The Determinants of Digital Health immunization technology; A Systematic Review

Reem Dhafer Alshehri[1*], Regidor III Poblete Dioso[2]

[1]School of Nursing & Applied Science, Lincoln University College, Malaysia, Reem11ss@hotmail.com

[2]School of Nursing & Applied Science, Lincoln University College, Malaysia, duke@lincoln.edu.my

[*]Corresponding Author's E-mail: Reem11ss@hotmail.com

Abstract: *Digital health technologies have become central to modern immunization systems, replacing paper-based processes with electronic registries, mobile health applications, interoperable platforms, and digital decision-support tools. While these innovations promise improvements in vaccination coverage, data quality, and program efficiency, their adoption and effectiveness vary widely across health system contexts. Fragmented evidence, diverse technologies, and inconsistent outcomes have made it difficult to understand what truly enables or constrains successful digital immunization implementation. This study therefore aimed to systematically identify and synthesize the key determinants of digital health immunization technology across global settings. A systematic review was conducted following PRISMA 2020 guidelines, drawing on multiple academic databases and applying clear inclusion and exclusion criteria to select empirical studies relevant to digital immunization systems. Thirty peer-reviewed studies were analysed using thematic synthesis to categorize determinants into technological, behavioural, organizational, and contextual domains. The findings reveal that electronic immunization registries, community-based mHealth tools, system interoperability, workforce capacity, governance structures, and digital infrastructure are the most influential determinants of performance. Positive outcomes were most consistently observed in vaccination coverage, timeliness, data reliability, and workflow efficiency, particularly when digital tools were embedded within well-coordinated health systems. The review concludes that digital immunization technologies are most effective when technological innovation is accompanied by strong leadership, sustained investment, user-cantered design, and supportive policy environments, rather than being implemented as isolated technical solutions.*

Keywords: Digital health; Immunization technology; Systematic review; Vaccine systems; Health information system.

1. Introduction

The rapid digitalization of health systems has transformed how immunization programs are planned, delivered, and monitored. Digital health immunization technologies such as electronic immunization registries, mHealth applications, decision-support systems, and interoperable health information platforms are increasingly embedded in routine vaccination services. These technologies enable real-

time tracking of immunization status, facilitate data sharing across systems, and support evidence-based decision-making at facility, district, and national levels. The transition from paper-based to digital immunization systems has been associated with improved data visibility, more efficient workflows, and stronger program management in national immunization programs (Dang, 2024). Despite these advancements, the implementation and effectiveness of digital immunization technologies vary considerably across different health system contexts. In many low- and middle-income countries, digital tools are deployed alongside traditional systems to strengthen vaccination coverage and timeliness, yet their success depends on infrastructure, connectivity, and workforce readiness. Evidence suggests that community-based digital interventions, particularly those involving community health workers, can significantly improve childhood immunization uptake when integrated with local health services (Gebreeyesus et al., 2025). However, weak digital infrastructure, limited training, and fragmented systems continue to hinder optimal use of these technologies in resource-constrained settings (Feroz et al., 2021).

Beyond technical capabilities, human and organizational factors play a central role in shaping digital immunization outcomes. Health workers' digital readiness, perceived usefulness of technology, and access to training influence the adoption and sustained use of digital tools. At the same time, governance structures, policy alignment, and leadership commitment determine whether digital systems are effectively scaled and integrated into national health strategies. Strengthening regional and national vaccination information systems has been shown to require coordinated governance mechanisms, clear accountability structures, and sustained institutional support (Shragai et al., 2024). Interoperability between digital immunization registries and other health information systems has emerged as a critical determinant of system performance. When electronic immunization records are integrated with electronic health records and national databases, they reduce duplication, enhance continuity of care, and streamline clinical workflows. Research indicates that stronger interoperability between immunization information systems and electronic health records improves vaccination workflows and data accuracy in clinical practice (Dombkowski et al., 2025). Nonetheless, inconsistent data standards and fragmented digital platforms remain major barriers to full system integration (Scharf et al., 2021).

In parallel, digital reminders, decision-support tools, and mobile applications have become key strategies for addressing vaccine hesitancy and improving uptake. Educational and reminder-based digital interventions have demonstrated effectiveness in increasing vaccination acceptance and completion rates, particularly for HPV vaccination (Chandeying & Thongseiratch, 2023). Similarly, digital interventions designed to address vaccine hesitancy have shown potential in shaping public perceptions and encouraging timely vaccination (Knight et al., 2021). Given the diversity of technologies, settings, and outcomes reported in the literature, existing evidence on digital health immunization systems remains fragmented. Some studies focus on technical infrastructure, others emphasize human factors, while few integrate technological, behavioral, organizational, and contextual determinants within a single framework. Systematic reviews of digital immunization technologies highlight the need for comprehensive synthesis across different interventions, populations, and health system contexts (Dudeja et al., 2024). Therefore, this paper aims to systematically review and synthesize empirical evidence on the determinants of digital health immunization technology. By analyzing studies across multiple regions and methodological approaches, the review seeks to identify common enablers, persistent barriers, and key determinants influencing digital immunization adoption, implementation, and outcomes. The findings are intended to inform policymakers, practitioners, and researchers in designing more effective, equitable, and sustainable digital immunization strategies (Wang et al., 2023).

2. Methodology

This study adopted a systematic review approach guided by the PRISMA 2020 (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) framework to ensure transparency, rigor, and reproducibility in identifying, selecting, and synthesizing evidence on digital health immunization technologies. The review was designed to capture empirical studies that examined digital tools, systems, or interventions used to support immunization programs, including electronic immunization registries, mHealth applications, interoperable health information systems, and digital decision-support platforms. The systematic approach enabled the integration of findings from diverse methodological designs, including quantitative, qualitative, mixed-methods, and implementation studies (Dudeja et al., 2024). A comprehensive search strategy was developed using multiple academic databases, including PubMed, Scopus, Web of Science, and Google Scholar. Search terms combined keywords related to digital health and immunization, such as "digital immunization," "electronic immunization registry," "mHealth vaccination," "immunization information system," "vaccine tracking," "electronic health records," and "digital reminders." Additional relevant studies were identified through reference list screening of key publications and manual searches of specialized digital health and public health journals. This approach ensured broad coverage of both high-income and low- and middle-income country contexts (Wang et al., 2023).

Clear inclusion and exclusion criteria were established prior to screening. Studies were included if they: (1) focused on digital health tools applied to immunization or vaccination programs, (2) reported empirical data or formal evaluations, (3) were peer-reviewed publications, and (4) were published in English. Studies were excluded if they were opinion pieces, editorials, technical manuals without empirical data, or focused solely on clinical treatment rather than vaccination systems. Both routine immunization and large-scale campaign settings were considered eligible to capture diverse implementation contexts (Mc Kenna et al., 2023). For data extraction, a structured template was developed to systematically capture key information from each included study. Extracted variables included country or region, type of digital technology (e.g., registry, mHealth, interoperability platform), study design, target population, implementation setting, key determinants, and reported outcomes such as coverage, timeliness, data quality, or system efficiency. Particular attention was given to determinants related to governance, workforce capacity, infrastructure, and system interoperability (Dang, 2024).

Data synthesis was conducted using a thematic analysis approach rather than a statistical meta-analysis, given the heterogeneity of study designs and outcome measures. Determinants were coded and organized into overarching categories, including technological, behavioral, organizational, and contextual factors. This approach allowed patterns to be identified across diverse settings, from community-based mHealth programs to national digital immunization systems (Gebreeyesus et al., 2025). To enhance validity and reliability, the extraction and synthesis process involved iterative review of findings, with cross-checking of interpretations against original studies. Implementation-focused studies were analyzed to understand not only whether digital tools worked, but how and under what conditions they were most effective. This emphasis on context was essential given the wide variation in health system capacity and digital readiness across countries (Shragai et al., 2024). The study selection process followed four sequential PRISMA stages: identification, screening, eligibility, and inclusion. In the identification phase, all records retrieved from database searches were compiled and duplicates removed. During screening, titles and abstracts were reviewed to exclude clearly irrelevant studies. In the eligibility phase, full-text articles were assessed against the inclusion criteria. Finally, studies meeting all criteria were included in the final synthesis. This process is summarized in Figure 1: PRISMA 2020 Flow Diagram (showing identification, screening, eligibility, inclusion).

The flow diagram provides a transparent account of how the final set of studies was derived from the initial search results (Brooks et al., 2024).

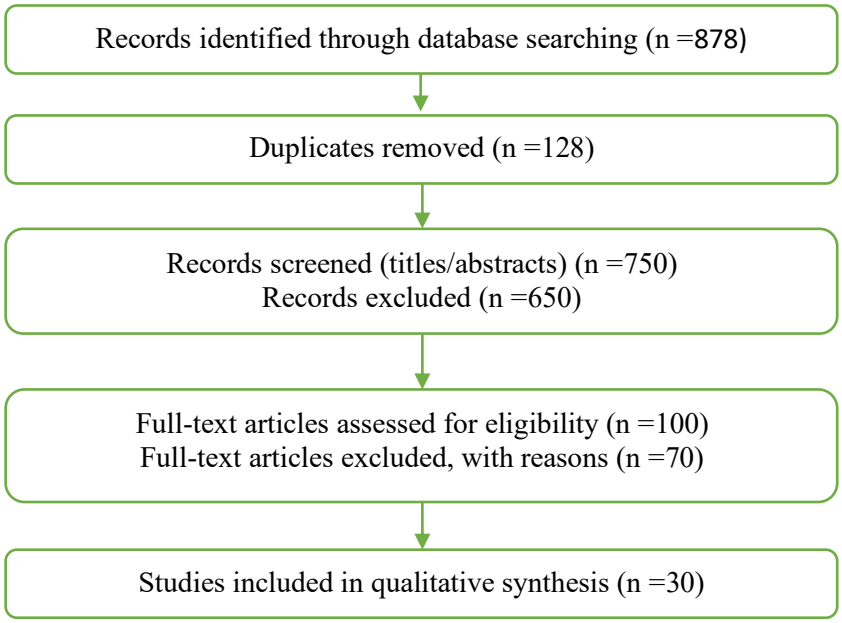

Figure 1: PRISMA 2020 Flow Diagram

3. Results

3.1 Study Selection and Characteristics

A total of 30 peer-reviewed studies met the eligibility criteria and were included in the final synthesis. These studies were conducted across diverse geographic settings, including low- and middle-income countries, high-income countries, and multi-country analyses, reflecting the global nature of digital immunization initiatives. The included studies employed a variety of methodological designs, including randomized controlled trials, mixed-methods evaluations, observational studies, implementation research, and narrative or systematic reviews of digital immunization tools. This methodological diversity enabled a comprehensive examination of both technical performance and real-world implementation challenges of digital health immunization technologies. Table 1 presents the Literature Review Matrix, mapping each included study against key determinants of digital immunization technology such as digital immunization registries, interoperability, mHealth use, training, governance, infrastructure, data quality, digital reminders, supply chain, coverage outcomes, and costs. The matrix demonstrates that electronic immunization registries and immunization information systems were the most frequently studied technologies, appearing in the majority of included articles. For example, Dang (2024) documented the transition from paper-based to digital immunization systems and its implications for program management in Vietnam. Similarly, Tchoualeu et al. (2021) illustrated how a district-level digital dashboard supported routine immunization monitoring in Nigeria.

The matrix further shows substantial attention to community-based digital approaches, particularly those involving community health workers. Juma et al. (2021) reported the use of simple mobile technologies to establish an electronic vaccination registry in Kenya. Gebreeyesus et al. (2025) provided experimental evidence that an mHealth application improved childhood vaccination

coverage and timeliness in Ethiopia. These findings highlight the prominence of decentralized, community-level digital strategies in strengthening immunization delivery. Interoperability between immunization systems and broader health information infrastructures was another recurring characteristic across studies. Scharf et al. (2021) emphasized persistent challenges in integrating immunization information systems with other digital platforms. Dombkowski et al. (2025) demonstrated that stronger interoperability between electronic health records and immunization systems improved clinical vaccination workflows. Overall, Table 1 illustrates that the included studies collectively span technological, behavioral, organizational, and contextual dimensions of digital immunization implementation.

Table 1: Literature Review Matrix

No	Author(s) & Year	Digital Immunization Registry / IIS	Interoperability (EHR / Systems)	mHealth / Community Health Workers	Training & Capacity Building	Governance / Policy Factors	Infrastructure / Connectivity	Data Quality / Monitoring	Digital Reminder / Recall	Vaccine Supply / Cold Chain	Coverage or Timeliness Outcomes	Costs / Resources
1	Dang et al. (2024)	✓			✓	✓		✓			✓	✓
2	Johri & Sharma (2022)					✓			✓			
3	Bigaard & Franceschi (2021)					✓					✓	
4	Scharf et al. (2021)	✓	✓			✓		✓				
5	Vasudevan et al. (2024)			✓	✓	✓		✓	✓		✓	
6	Shragai et al. (2024)	✓			✓	✓	✓	✓			✓	
7	Sheel et al. (2025)	✓			✓	✓		✓				
8	Wilson et al. (2023)	✓				✓					✓	
9	Tchoualeu et al. (2021)	✓			✓	✓		✓				
10	Kettlitz et al. (2025)	✓	✓					✓			✓	
11	Dudeja et al. (2024)	✓			✓	✓		✓	✓	✓	✓	
12	Chandeying & Thongseiratch (2023)				✓				✓		✓	
13	Mc Kenna et al. (2023)	✓				✓	✓	✓				
14	Ai et al. (2022)									✓		
15	Juma et al. (2021)	✓		✓	✓			✓	✓		✓	
16	Pavia et al. (2024)	✓	✓	✓		✓	✓	✓			✓	
17	Maserat et al. (2021)	✓				✓	✓				✓	
18	Brooks et al. (2024)	✓	✓			✓		✓	✓			
19	Paul (2025)					✓	✓			✓		
20	Vasquez et al. (2024)		✓		✓			✓				
21	Feroz et al. (2021)			✓	✓	✓	✓					
22	Dombkowski et al. (2025)	✓	✓					✓				
23	Kizilkilic et al. (2024)											
24	Karkonasasi et al. (2023)								✓		✓	
25	Tsiklauri & Endeladze (2024)		✓		✓	✓						

No	Author(s) & Year	Digital Immunization Registry / IIS	Interoperability (EHR / Systems)	mHealth / Community Health Workers	Training & Capacity Building	Governance / Policy Factors	Infrastructure / Connectivity	Data Quality / Monitoring	Digital Reminder / Recall	Vaccine Supply / Cold Chain	Coverage or Timeliness Outcomes	Costs / Resources
26	**Gebreeyesus et al. (2025)**			✓					✓		✓	
27	**Boikos et al. (2022)**		✓									
28	**Ahmed et al. (2025)**			✓		✓	✓					
29	**Knight et al. (2021)**			✓								
30	**Torella et al. (2023)**			✓					✓		✓	✓

3.2 Prevalence and Determinants

Analysis of the literature reveals that digital immunization registries and immunization information systems represent the most prevalent technological determinant across studies. National and subnational registries were commonly implemented to improve data visibility, reduce duplication, and support real-time decision-making in vaccination programs. Brooks et al. (2024) showed that developing national COVID-19 vaccination information systems was central to monitoring vaccine rollout across multiple countries. Sheel et al. (2025) similarly highlighted the role of electronic immunization registers in strengthening routine data quality and accountability. mHealth interventions and community health worker engagement emerged as another dominant determinant. Studies consistently demonstrated that mobile tools used by frontline workers enhanced service reach, follow-up, and timeliness of vaccinations. Vasudevan et al. (2024) described how a responsive digital health system combined with community health workers improved vaccination coverage in resource-limited settings. Feroz et al. (2021) further illustrated how equipping community health workers with digital tools strengthened pandemic response capacity in low- and middle-income countries.

Governance, policy alignment, and institutional coordination were repeatedly identified as critical contextual determinants. Shragai et al. (2024) documented how strengthening regional governance structures improved the functionality of the WHO AFRO COVID-19 vaccination information system. Maserat et al. (2021) emphasized that national e-health roadmaps were essential for coherent digital vaccine strategies in Iran. These findings suggest that technical solutions alone are insufficient without supportive policy environments. Infrastructure and connectivity also strongly influenced digital immunization performance. Many studies reported that limited internet access, weak power supply, and fragmented digital ecosystems constrained system effectiveness, particularly in rural settings. Ai et al. (2022) demonstrated that a traceable vaccine supply management system depended on reliable digital infrastructure to ensure cold-chain monitoring. Paul (2025) further emphasized that resilient pharmaceutical supply chains were inseparable from robust digital systems. Finally, digital reminders and decision-support tools were frequently used to address vaccine hesitancy and improve uptake. Chandeying and Thongseiratch (2023) found that digital educational and reminder interventions significantly increased HPV vaccination rates. Knight et al. (2021) showed that a tailored digital intervention could reduce vaccine hesitancy and promote timely immunization.

3.3 Outcomes

Across the included studies, the most commonly reported outcomes related to vaccination coverage, timeliness, data quality, and system efficiency. Multiple studies demonstrated that digital immunization tools were associated with measurable improvements in vaccination uptake. Dang (2024) reported enhanced coverage and operational efficiency following the shift to a digital immunization system in Vietnam. Gebreeyesus et al. (2025) provided randomized trial evidence that mHealth applications improved both coverage and timeliness of childhood vaccinations. Data quality outcomes were also consistently positive when digital systems were effectively implemented. Tchoualeu et al. (2021) showed that a digital dashboard improved accuracy and use of routine immunization data in Nigeria. Brooks et al. (2024) similarly found that national digital systems enhanced surveillance and reporting of COVID-19 vaccinations. These improvements in data reliability strengthened program planning and accountability.

Digital tools were also associated with better workflow efficiency and reduced administrative burden. Dombkowski et al. (2025) demonstrated that interoperable electronic health records streamlined clinical vaccination processes and reduced duplication of effort. Pavia et al. (2024) highlighted that integrating digital solutions with immunization strategies improved both service delivery and monitoring in the post-COVID-19 era. Several studies addressed cost and resource implications of digital systems. Dang (2024) provided evidence that digital transition generated long-term efficiencies despite initial investment costs. Wang et al. (2023) synthesized evidence that many digital health interventions for vaccination were cost-effective when implemented at scale. However, Paul (2025) cautioned that sustainable financing models were necessary to maintain digital infrastructure over time. Finally, equity outcomes varied across contexts. While digital systems expanded reach in many settings, disparities persisted where connectivity or digital literacy was limited. Feroz et al. (2021) noted that digital tools benefited underserved communities when accompanied by adequate training and support. Overall, the evidence suggests that digital immunization technologies can improve coverage, timeliness, and data quality, but their success depends on enabling environments, governance, and infrastructure.

4. Discussion

4.1 Interplay of Behavioral, Organizational, and Contextual Determinants

The findings of this review indicate that the effectiveness of digital health immunization technologies is not determined by technology alone but by the dynamic interaction between behavioral, organizational, and contextual factors. At the behavioral level, the attitudes, digital readiness, and confidence of health workers and caregivers strongly shape how digital tools are used in practice. When community health workers perceive digital platforms as useful and compatible with their routine tasks, adoption and sustained use are more likely, which in turn improves vaccination outcomes. Vasudevan et al. (2024) demonstrated that community health workers supported by a responsive digital platform were able to improve vaccination coverage and timeliness in resource-limited settings. Feroz et al. (2021) similarly showed that equipping frontline workers with digital tools strengthened their capacity to deliver immunization services during public health emergencies. At the organizational level, leadership commitment, institutional coordination, and structured training emerged as essential enablers of successful digital implementation. Digital systems were most effective when integrated into routine program management rather than treated as standalone technological add-ons. Shragai et al. (2024) illustrated that stronger governance arrangements within

regional vaccination information systems improved data use, accountability, and system performance. Sheel et al. (2025) further highlighted that continuous institutional support and structured evaluation were critical for sustaining electronic immunization registers over time.

Contextual determinants, particularly infrastructure, connectivity, and policy alignment, significantly influenced how digital tools translated into outcomes. In settings with unstable internet connectivity or fragmented health information systems, the potential benefits of digital technologies were often constrained. Ai et al. (2022) showed that a traceable vaccine supply management system depended heavily on reliable digital infrastructure to maintain cold-chain monitoring and supply integrity. Maserat et al. (2021) emphasized that coherent national e-health roadmaps were necessary to align digital immunization initiatives with broader health system strategies. Overall, behavioral, organizational, and contextual determinants operated as interdependent components rather than isolated factors. When supportive policies, adequate infrastructure, and well-trained health workers coexisted, digital immunization technologies generated the greatest improvements in coverage, timeliness, and data quality. Conversely, weaknesses in any one domain often limited overall system effectiveness, underscoring the need for integrated, multi-level implementation strategies.

4.2 Policy, Practical, and Theoretical Implications

From a policy perspective, this review highlights the importance of national coordination, interoperability, and sustainable financing in digital immunization systems. Brooks et al. (2024) showed that countries with coordinated national vaccination information systems were better able to monitor and manage COVID-19 vaccine rollout. Paul (2025) argued that resilient pharmaceutical supply chains require long-term investment in digital infrastructure and stable governance mechanisms to remain effective beyond emergency contexts. At a practical level, health systems should prioritize continuous training, technical support, and user engagement when implementing digital immunization tools. Juma et al. (2021) demonstrated that simple mobile technologies improved registry functions when accompanied by local capacity building and user support. Gebreeyesus et al. (2025) found that mHealth applications improved vaccination outcomes when embedded within routine service delivery rather than implemented as short-term pilot projects.

System design should also be user-centered and aligned with existing clinical workflows. Dombkowski et al. (2025) showed that interoperability between electronic health records and immunization systems reduced administrative burden and improved clinical efficiency. Vasquez et al. (2024) emphasized that applying human-factors methods in digital decision-support design can enhance usability, acceptability, and real-world impact. Theoretically, the findings reinforce socio-technical perspectives in digital health implementation, which emphasize the interaction between technology, people, and context. Rather than treating digital tools as neutral instruments, this review suggests that their effectiveness depends on social, organizational, and structural conditions. Chandeying and Thongseiratch (2023) illustrated how digital reminders influence both cognitive perceptions and behavioral responses to vaccination, supporting theories that link technology use to psychological and social processes.

4.3 Comparison with Existing Reviews, Limitations, and Future Research

Compared with prior reviews, this study provides a broader synthesis of determinants across multiple types of digital immunization technologies, including registries, mHealth tools, interoperability platforms, and decision-support systems. Dudeja et al. (2024) primarily examined technological

solutions for strengthening immunization coverage in India, whereas the present review integrates evidence from diverse global contexts. Mc Kenna et al. (2023) focused mainly on digital tools in emergency vaccination campaigns, while this review also considers routine immunization systems. Despite its contributions, this review has several limitations. First, only English-language publications were included, which may have excluded relevant studies from non-English speaking regions. Second, the heterogeneity of study designs, populations, and outcome measures limited the feasibility of conducting a quantitative meta-analysis. Wang et al. (2023) similarly noted that cost-effectiveness studies in digital vaccination often use varied methods, making direct comparison difficult.

Another limitation relates to potential publication bias, as studies reporting positive outcomes are more likely to be published than those documenting implementation challenges or failures. Additionally, some digital immunization initiatives in low-resource settings may not have been formally evaluated or published in academic journals, leading to underrepresentation in the literature. Future research should prioritize comparative, multi-country studies using standardized outcome measures such as coverage, timeliness, data quality, and cost-effectiveness. Longitudinal studies are needed to assess the sustainability of digital interventions beyond initial implementation phases. Brooks et al. (2024) suggested that cross-country analyses could strengthen understanding of best practices in national vaccination information systems. Further research should also examine how digital tools can reduce inequities in vaccination access, particularly in rural and marginalized communities, building on insights from Feroz et al. (2021).

5. Conclusion

This systematic review synthesized evidence on the determinants of digital health immunization technologies across diverse health system contexts. The findings demonstrate that successful digital immunization implementation depends not only on technological capabilities but also on the alignment of behavioral, organizational, and contextual factors. Digital tools such as electronic immunization registries, mHealth applications, interoperable systems, and decision-support platforms have considerable potential to strengthen vaccination programs, improve data quality, and enhance service delivery. However, their effectiveness is strongly mediated by workforce readiness, governance structures, infrastructure availability, and policy coherence. The review highlights that digital immunization technologies are most impactful when embedded within well-coordinated health systems rather than implemented as isolated interventions. Community engagement, continuous capacity building, and user-centered system design emerged as critical elements for sustainable adoption. At the same time, robust digital infrastructure and interoperable health information systems are essential for realizing the full benefits of digital transformation in immunization programs. Overall, digital health immunization technologies represent a powerful strategy for improving vaccination coverage, timeliness, and monitoring. Yet, achieving these benefits requires integrated, multi-level approaches that combine technological innovation with strong institutional support, adequate resources, and supportive policy environments. Future efforts should therefore focus on strengthening health system readiness, ensuring equitable access to digital tools, and promoting long-term sustainability of digital immunization initiatives.

Acknowledgement

The authors would like to express sincere gratitude to everyone who contributed, both directly and indirectly, to the completion of this study, including academic advisors, reviewers, and institutional supporters who facilitated access to scholarly resources.

Conflict of Interest Statement

The authors declare that there is no conflict of interest regarding the publication of this study.

References

Ahmed, M. M., Okesanya, O. J., Olaleke, N. O., Adigun, O. A., Adebayo, U. O., Oso, T. A., ... & Lucero-Prisno III, D. E. (2025, May). Integrating Digital Health Innovations to Achieve Universal Health Coverage: Promoting Health Outcomes and Quality Through Global Public Health Equity. In Healthcare (Vol. 13, No. 9, p. 1060). MDPI.

Ai, Y., Chen, C. L., Weng, W., Chiang, M. L., Deng, Y. Y., & Lim, Z. Y. (2022). A traceable vaccine supply management system. Sensors, 22(24), 9670.

Bigaard, J., & Franceschi, S. (2021). Vaccination against HPV: boosting coverage and tackling misinformation. Molecular Oncology, 15(3), 770-778.

Boikos, C., Imran, M., De Lusignan, S., Ortiz, J. R., Patriarca, P. A., & Mansi, J. A. (2022). Integrating electronic medical records and claims data for influenza vaccine research. Vaccines, 10(5), 727.

Brooks, D. J., Kim, C. I., Mboussou, F. F., & Danovaro-Holliday, M. C. (2024). Developing national information systems to monitor COVID-19 vaccination: a global observational study. JMIR Public Health and Surveillance, 10, e62657.

Chandeying, N., & Thongseiratch, T. (2023). Systematic review and meta-analysis comparing educational and reminder digital interventions for promoting HPV vaccination uptake. NPJ Digital Medicine, 6(1), 162.

Dang, T. T. H., Carnahan, E., Nguyen, L., Mvundura, M., Dao, S., Duong, T. H., ... & Nguyen, N. (2024). Outcomes and costs of the transition from a paper-based immunization system to a Digital Immunization System in Vietnam: mixed methods study. Journal of Medical Internet Research, 26, e45070.

Dombkowski, K. J., Patel, P. N., Peng, H. K., & Cowan, A. E. (2025). The Effect of Electronic Health Record and Immunization Information System Interoperability on Medical Practice Vaccination Workflow. Applied Clinical Informatics, 16(01), 101-110.

Dudeja, N., Khan, T., Varughese, D. T., Abraham, S. G., Ninan, M. M., Prasad, C. L., ... & Kang, G. (2024). Technologies for strengthening immunization coverage in India: a systematic review. The Lancet Regional Health-Southeast Asia, 23.

Feroz, A. S., Khoja, A., & Saleem, S. (2021). Equipping community health workers with digital tools for pandemic response in LMICs. Archives of Public Health, 79(1), 1.

Gebreeyesus, F. A., Temere, B. C., Amlak, B. T., Tarekegn, T. T., Shiferaw, B. Z., Emire, M. S., ... & Lane-Krebs, K. (2025). The effect of mHealth application on improving childhood immunization coverage and timeliness: a case of the Gurage Zone, SNNPR, Ethiopia, a randomized controlled trial. BMC Public Health.

Johri, A., & Sharma, A. (2022). Case Study–Quick Response (QR) Code Based Immunization Solution. In Designing Development: Case Study of an International Education and Outreach Program (pp. 33-69). Cham: Springer International Publishing.

Juma, S., Tabu, C., Gura, Z., Waweru, S., & Njeru, I. (2021). Use of Simple Mobile Technology to Create an Electronic Vaccination Registry in Kenya.

Karkonasasi, K., Cheah, Y. N., Vadiveloo, M., & Mousavi, S. A. (2023). Acceptance of a text messaging vaccination reminder and recall system in Malaysia's healthcare sector: extending the technology acceptance model. Vaccines, 11(8), 1331.

Kettlitz, R., Harries, M., Contreras, S., Reinecke, J., Wieder, M. S., von Lengerke, T., ... & Klett-Tammen, C. J. (2025). Self-reported poliomyelitis vaccination and documentation in adults indicates high uptake: a digital German epidemic panel, December 2024. BMC Public Health, 25(1), 3514.

Kizilkilic, S. E., Xu, L., Van Erum, H., Falter, M., De Pauw, M., Dendale, P., & Kindermans, H. (2024). Digital health readiness, health literacy, and patients' awareness in cardiac (tele) rehabilitation participation. European Journal of Preventive Cardiology, 31(Supplement_1), zwae175-105.

Knight, H., Jia, R., Ayling, K., Bradbury, K., Baker, K., Chalder, T., ... & Vedhara, K. (2021). Understanding and addressing vaccine hesitancy in the context of COVID-19: development of a digital intervention. Public health, 201, 98-107.

Maserat, E., Keikha, L., Davoodi, S., & Mohammadzadeh, Z. (2021). E-health roadmap for COVID-19 vaccine coverage in Iran. BMC public health, 21(1), 1450.

Mc Kenna, P., Broadfield, L. A., Willems, A., Masyn, S., Pattery, T., & Draghia-Akli, R. (2023). Digital health technology used in emergency large-scale vaccination campaigns in low-and middle-income countries: a narrative review for improved pandemic preparedness. Expert Review of Vaccines, 22(1), 243-255.

Paul, J. (2025). SUSTAINABLE AND RESILIENT PHARMACEUTICAL SUPPLY CHAINS: LESSONS FROM COVID-19 AND BEYOND.

Pavia, G., Branda, F., Ciccozzi, A., Romano, C., Locci, C., Azzena, I., ... & Scarpa, F. (2024). Integrating digital health solutions with immunization strategies: improving immunization coverage and monitoring in the Post-COVID-19 era. Vaccines, 12(8), 847.

Scharf, L. G., Coyle, R., Adeniyi, K., Fath, J., Harris, L., Myerburg, S., ... & Abbott, E. (2021). Current challenges and future possibilities for immunization information systems. Academic pediatrics, 21(4), S57-S64.

Sheel, M., Patel, C., Saravanos, G., Lynch, M., Tinessia, A., Chanlivong, N., ... & Danovaro-Holliday, M. C. (2025). Strengthening Immunization Data: Protocol for the Evaluation of an Electronic Immunization Register. JMIR Research Protocols, 14(1), e65663.

Shragai, T., Bukhari, A., Atagbaza, A. O., Oyaole, D. R., Shah, R., Volkmann, K., ... & Impouma, B. (2024). Strengthening the WHO Regional Office for Africa (WHO AFRO) COVID-19 vaccination information system. BMJ Global Health, 9(1).

Tchoualeu, D. D., Elmousaad, H. E., Osadebe, L. U., Adegoke, O. J., Nnadi, C., Haladu, S. A., ... & Sandhu, H. S. (2021). Use of a district health information system 2 routine immunization dashboard for immunization program monitoring and decision making, Kano State, Nigeria. The Pan African Medical Journal, 40(Suppl 1), 2.

Tsiklauri, N., & Endeladze, M. (2024, October). International Challenges with Digital Transformation to Manage Pandemics and Viral Infections. In International Scientific-Practical Conference (pp. 351-363). Cham: Springer Nature Switzerland.

Vasquez, H. M., Pianarosa, E., Sirbu, R., Diemert, L. M., Cunningham, H., Harish, V., ... & Rosella, L. C. (2024). Human factors methods in the design of digital decision support systems for population health: a scoping review. BMC Public Health, 24(1), 2458.

Vasudevan, L., Ostermann, J., Thielman, N., Baumgartner, J. N., Solomon, D., Mosses, A., ... & Ngadaya, E. (2024). Leveraging Community Health Workers and a Responsive Digital Health System to Improve Vaccination Coverage and Timeliness in Resource-Limited Settings: Protocol for a Cluster Randomized Type 1 Effectiveness-Implementation Hybrid Study. JMIR research protocols, 13(1), e52523.

Wang, Y., Fekadu, G., & You, J. H. S. (2023). Cost-effectiveness analyses of digital health technology for improving the uptake of vaccination programs: systematic review. Journal of Medical Internet Research, 25, e45493.

Wilson, K., Wilson, L. A., Rusk, K. T., Henry, J. L., Denize, K. M., Hsu, A. T., & Sveistrup, H. (2023). Digital immunization tracking in long-term care and assisted living facilities. Canadian Journal on Aging/La Revue canadienne du vieillissement, 42(3), 516-519.