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# Development of Health Information System Interoperability Models to Improve Primary Care Performance

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**ABSTRACT**

This study aims to develop a health information system interoperability model to improve primary care performance. The study addresses the problem of fragmented digital health systems, duplicate data entry, uneven facility readiness, and workflow disruption in primary care services. A qualitative case study design was used in Yogyakarta City, Indonesia, from January to March 2026. Data were collected through semi-structured interviews, non-participant observation, and documentation involving doctors, nurses, midwives, medical record officers, information technology staff, heads of primary care facilities, clinic managers, and local health office officers. Participants were selected through purposive sampling, with snowball sampling used to identify additional informants with specific knowledge of system integration. Thematic analysis identified five main themes: fragmented data entry, uneven readiness of facilities, disruption of service workflows, informal adaptation by health workers, and the need for a socio-technical interoperability model. The findings show that interoperability must combine technical connectivity, semantic standardization, organizational readiness, data governance, and workflow integration. This study contributes to a deeper understanding of digital health implementation by showing that interoperability improves primary care performance when it supports real service processes and reduces administrative burden. The study implies that policymakers and health facility managers need to strengthen standards, training, technical support, and user-centered system evaluation. Further research should test the proposed model across different primary care settings and measure its effect on service quality, reporting accuracy, referral coordination, and health worker workload.



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## 1. Introduction

Digital transformation in health care has become a strategic issue in strengthening primary care performance. Primary care functions as the first point of contact between communities and the health system, so the quality of its information flow directly affects service continuity, clinical decision-making, referral coordination, and population health monitoring. In many countries,

health facilities have adopted electronic medical records, digital reporting systems, telehealth platforms, and disease surveillance applications. However, these systems often develop separately and use different data structures, workflows, and technical standards. This condition creates fragmentation in patient data and weakens the value of digitalization. Electronic health record interoperability can support patient safety, service quality, productivity, and cost efficiency when health data can move across systems in a meaningful and secure way (Li et al., 2022). Torab-Miandoab et al. (2023) also argue that the lack of interoperability reduces care quality and wastes resources because health professionals must repeat data entry or make decisions with incomplete information. Therefore, interoperability should be treated as a core requirement for improving primary care performance.

In Indonesia, the urgency of health information system interoperability has increased with the development of the national digital health ecosystem through SATUSEHAT. This platform aims to enable health data exchange among health care organizations, especially Puskesmas and private clinics. The role of primary care is crucial because patient data are first recorded, updated, and used at this level. Aisyah et al. (2024) found that the maturity of information and communication technology in Indonesian primary health care remains between the basic and good levels, with gaps in human resources, software, hardware, and infrastructure. Heryawan et al. (2025) also identified several pain points in SATUSEHAT implementation, including FHIR server issues, FHIR profile selection problems, and difficulties in mapping electronic medical record data into standardized terminology. These findings indicate that interoperability is not only a technical agenda. It also involves organizational readiness, data governance, user capacity, workflow alignment, and policy support at the local health facility level.

Field problems in primary care often appear in practical and everyday forms. Health workers may need to enter the same patient data into several applications, adjust reports to different formats, and return to manual records when internet access or system servers are unstable. Some facilities already store patient data digitally, but these data cannot always be exchanged, interpreted, or reused by other systems. As a result, digital systems do not always reduce administrative workload. In some cases, they increase the burden on doctors, nurses, midwives, medical record officers, and information technology staff. Chukwu et al. (2022) found a similar pattern in Sierra Leone, where many digital health solutions were available in health facilities, but only limited data exchange occurred across systems. Fava and Lapão (2024) explain that digital primary health care interventions can improve access, coordination, and efficiency, but their success depends on how well technologies fit user needs and service processes. This means that interoperability must be understood through the experience of the actors who use, manage, and depend on the system.

The issue is important from social, organizational, and policy perspectives. From a social perspective, patients expect primary care facilities to provide fast, continuous, and coordinated services without repeated registration or repeated explanation of their medical history. From an organizational perspective, integrated information systems can reduce duplicate work, improve reporting accuracy, support referral management, and help facility managers monitor service performance. From a policy perspective, interoperable data can support public health surveillance, resource allocation, and evidence-based decision-making. Silva et al. (2024) developed a digital health evaluation model for primary care that considers first contact, longitudinality, comprehensiveness, and coordination. These dimensions are closely related to primary care performance. De Figueirêdo et al. (2024) also emphasize that digital health quality in primary care should be assessed through structure, process, and result dimensions. These studies show that interoperability should not be measured only by technical connectivity, but also by its contribution to service quality and health system responsiveness.

Previous studies have discussed interoperability from several perspectives, including FHIR architecture, electronic health record exchange, semantic standards, privacy, digital maturity, and

system integration. These studies provide important technical and policy insights. However, fewer studies have explored how primary care actors experience interoperability challenges, how they adapt to fragmented systems, and what model they consider suitable for their workflow. This gap is important because the success of interoperability depends on socio-technical interaction among users, technology, organization, regulation, data standards, and service culture. The socio-technical system perspective explains that information system success cannot be separated from human behavior, institutional context, and organizational routines. Hamilton and Finley (2020) note that qualitative methods are useful in implementation research because they help explain how and why an intervention succeeds or fails in real-world settings. Therefore, a qualitative study is needed to understand the meaning, experience, and process behind interoperability implementation in primary care.

This study aims to develop a health information system interoperability model to improve primary care performance. The study focuses on identifying interoperability needs, implementation barriers, user adaptation, data governance practices, workflow integration, and model components that fit Puskesmas and private clinics. The study is conducted in Yogyakarta City, Special Region of Yogyakarta, Indonesia, from January to March 2026. This location is selected because it represents an urban primary care setting with active digital health implementation while still facing challenges related to system integration, data standardization, infrastructure, and human resource readiness. Theoretically, this study contributes to the development of socio-technical and implementation-based health information system research. Practically, the study provides a context-sensitive interoperability model that can support better data exchange, reduce administrative workload, improve service coordination, and strengthen primary care performance.

## 2. Materials and Methods

This study uses a qualitative approach with a case study design. The case study design is selected because the research aims to explore the development of a health information system interoperability model within a real primary care context. Interoperability is not treated only as a technical connection between applications. It is examined as a socio-technical process involving health workers, facility managers, information technology staff, medical record officers, and local health authorities. This approach allows the researcher to understand how actors experience system fragmentation, how they solve data exchange problems, and how they define an ideal interoperability model. The qualitative design is also relevant to implementation research because it can explain how digital health innovation works in practice and why implementation barriers occur in daily service processes (Hamilton & Finley, 2020).

The research is conducted in Yogyakarta City, Special Region of Yogyakarta, Indonesia, from January to March 2026. The research sites include selected Puskesmas, private primary care clinics, and the Yogyakarta City Health Office. The location is determined purposively because Yogyakarta City has primary care facilities that actively use digital health systems, electronic medical records, and health reporting applications. At the same time, the facilities still face integration challenges related to data standards, application interoperability, user capacity, and technical infrastructure. The unit of analysis includes the process of health data recording, data exchange, reporting, referral coordination, and system use in primary care. This setting allows the researcher to examine interoperability not only from formal policy documents, but also from actual work practices in health facilities.

Participants are selected using purposive sampling. The main informants include doctors, nurses, midwives, medical record officers, information technology staff, heads of Puskesmas, managers of private clinics, and technical officers from the local health office. The inclusion criteria are: having at least one year of experience in using or managing health information systems, being involved in patient data recording or reporting, and being willing to provide

detailed information. The study plans to involve 20 to 25 participants, with the final number determined by data adequacy and thematic saturation. Snowball sampling is used when additional informants are needed, especially those who have specific knowledge about SATUSEHAT integration, electronic medical record administration, FHIR-based data exchange, or local system troubleshooting. This sampling strategy is suitable for qualitative research because it prioritizes information richness and relevance rather than statistical representation (Braun & Clarke, 2021a).

Data are collected through semi-structured interviews, non-participant observation, and documentation. Semi-structured interviews are used to explore participants' experiences with system use, duplicate data entry, interoperability barriers, data standardization, reporting workload, referral coordination, and expectations for an ideal interoperability model. Non-participant observation is conducted to examine patient registration, clinical documentation, electronic medical record use, reporting processes, and coordination between service units. Documentation includes technical guidelines, standard operating procedures, reporting formats, local policy documents, electronic medical record workflows, and records of system problems. Method triangulation is used to compare interview data, observation notes, and documents. This strategy is important because digital health implementation often shows a gap between written procedures and actual practice in health facilities (Byrne, 2022).

Data validity is ensured through source triangulation, method triangulation, member checking, and audit trail. Source triangulation is conducted by comparing information from clinical staff, administrative staff, information technology staff, facility leaders, and health office officers. Method triangulation is conducted by comparing findings from interviews, observations, and documents. Member checking is carried out by asking selected key informants to review the preliminary interpretation of findings. This step helps ensure that the researcher's interpretation reflects participants' experiences accurately. An audit trail is maintained by documenting the research process, interview decisions, coding development, category revision, and analytical reflections. Researcher reflexivity is also applied by recording assumptions, possible biases, and interpretive decisions during data analysis. This procedure follows the quality principles of reflexive thematic analysis, which requires transparency, coherence, and interpretive depth (Braun & Clarke, 2021b).

Data are analyzed using thematic analysis supported by the interactive model of data condensation, data display, and conclusion drawing. The analysis begins with interview transcription, repeated reading, initial coding, category development, and theme construction. Initial codes include duplicate data entry, FHIR server problems, terminology mapping, human resource readiness, data privacy, referral workflow, reporting burden, application integration, and perceived service performance. These codes are then grouped into broader categories, such as socio-technical readiness, data governance, workflow alignment, semantic interoperability, user adaptation, and primary care performance indicators. The final themes are used to develop a conceptual interoperability model for primary care. This model includes technical components, organizational components, human resource components, governance components, and performance-related components. The model is developed inductively from field data and then compared with current literature on interoperability, digital health evaluation, and primary care quality.

## 3. Results and Discussions

The analysis produced five main themes: fragmented data entry, uneven readiness of primary care facilities, workflow disruption, informal adaptation by health workers, and the need for a socio-technical interoperability model. These themes emerged from semi-structured interviews, non-participant observation, and document review at selected primary care facilities in Yogyakarta City. The findings show that interoperability problems were not only caused by technical limitations, but also by differences in work routines, staff capacity, infrastructure stability, and

local interpretation of digital health policy. Participants generally agreed that digital systems had improved data storage and reporting visibility. However, they also stated that the systems had not fully reduced workload because several applications still operated separately.

The first theme concerns fragmented data entry. Most participants reported that they had to input similar patient data into more than one system. Patient identity, diagnosis, treatment, referral status, and service reports were often entered into electronic medical records, local reporting applications, and national platforms. This duplication created frustration because health workers needed to balance clinical care and administrative reporting. One medical record officer stated, "The data are already in the electronic medical record, but we still need to open another application and enter similar information again." This finding shows that digitalization without interoperability may shift administrative burden from paper-based records to multiple digital systems. Observation also confirmed that officers often switched between applications during patient registration and service reporting, especially at peak service hours.

The second theme is uneven readiness across facilities. Some Puskesmas had stable internet access, trained staff, and internal technical support, while other facilities depended on a small number of staff who understood digital systems. Readiness was not only related to infrastructure. It also involved the ability of staff to understand data standards, troubleshoot errors, and interpret system requirements. One nurse explained, "The application is useful, but not all staff understand what to do when the data cannot be sent." This condition indicates that interoperability requires more than software availability. Facilities need human resource capacity, clear guidelines, and responsive technical support. Document analysis also showed that technical procedures existed, but staff often needed informal guidance because formal documents did not always explain practical problems faced during daily use.

The third theme relates to workflow disruption. Participants explained that system integration should follow the actual flow of primary care services. When applications did not fit the sequence of registration, examination, diagnosis, prescription, referral, and reporting, health workers had to create additional steps. This problem was most visible in services with high patient volume, such as maternal and child health, chronic disease management, and general outpatient care. A doctor stated, "The system should help us during service, not make us finish the data after service hours." This statement reflects a central concern among health workers. Interoperability must support clinical workflow in real time, not only produce data for reporting. Observation showed that some staff completed digital records after patients left because the system slowed down the service process.

The fourth theme concerns informal adaptation. Health workers developed local strategies to manage interoperability gaps. These strategies included using temporary spreadsheets, writing notes before entering data into the system, sharing instructions through messaging groups, and asking experienced staff to help with technical errors. These adaptations helped facilities maintain services, but they also created risks. Temporary records could lead to data inconsistency, delayed entry, and incomplete reporting. One IT staff member stated, "We usually make a small internal guide because the official guide is sometimes too general." This finding shows that users are not passive recipients of technology. They actively interpret, negotiate, and adjust digital systems according to local needs. However, these informal adaptations also show that formal interoperability design has not fully matched field realities.

The fifth theme is the need for a socio-technical interoperability model. Participants described an ideal model as one that connects systems, standardizes data, reduces duplicate work, protects patient information, and provides clear roles for each actor. The model should include technical components, such as standardized data formats, FHIR-based exchange, stable servers, and application programming interfaces. It should also include organizational components, such as staff training, local standard operating procedures, helpdesk support, monitoring mechanisms,

and leadership commitment. A health office officer stated, “Integration will work if facilities, vendors, and policymakers use the same standard and communicate regularly.” This statement highlights that interoperability depends on coordination among multiple actors. The findings suggest that a useful model for primary care must combine technical architecture with governance, capacity building, and workflow alignment.

**Discussion**

The findings confirm that interoperability is a socio-technical issue rather than a purely technical challenge. Fragmented data entry, uneven readiness, workflow disruption, and informal adaptation show that health information systems interact with human behavior, organizational routines, and institutional expectations. This supports the socio-technical system perspective, which views technology implementation as a process shaped by the relationship between users, tools, rules, tasks, and organizational context. The findings are also consistent with Hamilton and Finley (2020), who argue that qualitative implementation research is useful for explaining how digital innovations operate in real-world settings. In this study, the value of interoperability was not measured only by the existence of connected applications, but by how well the system supported daily primary care work.

The problem of duplicate data entry aligns with previous studies on electronic health record interoperability. Li et al. (2022) found that interoperability can improve safety, quality, productivity, and cost outcomes when health data can be exchanged effectively. However, the present study shows that these benefits may not appear when facilities still use separated applications. Health workers in this study experienced digital burden because data had to be entered repeatedly across systems. This finding is similar to Chukwu et al. (2022), who reported that digital health solutions in Sierra Leone were available but often lacked data-sharing capacity. The similarity suggests that low interoperability is a common challenge in developing health systems where digital tools grow faster than governance structures and data standards.

The finding on uneven readiness supports the study by Aisyah et al. (2024), which found that the ICT maturity of Indonesian primary health care remains at a transitional stage. In this study, readiness was not limited to internet access or device availability. It also included staff confidence, local technical support, leadership attention, and the clarity of operational procedures. This expands the meaning of digital readiness in primary care. A facility may have applications and devices, but still struggle to achieve interoperability if staff cannot manage errors, understand standards, or adapt the system to service needs. This finding also supports Bober et al. (2024), who emphasize that digital health readiness must include user capability and inclusion.

The workflow disruption found in this study strengthens the argument that digital health systems must be designed around service processes. Fava and Lapão (2024) explain that digital primary health care can improve access, coordination, and efficiency when it fits user needs and care processes. The present study provides a more specific insight: interoperability should not only connect data after services are completed, but also support real-time clinical and administrative decisions. If the system slows down registration, examination, referral, or reporting, health workers may delay data entry or create parallel records. This condition can reduce data quality and weaken the reliability of health information. Therefore, workflow alignment must become a central component of interoperability design.

The finding on informal adaptation offers an important contribution to the literature. Many studies discuss digital health implementation from the perspective of system architecture, standards, and policy. This study shows that health workers create practical solutions when systems do not fully meet local needs. These adaptations show agency and resilience, but they also reveal hidden risks in data governance. Temporary spreadsheets, manual notes, and messaging-based coordination may help maintain services, but they can produce inconsistent data and unclear accountability. This finding adds a critical perspective to studies on FHIR-based

interoperability, including Heryawan et al. (2025), who identified technical issues in SATUSEHAT implementation. Technical standards are necessary, but they must be supported by local implementation support and user-centered guidance.

The study also contributes to the development of an interoperability model for primary care. Based on the findings, the proposed model should contain five integrated components. The first component is technical interoperability, which includes standardized data formats, FHIR-based exchange, server reliability, and system connectivity. The second component is semantic interoperability, which includes shared terminology, diagnosis coding, and consistent data mapping. The third component is organizational readiness, which includes staff training, leadership support, and local operational procedures. The fourth component is data governance, which includes privacy protection, role clarity, audit mechanisms, and monitoring. The fifth component is workflow integration, which ensures that interoperability supports patient registration, clinical care, referral, reporting, and performance evaluation. These components respond to the evaluation perspective proposed by Silva et al. (2024) and de Figueirêdo et al. (2024), who emphasize that digital health quality in primary care must be linked to service structure, process, and outcomes.

The practical implication of this study is that policymakers and health facility managers should not evaluate interoperability only through technical indicators, such as system connection or data transmission success. They also need to evaluate whether the system reduces duplicate work, improves reporting accuracy, supports referral coordination, and helps health workers make decisions. Training should not only teach staff how to operate applications, but also explain why standardized data, privacy, and timely entry matter for service performance. Health offices should also provide responsive technical support and involve primary care users in system evaluation. Vendors and system developers need to design applications that follow real service workflows and reduce unnecessary data entry. For primary care facilities, the findings suggest the need to build internal digital teams that can bridge clinical, administrative, and technical functions.

The theoretical implication of this study lies in its integration of interoperability theory and socio-technical implementation research. The study shows that interoperability cannot be reduced to a technical exchange of data. It must be understood as a negotiated process that connects technology, human capacity, work culture, governance, and service performance. This perspective offers a more contextual explanation of why digital health transformation may not automatically improve primary care performance. The study also strengthens the argument that qualitative research is important for understanding the lived experience of digital health users, especially in settings where policy goals and field realities do not always align.

Future research should test the proposed interoperability model in different primary care contexts, including rural areas, private clinics, and districts with lower digital maturity. Comparative studies can examine whether the same model applies across regions with different infrastructure, governance capacity, and patient volume. Mixed-method research can also be used to measure the relationship between interoperability readiness and measurable performance indicators, such as waiting time, referral completion, reporting accuracy, and health worker workload. Further studies should also explore patient perspectives because interoperability affects not only providers, but also patient experience, continuity of care, and trust in primary health services.

## 4. Conclusions

This study concludes that health information system interoperability in primary care is not only a technical issue, but also a socio-technical process shaped by infrastructure readiness, human resource capacity, workflow alignment, data governance, and institutional coordination. The findings show five main themes: fragmented data entry, uneven facility readiness, workflow

disruption, informal adaptation by health workers, and the need for an interoperability model that integrates technical, semantic, organizational, governance, and service workflow components. These findings contribute to the literature by showing that the success of digital health transformation in primary care depends on how well interoperability supports daily clinical and administrative practices, not merely on the existence of digital applications or national data exchange platforms.

The study has theoretical, practical, and policy implications. Theoretically, it strengthens the socio-technical perspective in explaining digital health implementation in primary care. Practically, it provides a context-based interoperability model that can help health facilities reduce duplicate data entry, improve reporting accuracy, support referral coordination, and strengthen service performance. From a policy perspective, the findings suggest that interoperability development should be supported by clear standards, continuous training, responsive technical assistance, stronger data governance, and user involvement in system evaluation. Future research should test the proposed model in rural areas, private clinics, and regions with different levels of digital maturity. Mixed-method studies are also needed to examine the relationship between interoperability readiness and measurable primary care performance indicators.

## References

Abernethy, A., Adams, L., Barrett, M., Bechtel, C., Brennan, P., Butte, A., Faulkner, J., Fontaine, E., Friedhoff, S., Halamka, J., Howell, M., Johnson, K., Long, P., McGraw, D., Miller, R., Lee, P., Perlin, J., Rucker, D., Sandy, L., & Savage, L. (2022). The promise of digital health: Then, now, and the future. *NAM Perspectives, 2022*. https://doi.org/10.31478/202206e

Aisyah, D. N., Setiawan, A. H., Lokopessy, A. F., Faradiba, N., Setiaji, S., Manikam, L., & Kozlakidis, Z. (2024). The information and communication technology maturity assessment at primary health care services across 9 provinces in Indonesia: Evaluation study. *JMIR Medical Informatics, 12*, e55959. https://doi.org/10.2196/55959

Bober, T., Elnaggar, A., Autenrieth, L. K., Dev, S., Jarzabek, M., Puro, N., Xue, Y., Torous, J., & Rodriguez, J. A. (2024). Making digital health care more inclusive: Approaches to assessing digital health readiness. *JMIR mHealth and uHealth, 12*, e58035. https://doi.org/10.2196/58035

Braun, V., & Clarke, V. (2021a). Can I use TA? Should I use TA? Should I not use TA? Comparing reflexive thematic analysis and other pattern-based qualitative analytic approaches. *Counselling and Psychotherapy Research, 21*(1), 37-47. https://doi.org/10.1002/capr.12360

Braun, V., & Clarke, V. (2021b). One size fits all? What counts as quality practice in reflexive thematic analysis? *Qualitative Research in Psychology, 18*(3), 328-352. https://doi.org/10.1080/14780887.2020.1769238

Braun, V., & Clarke, V. (2022). Conceptual and design thinking for thematic analysis. *Qualitative Psychology, 9*(1), 3-26. https://doi.org/10.1037/qup0000196

Byrne, D. (2022). A worked example of Braun and Clarke's approach to reflexive thematic analysis. *Quality & Quantity, 56*, 1391-1412. https://doi.org/10.1007/s11135-021-01182-y

Chukwu, E., Garg, L., & Eze, G. (2022). Digital health solutions and state of interoperability: Landscape analysis of Sierra Leone. *JMIR Formative Research, 6*(6), e29930. https://doi.org/10.2196/29930

Cresswell, K., Williams, R., & Sheikh, A. (2025). Assessing digital maturity of hospitals: International case study. *Journal of Medical Internet Research, 27*, e57858. https://doi.org/10.2196/57858

de Figueirêdo, R. C., Silva, Í. S., Carvalho, C. J. N., Santos, T. M., & Medina, M. G. (2024). Preparation and validation of the instrument "QualiAPS Digital-Brazil" for assessing digital health care in primary health care: A required tool. *Frontiers in Public Health, 12*, 1304148. https://doi.org/10.3389/fpubh.2024.1304148

Endalamaw, A., Khatri, R. B., Mengistu, T. S., Erku, D., & Wolka, E. (2025). A scoping review of digital health technologies in care for people with multimorbidity. *BMC Health Services Research, 25*, 12548. https://doi.org/10.1186/s12913-025-12548-5

Fava, V. M. D., & Lapão, L. V. (2024). Provision of digital primary health care services: Overview of reviews. *Journal of Medical Internet Research, 26*, e53594. https://doi.org/10.2196/53594

Galazzi, A., Arrigoni, C., Dellafiore, F., Caruso, R., & Pittella, F. (2025). Recommendations to promote the digital healthcare transformation in clinical practice: Findings from an international consensus development method. *BMC Health Services Research, 25*, 13079. https://doi.org/10.1186/s12913-025-13079-9

Hamilton, A. B., & Finley, E. P. (2020). Reprint of: Qualitative methods in implementation research: An introduction. *Psychiatry Research, 283*, 112629. https://doi.org/10.1016/j.psychres.2019.112629

Heryawan, L., Mori, Y., Yamamoto, G., Kume, N., Lazuardi, L., Fuad, A., & Kuroda, T. (2025). Fast Healthcare Interoperability Resources-based interoperability design in Indonesia: Content analysis of developer hub's social networking service. *JMIR Formative Research, 9*, e51270. https://doi.org/10.2196/51270

Jerjes, W., Upile, T., Radhi, H., Petrie, A., & Kafas, P. (2024). Telemedicine in the post-COVID era: Challenges, opportunities, and future directions. *Frontiers in Digital Health, 6*, 1432871. https://doi.org/10.3389/fdgth.2024.1432871

Karami, M., Moghaddam, M. P., & Farzandipour, M. (2025). Artificial intelligence and digital health in primary health care systems in developing countries. *Frontiers in Digital Health, 7*, 1532361. https://doi.org/10.3389/fdgth.2025.1532361

Li, E., Clarke, J., Ashrafian, H., Darzi, A., & Neves, A. L. (2022). The impact of electronic health record interoperability on safety and quality of care in high-income countries: Systematic review. *Journal of Medical Internet Research, 24*(9), e38144. https://doi.org/10.2196/38144

Ndayishimiye, C., Lopes, H., & Middleton, J. (2023). A systematic scoping review of digital health technologies during COVID-19: A new normal in primary health care delivery. *Health and Technology, 13*, 273-284. https://doi.org/10.1007/s12553-023-00725-7

Silva, Í. S., Figueirêdo, R. C., Carvalho, C. J. N., Santos, T. M., & Medina, M. G. (2024). Digital health and quality of care in primary health care: An evaluation model. *Frontiers in Public Health, 12*, 1443862. https://doi.org/10.3389/fpubh.2024.1443862

Torab-Miandoab, A., Samad-Soltani, T., Jodati, A., & Rezaei-Hachesu, P. (2023). Interoperability of heterogeneous health information systems: A systematic literature review. *BMC Medical Informatics and Decision Making, 23*, 18. https://doi.org/10.1186/s12911-023-02115-5

Vasanthan, L., Natarajan, S. K., Babu, A., Kamath, M. S., & Kamalakannan, S. (2024). Digital health interventions for improving access to primary care in India: A scoping review. *PLOS Global Public Health, 4*(5), e0002645. https://doi.org/10.1371/journal.pgph.0002645

Woods, L., Cummings, E., Duff, J., & Walker, K. (2024). Strengthening rural healthcare outcomes through digital health capability. *BMC Health Services Research, 24*, 11402. https://doi.org/10.1186/s12913-024-11402-4

Xavier, P. B., Silva, Í. S., Figueirêdo, R. C., Carvalho, C. J. N., & Medina, M. G. (2024). Patient satisfaction and digital health in primary health care: A scoping review protocol. *Frontiers in Public Health, 12*, 1357688. https://doi.org/10.3389/fpubh.2024.1357688

Yi, Y., Chen, L., Li, J., & Wang, H. (2024). Digital health readiness and health information exchange in primary care: A systematic review. *BMC Health Services Research, 24*, 11876. https://doi.org/10.1186/s12913-024-11876-6

Zhang, X., & Saltman, R. (2022). Impact of electronic health record interoperability on telehealth service outcomes. *JMIR Medical Informatics, 10*(1), e31837. https://doi.org/10.2196/31837