴⁵ analyze the use of YouTube as a channel for training and strengthening the SUS, with a large reach among young people.

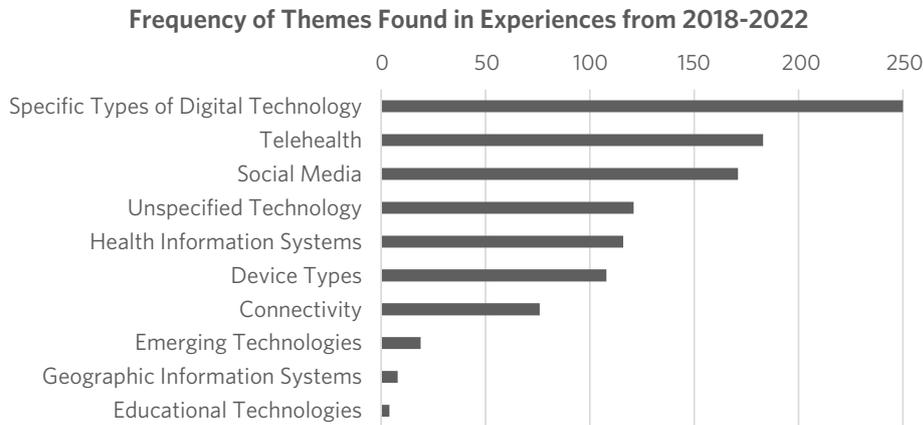
In many cases, tools such as WhatsApp and spreadsheets emerge as unofficial or emerging systems—spontaneously appropriated by professionals to fill gaps in approved information systems, which are often fragmented or unresponsive to the dynamics of daily services. Thus, these ‘artifacts’ acquire a central role in care practice and informal information management, demonstrating a hybrid ecosystem between institutional solutions and technological alternatives based on flexibility, timeliness, and local engagement⁴⁶.

It is noteworthy that emerging technologies (Big Data, AI, and the cloud) did not experience significant growth in publications during the period analyzed, despite new terms emerging over the years. This absence was also observed in TIC Saúde 2023²⁸, which highlighted the challenges and low adoption of emerging technologies in healthcare settings, especially in Primary Care, where their use is still incipient due to the technical, structural, and regulatory limitations faced. The lack of prioritization of PHC for investments in emerging technologies¹⁸ is an issue that

deserves attention from political actors and future studies.

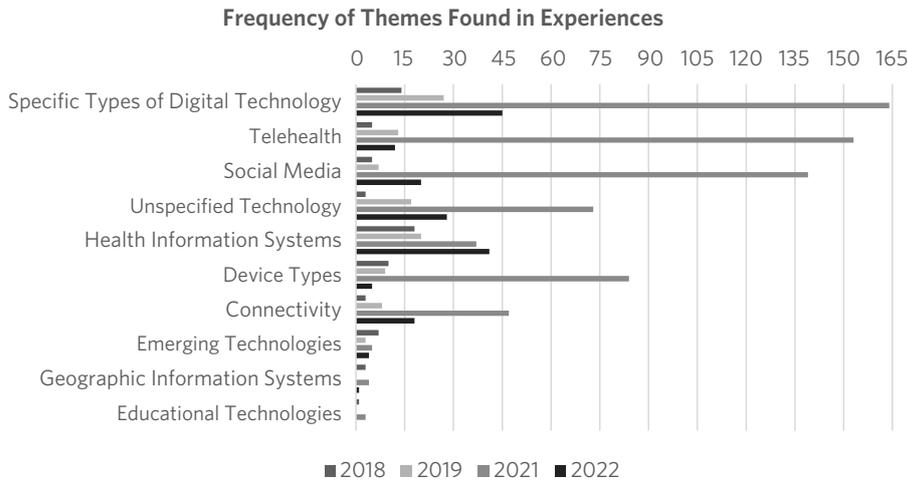
The complexity of digital health in PHC, with the coexistence of multiple systems, applications, multiple interests and uses, and market pressures and interference across diverse situations and contexts, highlights the challenges of regulating and governing these innovations. The growing use of digital technologies—specific or otherwise—and health information systems or those with a broader scope, as evidenced by the experiences reported in this study, points to significant transformations in PHC within the SUS (Unified Health System). These changes demonstrate, on the one hand, an increased use of technical, scientific, and informational systems and variables, often guided by a logic of efficiency, control, and data management⁴⁷. On the other hand, they also demonstrate attempts to improve health communication, expand the reach of PHC actions, and respond to the needs of populations, especially in areas historically underserved by services, teams, and technologies. This tension between the technical objectives and the assistance and social purposes of PHC raises questions about how experiences and innovations in digital health can simultaneously support and challenge the founding principles of PHC and the SUS, such as comprehensive care, equity, and attention to regional specificities.

Figure 2. Main themes related to the use of digital technologies in interface with APS/SUS according to the CONASEMS Catalog (all years)



Source: Prepared by the author, 2024, based on the 'Virtual Catalogue - Brazil, here there is SUS' from CONASEMS²¹.

Figure 3. Main themes related to the use of digital technologies in interface with PHC/SUS according to the CONASEMS Catalog - Brazil, 2018-2022



Source: Prepared by the author, 2024, based on the 'Virtual Catalogue - Brazil, here there is SUS' from CONASEMS²¹.

In the context of the digital transformation of the public sector in Brazil⁴⁸, the growth of digital health during the COVID-19 pandemic, the launch of the Digital Health Strategy (2020-2028)¹ and the Global Digital Health Strategy 2020-2025², the Organization for Economic Cooperation and Development (OECD) highlighted the great potential and complexity of using digital technologies for

PHC in the country⁴⁹. We agree with Araújo et al.⁵⁰ when they state that there is still a need to strengthen the inclusion of digital health in PHC policy. Digital health can have both positive and negative impacts on PHC, requiring policies and actions that ensure its potential is leveraged without losing sight of the functions and principles of PHC in public health systems¹⁹.

The challenges related to digital health go beyond infrastructure limitations and access to connectivity and equipment. In recent years, digital inclusion has been debated from the perspective of a second-level digital divide, which occurs due to inequality in capabilities, skills, and uses by certain social groups, based on their intersectionalities of age, race, gender, education, and income. Even with the expansion of access to electronic devices and the internet, a very large difference in the effective use of technologies is observed when analyzing these groups separately⁵¹.

One of the terms being used to refer to the capabilities and skills in using digital technologies is digital literacy, which is complemented, in the healthcare context, by the concept of digital health literacy. This second concept is characterized by:

[...] the individual's ability to search for and find health information in digital media, understand and evaluate such media, in order to interpret and classify them so that they can treat or solve a health-related problem⁵²⁽¹³⁶⁾.

Studies on digital literacy and digital health literacy are essential to highlight the barriers to the effective use of digital technologies applied to healthcare in specific groups, such as the elderly. This will enable the development of strategies targeted at these groups, ensuring equity in the use of these technologies and in healthcare. Furthermore, digital health literacy is a fundamental skill for avoiding the harsh consequences of mass dissemination of disinformation⁵³.

In this sense, considering the importance of PHC and the Unified Health System (SUS) to Brazil, serving as a benchmark for other countries, critical and comprehensive studies on digital health in PHC are needed, considering the countless possibilities and dimensions involved, as well as the diverse and unequal experiences that have been produced in the country. Digital health in PHC presents a proliferation of opportunities and

transformations, and it is necessary to ensure its use in order to achieve the principles of the SUS.

Final considerations

This study highlighted numerous digital health experiences and their interface with PHC, which are being reported by Brazilian municipalities, with growth driven by the COVID-19 pandemic and government programs and strategies in recent years. The exploratory study on digital health experiences in PHC within the Unified Health System (SUS) between 2018 and 2022, based on the CONASEMS (National Health System) 'Virtual Catalogue – Brazil, here we have SUS', showed the growing importance and interest of municipalities in this topic (668%), with 2021 as the benchmark. There are regional inequalities in the number of reported experiences, generally more concentrated in the South and Southeast regions. However, the Northeast region stands out as the region with the highest number of experiences reported in the Catalogue, as well as the formation, over the years, of a digital health expansion axis in PHC in Brazil, involving the South, Southeast, and Northeast regions.

The proliferation of topics and terms related to the use of digital technologies and their interface with PHC since 2018 has been notable—both in relation to more traditional uses, such as telehealth, and more recent ones, such as platforms, applications, social networks, and emerging technologies. The digital health landscape in PHC is highly complex and diverse, marked by diversity and inequalities and permeated by numerous interests and logics of action. In this context, the limited regulatory and governance capacity is notable, hindering the effective implementation of technologies in the broader SUS (Unified Health System). The increased use of technical, scientific, and informational systems and variables raises questions about how experiences and innovations in digital health

can simultaneously support and challenge the principles of PHC and the SUS.

There is a need for greater prioritization of PHC in digital health strategies and investments, both because of the fundamental role PHC plays in achieving the principles of the SUS and because of the potential and risks associated with digital health solutions in general. Traditionally, PHC has been considered less susceptible to major technological transformations, but in the case of digital transformation, it is necessary to take a closer look at PHC as a gateway to numerous digital technological solutions (and associated risks).

The study contributed to the development of an exploratory mapping method of digital health experiences with interfaces with PHC in Brazil, based on the identification of terms, themes, and databases that can serve as reference for further studies. The method involved the development and application of an automated scraping and filtering strategy for key terms, especially useful in non-indexed public repositories, such as the CONASEMS Catalog. The approach enabled an initial bibliometric analysis, revealing the main terms used to describe digital health in the context of PHC and the Unified Health System (SUS). It is recognized, however, that the method does not allow for in-depth analysis of the content of the reports, which constitutes a limitation. Nevertheless, it represents a relevant methodological contribution, which should be complemented by classical or automated qualitative approaches in future studies with this focus.

Despite the proliferation of terms and themes, a low presence of emerging technologies was observed in the reported experiences, which indicates structural, technical

and prioritization limitations of PHC in public investments. Although mentioned in some reports, these technologies remain incipient, especially given the demands and complexities of primary care. Also noteworthy is the recurrent use of unapproved technologies, such as social media and messaging apps, which have been incorporated into local practices in response to the limitations of institutional systems. These elements highlight the need for deeper analysis of the uses of these technologies, their functionalities in daily services, and their impact on care. Future studies can explore in greater depth the content of the experiences, the meanings attributed to the technologies, the governance arrangements involved in their implementation, as well as aspects related to digital health literacy, identifying how these dimensions influence access, the effective use of tools, and the development of technological solutions aligned with the principles of the Unified Health System (SUS).

It is believed that, in the next decade, important digital transformations in the Unified Health System (SUS) will occur through PHC. Other studies may follow this process and indicate paths and possibilities for digital health and its interfaces with PHC to occur towards strengthening the SUS and its principles, with greater access, quality and equity in health care.

Collaborators

Soibelman G (0009-0009-3833-1167)*, Fornazin M (0000-0002-0379-5801)* and Albuquerque MV (0000-0002-0763-6357)* contributed equally to the preparation of the manuscript.■

*Orcid (Open Researcher and Contributor ID).

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