LUMEN ET VIRTUS
ISSN: 2177-2789

PUBLIC HEALTH IN THE DIGITAL AGE: CHALLENGES AND OPPORTUNITIES FOR INNOVATION IN THE SUS

https://doi.org/10.56238/levv16n47-063

Submitted on: 18/03/2025 **Publication date:** 18/04/2025

Laura Rosa Francesconi[1], Manoel Borges dos Santos Filho[2], Rita de Cássia do Nascimento Medeiros[3], Emanuelle Ribeiro Lisboa Prasto Martins[4], Jaíne Campos Vieira[5], Giovana de Paulo Domingos Ramos[6], Cícero Ricarte Beserra Junior[7], Karen Cristine da Silva Gonçalves[8], Maria Sofia da Conceição Ximenes Feitosa[9], Maryane Breckenfeld Silva Diniz[10]

[1] Medical Student
Feevale University
E-mail: rosalaura786@gmail.com
ORCID: https://orcid.org/0009-0003-5978-7354
LATTES: http://lattes.cnpq.br/1375413625168471
[2] Undergraduate Nursing Student
UESPI
E-mail: manoelborgesdossf@aluno.uespi.br
ORCID: https://orcid.org/0000-0002-8228-1365
LATTES: https://lattes.cnpq.br/2037125616960468
[3] Eso Nutritionist. in Nutrition at TEA, postgraduate student in Public Management
Unipê - University Center of João Pessoa
Email: ritanascimento.nutri@gmail.com
ORCID: https://orcid.org/0000-0003-0558-2751
LATTES: https://lattes.cnpq.br/7456374159941847
[4] Psychologist and Master's student in Social Psychology
Unigranrio and Salgado de Oliveira University - Universe
E-mail: Emanuelle.lisboa@gmail.com
ORCID: https://orcid.org/0009-0004-3140-0135
LATTES: http://lattes.cnpq.br/6447711266541471
[5] Physiotherapist and Post-graduate in Collective Health
UFPB
Email: jainecampos@gmail.com
LATTES: http://lattes.cnpq.br/4645276323017567
[6] Undergraduate student in Dentistry
Mauritius University Center of Nassau
E-mail: giovanadomingosramos@gmail.com
LATTES: http://lattes.cnpq.br/5504734904873861
[7] Master in Technology and Innovation in Nursing Specialist in Collective Health, Specialist in Obstetric Nursing,
Nurse
UNIFOR/ CAPES/ COFEN.
Fortaleza-Ceará / Regional University of Cariri-URCA
[8] Undergraduate student in Nursing
UNIPAC - Presidente Antônio Carlos University, Governador Valadares Campus
E-mail: karencristine.sg@gmail.com
[9] Post-graduation in Psychological Assessment and Psychodiagnosis,
FATELOS and UFDPAR
Email: sofiamr738@gmail.com
ORCID: https://orcid.org/0009-0000-9181-5050
[10] Dental Surgeon

ABSTRACT
This study seeks to analyze digital innovations in the context of the Unified Health System (SUS), highlighting the challenges and opportunities offered by these technologies for the transformation of the Brazilian health system. The research was conducted through a narrative review of the literature, focusing on recent studies that address the implementation of digital technologies such as telehealth, electronic medical records, artificial intelligence, and big data, considering both the benefits and obstacles to their adoption in the SUS. The results indicate that, despite the significant advantages in terms of efficiency, quality and access to health services, there are substantial barriers, such as the digital divide, the lack of adequate infrastructure and the need for continuous training of health professionals. In addition, the survey discusses the importance of robust digital governance, with an emphasis on citizen participation and interinstitutional collaboration. The conclusion of the study highlights the need for careful strategic planning to ensure that digitalization in the SUS is inclusive and sustainable, promoting a more equitable and accessible health system for the entire Brazilian population.

Keywords: Digital innovations. Unified Health System. Telehealth. Electronic medical records. Artificial intelligence. Digital Divide. Digital governance.

Federal University of Ceará - Sobral campus
E-mail: marybreckenfeld@gmail.com
ORCID: https://orcid.org/0000-0002-2771-077X
LATTES: http://lattes.cnpq.br/2340385664860429

INTRODUCTION

In recent decades, the incorporation of digital technologies in the health sector has intensified exponentially, radically transforming operational and administrative processes, but also the forms of care and the very paradigms that guide the formulation of public policies. The so-called "digital age" has promoted a profound reconfiguration of health systems, making room for tools such as electronic medical records, predictive algorithms, telehealth, artificial intelligence, and big data — resources that promise to improve efficiency, quality of care, and the scope of health interventions (Leal Neto et al., 2023; Yi et al., 2024). This phenomenon, although global, takes on particular contours in countries with universal public systems and deep structural inequalities, as is the case of Brazil.

In the Brazilian context, the Unified Health System (SUS) faces historical challenges that involve chronic underfunding, inequality in access to services, fragmentation of care, and regional disparities that compromise comprehensive care. Technological innovation, in this scenario, emerges as a strategic way to mitigate such deficiencies, as long as it is implemented ethically, equitably, and based on evidence (Maugeri et al., 2022). However, the digital transition is not without contradictions: it requires robust governance, interoperable infrastructure, continuous professional training, and inclusive policies that prevent the widening of the digital divide, especially among the most vulnerable groups — such as the elderly, peripheral populations, rural communities, and people with low technological literacy (Takano et al., 2023; Baines et al., 2022).

The central problem that arises, therefore, concerns how the SUS can incorporate digital technologies in a critical, inclusive and sustainable way, without compromising the principles of universality, integrality and equity that guide its normative structure. The simple digitalization of processes does not guarantee the improvement of health indicators or the effectiveness of public policies. On the contrary, it can reinforce existing inequalities if it is conducted in a disjointed way, without dialogue with users, without impact assessment, and without community engagement strategies (Baines et al., 2022; Smith et al., 2023).

The justification for this investigation lies in the urgency of understanding the limits and possibilities of digital innovations in Brazilian public health in the light of recent digital transformation movements, which involve not only technical aspects, but also ethical, political, cultural, and social dimensions. The involvement of civil society, the creation of collaborative innovation environments, and the articulation between academia, the public sector, and the private sector are fundamental elements for the construction of solutions that are viable, scalable, and, above all, oriented towards the public good (Vecchiato et al., 2024; The European Journal of Public Health, 2024). The discussion about the hospital of

the future, for example, involves not only the adoption of technologies, but the reorganization of spaces and care flows to meet contemporary demands in an integrated, territorialized, and sustainable way (Cadeddu et al., 2024).

In view of this, the hypothesis that guides this study is that digital innovation, when guided by participatory strategies, scientific evidence, people-centered governance, and intersectoral partnerships, can represent a vector for strengthening the SUS, contributing to overcoming inequalities and increasing the effectiveness of collective health actions. On the other hand, if conducted in a technocratic way, disconnected from the real needs of the population and territories, digitalization can become a factor in deepening inequities.

Thus, the objective of this work is to critically analyze the contemporary perspectives of digital health in the context of Brazilian collective health, with emphasis on the potentialities and limits of technological innovation applied to the Unified Health System. The analysis is based on recent studies of national and international scope, considering successful experiences, recurring obstacles and elements that make up an innovation ecosystem focused on equity, sustainability and social participation.

METHODOLOGY

This study was developed from a narrative review of the literature, with a qualitative and exploratory focus, with the objective of gathering, interpreting and discussing current scientific productions that address the interface between collective health, technological innovation and digital transformation in the context of the Unified Health System (SUS). The selection of sources was carried out between February and March 2025, based on criteria of topicality, thematic relevance, methodological rigor, and relevance to the scope of the research.

The main scientific databases were used: PubMed, SciELO, Scopus, Web of Science, Google Scholar and CAPES Journal Portal. Technical reports and institutional documents from the World Health Organization (WHO) and the Ministry of Health were also included, when related to the theme of digital health and technological governance in public health.

The search strategy involved the use of keywords in Portuguese and English, considering the terminological diversity of the field. Among the descriptors used, the following stand out: *"innovation in health", "digital transformation", "collective health", "unified health system", "health technology", "digital health", "public health innovation", "digital transformation in health", "equity and technology", "health governance"* and *"digital inclusion in healthcare".*

To refine the results, Boolean operators were applied in order to perform intercrossings and expand or restrict the thematic combinations. For example, the following combination was used:

- ("digital health" AND "public health systems") AND ("inequities" OR "governance" OR "universal health coverage")

Another combination, applied in the SciELO database with terms in Portuguese, included:

- ("digital health" AND "SUS") AND ("innovation" OR "equity" OR "primary care")

The inclusion criteria included publications between 2022 and 2024, available in full text, with an emphasis on peer-reviewed articles, case studies, systematic reviews, qualitative research, and public policy analyses. Productions with an exclusively technical-operational focus, opinion documents without empirical basis and duplicate studies between the databases were excluded.

At the end of the screening, nine central studies and two international technical reports were selected, which provided the theoretical and empirical substrate for the construction of the results and discussion section. The sources were critically analyzed, seeking to identify convergences and tensions between the findings, with special attention to aspects such as digital governance, technological inclusion, social participation, organizational challenges, and comparable international experiences.

RESULTS

The search carried out in the main scientific databases, including PubMed, SciELO, Scopus, Web of Science and CAPES Journal Portal, initially resulted in 15 studies related to the theme of digital transformation in public health, innovation in health, and the impact of these technologies on the Unified Health System (SUS). These studies were evaluated based on the inclusion and exclusion criteria, as described in the methodology. The inclusion criteria were: publications between 2022 and 2024, peer-reviewed articles, and that addressed the interface between collective health and digital innovation in the SUS or in comparable contexts. Exclusion criteria included studies that were not accessible in full text, duplicates between databases, and articles that did not address the impact of digital technologies on the public health system or that were limited to technical discussions without empirical basis.

After applying the criteria, 8 studies were selected for detailed analysis, all focusing on aspects relevant to the discussion of the use of digital technologies in the SUS, its challenges, opportunities and implications for public health.

DISCUSSION

The analysis of the available evidence reveals that the digital transformation of public health is a strategic frontier for the strengthening of health systems in low- and middle-income countries, such as Brazil. Within the scope of the Unified Health System (SUS), digital innovations emerge as powerful mechanisms for overcoming historical challenges related to inequality in access, the overload of primary care units, the fragmentation of the care network, and the shortage of qualified professionals in remote areas. According to Yi et al. (2024), experiences in health systems in Southeast Asia demonstrate that, when evidence-based and underpinned by strong institutional partnerships, digital technologies can increase service coverage, as well as improve epidemiological surveillance, disease monitoring, and communication with the populations served.

However, the implementation of technological solutions in the SUS cannot do without a commitment to citizen participation and social accountability. The systematic review by Baines et al. (2022) emphasizes that the meaningful involvement of users in the design, implementation, and evaluation of digital tools is essential to ensure their effectiveness and acceptability. Barriers such as institutional distrust, lack of transparency in public policies, and the absence of accountability are obstacles that, if neglected, can compromise the legitimacy of digital initiatives and their long-term sustainability. Trust in technology, in this sense, is not a natural fact, but a social construction that demands constant dialogue between managers, health professionals and users.

From this perspective, the field of chronic non-communicable diseases — whose prevalence is growing in Brazil — presents itself as a fertile ground for the incorporation of solutions based on artificial intelligence and data analysis. According to Leal Neto et al. (2023), these tools can significantly increase the efficiency and effectiveness of public health interventions, while optimizing the user experience and promoting equity. However, the authors warn that such use must be intentional, critical and focused on the real needs of populations, avoiding the trap of technocracy or digital exclusion. This requires, therefore, governance capable of aligning the objectives of digital transformation with the founding principles of the SUS — universality, integrality, and equity — as proposed by Maugeri et al. (2022), when advocating human-centered approaches and the meaningful engagement of youth in digital policies.

The creation of an ecosystem of innovation in public health, as pointed out in a recent report by the World Health Organization for the European Region (The European Journal of Public Health, 2024), depends on building bridges between the public sector, the private sector, universities, research centers, and civil society. Public-private partnerships,

in this scenario, become essential to accelerate innovation and respond in an agile way to complex challenges. In the Brazilian case, successful experiences with health startups, innovation hubs, and policies to promote digital technology point to possible ways to strengthen the SUS, as long as ethical limits, regulatory frameworks, and the collective interest are respected. The work of Vecchiato et al. (2024), by presenting technological prospecting methodologies adapted to small and medium-sized enterprises (SMEs), shows how it is possible to design innovation strategies sensitive to the local context, with a real capacity to influence public policies.

In addition, the digitalization of healthcare requires resilient hospital and institutional architectures, which are capable of integrating technological solutions into their operational routines without compromising the values of humanized care. Cadeddu et al. (2024) discuss the concept of the "hospital of the future", guided by a multidisciplinary and territorial approach that articulates technological innovation, environmental sustainability, epidemiological needs, and social inclusion. This conception is particularly relevant for the SUS, which faces a growing demand for specialized services, while dealing with budget constraints and deep regional inequalities.

In the field of mental health, digital innovations have also been tested as alternatives to expand the reach of services, reduce waiting lines, and facilitate access to continuous care. Smith et al. (2023) argue that, although promising, such technologies require profound organizational changes, team training, adaptation of clinical protocols, and the development of new financing models. The case of digital psychiatry, for example, illustrates how innovative business models can increase patient engagement and improve therapeutic outcomes, as long as they are accompanied by effective regulatory frameworks and policies to encourage sustainability, as suggested by Kiss et al. (2024).

An aspect that is often neglected in debates on digital innovation in public health concerns the user experience, especially for vulnerable populations such as the elderly. Takano et al. (2023), when reviewing instruments to assess the usability of digital technologies, point to the *System Usability Scale (SUS)* as an effective tool to measure the acceptance of health platforms among the elderly. In Brazil, the progressive aging of the population and the still marked digital divide among the elderly require that any proposal for digitization of the SUS considers, from the beginning, accessibility, digital literacy, and the specific needs of this population.

Therefore, the results discussed here allow us to conclude that public health in the digital age demands more than the introduction of technological tools in the daily routine of public services. It requires, above all, the construction of a new paradigm of management,

planning and care, in which innovation is not seen as an end in itself, but as a means to guarantee the right to health. The effectiveness of this model in the SUS will depend on the ability to articulate knowledge, sectors and social actors, committed to an inclusive, participatory and evidence-based vision of the future.

CONCLUSION

The analysis of the selected studies revealed that digital innovations have the potential to transform the Unified Health System (SUS) in a significant way, providing improvements in service management, expanding access to health care, and greater efficiency in interventions, especially in regions with limited resources. Digital technologies, such as telehealth, electronic medical records, and artificial intelligence, offer powerful tools to address inequalities in access and improve the quality of care offered to the population.

However, the implementation of these technologies in the SUS faces substantial challenges, such as the digital divide, the need for adequate infrastructure, and the continuous training of health professionals. In addition, the resistance of certain groups of the population, especially those most vulnerable, can make it difficult to adopt these innovations. Overcoming these obstacles requires a strategic approach that considers the particularities of the Brazilian health system and the local realities of each region.

Digital governance in the SUS needs to be strengthened, with an emphasis on transparency, citizen participation, and collaboration between the public and private sectors. The creation of inter-institutional partnerships can accelerate the adoption of technological solutions that meet the needs of the SUS, without compromising the principles of universality and equity that characterize the Brazilian health system.

Finally, while the challenges are considerable, the opportunities offered by digital innovation are immense. With careful planning and implementation guided by evidence-based and equity-focused strategies, SUS has the potential to become an inclusive and sustainable digital health model, capable of ensuring quality care for the entire Brazilian population.

REFERENCES

1. BAINES, R. et al. Meaningful patient and public involvement in digital health innovation, implementation and evaluation: A systematic review. Health Expectations: An International **Journal of Public Participation in Health Care and Health Policy**, v. 25, n. 2, p. 367-379, 2022.

2. CADEDDU, C. et al. Scientific session: Challenges in healthcare architectures. **The European Journal of Public Health**, v. 34, n. 5, p. 945-950, 2024.

3. KISS, B. et al. Digital Psychiatric Innovations from a Business Perspective – New Era, New Business Models. **European Psychiatry**, v. 67, n. 1, p. 16-21, 2024.

4. LEAL NETO, O. L. et al. Digital Transformation of Public Health for Noncommunicable Diseases: Narrative Viewpoint of Challenges and Opportunities. **JMIR Public Health and Surveillance**, v. 9, n. 3, p. e23646, 2023.

5. MAUGERI, A. et al. Making the case for the governance of (digital public) health futures. **The European Journal of Public Health**, v. 32, n. 4, p. 544-549, 2022.

6. SMITH, K. A. et al. Digital mental health: Challenges and next steps. **BMJ Mental Health**, v. 30, n. 4, p. 214-219, 2023.

7. TAKANO, E. et al. User Experience of Older People While Using Digital Health Technologies: A Systematic Review. **Applied Sciences**, v. 13, n. 8, p. 1249-1255, 2023.

8. THE EUROPEAN JOURNAL OF PUBLIC HEALTH. Round table: Building a Public Health Innovation Ecosystem in the WHO European Region. **The European Journal of Public Health**, v. 34, n. 4, p. 563-568, 2024.