Digital Technologies: Tools for Increasing Vaccination Coverage

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Date of Receipt: Agosto 04, 2025 | Approval date: Maio 20, 2026

Abstract

Introduction: Despite the efficacy of vaccines, socioeconomic barriers and misinformation are challenging vaccination coverage. Digital tools have emerged as strategies to strengthen management and engagement; however, their practical integration in combating vaccine hesitancy still lacks supporting evidence. **Methods**: This study is an integrative review. Systematic review articles published up to January 2025, in Portuguese, English, or Spanish, that addressed the use of telemedicine to promote vaccination were included. The search was conducted in PubMed and LILACS databases, with articles selected via a peer-reviewed process following the PRISMA flow diagram. **Results:** The most frequently used and effective resources across the four selected reviews were text messages (SMS) and automated calls, standing out due to their low cost and speed. Other tools included interactive videos and electronic health records. Barriers such as "message fatigue" and infrastructure limitations were the primary obstacles identified. **Discussion:** Digital technologies are useful tools for increasing vaccination coverage and offer relatively low costs. Technology proves effective when adapted to the local context. Simple strategies offer good cost-effectiveness; however, digital exclusion and a lack of data interoperability may limit the reach of these innovations and exacerbate health inequities. **Conclusion:** Digital technologies hold promises for restoring vaccination coverage when integrated with digital inclusion policies, being a complementary support to in-person educational initiatives and active outreach efforts.

Key-words: Vaccination; Information technology; Vaccination coverage

Resumen

Tecnologías digitales: herramientas para aumentar la cobertura de vacunación

Introducción: A pesar de la efectividad de las vacunas, las barreras socioeconómicas y la desinformación dificultan la cobertura de la vacunación. Las herramientas digitales son una estrategia para fortalecer la gestión y la participación, pero su integración práctica para combatir la reticencia a la vacunación aún carece de evidencia. **Métodos**: Este es un estudio de revisión integradora. Se incluyeron artículos de revisión sistemática publicados hasta enero de 2025, en portugués, inglés o español, que abordan el uso de la telemedicina como medio para promover la vacunación. La búsqueda se realizó en las bases de datos PubMed y LILACS y fue revisada por pares mediante el flujo de trabajo PRISMA. **Resultados**: En cuatro revisiones seleccionadas, los mensajes de texto (SMS) y las llamadas automatizadas fueron los recursos más utilizados y efectivos, destacándose por su bajo costo y rapidez. Otras herramientas incluyeron videos interactivos y registros electrónicos de salud. Las barreras como la fatiga por exceso de mensajes y las limitaciones de infraestructura fueron los principales obstáculos identificados. **Discusión:** Las tecnologías digitales son herramientas útiles para aumentar la cobertura de vacunación y tienen costos relativamente bajos. La tecnología es efectiva cuando se adapta al contexto local. Las estrategias sencillas resultan rentables, pero la exclusión digital y la falta de interoperabilidad de datos pueden limitar el alcance de las innovaciones y agravar las desigualdades. **Conclusión:** Las tecnologías digitales son prometedoras para recuperar la cobertura de vacunación cuando se integran con políticas de inclusión digital, sirviendo como apoyo complementario a la educación presencial y las acciones de divulgación activa.

Palabras clave: Vacunación; Tecnologías de la información; Cobertura de vacunación

Resumo

Tecnologias Digitais: Ferramentas Para Aumento Da Cobertura Vacinal

Introdução: Apesar da eficácia das vacinas, barreiras socioeconômicas e a desinformação desafiam a cobertura vacinal. Ferramentas digitais surgem como estratégias para fortalecer a gestão e o engajamento, mas sua integração prática contra a hesitação vacinal ainda carece de evidências. **Métodos**: Trata-se de um estudo de revisão integrativa. Foram incluídos artigos de revisão sistemática publicados até janeiro 2025, em português, inglês ou espanhol, que abordassem: uso da telemedicina como promoção à vacinação. A busca foi feita nas bases de dados "Pubmed", "Lilacs", selecionadas por pares via fluxo PRISMA. **Resultado**: Em quatro revisões selecionadas, mensagens de texto (SMS) e ligações automatizadas foram os recursos mais utilizados e eficazes, destacando-se pelo baixo custo e rapidez. Outras ferramentas incluíram vídeos interativos e prontuários eletrônicos. Barreiras como a "fadiga de mensagens" e limitações de infraestrutura foram os principais obstáculos identificados. **Discussão**: As tecnologias digitais são ferramentas úteis para aumentar a CV e apresentam custos relativamente baixos. A tecnologia é eficaz quando adaptada ao contexto local. Estratégias simples funcionam bem para custo-benefício, mas a exclusão digital e a falta de interoperabilidade de dados podem limitar o alcance das inovações e aprofundar iniquidades. **Conclusão**: Tecnologias digitais são promissoras para recuperar coberturas vacinais quando integradas a políticas de inclusão digital, servindo como suporte complementar às ações presenciais de educação e busca ativa.

Palabras-chave: Vacinação; Tecnologia da informação; Cobertura vacinal

INTRODUCTION

Vaccines work by stimulating the immune system to mount a protective response against specific infectious agents, altering the natural course of diseases, and their incidence and transmissibility. Historically, immunization has transformed public health by protecting vulnerable groups, particularly children, against various illnesses. A significant and positive transformation has been observed in both the quality of life and the life expectancy of the population with the systematic implementation of vaccination. Furthermore, substantial reductions have been noted in rates of school and workplace absenteeism, as well as in the morbidity and mortality associated with vaccine-preventable diseases; concurrently, improvements have been observed in academic performance and in the expansion of collective protection, also known as herd immunity.[1]

The monitoring of vaccination coverage (VC) is an indicator of child health, used for planning and tailoring interventions to local epidemiological needs.[2,3] However, maintaining adequate VC faces multifactorial challenges, ranging from geographic and operational barriers to socioeconomic determinants and the impact of misinformation.[3]

In this context, digital technologies and tools emerge as instruments to strengthen engagement and immunization management. The digital social listening, a technique for the systematic monitoring of public discourse across digital and traditional media, is highlighted, capable of mapping sentiments and neutralizing false information regarding vaccination. Concurrently, digital training for professionals, together with remote supervision, holds the potential to enhance service quality in hard-to-reach areas, boosting technical competencies and team motivation.[4]

In the Brazilian scenario, digital transformation in healthcare is driven by tools such as Meu SUS Digital. Since 2019, it has centralized access to vaccination records, the National Vaccination Card, and personal clinical history.6 In 2025, this infrastructure was enhanced with the Digital Child Health Record, a tool that integrates data on immunization, growth, and child development, while also offering comprehensive guidance on family care. It encourages breastfeeding and healthy nutrition to accident prevention and combating violence against children.[7]

Despite the rapid expansion of these technologies and the availability of these tools, there is a gap in the literature on how to effectively integrate digital tools to address vaccine hesitancy and optimize clinical practice in different epidemiological contexts. Consolidated evidence is still lacking to demonstrate which digital strategies are most effective in promoting adherence across diverse social realities.

Therefore, this study aims to analyze the scientific evidence regarding the use of digital technologies as strategies to promote vaccination adherence. To this end, an integrative review was selected, a methodology that allows for the synthesis of knowledge and provides a foundation for incorporating technological innovations into vaccination practice.

METHODOLGY

This is an integrative review study following the approach proposed by Soares et al.8 To structure the study, the PICO strategy (Population, Intervention, Comparison, and Outcomes) was employed to formulate the guiding question:

"What is the scientific evidence regarding the use of digital technologies as a strategy to promote and increase vaccination adherence?"

Data collection took place in January 2025, conducted through independent parallel searches of the PubMed (via MEDLINE) and LILACS (via the VHL Regional Portal) databases. The selection of distinct descriptors for each database (Table 1) international literature, whereas LILACS centers on scientific output from Latin America and the Caribbean

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was justified by the need to align with their specific controlled vocabularies: Medical Subject Headings (MeSH) for PubMed and Health Sciences Descriptors (DeCS) for LILACS. This modification aimed to enhance sensitivity, enabling each database to be leveraged to its full retrieval potential and ensuring the inclusion of regionally specific terms, given that MEDLINE focuses on

Table 1- Type of information resource, search strategy, and number of references retrieved

Informational Resource	Search Strategy	Retrieved References
Pubmed	'Mobile Health' OR "Telehealth" OR "Artificial intelligence" OR "Mobile Application" AND "Immunization Program" OR "Vaccination Campaign"	106
Lilacs	'Telehealth Monitoring' OR "Telemedicine" OR "eHealth" OR "Mobile Health" AND "Immunization Schedule" OR "Vaccination Coverage" OR "Vaccines"	12

Source: Created by the authors

The study selection process was conducted to ensure the reproducibility of the study. Initially, two researchers independently screened the titles and abstracts of the retrieved works, applying the previously established eligibility criteria. Systematic review articles published in Portuguese, English, or Spanish that directly addressed the use of telemedicine and other digital tools to support vaccination promotion were included. Publications regarding research projects, protocols, or studies in which the technology had a strictly laboratory or logistical verification purpose, without a focus on promotion or adherence, were excluded. In cases where there was disagreement between the two initial reviewers regarding the inclusion or exclusion of a specific study, a third senior reviewer was consulted to resolve the discrepancy and ensure consensus.

After the final selection, the data extraction and synthesis phase was undertaken, during which the selected articles were read in full. To organize the information, a standardized form was used to capture the title, authors, year of publication, study objectives, methodological design, and the main results. The analysis was conducted descriptively and critically, seeking to integrate the various findings to identify knowledge gaps and provide a foundation for incorporating these digital tools into the daily practice of immunization services.

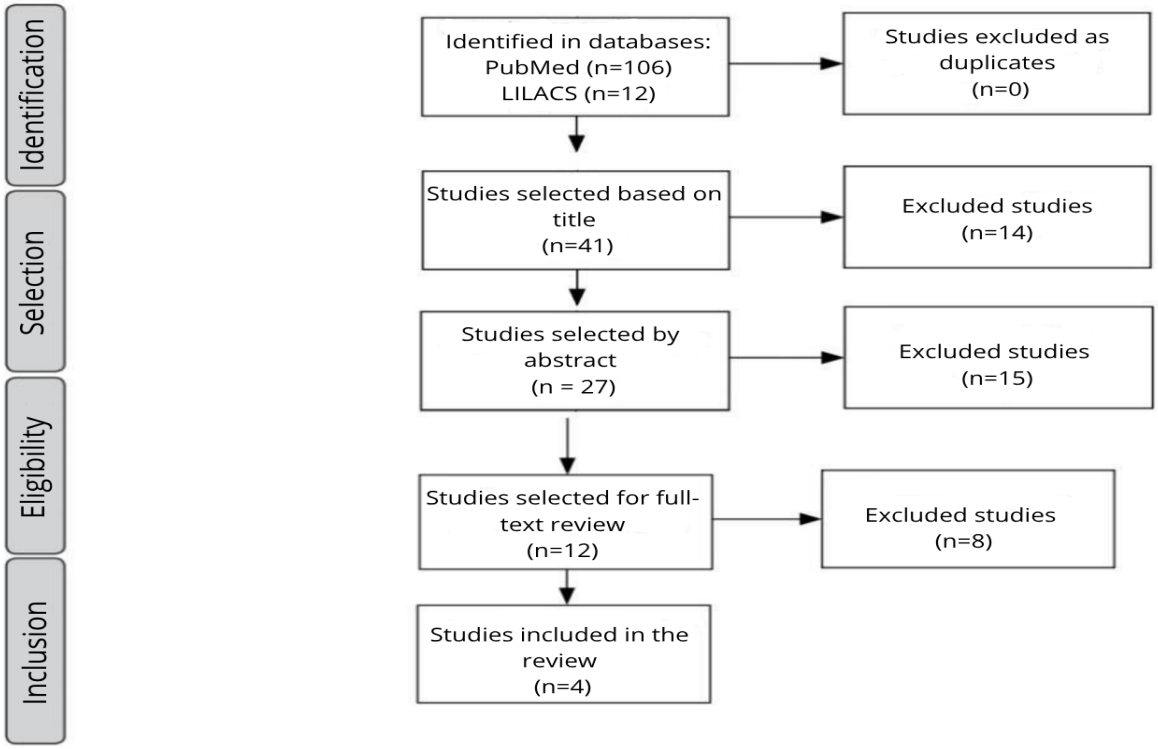
DOI: 10.32443/2175-2990 (2025)496

RESULTS

The initial search strategy found 118 references across the selected databases. Following screening by title and abstract, 27 publications were pre-selected. Of these, 15 were removed for failing to meet the eligibility criteria, leaving 12 articles for full-text review. At this final stage, 8 studies were excluded (due to having a primary study design or a strictly logistical focus), resulting in a final sample of 4 systematic reviews.

Figure 1 details the selection flow following PRISMA guidelines, illustrating the trajectory from identification to final inclusion. For the inclusion of the "overview" of reviews, a cross-check was conducted to ensure the absence of data overlap with the other selected articles, preserving the integrity of the synthesis.

Figure 1- Selection process for studies included in the review, in accordance with the PRISMA strategy.



Source: Created byt hte authors

The final sample of this integrative review consisted of four systematic review articles published between 2015 and 2023. Scientific production on the topic is predominantly concentrated in low- and middle-income settings, with a prevalence of investigations conducted in communities within African and Asian countries.

Regarding the technological resources identified, interventions ranged from traditional telehealth methods to mobile digital tools. The most frequent technologies were text messages (SMS) and automated phone calls, cited in all selected studies as strategies characterized by low cost, rapid implementation, and high efficacy. Other resources mentioned included emails,[9,10] remote monitoring in home telehealth programs,[9,11] interactive videos[10], and the use of electronic health records to send alerts[9,10].

The application of these technologies encompasses various age groups, from children to the elderly, and different vaccination contexts, demonstrating high heterogeneity in the studied populations.

Despite positive outcomes on vaccine uptake, the studies reported critical barriers to the effectiveness of the technologies. Message fatigue is highlighted, which diminishes the long-term impact of the strategy, and infrastructural obstacles such as connection instability, power outages, and difficulties in comprehending the transmitted content. These findings indicate that the success of digital tools is contingent upon technological stability and the linguistic appropriateness of the content relative to the socioeconomic context of the target populations. Table 2 presents a critical synthesis of these findings.

Table 2- Identification, objectives, and results of the four articles selected for the study

Title/Authors/Year	Objectives	Results
Use of Information and Communication Technology Strategies to Increase Vaccination Coverage in Older Adults: A Systematic Review. Buja *et al*., 2023.[9]	To analyze interventions that apply information and communication technology to improve adherence to immunization rates for influenza, pneumococcus, COVID-19, and herpes zoster among older adults.	Half of the interventions demonstrated effectiveness in increasing vaccination among older adults. Multicomponent approaches are the most robust, but simpler interventions—such as electronic messages or automated calls—also yielded good results at a lower cost.
The use of eHealth with immunizations: An overview of systematic reviews. Dumit *et al*., 2018.[10]	To understand how and which eHealth technologies contribute to increased vaccination adherence, improved immunization program effectiveness, and the promotion of health education.	None of the analyzed articles presented negative results regarding the use of eHealth technologies for vaccination initiatives. ICT improves clinical outcomes, expands vaccination coverage, and enhances medication adherence. Text messages (mHealth) can be a useful tool for positively influencing patient behavior.
Using Mobile Phones to Improve Vaccination Uptake in 21 Low- and Middle-Income Countries: Systematic Review. Williams et. al, 2017.[11]	To review the use of mHealth to expand vaccination coverage in low- and middle-income countries with a high number of unvaccinated children.	SMS reminders have contributed to improving adherence and reducing patient delays. However, the study warns of the risk of "message fatigue," where an excess of notifications may reduce the effectiveness of the intervention in the long term.

DOI: 10.32443/2175-2990 (2025)496

Using mHealth to Improve Usage of Antenatal Care, Postnatal Care, and Immunization: A Systematic Review of the Literature. Watterson et. al, 2015.[12]	To evaluate the efficiency of mHealth in postnatal care and vaccination in developing countries.	The use of applications with electronic records integrated with SMS significantly increased timely vaccination (from 34.5% to 44.2%). Technology addresses gaps in infrastructure and a lack of information.

Source: Created by the author

DISCUSSION

The findings of this review showed that the effectiveness of digital technologies in immunization is not intrinsic to the tool but rather dependent on the mode of intervention and the socioeconomic context. The predominance of evidence focusing on SMS and automated calls reflects a low-cost strategy for overcoming access barriers in low- and middle-income countries. However, the identified phenomenon of "message fatigue" suggests that purely technological interventions have an efficacy ceiling; user saturation can lead to desensitization, indicating that technology should be a complement, rather than a substitute, for active outreach and in-person health education.

Upon analyzing population heterogeneity, it becomes evident that while multicomponent strategies, combining digital notifications with direct support, had superior results among the elderly, for younger populations and in developing countries, mobility and immediate access via mobile applications were the key differentiators. However, the efficacy of these platforms is frequently curtailed by digital inequality. Infrastructure instability and low digital literacy are barriers that may exacerbate health inequities if the digitalization of immunization services is not accompanied by policies aimed at technological inclusion.

Due to the rapid technological progress, facilitating access to information and organizing individual vaccination records have become pillars for restoring vaccination coverage rates. The increased use of mobile applications (apps) represents a central strategy for facilitating access to information and the organization of individual vaccination data. Tools such as "Conecte SUS" and "Minhas Vacinas no Brasil", as well as "CANImmunize" and "MyIR Mobile" internationally, exemplify how digital record-keeping and personalized reminders can integrate citizens into public health systems. [13, 14, 15, 16]

Thus, the development of mobile applications and the application of artificial intelligence techniques for data cross-referencing, identifying at-risk population groups, and proposing personalized vaccination interventions emerge as promising technological tools for strengthening immunization strategies. However, the implementation of these innovations faces obstacles such as digital exclusion and socioeconomic inequalities, which may marginalize those populations with the greatest immunological vulnerability. The lack of interoperability among different health information systems, together with growing concerns regarding the privacy of sensitive data, shows barriers to the full effectiveness of these technologies. To fulfill their role, such interventions must be integrated into robust public policies and investments in technological infrastructure, recognizing that technology serves as an educational and logistical support tool that does not replace the need for in-person strategies to foster acceptance and adherence.

Regarding the limitations of this review, particular note is made of the bibliographic restriction to Portuguese, English, and Spanish, which may have resulted in the omission of successful experiences from countries with high digital maturity in other regions. The selection of descriptors and the necessary strategic differentiation between search strategies across the PubMed and LILACS databases may have influenced the scope of data retrieval and the identification of duplicates. A gap is also observed between the numerous practical technological initiatives and their proper systematization in indexed scientific journals, limiting the volume of robust evidence available for analysis. Despite these limitations, this study systematizes current knowledge and provides a foundation for the development of digital strategies aimed at

expanding vaccination coverage and reducing global morbidity and mortality.

CONCLUSION

Digital technologies show promise as tools for promoting public health, offering a favorable cost-benefit profile for restoring and maintaining vaccination coverage. This review highlights that strategies such as mHealth (SMS and automated calls) and the use of mobile applications optimize vaccine adherence by facilitating the individual organization of immunization records. However, the findings underscore that technology is not a standalone solution; its effectiveness is contingent upon infrastructural stability and integration with public policies for digital inclusion.

Clinical practice recommends that health managers use these tools to support multicomponent strategies, avoiding the isolated delivery of messages to prevent user saturation. Applications and digital health records should prioritize data interoperability and information security to ensure continuity of care across different life cycles.

Although the body of evidence remains nascent based on the pace of innovation, expanding investigations are imperative. It is recommended that future research focus on the impact of emerging technologies, such as Artificial Intelligence, and on methods to overcome digital exclusion among vulnerable populations, ensuring that technological transformation translates into a sustainable enhancement of immunological protection on a global scale.

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DOI: 10.32443/2175-2990 (2025)496

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Statement of responsibility: We declare that all authors participated in the construction, development, and preparation of the work.

Funding: The authors declare that there was no funding or financial support source for the execution, preparation, or publication of this manuscript.

Conflict of interest: The authors declare that there is no conflict of interest regarding this research, the authorship, or the publication of this article.

How to cite this article: Melo MCB, Melo GO, Melo CO, Melo VMO. Digital Technologies: Tools for Increasing Vaccination Coverage. Latin Am J telehealth, Belo Horizonte, 2025; 12(2): 136-143 ISSN: 2175-2990.