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Impact of Electronic Immunization Record on Accurate Clinical Decision-Making in Ghana

Jacob B. Arhin
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Walden University

College of Health Sciences and Public Policy

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Jacob Arhin

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Walden University
2026

Abstract

Impact of Electronic Immunization Record on Accurate Clinical Decision-Making in
Ghana

By

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MS, Stratford University, 2015

MPhil, Walden University, 2025

Dissertation Submitted in Partial Fulfillment
of the Requirements for the Degree of
Doctor of Philosophy
Health Services

Walden University

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Abstract

The increasing complexity of healthcare delivery in Ghana highlighted the need for accurate and timely data-driven decision-making in clinical settings. The study examined how implementation affects the accuracy of immunization records, the speed of clinical decision-making, and overall immunization coverage rates in Ghanaian healthcare facilities. A quasi-experimental, cross-sectional design was used to compare clinical encounters in facilities that implemented the EIR with those that continued using paper-based systems. The Technology Acceptance Model guided the assessment of how healthcare providers' perceptions of the EIR affected system utilization, while the Data-Driven Decision-Making framework and Anderson's Behavioral Health Theoretical Model provided additional conceptual support. Findings indicated that healthcare providers who used the EIR demonstrated improved accuracy in immunization status verification ($r = 0.345$, $p < .001$, $M = 1.72$, $SD = 0.45$), increased immunization uptake and patient follow-up ($r = 0.171$, $p = .031$, $M = 1.79$, $SD = 0.41$), and increased in patient immunization coverage rate ($r = 0.503$, $p < .001$, $M = 1.92$, $SD = 0.28$). Key factors that influenced EIR adoption included perceived usefulness ($M = 1.72$, $SD = 0.45$), system usability ($M = 1.79$, $SD = 0.41$), and organizational support ($M = 1.92$, $SD = 0.28$). The potential implications for positive social change included strengthening immunization coverage, reducing preventable diseases, and improving equitable access to immunization services through enhanced digital data systems. These results supported the need for scaling EIR implementation across Ghana and offered evidence to inform future research, digital health policy development, and strategies for improving data-driven healthcare delivery in resource-limited settings.

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Chapter 1: Introduction to the Study

Introduction

Immunization remains one of the cornerstones of health service delivery, considerably reducing the morbidity and mortality associated with vaccine-preventable diseases. Although there had been substantial progress towards improving immunization coverage in Ghana, several challenges persist. In 2022, Ghana declared an estimated national immunization coverage rate of around 80%, which, although laudable, still left gaps that could harm health service (World Health Organization, 2023).

The implementation of an electronic immunization record (EIR) in Ghana has become a vital measure to improve the quality of data on immunization, which was crucial for the effective decision-making of healthcare service delivery. As countries are faced with increasing challenges associated with the management of immunization programs, the need for reliable data has become essential (World Health Organization, 2023). EIRs significantly influenced data-based decision-making processes, leading to substantial social changes in health care (World Health Organization, 2023).

A central aspect of the need for an EIR in Ghana was the facilitation of the collection and management of high-quality immunization data. According to Adoma et al. (2023), the inadequate quality of data remained an obstacle to healthy health decision-making, especially in immunization programs. An EIR can rationalize the data collection process by scanning the necessary input forms and automating data validation, thus considerably reducing human error and increasing data accuracy (Adoma et al.2023). The study pointed

out that improving data quality is essential for effective formulation of policies and resource allocation in the health system.

In addition, the ability to follow the immunization files in real time improved the decision-making capacities of healthcare providers. EIRs allowed health service professionals to monitor immunization coverage rates and identify demographic disparities, which can shed light on targeted interventions. Laryea et al. (2022) emphasized that the systematic evaluation of undesirable events after immunization contributes to a clearer understanding of the potential hesitations of immunization. The incorporation of an EIR facilitated this assessment improved data monitoring mechanisms.

The need to implement an EIR in Ghana could not be overestimated. A robust digital record improved data accuracy and immunization coverage rates across the country, ultimately supporting decision-making in health service (Ogundeko-Olugbami et al., 2025). Improving data integrity was crucial for health planning and resource allocation; it allowed health policies to be adapted according to the real needs of the population (Ogundeko-Olugbami et al., 2025). In addition, complete and accurate data on immunization were decisive in identifying and combating disparities in the provision of services, in particular among marginalized communities where access to health services was limited.

The social implications of the adoption of an EIR extended beyond simple data management. By promoting confidence in the immunization process, an EIR can help strengthen community trust and increase vaccine intake. The implementation of an EIR facilitated a more coherent integration of immunization data in broader health service networks, improving interinstitutional collaboration. This integration promoted a more

comprehensive approach to health service delivery by linking immunization data with other health indicators, such as maternal and infantile health. Hassan et al. (2023) highlighted the importance of the quality and use of routine immunization data in decision-making through Sub-Saharan Africa, highlighting the need for systems that can aggregate data from various health services. An EIR filled this gap, ultimately leading to an increased understanding of health trends and outcomes in Ghana.

In conclusion, the implementation of an electronic immunization record in Ghana is not only a technical necessity; this is a transformative step towards achieving better health results and greater equity in access to health service delivery (Hassan et al., 2023). The collective evidence of various studies, in particular those of Ghana and other sub-Saharan countries, illustrates the potential impact that this initiative can produce, which is a long-standing challenge of immunization and healthcare service delivery as a whole (Adoma et al., 2023; Addy et al., 2024; Ansah et al., 2023). The moment is opportune for Ghana to advance towards an EIR, emphasizing the integration of technology with health to lay the foundations for a healthier future.

Background

Electronic immunization records (EIR) represent a fundamental development in the field of health services, particularly within the context of immunization programs. Defined as digital systems designed to collect, administer, and analyze immunization data, thereby enabling efficient monitoring of vaccinated individuals and supporting broader health service objective (More et al., 2024). Its importance cannot be exaggerated, since they have improved the ability of health professionals to monitor immunization coverage, identify

gaps within the immunization process, and respond to outbreaks quickly (Mwogosi et al., 2024). By providing real-time data on immunization rates, EIR contributes significantly to informed, accurate health decision-making, the allocation of resources, and the implementation of policies, ultimately improving health results at various health service facilities (Mwogosi et al., 2024).

In the context of Ghana, the existing literature underlines the role of EIR in the collection and management of critical immunization data for national immunization programs. For example, Addy et al. (2024) provided an exhaustive review of the current methodologies used in the EIR of Ghana, highlighting its effectiveness to rationalize vaccine distribution efforts and reduce waste. Despite these advances, the authors notice significant challenges, including infrastructure limitations and inadequate training of medical care personnel, which hinder optimal functioning. While there has been a growing recognition of EIR's potential in Ghana, literature remained incipient with respect to its systematic evaluation and practical impacts on health results, revealing a crucial gap that guarantees greater exploration.

The current state of the EIR in Ghana, compared to other nations, illustrated a varied landscape of digital health integration within immunization frames. Recent insights of the Nigerian health surveillance system, as discussed by Ogunboye et al. (2023), revealed that although Nigeria had implemented a robust EIR that significantly improved the monitoring and coverage of immunization, Ghana had not yet taken full advantage of the capabilities of such systems. In comparison, Nigeria's investment in infrastructure and technology has led to a more simplified process, resulting in improved data collection efforts. This comparison

highlights both EIR's capabilities when they are properly supported and the need for Ghana to strengthen its digital health initiatives to align with regional progress.

To enhance the impact of EIR on decision-making processes within Ghana's health service system, greater research was essential. As articulated by Azalekor (2024), there was a pressing need to address current gaps in the literature on the effectiveness of digital health interventions, particularly those related to EIR. An exhaustive investigation of how these records influence data-based decision-making can illuminate their role in the configuration of health service policies, improve vaccine dissemination, and facilitate the training programs for health services workers.

In summary, while EIR's integration in Ghana demonstrated promise to improve immunization rates and improve health service infrastructure, significant knowledge gaps remain. This underscored the need for specific research to formally evaluate its impact on decision-making based on data within Ghana's health system, paving the way for more effective health service strategies and better health results throughout all the health service centers. Literature on electronic immunization records (EIR) had expanded in recent years, illustrating its potential to significantly improve health services results through improved data management and the provision of immunization services. However, despite these advances, substantial knowledge gaps persisted that hinder the full realization of EIR's benefits, particularly within the context of the Ghana health system. The most pressing gaps identified include problems related to data privacy, user participation, and EIR integration with existing health systems (Ogundeko-Olugbami et al., 2025).

Data privacy was a critical concern, since EIRs stored confidential health information that could be misused if not properly protected. Current literature often lacked robust frameworks to guarantee privacy and security measures adapted to local contexts, which were essential to generate trust between users and interested parties (Addy et al., 2024). This knowledge gap required comprehensive studies that explored not only the technical aspects of data protection but also the sociocultural dynamics that influenced users' perceptions and participation with EIR.

In addition, user participation was essential to facilitate the effective use of EIR. Although some studies highlighted innovative strategies used in several environments to improve the participation of interested parties, there was a shortage of research focused on specific factors that affected user participation in Ghana, including literacy levels, cultural beliefs, and training needs. Therefore, understanding and addressing these variables was essential to ensure that EIRs were not only adopted but also used to maximum potential to improve immunization rates and health service responses.

Integration with existing health systems was another crucial area where literature remains insufficient. The successful implementation of EIR often depended on its ability to work without problems with pre-existing health information systems. However, in Ghana, research had not yet fully examined the challenges and the ways to integrate EIR with established systems, such as Ghana's health databases (Azalekor, 2024) (Gyaase et al., 2021). Integral studies that evaluated these integration challenges would have illuminated the necessary processes to establish a more cohesive health architecture and facilitate the

flow of data on all platforms, thus improving the general effectiveness of immunization programs.

By arguing the need for comprehensive studies, it was essential to consider the broader implications of the EIR in decision-making based on data within Ghana's health framework. The research needed to focus on the effectiveness of the EIR to provide actionable information that led to informed decisions, particularly the resources allocation, outbreak response, and policy formulation.

This involved assessing how effectively electronic immunization registries (EIRs) supported evidence-based practices and contributed to strengthening health system resilience, as highlighted in recent literature. The use of EIRs had been shown to enhance data-driven decision-making, which was central to evidence-based practices (WHO, 2021). EIRs improved the accuracy and timeliness of immunization data, enabling health officials to identify coverage gaps, allocate resources more efficiently, and respond rapidly to outbreaks, all of which were crucial components of resilient health systems (Panunzi et al., 2022)

In summary, addressing the described knowledge gaps was essential to maximize the benefits of EIR in Ghana. Integral studies that deepened data privacy, user participation and integration challenges could not only have improved the results of immunization but also strengthened the general response of health services encounters through information-reported data.

Problem Statement

Implementing electronic immunization records (EIRs) was widely recognized in this study as a promising approach to improving the effectiveness of immunization programs by facilitating data-driven decision-making (More et al., 2024). In the context of Ghana, this study explored how such systems may support similar improvements. Studies in other low- and middle-income countries showed that EIRs enhanced data accuracy, support timely interventions that contribute to more effective immunization programs and improve overall immunization coverage rates (Goggin et al., 2021; WHO, 2021). Although evidence from Ghana remained limited, these findings provided a rationale for investigating the potential of EIRs in the Ghanaian health system. This review summarized the recent literature focused on the impact of the EIRs on the data on immunization in Ghana, which faced the prevailing challenges of immunization. It also identified the gaps in current research on health services relevant to this transformative approach.

Despite the recognized potential of electronic immunization records (EIRs) to improve data quality and support evidence-based decision-making in immunization programs, there remained a limited understanding of their effectiveness and impact within the specific context of Ghana's health system (More et al., 2024). While preliminary efforts toward digitization have begun, persistent challenges including inconsistent data quality, infrastructure limitations, and varying levels of digital literacy among health workers continue to hinder the successful implementation and integration of EIRs. Moreover, there is a notable gap in empirical and longitudinal research evaluating how EIRs influence decision-making processes and immunization outcomes at the sub-national level. This study

sought to address this gap by examining how the implementation of EIRs influenced accurate clinical decision-making in Ghana, with particular attention to the contextual factors that facilitated or hindered their effective use.

The need for solid immunization data systems was underlined by the challenges of health service delivery in Ghana, which included incomplete immunization coverage and data quality problems (Piu et al., 2024). Adoma et al. (2023) further underscored the importance of quality data in guiding health decisions, particularly within the Municipality of Sunyani West. Their research highlighted how inconsistent immunization data can hinder a practical implementation of health service policies and lead to the incorrect allocation of health resources. Health authorities could have overcome these data quality problems through the use of EIR, facilitated the most informed and timely decision-making process.

In the context of preventive health measures, dependence on accurate data for immunization was fundamental. Hassan et al. (2023) reviewed the discovery literature of facilitators and obstacles to maintaining the quality of routine immunization data in sub-Saharan Africa, highlighting the complexities of data management practices. They clarify that the transition to the EIRs could simplify data collection and improve accessibility, which was fundamental for health service planning and strategy formulation. Although there were optimistic perspectives regarding the EIRs, gaps still existed in understanding how they effectively impacted the decision-making process within Ghana's specific health context.

More et al. (2024) provided information on the quality of routine data of immunization programs in the UPPER East region but also identified persistent challenges, such as various levels of digital literacy between health workers and infrastructure deficiencies that hindered the success of EIRs. These gaps needed to be systematically addressed to fully exploit the advantages of EIR systems.

The fundamental research conducted by Adoma et al. (2023) and More et al. (2024) suggested that while the initial passages toward digitization were promising, continuous evaluation was necessary to measure the long-term effectiveness of the EIRs in overcoming the endemic challenges of immunization. There was a remarkable lack of longitudinal studies that study the sustainability of the EIRs in improving the quality of data and their direct effect on immunization coverage rates. Establishing a multi-stakeholder partnership that included health service officials, technology suppliers, and patient representatives is essential to create an all-around approach to implementing the EIR. The literature indicated that such collaborations encouraged a sense of property and responsibility among stakeholders, which could improve data collection and use (Hassan et al., 2023).

EIRs served as a fundamental tool capable of transforming the landscape of immunization of Ghana, but reaching this potential required concerted efforts to address the barriers to their effective implementation. The education and training of healthcare professionals, the improvement of infrastructure, and the continuous evaluation of EIR systems were fundamental to ensure that these technologies improve the decision-based process based on the immunization policies.

In conclusion, EIRs held significant promise for enhancing immunization data quality and supporting more accurate decision-making processes in Ghana. Future research needed focus on understanding how the EIRs can be completely integrated into the health system to ensure they effectively deal with immunization gaps. In addition, collaboration in various sectors was essential to exploit the full potential of digital solutions to combat the challenges of health service in immunization (Eze et al., 2023; Più et al., 2024). The results discussed in this review underlined a forward-moving journey that, if navigated carefully, could have significantly improved the healthcare service landscape in Ghana and beyond.

Purpose of the Study

The purpose of this quantitative quasi-experimental study was to evaluate the impact of implementing an Electronic Immunization Records (EIR) on clinical decision-making within healthcare facilities in Ghana. Specifically, the study sought to address three central research questions: first, to determine how the use of an EIR influences the accuracy of patient immunization records during clinical encounters (RQ1); second, to assess whether the adoption of an EIR improves the timeliness of immunization-related decision-making by healthcare providers (RQ2); and third, to explore whether EIR implementation contributes to an increase in overall immunization coverage rates among patients served by these facilities (RQ3).

By comparing facilities that utilized EIRs with those that relied on traditional paper-based systems, this study sought to identify measurable improvements in accuracy of immunization records, clinical decision-making speed, and immunization coverage rates in Ghana. Drawing upon prior evidence that digital health tools enhanced data quality and

service delivery, particularly in resource-limited settings (WHO, 2019; Goggin et al., 2021), this research investigated whether EIR adoption led to measurable improvements in patient-level outcomes and clinical efficiency.

This quantitative study addressed gaps in understanding the relationship between the implementation of electronic immunization records (EIR) and measurable outcomes such as the accuracy of immunization records, clinical decision-making speed, and immunization coverage rates in Ghana. It hypothesized that facilities with higher EIR utilization demonstrated significantly improved immunization outcomes compared to those with lower or no EIR usage. A comparative analysis drew on data from successful digital health interventions in other settings, such as Côte d'Ivoire, to support generalizability and contextualize the results (*Goggin et al., 2021*).

By addressing these research questions, the study sought to fill a gap in the literature regarding the practical effects of EIR systems on real-time, data-driven clinical decision-making and immunization service delivery in Ghana. Ultimately, the findings were expected to inform healthcare policymakers and practitioners on strategies to optimize the integration of digital health technologies into national immunization programs, with the overarching goal of improving public health outcomes through enhanced data accuracy, timely decision-making, and broader immunization coverage.

Research Question(s) and Hypotheses

RQ1: How does the implementation of an Electronic Immunization Registry (EIR) impact the accuracy of patient immunization records in clinical encounters in Ghana?

Hypothesis (H₁): Implementation of an Electronic Immunization Registry (EIR) resulted in a statistically significant increase in the accuracy of patient immunization records. Clinical encounters with the EIR showed measurable improvement in the percentage of complete and accurate records compared to encounters without EIR, suggesting no impact on data reliability and consistency.

Null Hypothesis (H₀): Implementation of an Electronic Immunization Registry (EIR) did not result in a statistically significant increase in the accuracy of patient immunization records. Clinical encounters with the EIR showed no measurable improvement in the percentage of complete and accurate records compared to encounters without EIR, suggesting no impact on data reliability and consistency.

RQ2: What is the effect of implementing an Electronic Immunization Registry (EIR) on the timeliness of immunization-related decision-making during clinical encounters in Ghana?

Hypothesis (H₁): Implementation of an Electronic Immunization Registry (EIR) significantly reduced the time required for immunization-related decision-making during clinical encounters. There was a statistically significant difference in clinical decision-making speed or waiting times between providers using the EIR and those who are not, suggesting an impact on the timeliness of clinical decisions

Null Hypothesis (H₀): The implementation of an Electronic Immunization Registry (EIR) did not significantly impact the time required for immunization-related decision-making during clinical encounters. There was no statistically significant difference in

clinical decision-making speed or waiting times between providers using the EIR and those who are not, suggesting no impact on the timeliness of clinical decisions.

RQ3: Does the implementation of an EIR improve overall immunization coverage rates among patients in healthcare facilities in Ghana?

Hypothesis (H₁): Implementation of an Electronic Immunization Registry (EIR) significantly improved overall immunization coverage rates among patients in healthcare facilities in Ghana. Healthcare facilities using EIRs demonstrated a statistically significant increase in immunization coverage rates compared to those using paper-based systems.

Null Hypothesis (H₀): Implementation of an Electronic Immunization Registry (EIR) did not significantly improve overall immunization coverage rates among patients in healthcare facilities in Ghana. There was no statistically significant difference in immunization coverage rates between EIR-using and non-EIR-using facilities.

Theoretical and/or Conceptual Framework for the Study

Implementing an Electronic Immunization Record (EIR) in Ghana presents a promising opportunity to improve clinical decision-making and health results. This initiative was based on theoretical frameworks highlighting the essential role of precise immunization data and timely health service systems. The theories and/or concepts that grounded this study included the technology acceptance model (TAM), which served as a critical framework for understanding the factors influenced the adoption of new technologies, especially in health service environments. TAM postulated that two primary constructions, that is perceived utility (PU) and perceived ease of use (PEOU) and played a crucial role in determining the will of an individual or an organization to embrace new systems. In the

specific context of the electronic record of immunization (EIR), these constructions were particularly prominent, given the complex dynamics of the provision of health care and precise monitoring of the data on immunization (Hassan et al., 2023).

The perceived utility referred to the measure in which an individual believed that using a technology improved its performance in a particular task (Marikyan et al., 2023). In the case of EIR, health professionals were likely to assess the potential of these systems to improve the efficiency and accuracy of immunization data management. This concept was aligned with research on personal health file systems, where the perceived advantages of usability and results considerably affect the acceptance and commitment of patients (Alsyof et al., 2023). The clear link between PU and the acceptance of technology in various health systems underscored the relevance of this construction in the broader discourse on the adoption of the EIR.

On the other hand, the ease of perceived use indicated the extent to which an individual believed that using a particular technology required a minimum effort (Marikyan et al., 2023). In the context of EIRs, a user-friendly and intuitive system improved the confidence of healthcare providers in the effective use of technology. If EIRs were perceived as complex or bulky, health professionals were often dissuaded from adopting them, whatever their potential usefulness.

Using the technology acceptance model's ideas, primarily through the lenses of perceived utility and ease of use, provided a compelling understanding of the factors that drove the adoption of electronic immunization records. By addressing these construct, healthcare organizations were able to facilitate a smoother transition to these vital

technologies, ensuring that the precious data associated with immunizations were effectively recorded and used for health service progress (Marikyan et al., 2023). The construct of the ease of perceived use played a fundamental role in determining users' attitudes toward adopting electronic immunization records (EIR). The ease of perceived use referred to the extent to which an individual believed that using a particular technology was free of effort. In the context of EIR, this construct significantly influenced the disposition of health professionals to integrate these systems into their regular practices. When health workers perceived EIR system as intuitive and straightforward, they were more likely to demonstrate stronger intention to use these technologies, leading to better participation and adherence to immunization protocols.

Nature of the Study

The Electronic Immunization Record (EIR) is a pivotal innovation that improved the accuracy of immunization data and strengthen clinical decision-making in the Ghana health system (Azalekor et al., 2023). The study adopted a quantitative approach to thoroughly examine how clinical decision-making within the context of healthcare delivery in Ghana was impacted by the implementation of electronic immunization records (EIR). This methodology was based on the recognition that quantitative research could provide a significant understanding of complex health interventions, particularly in low- and middle-income countries. As indicated by Osterman et al. (2021), a quantitative approach enhanced the breadth and depth of the data collected, enabling a more comprehensive interpretation of health-related phenomena.

To capture the multifaceted impact of EIR adoption, data collection combined structured surveys of healthcare providers with analysis of facility-level immunization service data. Structured surveys included validated, closed-ended questions to quantify how EIR use influenced providers' perceptions of data accuracy, decision-making speed during clinical encounters, and overall usability of the system (Burnett et al., 2023). This helped identify whether providers who actively used the EIR report faster and more confident immunization-related decisions.

Importantly, to test for the measurable outcomes specified in the study purpose, the research also analyzed objective service data on immunization uptake and coverage rates. This includes tracking the number and proportion of eligible patients receiving scheduled vaccines and comparing these rates across facilities using EIRs and those relying on manual systems. By integrating provider-reported data with facility-level immunization records, the study empirically examined whether EIR adoption led to demonstrable improvements in immunization service delivery and patient-level coverage outcomes.

The sampling frame for this study employed purposive sampling techniques to ensure representation across various healthcare settings, including both urban and rural facilities. This diversity was crucial, as it was essential to understand the differential impact of EIR on clinical decision-making in varied contexts. Urban health centers often had more resources and better access to technology than their rural counterparts, which were constrained by infrastructure challenges that potentially affected EIR use. The inclusion of diverse health centers aligned with the recommendations of Adoma et al. (2023), who

advocated for research designs that considered the socio-economic and infrastructural diversity within Ghana's health system.

Data analysis involved statistical techniques for quantitative elements. For the quantitative survey responses, descriptive and inferential statistics were used to clarify trends and patterns, as well as to identify significant relationships between the supplier's characteristics and the decisions influenced by EIR (Gyaase et al., 2021). This triangulation of data sources enhanced the validity of the findings and provide a deeper understanding of how EIR can be utilized to improve clinical decision-making processes within Ghanaian health systems (Ebrahimi et al., 2021). The data collection process for this study employed quantitative methodologies to provide a comprehensive analysis of the impact of electronic immunization records (EIR) on data accuracy, decision-making speed during clinical encounters, and the overall immunization coverage rates in Ghana (Burnett et al., 2023). To quantify the use and effects of the EIR, variables were selected based on existing literature that addresses similar contexts in sub-Saharan Africa. The key variables included data accuracy, decision-making speed during clinical encounters, and overall usability of the system (Burnett et al., 2023). These variables served as main measures to assess the effectiveness and acceptance of the EIR in clinical environments.

Standardized and validated questionnaires were used to collect quantitative data. These instruments were adapted to existing studies that have examined the quality of the data in the immunization programs and the general adoption of health technology interventions (Nantongo et al., 2021). The questionnaire pilot tests were administered to

ensure clarity and relevance in the local context, thereby improving the validity of the instruments (Presser et al., 2004; Van Teijlingen et al., 2001).

Additionally, the study employed a stratified random sampling design to ensure that participants represent a diverse range of roles and experiences within the health system. Stratified random sampling has been widely recommended in quantitative research for improving representativeness and reducing sampling bias by dividing the target population into relevant strata (Creswell & Creswell, 2018; Fowler, 2014). The analytical framework of this study included both descriptive and inferential statistical analyses for quantitative data, aimed at identifying trends and correlations between selected variables. This implied using statistical software to conduct regression analysis to determine the relationships between using the EIR and the clinical decision-making results.

This quantitative study aims to assess the impact of Electronic Immunization Records (EIR) systems on clinical decision-making among healthcare providers in Ghana. The study employed a quasi-experimental design, comparing clinical encounters that utilize EIR with those that do not. Data were collected through structured surveys and electronic health records, focusing on measurable outcomes such as the accuracy of immunization records, the timeliness of immunization decision-making, and the overall usability of the system in Ghana (Burnett et al., 2023; O'Neil et al., 2021). Descriptive statistics were used to summarize demographic and contextual variables. At the same time, inferential statistical techniques, including regression analysis and analysis of variance (ANOVA), were applied to examine relationships between EIR use and clinical decision-making outcomes. This approach was grounded in previous research that demonstrates the utility of statistical

modeling in evaluating the effectiveness of health information technologies (Aisyah et al., 2025). By employing rigorous quantitative methods, the study seeks to generate empirical evidence on the extent to which EIR adoption influences data-driven clinical decision-making processes in immunization services. The findings are expected to inform policy development and practical strategies for strengthening digital health systems in resource-constrained settings.

The establishment of EIR provided a standardized method for recording immunization data, thereby improving the accessibility and consistency of immunization records across various health service establishments (Adoma et al., 2023). By facilitating the real-time entry and retrieval of data, the EIR ensured that healthcare providers had access to reliable immunization records, significantly reducing the risk of missed or erroneous data. This system played a crucial role in the effective management of immunization programs, particularly in healthcare settings where such data were essential for informed clinical interventions.

The study of the impact of EIR on the accuracy of clinical decision-making in Ghana was justified due to the disparities and existing challenges associated with the quality of data in the health system (Piu et al., 2024). The key variables in this study included the accuracy of immunization records, the accessibility of these records to healthcare providers, and the clinical decisions made based on the available information. Accuracy referred to the correctness of data entries within the EIR, which was crucial for maintaining the integrity of immunization records. Accessibility referred to the ease with which healthcare providers obtained information on relevant immunizations, directly impacting their ability to make

timely and informed clinical decisions. Clinical decisions made by healthcare providers, informed by precise and accessible data, encompassed actions such as vaccine administration, follow-ups on immunization schedules, and mitigation of potential health risks associated with known gaps in immunization (Adoma et al., 2023).

The sampling population comprised a diverse cohort of health professionals from various districts in Ghana, including doctors, nurses, midwives, physician assistants, pharmacists, allied health professionals, and health records officers. This ensured representation from both urban and rural areas, which was crucial for understanding how EIR implementation affected clinical decision-making in different socio-economic contexts. Participants were selected using stratified random sampling to ensure that all demographic variations, including geographic location, level of healthcare, and professional experience, were represented. Data collection instruments consisted of structured surveys designed to collect quantitative data and assess the frequency of EIR use, correlating it with clinical decisions made regarding immunizations.

Quantitative data were analyzed using statistical methods, including regression analysis, to quantify the relationship between EIR use and accurate clinical decision-making outcomes. The key variables included data accuracy, decision-making speed during clinical encounters, and overall usability of the system. The study identified potential correlations and determined the predictive capacity of EIR use in achieving better health outcomes.

The contributions of this research extended beyond its academic scope, as it aimed to generate evidence to inform and support the refinement of immunization practices throughout Ghana. By assessing the implications of EIR for the accuracy of clinical

decision-making, the study highlighted areas for improvement in policies and resource allocation. The results underscored the critical importance of data quality and accessibility in primary healthcare service strategies (Hassan et al., 2023).

Definitions

The contextual structure around implementing an Electronic Immunization Record (EIR) in Ghana is intrinsically linked to various terms and concepts related to digital health interventions and regulatory measures to improve immunization practices

Access to Internet and Electricity: The availability of stable Internet and electricity may influence the effectiveness of EIR implementation.

Clinical Decision-Making Accuracy: This refers to the precision with which healthcare providers make immunization-related decisions based on available data. These decisions include determining appropriate immunization schedules, identifying missed vaccines, and verifying immunization history (Parikh et al., 2019).

Clinical Decision Support Systems (CDSS): These are health information technologies that assist healthcare professionals in making clinical decisions by providing data-driven recommendations, alerts, or reminders. In this study, the CDSS is considered part of the broader EIR system, where it helps clinicians in decision-making related to immunization schedules, patient eligibility, and tracking vaccine doses. The operational definition focused on the use of automated alerts and recommendations derived from the EIR system to improve immunization practices (Sutton et al., 2020).

Data-Driven Decision-Making (DDDM): The use of real-time data analytics to inform healthcare decisions, ensuring accuracy and efficiency in patient care.

Digital health technologies refer to electronic tools and platforms used in healthcare settings to manage, monitor, and improve patient care through digital means. These include technologies such as electronic health records (EHR), telemedicine, mobile health applications, and, in this study, the Electronic Immunization Registry (EIR).

Educator: The term educator within this study refers to individuals responsible for the training and instruction of healthcare professionals on using the Electronic Immunization Registry. Educators in this context may include trainers, program coordinators, or clinical mentors. Although the general definition of educator includes teachers in academic settings, in this case, it pertains specifically to individuals delivering training on healthcare technologies and protocols related to immunization

Facility Type: The healthcare facility level, as higher-tier facilities may have better infrastructure to support EIR use.

Health Information Systems (HIS) are digital platforms, including EHRs and EIRs, used to collect and manage patient health data to improve healthcare delivery (Chaudhry et al., 2016).

Healthcare Professional: The term healthcare professional describes individuals involved in providing medical or clinical services, particularly those responsible for administering immunizations. While this term typically includes doctors, nurses, and other allied health workers, in the context of this study, it refers explicitly to those directly involved in immunization decision-making and practices. This term may also include

immunization officers or healthcare managers overseeing immunization programs (Tawiah, 2019).

Healthcare Professional Experience: This covariate represents the clinical expertise and years of practice of the healthcare provider utilizing the EIR. Experience levels may affect how well professionals can integrate new technologies into clinical decision-making (Lau et al., 2015).

Healthcare Provider Experience: The number of years a healthcare professional has been practicing, which may impact their ability to make immunization decisions

Training on EIR Use: Participation in formal training programs for using the electronic registry, which may affect adoption and decision accuracy. (Clark et al., 2019)

Health system infrastructure refers to the physical and organizational structures supporting healthcare services, including hospitals, clinics, transportation, communication networks, and workforce capacity. This study relates explicitly to the infrastructure needed to support the implementation of the EIR, such as internet connectivity, computer hardware, and training facilities (Sutton et al., 2020).

Immunization Compliance: Immunization compliance refers to how individuals or healthcare systems follow established immunization protocols, including recommended schedules and vaccine selection. This term can have different meanings depending on the context (Clark et al., 2019).

Immunization Coverage rate: The proportion of the target population that has received recommended immunizations within a given period, often used as an indicator of health service success (World Health Organization, 2020). In the context of this study,

immunization coverage specifically referred to the extent to which the EIR system ensured that children and adults in Ghana receive timely and accurate immunizations. The operational definition was based on the percentage of people vaccinated as per the recommended immunization schedule (GAVI, 2020).

Implementation of Electronic Immunization Registry (EIR): The EIR is a digital tool used by healthcare professionals in Ghana to record, manage, and track immunization data for individuals. It aims to replace traditional paper-based systems with a more efficient, accurate, and accessible system for managing immunization records (World Health Organization, 2020).

Socioeconomic Status (SES): Socioeconomic status (SES) is a covariate that may influence access to immunization services and the accuracy of clinical decision-making. SES refers to individuals' or communities' economic and social standing, typically measured by income, education, and occupation.

Timeliness of immunization refers to the adherence to established schedules for administering vaccines, particularly as it impacts the prevention of vaccine-preventable diseases.

Assumptions

At the center of EIR operations were fundamental assumptions that governed its development, implementation, and intended impact on the accuracy of clinical decision-making in immunization practices. These assumptions were critical for understanding both the potential and limitations of the EIR. A primary assumption was that health professionals possessed adequate digital literacy and could effectively use EIR to access and enter data

(Kipterer et al., 2020). This assumption was important because the effectiveness of EIR relied on health professionals accurately entering and retrieving data, which directly influenced the quality of immunization information used for decision-making.

In addition, the assumption that data collected through EIR were complete and accurate had important implications for clinical decision-making. Inaccurate or incomplete data could lead to delayed vaccinations, unnecessary repeat doses, or vaccine wastage. As Abbott et al. (2021) suggested, without monitoring and evaluation vigilance, critical data gaps had the potential to undermine the intended effectiveness of the system. Therefore, it was imperative to continually evaluate the premises on data integrity to reinforce the credibility of the health information system.

Another fundamental assumption of the EIR was that the system's technical infrastructure could support seamless data integration across various health facilities. This assumption was essential for creating a unified database that reflected a comprehensive immunization scenario. However, realities in many regions differed, with varied internet connectivity and power supply hindering consistent system access. This discrepancy indicated that contextual elements had to be considered in evaluating the EIR's operational capacity, as emphasized by Osterman et al. (2021). Without robust technical support, health professionals' confidence in clinical decision-making could be severely compromised.

Furthermore, there was an implicit assumption regarding EIR interoperability with other health information systems, which was critical for comprehensive data analysis and strategic planning. If the EIR could not communicate properly with related systems, it could lead to missing information, limiting health managers' capacity to make informed decisions.

Promoting interoperability was therefore fundamental to improving the clinical utility of the EIR and ensuring cohesive public health strategies.

An additional and critical assumption specific to this study design was that any observed differences in vaccination uptake between facilities using the EIR and those not using it were primarily attributable to the EIR itself. This assumed that organizational differences between facilities, aside from EIR implementation, were minimal or balanced and did not significantly influence vaccination rates. Recognizing this helped clarify the study's causal interpretation: that the EIR, rather than other unmeasured factors, accounted for differences in uptake.

In short, the assumptions underlying the implementation of electronic immunization records in Ghana justified meticulous analysis, as they were fundamental to assessing its effectiveness and reliability. The need for thorough analysis became particularly evident when considering the implications of these assumptions for the accuracy of clinical decision-making. Understanding these factors helped identify weaknesses in the EIR and informed the creation of solutions to improve data accuracy and usability in immunization practices. The implications of these assumptions were crucial in shaping the landscape of clinical decision-making, particularly regarding the accuracy of immunization practices.

One basic hypothesis was that confidence in the technology underpinned the effective use of EIR. As Ebrahimi et al. (2021) noted, confidence was essential for clinicians relying on the EIR for immunization services. If healthcare providers lacked confidence in the EIR due to perceived problems such as data integrity or system reliability, this skepticism could directly impact their adherence to immunization protocols. Consequently,

reduced confidence could lead to inconsistencies in immunization delivery and a potential increase in vaccine-preventable diseases.

The efficiency of electronic health record (EHR) systems played a vital role in supporting clinical decision-making and enhancing the effectiveness of immunization practices (Mwogosi & Kibusi, 2025). The hypothesis that digital systems provided timely and usable data was essential; however, if these systems failed to integrate complete and precise immunization data, clinicians could be poorly informed about immunization status or schedules. This gap could lead to erroneous clinical decisions, such as the inadvertent administration of unnecessary immunizations or failure to follow up on missed doses. It raised the question of whether the EIR could serve as a reliable clinical decision-support tool, requiring an in-depth assessment of its data management practices and interoperability with existing health information systems.

Additionally, user acceptance was an assumption that required close examination, particularly when implementing auxiliary digital health interventions, such as text messaging systems for immunization reminders. Research by Karkonasasi et al. (2023) revealed that the success of these interventions strongly depended on design centered on the user and adapted to the needs of clinicians and patients. If users, including healthcare providers and target populations, did not perceive reminders as valuable or relevant, their acceptance and use of these tools could be compromised. This could reduce participation in immunization programs and increase the risk of epidemic outbreaks. Understanding the factors that promoted or inhibited user acceptance was therefore essential for optimal integration of these technologies alongside EIR.

Finally, the importance of contextual and cultural considerations in implementing the EIR and associated technologies could not be overestimated. Hypotheses regarding the uniform applicability of clinical practices often overlooked the significant variability in community health beliefs and practices among different populations in Ghana (Muhoza et al., 2024). Disconnects between clinical decision-making and local health contexts could cause reluctance to follow EIR-guided protocols, further exacerbating inequalities in immunization. To improve decisions regarding immunization practices, it was essential to involve communities and consider their feedback and experiences so that EIR-based strategies aligned with the real needs of the populations they aimed to serve.

Scope and Delimitations

Implementing an electronic immunization record (EIR) in Ghana represents a significant advance in managing and administering immunization records within the health system. The center of this discussion is the interaction between the clinical precision of decision-making, which is expected to benefit from real-time data provided by an EIR and surrounding sociocultural and systemic factors that can delimit their effectiveness. The accuracy of clinical decision-making is critical since medical care providers rely on timely and reliable immunization data to make informed vaccine recommendations, thus ensuring the health and well-being of health service efforts to prevent communicable diseases (Nickels et al., 2024)

In addition, delineating the population limits within which the EIR operates is imperative in evaluating its impact. Factors such as socioeconomic status, cultural beliefs, and geographical location play a substantial role in the accessibility and adhesion of the

vaccine. A cross-sectional study by Akanpaabadai et al. (2024) sheds light on the disparities faced by rural populations in Ghana, where limited access to medical care facilities and erroneous information regarding the safety of vaccines considerably hinder immunization rates. These findings underline the importance of contextualizing the implementation of EIR within the socio-economic and cultural landscapes that report the community's attitudes towards immunization.

In summary, while the registration of electronic immunization is promising to improve immunization monitoring and inform clinical decisions in Ghana, its successful implementation depends on understanding and addressing the innumerable sociocultural factors that influence public participation in immunization programs. In addition, carefully considering internal and external validity ensured that the ideas obtained from the EIR data are robust and applicable in various population segments. In addition, the scope of implementing an electronic immunization record (EIR) must consider delineating its operational framework, which refers to the geographical and demographic parameters within which it worked. The effectiveness of the EIR depended on the robustness of data governance, adaptation training for health workers, and technological infrastructure available in various regions, such as urban and rural environments in Ghana (Ogundeko-Olugbami et al., 2020). The disparity in access to medical care resources and technological advances between urban and rural areas further complicates the uniform deployment of EIR (Pavia et al., 2024)

The effective implementation of an electronic immunization record in Ghana requires meticulous attention to various delineations in the operational scope, including

technological infrastructure, population limits, and integral training for health workers. These factors play a crucial role in guaranteeing the precision of clinical decision-making and the general efficacy of immunization efforts, thus configuring health service results in the country. The implications of internal and external validity in implementing an electronic immunization record (EIR) are fundamental considerations that guarantee global attention.

Limitations

The study examining the impact of the electronic immunization record (EIR) on the accuracy of clinical decision-making in Ghana operated under several significant design limitations, which considerably restricted its overall validity. At the core of these limitations was the absence of a control group, which hindered the ability to draw definitive conclusions regarding the effectiveness of the EIR. The inability to compare clinical decisions made with the record to those made without it introduced ambiguity in attributing any observed improvement in the accuracy of clinical decision-making directly to the implementation of the system. This lack of a control group was consistent with the findings of Piu et al. (2024), who argued that controlled environments were essential for precisely assessing the impact of health data systems on clinical practices.

In addition, the insufficient sample size represented a significant barrier to the validity of the study results. As Adoma et al. (2023) noted, a robust sample size was necessary to achieve statistical power, enabling researchers to discern significant patterns and relationships within the data.

Potential biases inherent in the study design also required consideration. Selection bias was a notable concern, particularly if participants were not randomly chosen or if there

was a predisposition to include healthcare providers who were already more familiar with or comfortable using digital health solutions. Such bias skewed the results by over-representing individuals who naturally demonstrated higher clinical decision-making precision (Piu et al., 2024), thereby distorting the apparent effectiveness of the EIR.

Another critical limitation involved contextual obstacles to research, including infrastructural challenges and varying levels of digital literacy among healthcare providers. In Ghana, disparities in access to technology and differences in training hindered the implementation and consistent use of the EIR, which impacted the study's findings.

In summary, although the study of the electronic immunization record's impact on clinical decision-making in Ghana provided valuable insights, design limitations, biases, and contextual barriers considerably restricted the reliability and generalizability of its conclusions. Addressing these limitations in future research would be essential for strengthening the evidence base regarding the effectiveness of digital health interventions within the Ghanaian healthcare system.

Significance

Adopting electronic health systems represented a significant advance in managing immunization data and health service delivery, particularly in developing contexts such as Ghana. Electronic immunization registration (EIR) systems provided a digital framework to track vaccine management, patient history, and immunization schedules, thereby simplifying data collection and improving the availability of health information for providers. The relevance of these systems extended beyond administrative efficiency; they played a fundamental role in ensuring that healthcare providers had accurate, real-time data

to guide clinical decision-making. EIR systems significantly improved care in immunization services by facilitating better communication among healthcare providers and reducing the likelihood of poor data management (Ogbuabor et al., 2023).

Precise clinical decision-making was essential for adequate healthcare, particularly in vaccine administration, where appropriate and accurate interventions were crucial to prevent disease outbreaks. Decisions regarding vaccines were often based on patient history, previous vaccinations, and risk factors. Inconsistencies inherent in maintaining manual records frequently led to errors such as lost vaccines or duplicate doses, ultimately compromising patient safety and health service outcomes (Brooks et al., 2024). Electronic immunization registration systems mitigated these risks by providing health professionals with comprehensive and updated information, thereby improving individual care and supporting broader health service initiatives aimed at achieving higher immunization coverage (Ogbuabor et al., 2023).

In addition, digital transformation played an increasingly vital role in healthcare delivery, as discussed by Yadav (2024). In Ghana, EIR systems symbolized a fundamental shift toward more effective health practices. Integrating digital tools into immunization efforts encouraged a culture of accountability among healthcare providers and improved coordination across multiple health sectors. By streamlining processes and ensuring timely access to immunization records, these systems enabled health professionals to make informed decisions, thereby improving service delivery and patient outcomes. The growing reliance on electronic health technologies also aligned with global health trends, positioning Ghana as a progressive actor in digital health innovation.

Social change was another significant dimension influenced by EIR systems, primarily through improved access to healthcare and the establishment of trust in immunization processes. The World Health Organization (2023) emphasized that robust immunization data directly correlated with increased community participation and confidence in vaccination campaigns. As communities perceived a more organized and transparent immunization process, vaccine acceptance improved, resulting in higher coverage rates and better health outcomes. These dynamics highlighted how EIR systems could address public hesitation regarding immunization, ultimately contributing to broader health improvements within Ghanaian society.

Mobile health innovations also played an essential role in reinforcing the importance of technology in managing healthcare resources effectively. Shahil (2024) explored mobile health solutions that integrated applications and platforms to support health workers in monitoring immunization campaigns and managing patient interactions. Particularly in underserved areas, mobile health initiatives promoted by EIR systems facilitated timely immunizations and improved communication between healthcare providers and communities, thereby strengthening overall immunization infrastructure (Brooks et al., 2024). This technological synergy expanded access to healthcare and contributed to improved health literacy among the population.

Despite the promising potential of EIR systems, several challenges needed to be addressed to ensure their successful implementation and sustainability within Ghana's health system. Burnett et al. (2023) observed that, across sub-Saharan Africa, infrastructure deficiencies, inadequate training for healthcare providers, and persistent data privacy

concerns posed considerable obstacles. Recommendations to overcome these challenges included investing in robust infrastructure, providing comprehensive training programs for health personnel, and promoting public-private partnerships to enhance resource availability and technological capacity. By addressing these barriers, Ghana could capitalize on the potential of EIR systems, ultimately promoting a more efficient and equitable healthcare landscape.

Summary

In this study, I examined the crucial role of immunization in health service delivery and the need for reliable data to support accurate clinical decision-making in Ghana. Despite achieving an 80% national immunization coverage rate, challenges persisted in data accuracy and accessibility, which affected healthcare service delivery. Implementing an Electronic Immunization Record (EIR) improved data quality, enhanced accurate decision-making, and strengthened healthcare service interventions.

The background section emphasized the significance of EIRs in immunization programs, detailing how they streamlined data collection, enhanced real-time monitoring, and contributed to improved policy formulation and resource allocation. The literature review identified key challenges, including infrastructural limitations, insufficient training of healthcare personnel, data privacy concerns, user engagement issues, and integration with existing health systems. These knowledge gaps underscored the need for further research on how EIRs influenced clinical decision-making in Ghana.

In this chapter, I established the rationale for investigating the impact of EIRs on clinical decision-making accuracy. This quantitative study addressed gaps in understanding

the relationship between the implementation of electronic immunization records (EIR) and measurable outcomes, such as the accuracy of immunization records, clinical decision-making speed, and immunization coverage rates in Ghana.

With the foundation set in Chapter 1, the subsequent chapter delved deeper into the theoretical frameworks that informed this study. Chapter 2 provided a comprehensive review of existing literature on electronic immunization registries, data-driven healthcare decision-making, and related technology adoption models. By critically analyzing previous research, this chapter contextualized the significance of EIRs within Ghana's healthcare landscape and highlighted the theoretical perspectives that guided the study.

Chapter 2: Literature Review

Introduction

The advent of electronic immunization records (EIRs) represented a significant shift in health information systems in low- and medium-income countries, particularly Ghana. As a central component in managing immunization programs, EIRs facilitated the collection, storage, and recovery of immunization data, thereby improving the accuracy and timeliness of immunization services. This literature review explored the significance of the EIRs in Ghana, examined the current state of research and identified gaps that justified further investigation

Recent studies indicated that EIRs helped increase immunization rates by giving health workers immediate access to immunization data, which enabled better decision-making and higher-quality service delivery (Preko et al., 2024). Evidence from the Ghana Health Service showed that districts using EIR reported higher immunization rates than those using traditional paper records, thanks to improved tracking of individual immunization histories and follow-up reminders. Additionally, Mugauri et al. (2020) linked EIR use to improved data quality, reduced duplication requests, and fewer data entry errors.

Despite these promising results, implementing EIR in Ghana was not without challenges. Technical issues such as system downtime and poor interoperability with existing health information systems remained significant barriers (Addo & Agyepong, 2024). Furthermore, training and capacity building for healthcare professionals were essential, as limited technological proficiency hindered the full utilization of EIRs (Preko et al., 2022). Although numerous studies documented the operational efficiencies associated

with EIRs, a more comprehensive evaluation of their impact on immunization effectiveness remained largely unexplored. The relationship between electronic data management and immunization coverage required deeper investigation to identify causal factors influencing coverage rates.

Research gaps also included the absence of longitudinal studies assessing the sustainability of EIRs and their influence on behavioral changes among healthcare professionals. While recent studies focused primarily on early implementation stages, it was essential to understand how these systems affected ongoing immunization practices and community engagement over time, especially in low-resource settings where maintaining system functionality posed challenges (Laryea et al., 2024). Moreover, limited studies examined sociocultural determinants influencing EIR acceptance and use among health workers and the general population.

Significant challenges in data management associated with EIRs also required attention. Concerns regarding privacy and data security were fundamental, particularly in contexts involving sensitive health information (Nardey et al., 2023). The integration of electronic systems needed to align with ethical standards to protect individual rights while enabling access to essential health services. As communities increasingly adopted EIRs, addressing confidentiality concerns helped foster trust in digital health initiatives.

Another important area requiring further research concerned the financial sustainability of EIRs. The initial costs associated with developing these systems were substantial, creating hesitation among policymakers and stakeholders to commit long-term resources to electronic solutions (Mensah et al., 2022). Exploring public-private

partnerships and alternative financing models offered potential pathways for sustaining EIR investments.

Additionally, assessing EIR integration within national health information systems was crucial for cohesive data management. In Ghana, where multiple health interventions coexisted, harmonizing data systems was essential for strengthening immunization services and improving overall health outcomes (Piu et al., 2021). The lack of standardized data-sharing protocols across health programs complicated EIR effectiveness and ultimately influenced immunization strategies.

A comprehensive literature review therefore included an examination of immunization effectiveness, particularly how EIRs contributed to increased coverage, reduced dropout rates, and enhanced community awareness. Another section addressed data management challenges associated with EIRs, including privacy concerns, workforce training needs, and system sustainability. A final section outlined future research directions, suggesting opportunities to evaluate EIR performance more rigorously and develop strategies to address identified challenges.

In conclusion, the significance of electronic immunization records in Ghana extended beyond technological advancement; they represented a shift toward a more efficient and effective immunization landscape. However, for EIRs to achieve their full potential, ongoing research needed to address the existing gaps and challenges, thereby fostering an environment conducive to improved health outcomes for the population.

Problem Statement: Implementing Electronic Immunization Records (EIRs) in Ghana represented a significant step toward improving immunization programs through data-driven decision-making. This review examined the existing literature on the impact of EIRs on immunization data in Ghana, where substantial challenges persisted related to the accuracy of immunization records, clinical decision-making speed, and immunization coverage rates. In particular, the review identified gaps in current research on health services that were critical to the effective implementation of EIRs. Effective health service delivery in Ghana continued to be hampered by data-related issues such as insufficient immunization coverage and erroneous records, as noted by Piu et al. (2024). Adoma et al. (2023) emphasized the importance of accurate data in healthcare decisions, particularly in Sunyani West, where inconsistent immunization data complicated policy implementation and resource allocation. Transitioning to EIRs had the potential to address these issues by enabling timely and informed decision-making. However, several challenges, including digital literacy limitations and infrastructural deficiencies, remained, as noted by More et al. (2024). The research indicated that for EIRs to be successful, they needed to be supported by adequate training for healthcare professionals, improved infrastructure, and continuous evaluation. Overall, the literature pointed to an urgent need for further research on the long-term impact of EIRs in Ghana, particularly their effects on immunization coverage and overall health outcomes.

Purpose of the Study: This study aimed to assess the impact of EIR implementation on healthcare professionals' immunization-related decisions and the subsequent health outcomes in Ghana. Previous research demonstrated that digital health solutions

significantly improved health management and outcomes in resource-limited settings (Azalekor, 2024). EIRs were intended to enhance the collection, management, and accessibility of immunization data, thereby improving decision-making. Understanding healthcare providers' perceptions of EIR systems was crucial, as negative perceptions could hinder adoption and affect immunization outcomes (Amani et al., 2023). By evaluating how healthcare workers viewed and used EIRs, the study contributed to the ongoing dialogue on optimizing health information systems in Ghana. This research also examined how EIRs influenced immunization decisions and public health outcomes, suggesting that positive views of EIRs were linked to improved immunization services and health results, similar to findings reported in other African countries.

Synopsis of Current Literature: The literature on EIR implementation highlighted the potential benefits and challenges of these systems in Ghana and similar contexts. Studies by Hassan et al. (2023) and More et al. (2024) revealed that data-quality issues, such as poor infrastructure and insufficient training, were significant barriers to effective EIR deployment. However, the introduction of EIRs showed promise in improving the accuracy of immunization data and supporting better decision-making, as evidenced by research from Tanzania (Dolan et al., 2022) and Rwanda (Uwera et al., 2024). Additionally, integrating EIRs into national health systems demonstrated improvements in immunization rates and data accuracy in other parts of Africa, suggesting that similar outcomes were possible in Ghana (Kim et al., 2024). Despite these successes, the literature indicated that strategies needed to be targeted to address barriers such as infrastructure, training, and digital literacy, particularly in resource-constrained settings.

The following sections provided a detailed review of existing research related to EIRs, with a focus on their implementation, associated challenges, and potential impact on decision-making in clinical settings.

Immunization Data Challenges in Ghana and Sub-Saharan Africa

Ghana, like many other Sub-Saharan African countries, faced significant challenges in immunization data management. Piu et al. (2024) assessed the quality of routine immunization data in the Upper East Region of Ghana and identified gaps in data completeness and accuracy, which affected service delivery. Similarly, Adoma et al. (2023) found that poor data quality in the Sunyani West Municipality hampered effective decision-making. These findings underscored the need for reliable data systems such as Electronic Immunization Registries (EIRs) to improve immunization coverage and the accuracy of healthcare decisions.

Global Experiences with EIR Implementation

Studies from other countries highlighted the potential benefits of EIRs in improving immunization outcomes. Dolan et al. (2022) examined the impact of EIR implementation in Tanzania and found a significant increase in timely immunizations, demonstrating the effectiveness of EIRs in improving vaccine management. Similarly, Uwera et al. (2024) reported that the EIR in Rwanda improved data accuracy, reduced administrative burdens, and facilitated better decision-making, despite challenges such as infrastructure limitations and the need for adequate training.

Barriers and Facilitators of EIR Implementation

Numerous studies highlighted the barriers to successful EIR implementation, including inadequate infrastructure, limited training, and insufficient internet connectivity (Adeoye et al., 2022; Hassan et al., 2023). These challenges were particularly relevant to Ghana's healthcare system, where such limitations could have hindered the success of EIR systems. Namageyo-Funa et al. (2024) suggested strategies such as stakeholder engagement and capacity building to overcome these barriers and to ensure the effective use of EIRs.

Benefits of EIRs in Clinical Decision-Making

The implementation of EIRs was expected to enhance clinical decision-making by providing real-time access to immunization data, improving vaccine tracking, and supporting informed clinical decisions (Pavia et al., 2024). These benefits had been observed in other regions, where EIRs facilitated better health outcomes through improved immunization coverage and more accurate data reporting. The integration of EIR systems into Ghana's health system had the potential to reduce diagnostic uncertainty and enhance the effectiveness of immunization strategies (Nickels et al., 2024).

Theoretical Frameworks and Data-Driven Decision-Making

Theories of Change (ToC) provided a structured framework for understanding the factors that contributed to successful immunization programs. Vadrevu et al. (2024) highlighted the role of ToC in routine immunization programs and emphasized the importance of data-driven monitoring and evaluation. EIRs could have enhanced the application of ToC by providing real-time data that informed program effectiveness and decision-making, ultimately contributing to improved immunization coverage and health outcomes.

Preview of Major Sections of the Chapter

Introduction: This section introduced the problem, the relevance of EIRs to immunization programs, and the study's purpose.

Literature Review: A comprehensive overview of the literature on EIR implementation in Ghana and similar contexts was provided, with emphasis on data quality, healthcare provider perceptions, and challenges such as digital literacy and infrastructure.

Research Methodology: This section outlined the study's design, including the data collection and analysis methods, and offered the rationale for adopting a quantitative approach.

Results and Discussion: The findings were presented and discussed, emphasizing how healthcare professionals' perceptions of EIRs influenced their clinical decision-making and the associated health outcomes.

Conclusion: Based on the study's findings, the chapter concluded with recommendations for improving the implementation and integration of EIRs in Ghana. The literature provided strong evidence for the potential of Electronic Immunization Registries to improve immunization data quality, enhance clinical decision-making accuracy, and increase immunization coverage in Ghana. However, challenges such as inadequate infrastructure, limited digital literacy, and training deficiencies remained significant barriers to successful implementation. Future research needed to address these barriers and to explore the long-term impact of EIRs on immunization outcomes. Additionally, the integration of multi-stakeholder partnerships and the application of digital health solutions

in Ghana's immunization strategies were crucial for realizing the full potential of EIR systems in enhancing healthcare delivery.

Literature Search Strategy

Implementing an Electronic Immunization Registry (EIR) in Ghana was widely recognized as a strategy that promised to improve the quality and reliability of immunization data, a critical component of national health service infrastructures. When properly implemented and sustained, EIR systems facilitated more accurate monitoring of immunization status, simplified data collection and management processes, and informed health policy and resource allocation. This literature review therefore summarized the existing research on EIR use in Ghana, with particular attention to the challenges associated with data quality in immunization programs. Accurate immunization data were fundamental for monitoring and evaluating program performance, improving childhood immunization rates, reducing morbidity and mortality, and achieving broader health system objectives. Evidence from previous studies indicated that low data quality in immunization records made it difficult for health authorities to meet immunization needs effectively, highlighting significant data accuracy challenges across Sub-Saharan Africa, including deficiencies in training, infrastructure, and resource distribution (Hassan et al., 2023). Addressing these data quality gaps remained essential for the successful implementation of an EIR, as they directly influenced the effectiveness of immunization campaigns and population-level health outcomes.

Databases and Search Engines Accessed

Given the need to improve immunization data quality, the literature review focused on gathering and analyzing research from multiple scholarly sources, including peer-reviewed journals, government and non-government organizations, and case studies of EIR implementations in similar situations and specific areas in Ghana

The following databases and search engines were accessed to gather peer-reviewed articles, systematic reviews, government reports, and other scholarly sources:

Academic Databases: Walden University Library, PubMed, CINAHL, IEEE Xplore, Scopus, Web of Science, ProQuest Dissertations & Theses, MEDLINE, ScienceDirect, SpringerLink, ACM Digital Library, Global Health, Health Systems Evidence, and the WHO Global Index Medicus.

Search Engines and Supplementary Sources: Google Scholar, ResearchGate, HealthIT.gov, and official reports from the World Health Organization (WHO) and Ghana Health Service (GHS).

Journals Consulted Included: The Lancet, New England Journal of Medicine, Journal of Medical Internet Research, American Journal of Health Services, Health Education Research, Journal of the American Medical Association, Health Communication, Journal of Health Service Informatics, *and* Journal of Health Psychology.

The review encompassed empirical studies, theoretical papers, and systematic reviews addressing the implementation of EIR systems and the persistent challenges associated with producing accurate immunization data. This comprehensive approach was intended to address the technical and operational limitations associated with EIR adoption in

Ghana, as well as the sociocultural factors influencing system use and data reporting practices.

Key Search Terms and Combinations

The literature review employed precise research terms based on the study's theoretical framework, core variables, and geographical context. We optimized search results using Boolean operators and truncations. Core keywords and search term combinations included: Electronic Immunization Registry (EIR) in Ghana, Health Information Systems and Data-Driven Decision-Making, Digital Health Innovation, Immunization Data Management, Technology Acceptance Model (TAM), Clinical Encounters in Ghana, Electronic Medical Records (EMR), Healthcare Decision-Making, Telehealth in Ghana, Digital Health Systems Ghana, Health System Strengthening, Immunization Coverage, Barriers to EIR Implementation, Sub-Saharan Africa, Ghana Health Service, and Digital Transformation.

Using Boolean operators improved the research results, enabling a more focused look at studies that talk about how digital clinical folders affect immunization rates and ways to fix data quality issues. In addition to identifying existing literature, the review also strived to highlight the research gaps that could hinder the successful distribution of EIR systems in Ghana. Recognizing that most of the literature can focus on the successes of EIR in high-income countries or neglect the unique contextual challenges of Ghana, it is necessary to support tailor-made research that explains the local factors that influence the implementation of the EIR. As a result, carefully examining the obstacles discussed in the literature, especially those highlighted by Hassan et al. (2023), helped shape future research

focus and guide the plans for including an EIR system in Ghana's health framework. In the search for an integral understanding of the implementation of electronic immunization records (EIR) in Ghana, it is essential to use various key academic databases that provide access to relevant literature and research. Among these are prominent Scopus and Web of Science, each known for its vast collections of biomedical and health-related articles. PubMed is a critical resource, offering access to peer-reviewed articles addressing health technologies and public health systems. These are crucial to understanding the context and effectiveness of electronic health initiatives. Scopus and the Web of Science help broaden search options by including research from different fields, like information technology, social sciences, and public policies, which can affect how EIR is accepted and successful in Ghana.

Scope of the Literature Review

The scope of the literature that addressed the integration of the Electronic Immunization Registry (EIR) in Ghana remained limited, particularly in studies evaluating long-term sustainability and system scalability. Although notable progress had been made in applying clinical and evidence-based decision-making approaches (Adoma et al., 2023), a clear gap persisted in research examining the long-term effectiveness of EIR systems. Addressing this gap required longitudinal research and comparative studies that evaluated EIR outcomes across different regions and healthcare infrastructures in Ghana.

The literature review covered publications from 2015 to 2025 and included both seminal and contemporary studies. Peer-reviewed journal articles focusing on digital health, immunization systems, and healthcare decision-making were emphasized, along with

reports from governmental and nongovernmental organizations such as the World Health Organization (WHO), Ghana Health Service (GHS), and health development partners. Empirical studies and systematic reviews applying the Technology Acceptance Model (TAM) and research grounded in the Data-Driven Decision-Making (DDDM) framework were also included. Priority was given to literature published between 2020 and 2025 to capture recent developments in EIR technology and implementation, while foundational works such as Davis (1989) and Venkatesh and Davis (2000) were incorporated to provide theoretical grounding.

Despite the growing global literature on EIRs and digital health interventions, research that examined the long-term effectiveness, scalability, and sustainability of EIR systems within the Ghanaian context remained scarce. In particular, empirical studies that assessed EIR impact at the subnational level or incorporated longitudinal analysis were limited.

To address these gaps, relevant findings from comparable contexts in Sub-Saharan Africa were integrated to draw parallels (e.g., Hassan et al., 2023). Grey literature and implementation report from WHO and GHS were also used to supplement gaps in peer-reviewed evidence. Regional studies such as Piu et al. (2024) were incorporated to contextualize implementation dynamics specific to Ghana's Eastern Region, ensuring that the review maintained both contextual depth and theoretical breadth.

Additionally, a notable research gap persisted in understanding EIR interoperability with existing health systems in Ghana. Available literature offered insufficient real-world evidence regarding technological challenges and system compatibility issues faced by health

facilities. Addressing this gap required collaborative studies involving health informatics experts, software developers, and healthcare professionals to develop standards and frameworks that ensured seamless integration of EIR systems with national health databases and existing information systems.

Furthermore, gaps remained in evaluating health workers' training needs related to EIR use. Limited or inadequate training, along with unaddressed usability concerns, risked creating resistance or reducing system effectiveness. Recommendations for future research included assessing current training programs and developing targeted capacity-building interventions based on identified barriers. Another underexplored area involved the financial implications of EIR implementation. Existing literature provided minimal attention to topics such as cost-benefit analyses and sustainable financing models. Consequently, future studies needed to investigate economic factors—including potential long-term savings resulting from improved immunization rates and reduced disease burden—to articulate the financial justification for EIR investment. Addressing these gaps strengthened the evidence base for EIR implementation in Ghana and contributed to the development of more effective immunization programs responsive to local needs. A comprehensive understanding of these issues remained critical for informing strategies that ensured the successful adoption, utilization, and long-term sustainability of EIR systems within Ghana's healthcare framework.

In summary, advancing the implementation of EIR systems in Ghana required a multifaceted and rigorous literature review strategy. By leveraging appropriate databases, well-defined search terms, and a broad yet purposeful scope of literature, researchers were

able to clarify essential factors influencing EIR effectiveness. Recognizing and addressing literature gaps, particularly those related to sustainability, interoperability, and qualitative user experiences was fundamental for informing the adaptation, enhancement, and innovation of Ghana's immunization management practices. As the research landscape evolved, it became evident that a strategically designed literature review approach played a critical role in shaping future immunization policies and contributing to the effective modernization of health information systems in Ghana.

Theoretical Foundation

The implementation of electronic immunization records (EIR) in Ghana was significantly influenced by the Technology Acceptance Model (TAM), which evaluated user acceptance based on perceived utility and ease of use. The perceived utility refers to how health professionals in Ghana perceive the benefits of EIR systems in improving health results and clinical decision-making processes. The existing literature indicated that effective electronic immunization registration systems (EIRs) facilitate the provision of improved medical care by providing real-time data on vaccine management and the patient's immunization status (Amoah, 2021).

A pertinent study by Mwogosi and Kibusi (2024) clarified the role of comprehensive decision support systems within EIR, demonstrating their ability to improve health outcomes. The integration of such systems in the EIR framework fostered positive perceptions of EIR among health professionals in Ghana. The ability to access updated immunization data empowered healthcare providers and supported strategies for managing population health. This access to real-time information was crucial for ensuring adherence

to immunization guidelines, illustrating a clear link between perceived usefulness of EIR systems and their acceptance.

Further supporting this view, Walle et al. (2023) examined predictors of health professionals' acceptance and emphasized that perceived usefulness was a key determinant in the decision to adopt EIR. They noted that when health professionals recognized functional benefits such as improved accuracy in patient records and simplified reporting mechanisms the likelihood of acceptance increased significantly. In Ghana, where health resources were limited, improvements in efficiency and patient safety offered by EIR systems were particularly crucial in gaining support from healthcare stakeholders and promoting widespread adoption.

Similarly, Adzakupah and Dwomoh (2023) highlighted the potential of digital health technologies, including EIR, to reduce rejection rates of health insurance claims. This aspect was not underestimated, as financial barriers and administrative challenges often hindered immunization program effectiveness in resource-constrained settings. Because EIR systems promised enhanced financial monitoring and improved documentation, their perceived usefulness in reducing such barriers further reinforced their acceptance within Ghana's healthcare system.

The concept of ease of use, another cornerstone of TAM, also informed the implementation of EIR in Ghana. Perceptions of ease of use played a crucial role in determining whether health professionals integrated EIR systems into their daily practice. Training requirements, interface simplicity, and system intuitiveness were critical factors that shaped perceptions of ease of use. Studies suggested that when health workers found a

system easy to navigate, their confidence in using information technologies increased, which in turn strengthened their commitment to adopting such systems (Davis, 1989).

In Ghana, addressing ease of use was particularly vital, given that users possessed varying levels of technological competence. The success of EIR systems depended largely on customized training programs and user-support mechanisms that enhanced users' familiarity and comfort with the system (Amoah, 2021). Therefore, initiatives designed to improve ease of use such as user-friendly system design and comprehensive training—positively influenced health professionals' perceptions and, consequently, their acceptance of EIR systems nationwide.

In summary, TAM, comprising perceived usefulness and ease of use, provided a valuable framework for understanding factors that shaped the use and acceptance of electronic immunization records in Ghana. By improving these perceptions, stakeholders supported a more effective transition to digital health solutions that aimed to enhance immunization outcomes within Ghana's healthcare system. The implementation of EIR in the Ghanaian health sector required close examination of perceived ease of use, as outlined by TAM (Gyaase et al., 2021). A user-friendly interface and intuitive system design were essential for ensuring smooth integration of EIR into healthcare facilities, particularly for professionals with diverse levels of digital literacy.

Kwarteng et al. (2024) underscored that perceptions of system friendliness significantly influenced acceptance of new technologies. Their research suggested that if EIR systems appeared overly complex or difficult to navigate, potential users hesitated or refused to adopt them, limiting the progress of immunization programs.

Additionally, Alsyof et al. (2023) highlighted the role of usability in improving patient engagement with health information systems. An EIR that was simple and accessible not only supported effective management of immunization records by healthcare providers but also encouraged patient participation in scheduled vaccinations.

It therefore became evident that the functional design of an EIR system needed to prioritize user interaction to improve workflow efficiency. Systems that incorporated user feedback into their design and provided adaptive training modules proactively addressed challenges associated with technology acceptance in healthcare environments.

Overall, considering perceived ease of use was essential for the successful implementation of EIR in Ghana. As the healthcare sector continued to evolve toward digital transformation, understanding the relationship among usability, user acceptance, and practical implementation strategies was critical for achieving optimal health outcomes. The relationship between perceived usefulness and ease of use further illustrated how TAM supported the adoption of EIR in Ghana. Perceived usefulness—defined as the extent to which health professionals believed that using EIR improved their job performance—emerged as a crucial determinant of acceptance. Literature suggested that when health professionals recognized the contribution of electronic records to service quality and efficiency, their willingness to adopt EIR increased significantly (Geng & Demuyakor, 2022). Practitioners who viewed EIR as a means of supporting timely immunization monitoring, reducing vaccine-related errors, and improving patient care were more likely to advocate for its routine integration into clinical practice.

Conceptual Framework

The conceptual framework for this study was based on the Technology Acceptance Model (TAM), which addressed the adoption and use of technology to support data-driven decision-making in clinical encounters. The Electronic Immunization Registry (EIR) was a digital tool designed to enhance immunization data management and improve the accuracy of clinical decision-making. This study focused on how healthcare providers' perceptions of the EIR, influenced by Perceived Usefulness (PU) and Perceived Ease of Use (PEOU), impacted their willingness to adopt and integrate the system into their daily workflows.

Governments worldwide emphasized optimizing immunization data systems to strengthen preparedness and epidemic response capacity. In Ghana, the successful integration of technology such as the EIR improved the surveillance of adverse events following immunization (Laryea et al., 2022). These surveillance mechanisms, implemented within the EIR framework, enabled healthcare providers to make informed clinical decisions. By automating data reporting and enabling real-time monitoring, the EIR minimized the risk of clinical errors associated with inaccurate or delayed information (Hassan et al., 2023).

Gyaase et al. (2021) highlighted the central role of knowledge management in health establishments, stressing that high-quality data derived from the EIR could considerably improve clinical practices. This assertion was reinforced by the findings of Tchoualeu et al. (2021), who demonstrated the impact of integrated health information systems on improving immunization program surveillance and the quality of clinical decision-making in related regional contexts, such as the state of Kano in Nigeria. The systematic collection and

processing of immunization data through the EIR created an information repository that could be used for evidence-based decision-making, underscoring the dependence on technology to maintain data integrity in clinical environments.

Additionally, the successful implementation of the EIR required addressing obstacles identified in the existing literature. These obstacles often included insufficient training and inadequate infrastructure, both of which undermined healthcare providers' ability to adopt technology effectively (Hassan et al., 2023). Strengthening human capacity through dedicated training sessions improved the EIR's perceived ease of use and increased acceptance, thereby enhancing healthcare delivery.

The relationship between technology acceptance and the accuracy of clinical decision-making aligned with the findings of the systematic review of digital health interventions in Ghana (Azalekor, 2024). The review illustrated the importance of user-centered design in technological deployments, emphasizing that technology perceived as user-friendly tended to be more readily adopted. As health professionals in Ghana made complex clinical decisions, the seamless integration of technology, including the EIR, into their workflows was crucial for promoting effective immunization strategies.

Synthesizing the complexities surrounding the EIR in Ghana made it evident that aligning technology acceptance with user needs was central to improving clinical decision-making related to immunization. Effective technological integration depended on a comprehensive understanding of the obstacles and facilitators that shaped healthcare providers' engagement with such systems. While technology continued to evolve, the sustained commitment of stakeholders, iterative feedback mechanisms, and improvements

in infrastructure were essential to ensuring that the EIR achieved its intended objectives and strengthened overall health service delivery in Ghana. This continued commitment to developing a robust conceptual framework likely established a foundation for similar initiatives across sub-Saharan Africa, reinforcing the importance of technology in health service innovation.

Literature Review Related to Key Variables and/or Concepts

Managing immunization data was a milestone of an effective health service strategy, particularly in vaccine absorption and distribution. The importance of accurate and reliable data could not be overstated, as it directly affected clinical decision-making processes, resource allocation, and policy formulation. Recent global health challenges, notably the COVID-19 pandemic, underlined the need for strengthened immunization data systems. The complexities surrounding these programs were amplified by the urgent need for real-time data on vaccine distribution and outcomes, which were fundamental to addressing both immediate and long-term public health challenges.

This literature review explored existing research related to the constructs of Electronic Immunization Registries (EIR), data-driven decision-making, and healthcare service delivery. The review examined studies that highlighted the opportunities and challenges associated with implementing EIRs, the impact of immunization data quality, and the methodological approaches used in similar research. Additionally, the review synthesized findings to justify key variables, address controversies, and identify gaps that required further investigation.

Constructs of Interest and Chosen Methodology

It was essential to summarize existing findings to identify significant research gaps and points of contention within these complexities. While considerable attention had been directed toward the impacts of digital tools on immunization data management—particularly their roles in enhancing data accuracy, accessibility, and timeliness (WHO, 2021; Adoma et al., 2023)—little was known about the sociopolitical factors that influenced data collection and reporting practices. There remained an urgent need for comprehensive studies that integrated qualitative insights with quantitative analyses to provide a holistic understanding of immunization data management. Furthermore, the involvement of key stakeholders, including community leaders and frontline health workers, in the development of these systems remained understudied, potentially resulting in missed opportunities to improve data applicability and community trust.

The continuous exploration of methodologies, their intrinsic strengths and limitations, and engagement with relevant stakeholders paved the way for more effective immunization strategies. Various methodologies had been applied in multiple studies to examine immunization data, primarily classified as qualitative and quantitative approaches. Quantitative methods, such as systematic reviews and meta-analyses, were particularly influential in synthesizing data to inform policies and strategies that improved vaccine uptake. Crawshaw et al. (2022), for example, used a systematic review to consolidate findings from several studies evaluating the effectiveness of different immunization strategies. These methods were advantageous because they allowed researchers to draw conclusions from broader datasets, thereby facilitating evidence-based clinical decision-making. Similarly, Dolan et al. (2022) utilized an interrupted time-series analysis to evaluate

the impact of EIR implementation on on-time immunization rates in Tanzania, while Kim et al. (2024) conducted a longitudinal study to assess the development and impact of Korea's Immunization Registry Information System over two decades. These approaches offered robust evidence of the role of EIRs in enhancing immunization tracking, data accuracy, and clinical decision-making processes.

Approaches to the Problem: Strengths and Weaknesses

Researchers approached the problem of immunization data management through both quantitative and qualitative methods. Quantitative approaches, such as those used by Dolan et al. (2022) and Pavia et al. (2024), provided measurable evidence of the impact of EIRs, including increased immunization coverage and improved real-time data access. The strength of these studies lay in their ability to produce statistically significant findings; however, they often lacked detailed insights into the lived experiences of healthcare providers and system users. Qualitative research, such as that conducted by Uwera et al. (2024) and Hassan et al. (2023), offered rich contextual understanding and identified challenges related to infrastructure, training, and data utilization.

However, these methodological approaches were not without limitations. Systematic reviews and meta-analyses were constrained by the quality of the primary studies included. A significant concern was publication bias, which tended to favor studies with positive outcomes over those reporting neutral or negative results. Consequently, such bias had the potential to distort understanding of vaccine effectiveness and lead to misleading conclusions about population-level outcomes. Additionally, these methodologies faced

challenges in standardizing data collection practices across studies, resulting in heterogeneity that complicated the synthesis and interpretation of findings.

Justification for Selection of Variables

The selection of key variables such as immunization data quality (dependent variable), implementation of EIRs (independent variable), and infrastructure and training (covariate variables) were justified based on existing literature. Studies such as Piu et al. (2024) and Adoma et al. (2023) highlighted the direct relationship between data quality and healthcare decision-making. Hassan et al. (2023) and Namageyo-Funa et al. (2024) identified infrastructure and training as critical factors that affected EIR effectiveness, making them essential covariate variables in this study.

Review and Synthesis of Studies Related to Key Variables

Independent Variable: Implementation of Electronic Immunization Record (EIRs)

Research consistently showed that the implementation of Electronic Immunization Registries (EIRs) positively influenced various aspects of immunization service delivery. Dolan et al. (2022) demonstrated that introducing an EIR in Tanzania significantly improved the timeliness of immunizations, a finding relevant to timely immunization-related decision-making during clinical encounters. Similarly, Pavia et al. (2024) highlighted how digital health solutions, including EIRs, enhanced the monitoring and tracking of immunizations, thereby supporting overall immunization coverage rates and enabling more accurate immunization recordkeeping.

Despite these benefits, challenges such as inadequate infrastructure and limited training remained significant barriers to successful implementation. Hassan et al. (2023) and

Namageyo-Funa et al. (2024) emphasized that sustainable EIR adoption in African healthcare settings required strong stakeholder engagement and targeted capacity-building initiatives.

Dependent Variable 1: Accuracy of Patient Immunization Records

The accuracy of patient immunization records was foundational to effective healthcare delivery. Inaccurate records could lead to missed or duplicate vaccinations. Studies such as Piu et al. (2024) and Adoma et al. (2023) revealed that incomplete and inaccurate immunization data were widespread issues, particularly in low-resource settings. Uwera et al. (2024) found that EIR implementation improved data accuracy by reducing manual entry errors and enabling real-time updates, though they also emphasized the need for ongoing technical support and user training to maintain data integrity.

Dependent Variable 2: Timeliness of Immunization-Related Decision-Making During Clinical Encounters

Timely clinical decisions regarding immunizations were essential to ensuring that patients received vaccines according to national schedules. EIRs contributed to timely decision-making by providing healthcare providers with up-to-date immunization histories and reminders. Dolan et al. (2022) reported improved decision-making timelines following the adoption of EIRs, which enabled quicker identification of patients due for vaccination. However, Namageyo-Funa et al. (2024) noted that insufficient training and system downtimes could delay access to this critical information, limiting the effectiveness of EIRs.

Dependent Variable 3: Overall Immunization Coverage Rates

Several studies confirmed that EIR implementation correlated with increased immunization coverage rates. Pavia et al. (2024) and Hassan et al. (2023) found that digital registries facilitated better follow-up with defaulters and improved coverage tracking. Nevertheless, Adoma et al. (2023) cautioned that although EIRs offered strong potential, actual improvements in coverage rates depended on system reliability, healthcare worker engagement, and community acceptance.

Covariate Variables: Infrastructure and Training

Infrastructure limitations, including internet connectivity and digital literacy among healthcare workers, were key challenges affecting EIR implementation. Adeoye et al. (2022) identified gaps in data infrastructure and training as critical barriers to effective immunization data management in Nigeria, findings that parallel those of Hassan et al. (2023) in broader Sub-Saharan Africa.

Controversies and Gaps in Literature

There was consensus that EIRs improved immunization coverage and data management, yet studies revealed mixed findings regarding their long-term sustainability. While Kim et al. (2024) highlighted Korea's success with EIRs, Nickels et al. (2024) cautioned that electronic health records (EHRs), including EIRs, could contribute to diagnostic uncertainty when data were incomplete or misinterpreted. Additionally, Vadrevu et al. (2024) argued that integrating EIRs with Theories of Change (ToC) could enhance program effectiveness, but gaps remained in real-time data monitoring. Further research was needed to examine how EIRs could be optimally integrated into healthcare decision-making frameworks in Ghana.

Review of Studies Related to Research Questions

The research questions in this study focused on the impact of EIRs on the accuracy of patient immunization records, the timeliness of immunization-related decision-making during clinical encounters, and overall immunization coverage rates among patients in healthcare facilities in Ghana. Studies such as Pavia et al. (2024) and Dolan et al. (2022) provided empirical evidence of the role of EIRs in improving clinical decision-making and immunization coverage. Conversely, studies like Hassan et al. (2023) and Namageyo-Funa et al. (2024) underscored persistent barriers to implementation, including training gaps and infrastructure deficits.

The reviewed literature offered strong support for the potential of EIRs to enhance immunization data quality and decision-making; however, challenges such as infrastructure limitations, training deficiencies, and privacy concerns needed to be addressed to ensure successful implementation. Further research was needed to explore integrated approaches that combined EIRs with existing health information systems to optimize their impact on immunization services in Ghana.

Summary and Conclusions

The introduction of electronic immunization records (EIRs) in Ghana marked significant progress in the health service delivery system, particularly in strengthening immunization programs. EIRs supported real-time monitoring of immunization records, thereby influencing data accessibility, accuracy, and reliability. The systematic review by Azalekor (2024) demonstrated how digital health tools, such as EIRs, could transform healthcare service delivery in Ghana, emphasizing their importance in addressing persistent

challenges. The literature overwhelmingly supported the transformative potential of EIRs in improving data quality, enhancing clinical decision-making, and increasing immunization coverage in low- and middle-income countries. Key themes included (a) the problems of poor data quality and low immunization rates in Ghana and similar settings, (b) the ability of EIRs to improve real-time accuracy and support clinical decision-making, (c) challenges such as weak infrastructure, low digital literacy, and inadequate training, and (d) the need for stakeholder engagement and user-centered design for successful implementation. Studies from Tanzania, Rwanda, and Korea provided valuable evidence of the benefits of EIR adoption, while Theories of Change (ToC) and the Technology Acceptance Model (TAM) offered useful theoretical frameworks for understanding EIR uptake.

Despite these insights, gaps remained in the literature regarding the long-term effects of EIRs on immunization compliance and health outcomes. While some studies examined the initial impacts of digital health systems, comprehensive assessments of their sustained influence on healthcare delivery and clinical decision-making were still lacking. Arhin et al. (2025) emphasized the need for continuous benchmarking of health systems in sub-Saharan Africa, particularly regarding childhood immunization services, to identify best practices and areas requiring further support. Such insights could assist policymakers and stakeholders in making informed decisions about future investments in digital health technologies. Many healthcare workers in Ghana remained accustomed to traditional methods of maintaining immunization records; thus, transitioning to an electronic system required substantial capacity building. The development of training programs focused on the operational aspects of EIR systems could strengthen healthcare workers' confidence in

effectively using these tools. Addy et al. (2024) underscored the importance of integrating artificial intelligence algorithms into EIRs to optimize vaccine distribution and enhance data-driven clinical decision-making, although such integration required foundational knowledge that many professionals might not yet possess.

In summary, while electronic immunization records held strong promise for transforming healthcare delivery and improving clinical decision-making in Ghana, significant challenges persisted. Addressing infrastructure inadequacies, filling existing literature gaps, implementing comprehensive training, and ensuring data security were imperative for the successful integration of EIRs into the Ghanaian health system. Future research should focus on longitudinal studies to evaluate the long-term impacts of EIRs on immunization uptake and to identify best practices for implementation and capacity development. As Ghana continued to navigate the complexities of equitable healthcare and immunization delivery, the strategic use of EIRs guided by empirical evidence and stakeholder collaboration was crucial to achieving national health service goals.

Chapter 3: Research Method

Introduction

The adoption of electronic immunization records (EIRs) was transforming health service delivery in many countries, including Ghana. Investigating the influence of these systems on healthcare professionals' perceptions, decision-making processes, and health outcomes was crucial to understanding their impact on immunization strategies. This study aimed to evaluate the impact of implementing electronic immunization records on the accuracy of clinical decision-making and immunization outcomes among healthcare professionals in Ghana. Healthcare workers played a vital role in immunization efforts, and their perceptions significantly affected the implementation of immunization strategies. Mensah et al. (2024) reported that the integration of electronic medical records into Ghana's healthcare practice elicited mixed reactions from healthcare workers. Many recognized the potential for such systems to improve efficiency and accuracy in managing patient data, leading to better health outcomes (Eze et al., 2023; Più et al., 2024). However, concerns about system reliability and potential workflow disruptions also emerged, which adversely affected professionals' willingness to adopt EIRs.

The clinical decision-making process within health facilities was often dependent on the availability of timely and accurate information. EIRs could significantly improve this process by providing real-time data on immunization status and coverage rates. Okyere Boadu et al. (2024) found that healthcare professionals in the Cape Coast Metropolis reported a greater inclination to use health information applications when they perceived the systems as beneficial to their practice. These perceptions contributed to more favorable

attitudes toward EIRs, which could lead to improvements in immunization rates. Despite these advantages, several factors hindered the widespread adoption of EIRs in Ghana. Challenges such as inadequate training, limited infrastructure, and resistance to change reduced healthcare professionals' commitment to new technologies. Ansah et al. (2023) documented similar constraints when examining the challenges health workers faced in reporting adverse events following immunization in northern Ghana, highlighting significant gaps in knowledge and technology use. Addressing these barriers was essential to improving the effectiveness of electronic immunization records.

Furthermore, the proper implementation of EIRs required a supportive policy environment and adequate resources (Adoma et al., 2023). Azalekor (2024) emphasized the need for systematic assessments of digital health interventions to fully understand their potential. A comprehensive review of digital health initiatives in Ghana provided insight into current capabilities and underscored the need to strengthen infrastructure and training programs to address existing gaps. Promoting an environment that encouraged experimentation and the sharing of best practices could help healthcare professionals feel more empowered to engage actively with EIRs. In conclusion, electronic immunization records held significant promise for improving the accuracy of immunization data, enhancing the speed of clinical decision-making, and increasing immunization coverage rates in Ghana, ultimately influencing the country's immunization outcomes. However, the successful adoption of these systems depended on addressing the multifaceted barriers identified in previous studies. By providing targeted training, improving infrastructure, and deepening understanding of how EIRs enhanced service delivery, stakeholders could foster

an enabling environment that supported the effective use of electronic immunization records. Future research should focus on longitudinal studies to evaluate the long-term effects of EIRs on immunization rates and to explore how healthcare professionals' perceptions evolved as they adapted to these digital health innovations.

Research Design and Rationale

This study aimed to assess how using an Electronic Immunization Registry (EIR) affects healthcare by looking at two main areas: the correctness of patient immunization records and how quickly immunization decisions are made during medical visits in Ghana. The following research questions guide the study:

Research Questions:

- RQ1: How does the implementation of an Electronic Immunization Registry (EIR) impact the accuracy of patient immunization records in clinical encounters in Ghana?
- Hypothesis (H1): Implementation of an Electronic Immunization Registry (EIR) resulted in a statistically significant increase in the accuracy of patient immunization records. Clinical encounters with the EIR showed measurable improvement in the percentage of complete and accurate records compared to encounters without EIR.
- Null Hypothesis (H0): Implementation of an Electronic Immunization Registry (EIR) did not result in a statistically significant increase in the accuracy of patient immunization records. Clinical encounters with the EIR showed no measurable improvement in the percentage of complete and accurate records compared to encounters without EIR.

- RQ2: What is the effect of an Electronic Immunization Registry (EIR) on the timeliness of immunization-related decision-making in clinical encounters in Ghana?
- Hypothesis (H1): Implementation of an Electronic Immunization Registry (EIR) significantly reduced the time required for immunization-related decision-making during clinical encounters. There was a statistically significant difference in decision-making speed or waiting times between providers using the EIR and those who are not.
- Null Hypothesis (H0): Implementation of an Electronic Immunization Registry (EIR) did not significantly affect the time required for immunization-related decision-making during clinical encounters. Providers using the EIR did not have statistically significant differences in decision-making speed or wait times.
- RQ3: Does the implementation of an EIR improve overall immunization coverage rates among patients in healthcare facilities in Ghana?
- Hypothesis (H1): Implementation of an Electronic Immunization Registry (EIR) significantly improved overall immunization coverage rates among patients in healthcare facilities in Ghana. Healthcare facilities using EIRs demonstrated a statistically significant increase in immunization coverage rates compared to those using paper-based systems.
- Null Hypothesis (H0): Implementation of an Electronic Immunization Registry (EIR) did not significantly improve overall immunization coverage rates among patients in healthcare facilities in Ghana. There was no statistically significant difference in immunization coverage rates between EIR-using and non-EIR-using facilities.

The central concepts of this study are

- **Electronic Immunization Registry (EIR):** A digital system designed to collect, manage, and store immunization data to enhance record accuracy and facilitate decision-making (Azalekor, 2024).
- **Accuracy of Patient Immunization Records:** The completeness and correctness of immunization data documented during clinical encounters.
- **Timeliness of Immunization-Related Decision-Making:** The speed at which healthcare providers access information and make immunization decisions during clinical encounters.

This study employs a quantitative research tradition utilizing a quasi-experimental design to assess the impact of the Electronic Immunization Record (EIR) on the accuracy of immunization data and clinical decision-making in Ghana. Quantitative methods are appropriate for examining measurable variables such as data accuracy, decision-making speed, and immunization coverage rates (Creswell & Creswell, 2018). The study specifically compared clinical encounters that implement an EIR with those that rely on traditional paper-based or non-digital record systems. The reason for using a quantitative quasi-experimental design is to measure and compare results like how accurate records are and how quickly decisions are made in a clear and statistically reliable way. This study employs a quantitative research tradition utilizing a quasi-experimental design to assess the impact of the Electronic Immunization Registry (EIR) on the accuracy of immunization data and clinical decision-making in Ghana. Quantitative methods are appropriate for examining measurable variables such as data accuracy, decision-making speed, and immunization

coverage rates (Creswell & Creswell, 2018). Because it's not possible to randomly assign participants to EIR and non-EIR groups in real healthcare situations in Ghana, the quasi-experimental approach lets us make useful comparisons between the groups that already exist while still being relevant to real-life settings. Additionally, using quantitative methods allows for clear measurement of differences in how immunization services are provided, which helps in making conclusions and policy suggestions that are useful for healthcare leaders and decision-makers in Ghana and similar places.

Methodology

This chapter detailed the methodology that was used to carry out the study. It outlined the participant selection logic, population, sampling strategy, recruitment procedures, data collection methods, and considerations for data analysis. It also addressed the use of archival data and ethical issues related to participant involvement.

Target Population

The target population for this study included healthcare providers (such as doctors, nurses, midwives, and community health officers) working in health service facilities in Ghana that were involved in immunization services. Specifically, the focused was on providers who either use an Electronic Immunization Record (EIR) or continued to use traditional paper-based systems.

Sampling and Sampling Procedures

A purposive sampling strategy was employed to select participants. This strategy was appropriate because the study required healthcare providers who were directly involved in immunization service delivery and who had experience with either the EIR system or

traditional methods. Purposive sampling allows for the deliberate selection of participants who possessed rich, relevant experience necessary to address the research questions (Robinson, 2024).

Inclusion Criteria: Healthcare providers who were directly responsible for recording and managing immunization data. The inclusion criteria also included providers who had at least six months of experience either using the EIR or working with paper-based systems. Providers working in facilities where EIRs had been implemented or that still relied solely on paper-based immunization records.

Exclusion Criteria: Providers who did not have direct roles in immunization decision-making. Providers who had been using the EIR system for less than six months were excluded to ensure they had adequate exposure. Participants' eligibility was confirmed through facility managers and administrative records to ensure they meet the criteria.

Sample Size and Rationale

To determine an appropriate sample size for this study, G*Power 3.1 software was used to conduct a priori power analyses for both an independent samples t-test and a linear multiple regression. The total population size under consideration is 225,454 individuals. While this is a large population, the study focused on a more targeted comparison between two groups: facilities implementing the Electronic Immunization Registry (EIR) and those not implementing it. Using G*Power for an independent samples t-test (two-tailed), with a medium effect size (Cohen's $d = 0.5$), alpha level of 0.05, and a power of 0.80, the minimum required sample size was approximately 102 participants (51 per group). This effect size was considered appropriate based on prior studies assessing the impact of health

information systems, where moderate changes in performance and behavior had been observed.

To ensure robust results across both analytical approaches and to account for potential non-responses or incomplete data, the study recruited a total of one hundred and twenty participants, sixty from EIR-implementing facilities and sixty from non-EIR facilities. This number slightly exceeded the minimum required for both statistical tests, which enhanced the reliability of the findings and maintained adequate power even with modest attrition.

Determining the appropriate sample size was fundamental to the integrity of the research results; inadequate samples often led to unreliable findings and reduced statistical power. Lee and Kim (2022) clarified this concept by stating that inferential statistics provided researchers with the tools necessary to understand the relationship between sample size and the reliability of conclusions drawn from the data. They emphasized that larger sample sizes resulted in stronger statistical inferences, thereby improving the generalizability of the results to similar populations.

In addition, Kumar et al. (2025) reinforced the idea that the adequacy of a sample size significantly influenced the power of a statistical test—the probability that the test correctly rejected a false hypothesis. A power analysis, a method often used to determine appropriate sample size, established a critical threshold that researchers sought to meet to ensure their studies could detect real effects when they existed. In this study, having a sample of 120 participants increased the likelihood of identifying meaningful differences between EIR and non-EIR facilities, thereby strengthening the analysis and reducing the risk

of Type II errors, which were particularly problematic when assessing subtle differences in outcomes.

Procedures for Recruitment, Participation, and Data Collection

Recruitment: Participants were recruited through official collaboration with district and regional health directorates. Letters of introduction and approval were obtained from institutional authorities to gain access to the selected facilities.

Contact: Facility managers were first approached to identify eligible healthcare providers. Flyers and information sheets explaining the purpose of the study, procedures, and participants' rights were distributed.

Participation: Interested participants voluntarily enrolled by signing informed consent forms. A clear explanation of the study, including its voluntary nature and confidentiality assurances, was provided.

Data Collection: Data collection involved reviewing immunization records, timing decision-making processes during clinical encounters, and gathering demographic information using a structured data collection form.

Relationship Between Saturation and Sample Size

Saturation in quantitative research refers to collecting sufficient data to identify statistically significant differences or effects. A sample of one hundred and twenty participants (sixty per group) was sufficient to reach data adequacy for comparative statistical analysis (Wibowo, 2024). The selection of sixty participants per group (total N = 120) is grounded in established statistical guidelines for detecting medium effect sizes with sufficient power. According to Cohen (1992), a sample size of approximately 60 per group

was needed to detect a medium effect size (Cohen's $d = 0.5$) with 80% power at a significance level of $\alpha = 0.05$ using two-tailed tests. This guideline was supported by Adamu et al., 2018 and Bujang et al., 2017, who argued that power analysis is essential to determine an adequate sample size and minimize Type II errors in comparative health studies. Given the study's quasi-experimental design comparing EIR and non-EIR clinical settings, a sample of 60 participants per group closely aligns with this guideline and was expected to yield meaningful statistical comparisons using t-tests or multiple regression analysis. While the concept of "saturation" is more traditionally associated with qualitative research, the equivalent in quantitative studies is statistical power and effect size sensitivity (Wibowo, 2024). The chosen sample size allowed for robust analysis and accounted for potential data attrition. Furthermore, digital health studies in low- and middle-income countries have shown that sample sizes ranging from 100 to 150 participants were sufficient to evaluate the effectiveness of electronic health interventions, including electronic immunization systems (Wibowo, 2024). Therefore, the proposed sample size was both methodologically sound and contextually supported by the literature. If substantial missing data had emerged during data collection, the sample would have been expanded slightly to meet analytic requirements.

Pilot Study

A small pilot study was conducted with 5 participants prior to full data collection to test the data collection instruments and procedures.

Purpose: The purpose of the pilot study was to refine the data collection tools, ensure clarity of the measurement criteria (accuracy and timeliness), and adjust procedures to minimize disruptions during clinical encounters.

Adjustments: Feedback from the pilot study informed the necessary adjustments before proceeding with the full study.

Intervention

Although no new intervention was implemented as part of this study, the existing intervention, the use of an Electronic Immunization Registry (EIR), constituted the basis for comparison against traditional paper-based methods. The study observed the natural implementation of EIR rather than manipulating it.

Instrumentation and Operationalization of Constructs

This study utilized three main data collection instruments:

EIR Data Accuracy, Timeliness Observation and overall usability Checklist

Source: Researcher-produced based on guidelines from the Ghana Health Service's immunization protocols and WHO recommendations for evaluating health information systems.

Description: The checklist was used to assess the completeness and accuracy of immunization records during clinical encounters. It also measured the time taken from patient arrival to the immunization decision, comparing facilities using the Electronic Immunization Registry (EIR) with those using traditional paper-based records.

Provider Perception Survey Questionnaire

Source: Researcher adapted from validated instruments, including elements from the Technology Acceptance Model (TAM) survey tools and the WHO's Health Facility Assessment surveys.

Description: The survey measured healthcare providers' perceptions of the EIR system, focusing on constructs such as perceived usefulness, perceived ease of use, system reliability, and impact on decision-making speed. The survey used a 5-point Likert scale to capture participant responses.

Sufficiency of Data Collection Instruments

The combination of the EIR Data Accuracy, Timeliness Observation, and Overall Usability Coverage Checklist and the Provider Perception Survey Questionnaire was sufficient to answer the research questions for this study. The Observation Checklist provided objective measures of the accuracy of immunization records, the speed of immunization-related decision-making, and overall immunization coverage rates, directly addressing RQ1, RQ2, and RQ3. The Survey Questionnaire captured healthcare providers' perceptions, which helped interpret the observational findings and offered insight into the factors influencing the success or challenges of EIR implementation. Together, these instruments ensured comprehensive data collection that linked system implementation (EIR use) to measurable outcomes (record accuracy and decision-making speed) and provider perspectives, thereby supporting robust analysis and answering the study's research questions.

Operationalization of Constructs

The central constructs of this study; accuracy of immunization records, timeliness of decision-making, and provider perceptions of the EIR were operationalized as follows:

Accuracy of Immunization Records: The degree to which the immunization records in the health facility's system correctly and completely reflected the actual immunization history of each patient during a clinical encounter was measured by comparing recorded immunization data in the EIR (or paper records) against a validated source. Accuracy was scored as a percentage of correctly recorded immunizations compared to the validated data (e.g., if 8 out of 10 vaccinations were correctly recorded, the accuracy score was 80%).

Timeliness of Immunization-Related Decision-Making: The time it took for healthcare providers to retrieve a patient's immunization history and make appropriate immunization-related decisions during clinical encounters was measured using time logs or direct observation, from the point a patient record was accessed to when the decision was made. Timeliness was recorded in seconds or minutes, with lower scores indicating faster decision-making.

Overall Immunization Coverage: The proportion of the eligible child population within the study facilities who had received all age-appropriate immunizations according to the national immunization schedule was measured using facility-level reports or aggregated EIR data on the number of children fully immunized divided by the total number of eligible children. Coverage is expressed as a percentage.

Data Analysis Plan

This section outlined how the collected data was analyzed in relation to the study's research questions and hypotheses. It included the data types, connections to specific research questions, coding procedures, analytical software, and how discrepant cases were managed.

Research Question 1

RQ1: How does the implementation of an Electronic Immunization Registry (EIR) impact the accuracy of patient immunization records in clinical encounters in Ghana?

Hypothesis (H1): EIR implementation significantly increases the accuracy of patient immunization records.

Null Hypothesis (H0): EIR implementation has no significant effect on accuracy.

Type of Data Collected. I extract quantitative data from immunization records (both paper-based and EIR-based), focusing on the completeness, accuracy, and consistency of recorded immunizations.

Connection to RQ1. Accuracy will be operationalized as the percentage of records with complete immunization data (e.g., name, date of birth, vaccine type, dose, and date administered) and internal consistency between visits.

Procedure for Coding. A coding rubric will be used to classify each record as either complete or accurate, incomplete, inconsistent.

I will score the records (e.g., 1 = complete/accurate, 0 = incomplete/inconsistent) for statistical comparison.

Software to use. I will compute descriptive statistics to compare the EIR and non-EIR groups using IBM SPSS.

Treatment of Discrepant Cases. Any ambiguous or inconsistent entries in the dataset were flagged and reviewed with facility staff as needed. These cases were either corrected (if possible) or excluded from analysis, with justification noted. A sensitivity analysis was also conducted to evaluate their impact on the overall results. Sensitivity analysis is widely recommended in quantitative research and program evaluation, as it tests the robustness of findings under different scenarios, thereby strengthening the credibility and transparency of the conclusions (Saltelli et al., 2008; Thabane et al., 2013). According to Saltelli et al. (2008), this approach helped identify which assumptions most affected outcomes, supporting more informed interpretation and policy recommendations.

Research Question 2

RQ2: What is the effect of an Electronic Immunization Registry (EIR) on the timeliness of immunization-related decision-making in clinical encounters in Ghana?

Hypothesis (H1): EIR implementation significantly reduces time required for immunization decision-making.

Null Hypothesis (H0): EIR implementation does not significantly affect decision-making time.

Type of Data Collected. Quantitative time-tracking data were collected during clinical encounters, noting how long providers took to retrieve immunization history and make immunization decisions.

Connection to RQ2. Timeliness was defined as the time (in seconds or minutes) between the start of the encounter and the final immunization decision.

Procedure for Coding. Raw timing data were collected and then coded into continuous variables. The mean decision-making time was calculated for providers with multiple observations.

Software Used. Independent samples t-tests was conducted using IBM SPSS to compare decision times between EIR and non-EIR users.

Treatment of Discrepant Cases. Outliers (e.g., encounters significantly longer or shorter than average due to interruptions) were analyzed separately to determine whether exclusion was warranted. All exclusions were documented, and results with and without such data points were compared to ensure transparency.

Each research question was directly addressed with appropriate quantitative analysis. The accuracy of immunization records and the speed of decision-making were compared using statistical methods between the EIR and non-EIR groups, employing reliable software and consistent coding procedures. Discrepant cases were handled with methodological rigor to ensure the integrity and robustness of the findings.

Research Question 3

(RQ3): Does the implementation of an EIR improve overall immunization coverage rates among patients in healthcare facilities in Ghana?

Hypothesis (H1): Implementation of an EIR will significantly improve overall immunization coverage rates among patients. Facilities using EIRs will demonstrate statistically higher immunization coverage rates than those using paper-based systems.

Null Hypothesis (H0): Implementation of an EIR will not significantly improve immunization coverage rates. There will be no statistically significant difference between EIR and non-EIR facilities.

Type of Data Collected: Aggregated facility-level data on immunization coverage.

Connection to RQ3: Immunization coverage defined as the percentage of children receiving all age-appropriate vaccines.

Coding Procedure: Data coded as continuous percentage scores for each facility.

Treatment of Discrepant Cases: Facilities with incomplete reporting flagged and analyzed separately. Sensitivity analysis performed.

Threats to Validity

In quantitative research, particularly in a quasi-experimental design, it was essential to ensure that internal, external, statistical, and construct validity were maintained to maintain the reliability and accuracy of the findings (Maggin, 2022).

Internal validity (or credibility equivalent) refers to the degree to which observed outcomes can be attributed to the intervention rather than to other factors (Duckett, 2021). This study will use matched comparison groups of facilities that have implemented EIR versus those that have not, while controlling for variables such as facility size, location (urban or rural), and staff capacity. Consistent data collection instruments, such as audit tools for record accuracy and timing logs for decision-making, were used across all sites. These tools were pilot tested for clarity and reliability. Data were collected over a limited and controlled time frame to minimize the impact of external changes, such as new policies

or training initiatives, that could have influence the outcomes. Data collectors will be trained uniformly to reduce variability in how observations or measurements are recorded.

External validity, also known as transferability, addressed the generalizability of study findings beyond the specific sample studied (Ducket, 2021). The study included healthcare facilities from multiple geographic regions of Ghana, encompassing both urban and rural areas, and representing a range of sizes and administrative structures. Detailed contextual descriptions of each participating facility were documented to help readers assess the relevance and applicability of findings to other healthcare environments. The study design, instruments, and procedures were transparently documented to support replication in similar settings in other low- and middle-income countries.

Statistical conclusion validity referred to the accuracy of conclusions regarding the relationship between the independent variable (EIR implementation) and the dependent variables (accuracy of records and timeliness of decisions) (Ducket, 2021). Tests such as t-tests, ANOVA, or regression analysis were selected based on the level of measurement and data distribution. Assumptions of normality, homoscedasticity, and independence were tested, and any violations were addressed using transformations or non-parametric alternatives.

Construct validity examined whether the instruments truly measured the intended variables (Maggin, 2022). Key constructs, such as “accuracy of immunization records,” “timeliness of decision-making,” and “overall immunization coverage rates,” were clearly defined and calculated using validated indicators, including completeness scores and average decision time. All researcher-developed instruments were pilot-tested and revised as

needed based on expert feedback and preliminary analysis. Additional data on possible confounding factors (e.g., staff training level, internet access availability) were collected and statistically controlled for in the study.

Summary Ethical Procedures

Formal agreements were secured with healthcare facilities participating in the EIR implementation to gain access to participants and relevant immunization data. Permission letters from facility management and district health offices were obtained and included in the Institutional Review Board (IRB) application. Additionally, collaboration occurred with Regional Directors of the Ghana Health Service (GHS) and local clinic managers to authorize access to healthcare providers for data collection.

Approval was obtained from the Walden University Institutional Review Board (IRB) before data collection began. Institutional permissions from healthcare facilities and district/regional health offices in Ghana were also obtained. IRB approval numbers were provided for the completed dissertation.

To minimize undue influence, participation was strictly voluntary. Recruitment scripts clearly stated that choosing to participate or not would not affect participants' job status, evaluations, or relationships with their employers. Recruitment occurred outside of supervisory settings to avoid power dynamics influencing consent.

Informed consent was obtained from all participants prior to data collection. Participants received a consent form stating the purpose of the study, procedures, benefits, confidentiality measures, and the voluntary nature of participation. Those who agreed to participate had the opportunity to ask questions and sign the consent form. For providers

participating in surveys, consent was indicated electronically or in writing, depending on the mode of survey administration.

Data collection avoided collecting personally identifiable information (PII) whenever possible. Where minimal identifiers were necessary (e.g., for record linkage), unique participant codes were assigned. Recruitment was conducted independently of management staff, considering the potential for power differentials, such as supervisors encouraging participation. Participation was emphasized as voluntary and unrelated to employment evaluations. All collected data, including survey responses and observation data, were treated as confidential. Data were stored securely on encrypted, password-protected devices and backed up on a secure institutional cloud storage system accessible only to the research team.

Summary

This chapter described how the study was set up and conducted to investigate how the Electronic Immunization Registry (EIR) affected clinical decision-making and the accuracy of data in healthcare facilities in Ghana. The research questions were restated to focus on three primary outcomes: (1) the accuracy of patient immunization records, (2) the timeliness of immunization-related clinical decisions, and (3) overall immunization coverage rates among patients in healthcare facilities in Ghana.

The study population comprised healthcare professionals involved in immunization delivery across selected regions of Ghana. A purposive sampling strategy was used to select facilities that had implemented the EIR and those that had not, ensuring comparability between groups. The selection criteria, sampling rationale, and participant recruitment

procedures were clearly articulated to promote transparency and alignment with ethical standards.

Data were collected using structured audit tools and timing logs developed for the study, drawing on best practices described in the methodological literature (Creswell & Creswell, 2018; Fowler, 2014). A detailed data analysis plan was provided, specifying the statistical techniques used, software tools (such as SPSS), coding strategies, and treatment of discrepant data. The plan explained how reliability and validity were ensured by describing steps to improve trustworthiness, including considerations of internal and external validity, statistical conclusion validity, and construct validity.

All ethical considerations, including informed consent, data protection, and IRB approvals, were addressed in compliance with established research ethics. The study aimed to contribute to health policy improvements by examining how digital health tools, such as the EIR, affected routine immunization services in resource-limited settings.

Transition to Chapter 4

Chapter 4 presented the results of the data collection and statistical analyses. This phase included descriptive statistics, comparative analyses between EIR and non-EIR sites, and evaluation of the study hypotheses. Tables, figures, and narrative interpretations were used to summarize key findings in alignment with the research questions. This chapter served as the foundation for drawing conclusions and recommendations in Chapter 5.

Chapter 4: Results

Introduction

Chapter 4 presents the results of the quantitative quasi-experimental study designed to evaluate the impact of implementing an Electronic Immunization Record (EIR) system on clinical decision-making and immunization outcomes in healthcare facilities in Ghana. This chapter reports the findings derived from statistical analyses that compare facilities using EIRs with those relying on traditional paper-based immunization records. The results address the primary purpose of the study, to determine whether EIR implementation contributes to improvements in the accuracy of immunization records, the timeliness of clinical decision-making, and overall immunization coverage rates.

As outlined in previous chapters, the study is guided by three central research questions:

1. **RQ1:** How does the implementation of an Electronic Immunization Registry (EIR) impact the accuracy of patient immunization records in clinical encounters in Ghana?
 - **H1:** EIR implementation results in a statistically significant increase in the accuracy of patient immunization records.
 - **H0:** EIR implementation has no statistically significant effect on the accuracy of patient immunization records.
2. **RQ2:** What is the effect of implementing an EIR on the timeliness of immunization-related decision-making during clinical encounters in Ghana?
 - **H1:** EIR implementation significantly reduces the time required for immunization-related decision-making.

- **H0:** EIR implementation has no significant effect on the time required for immunization-related decision-making.
3. **RQ3:** Does the implementation of an EIR improve overall immunization coverage rates among patients in healthcare facilities in Ghana?
- **H1:** EIR implementation significantly improves immunization coverage rates.
 - **H0:** EIR implementation does not significantly improve immunization coverage rates.

This chapter is organized into four main sections. The first section provides a description of the sample and preliminary data screening results. The second section outlines the statistical procedures used to evaluate each research question and test the corresponding hypotheses. The third section presents the findings for RQ1, RQ2, and RQ3, including tables and figures summarizing key outcomes. The final section offers a brief summary of the results, setting the stage for the interpretation and implications that will be discussed in Chapter 5.

Through this structure, Chapter 4 aims to clearly and systematically present the empirical evidence needed to evaluate the effectiveness of Electronic Immunization Records in improving clinical and immunization outcomes within the Ghanaian healthcare context.

Pilot Study

A pilot study was conducted with five participants drawn from different healthcare facility types (Teaching Hospital, District Hospital, Private Hospital, and Regional Hospital). Participants represented diverse professional roles, including general nurses,

medical doctors, health records officers, and community health nurses. Their years of experience ranged from less than 1 year to over 10 years, and EIR exposure varied from non-use to more than two years of use.

(a) Key Findings

1. Clarity and Functionality of the Survey Instrument

Across all participants, there was consistent response completeness, indicating that the questionnaire items were clear and easy to understand. No participant skipped items in Sections B, C, or D. The Likert-scale design supported straightforward responses, with no patterns suggesting confusion or misinterpretation.

2. Reliability of Measurement Constructs

Initial descriptive review showed strong internal alignment among items within the constructs of:

- Data accuracy and completeness (Section B)
- Decision-making speed (Section C)
- Perceived usefulness and ease of use (Section D)

Most participants regardless of facility type or EIR status reported Strongly Agree or Agree across nearly all items. This suggests the constructs are measuring cohesive perceptions, though the lack of response variability signals that additional items may be needed to avoid ceiling effects in the full study.

3. Practicality of Administration

The survey was completed smoothly with no reported burden on workflow. However,

participants suggested that response options for “Professional Role” and “Facility Type” needed broader categories to reduce reliance on “Other (please specify).”

Impact of Pilot Study on the Main Study

1. Instrumentation Changes

Based on pilot feedback and observed patterns:

- There were no revised instructions for clarity regarding the difference between EIR users and non-users.

2. Data Analysis Adjustments

- Introduced a stratified analysis plan to compare EIR users and non-users separately.
- Planned inclusion of non-parametric tests if Likert scores remain highly skewed in the main study.

3. Procedural Adjustments

- Confirmed that the survey can be administered without workflow disruption; however, procedures will now emphasize administering the instrument before or after peak clinic hours to ensure uninterrupted participation.
- Added a step to verify participants’ actual EIR experience prior to completing the full instrument.

The pilot study demonstrated that the data collection tool is clear, feasible, and functional for the full-scale study. The adjustments derived from the pilot particularly clarifying demographic items, integrating skip logic, and refining data analysis strategies strengthened internal validity and improve the accuracy of comparisons between EIR and paper-based

immunization processes. The pilot confirmed the readiness of the instrument and procedures for full implementation.

Data Collection

Data collection occurred over a two-week period across selected healthcare facilities operating under the Ghana Health Service (GHS). Recruitment procedures followed the approved protocol. A total of 120 healthcare providers participated in the study.

Recruitment and Participation

Participants were recruited through district and regional health directorates. Facility managers identified eligible immunization providers, and information sheets and flyers were distributed. Participation was voluntary, and all participants signed informed consent forms.

Data Collection Procedures

Data were collected using structured questionnaires. Questionnaires were delivered to participant via email or scanning of assigned QR code. No major deviations from the Chapter 3 plan occurred.

Response Rates

- Target sample: 120 participants
- Actual participants: 120 (100% response rate) No participants withdrew from the study.

Representativeness of the Sample

The sample composition (n=120) was consistent with the structure of Ghana's primary healthcare workforce predominantly composed of general nurses, midwives, medical doctors, disease control officers, health records officer and other health

professionals. While non-probability sampling limits generalizability, the proportion of workers from different facility types (hospitals, health centers, CHPS compounds) reflected national workforce distribution.

Descriptive Statistics Overview on Demography

All five demographic and implementation variables achieved a 100% response rate (N = 120), indicating strong participant engagement and a complete dataset for analysis.

Descriptive results showed a diverse sample with generally moderate EIR use and a relatively new immunization workforce, and all skewness and kurtosis values fell within acceptable ranges, supporting the suitability of the data for subsequent inferential analyses.

Table 1: Descriptive Statistics Overview on Demography

		Q1	Q2	Q3	Q4	Q5
N	Valid	120	120	120	120	120
	Missing	0	0	0	0	0
Mean		3.23	4.12	2.33	3.06	2.40
Skewness		-.329	-.075	.617	-.391	-.191
Std. Error of Skewness		.221	.221	.221	.221	.221
Kurtosis		-1.727	-.956	-1.069	-.974	-.883
Std. Error of Kurtosis		.438	.438	.438	.438	.438
Minimum		1	1	1	1	1
Maximum		5	6	5	6	3

Q1. What type of healthcare facility do you work in?

Q2. What is your professional role in the healthcare facility?

Q3. How many years have you worked in clinical immunization services?

Q4. How long have you personally used the EIR (if applicable)?

Q5. Does your facility currently use an Electronic Immunization Registry (EIR)?

Demography

Type of Healthcare facility

The majority of respondents worked in teaching hospitals (37.5%) and district hospitals (35.8%), indicating that the sample was largely drawn from secondary and tertiary healthcare facilities where immunization services are more structured and digital health systems are more frequently implemented. EIR impact.

Figure 1: *Type of Healthcare facility*

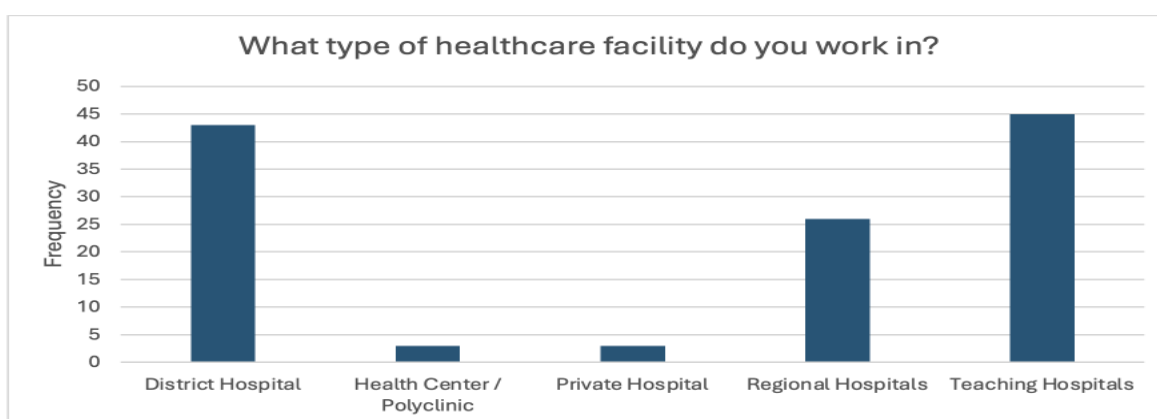


Table 2: *Type of Healthcare facility*

What type of healthcare facility do you work in?

	N	%
District Hospital	43	35.8%
Health Center / Polyclinic	3	2.5%
Private Hospital	3	2.5%
Regional Hospitals	26	21.7%
Teaching Hospitals	45	37.5%

Professional role

The analysis showed that most respondents were frontline clinical staff, with General Nurses and Midwives forming the largest groups, while Disease Control Officers constituted the smallest proportion of the sample. This distribution indicates that the study primarily captured perspectives from professionals directly engaged in immunization service delivery, thereby strengthening its ability to evaluate the Electronic Immunization Registry's (EIR) impact on real-time data entry, workflow, and decision-making.

Figure 2: ***Professional role***

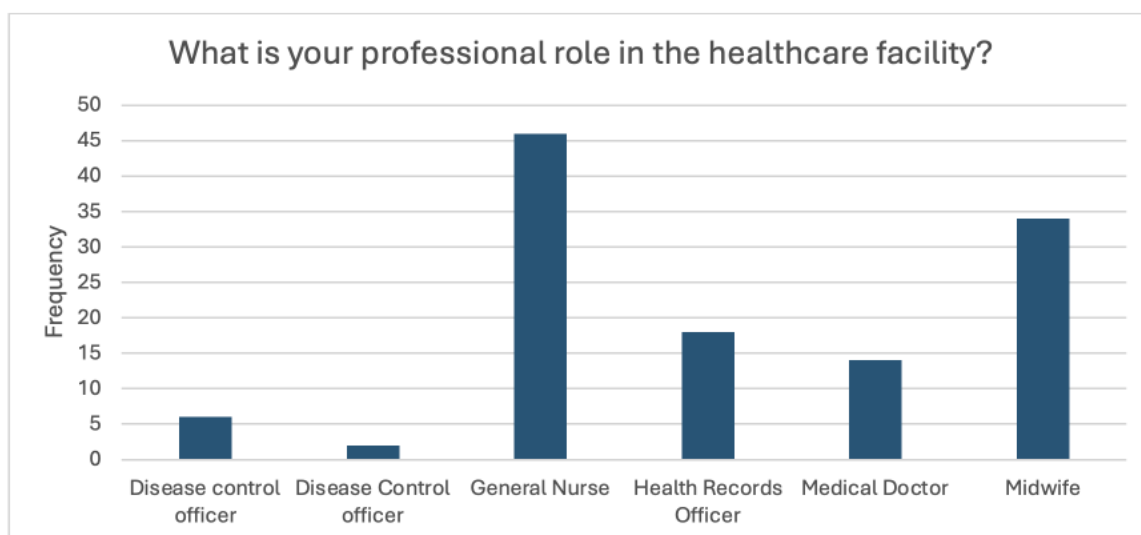


Table 3: ***Professional role***

What is your professional role in the healthcare facility?		
	N	%
Disease control officer	6	5.0%
Disease Control officer	2	1.7%
General Nurse	46	38.3%
Health Records Officer	18	15.0%
Medical Doctor	14	11.7%

Midwife	34	28.3%
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Years of experience

Analysis of respondents' clinical immunization experience indicated that the majority (84.2%) had six years or fewer in the field, with the largest group reporting 1–3 years of experience (40.0%). This distribution suggests that most participants were relatively early-career professionals, whose perceptions and use of the Electronic Immunization Registry (EIR) may reflect ongoing learning and adaptation rather than long-term practice integration.

Figure 3: *Years of experience*

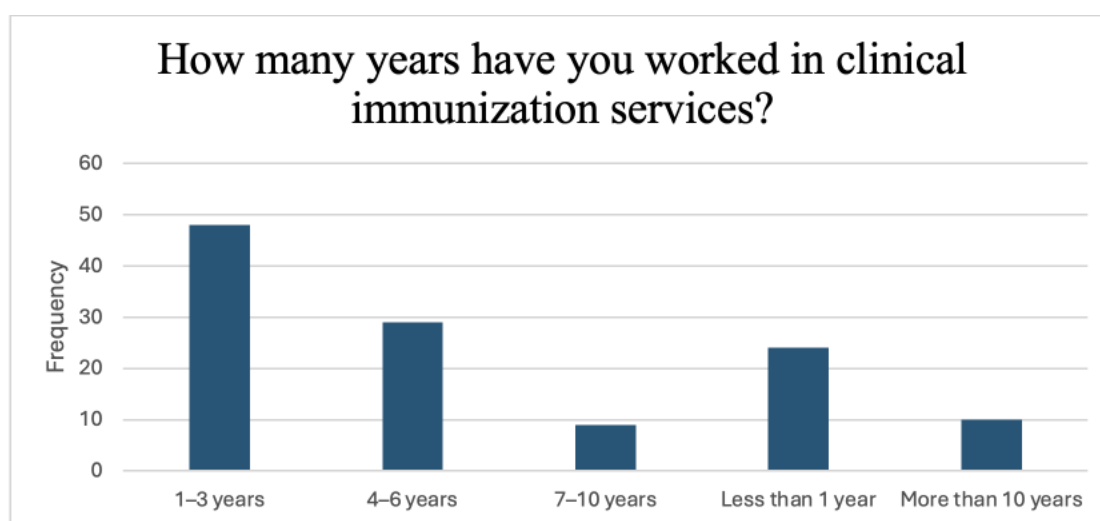


Table 4: *Years of experience*

How many years have you worked in clinical immunization services?		
	N	%
1–3 years	48	40.0%
4–6 years	29	24.2%
7–10 years	9	7.5%

Less than 1 year	24	20.0%
More than 10 years	10	8.3%

Personal usage of EIR

Analysis of respondents' personal use of the Electronic Immunization Registry (EIR) showed that 95.8% had direct experience with the system, with half of the sample reporting more than two years of use, indicating strong system penetration and sustained engagement across facilities. The predominance of long-term users, alongside smaller groups with shorter durations of experience, reflects both the maturity of EIR adoption in many settings and the continued presence of newer users still transitioning into full operational familiarity.

Figure 4: *Personal usage of EIR*

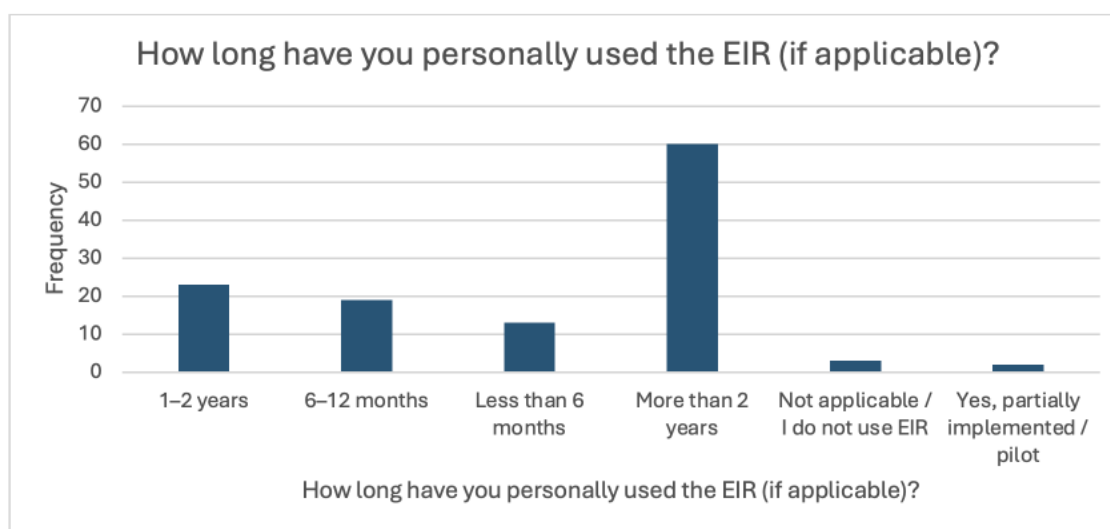


Table 5: *Personal usage of EIR*

How long have you personally used the EIR (if applicable)?		
	N	%
1-2 years	23	19.2%
6-12 months	19	15.8%
Less than 6 months	13	10.8%

More than 2 years	60	50.0%
Not applicable / I do not use EIR	3	2.5%
Yes, partially implemented / pilot	2	1.7%

Facility usage of EIR

The results demonstrated that Electronic Immunization Registry (EIR) adoption was widespread across participating healthcare facilities, with 96.6% reporting full or partial implementation, indicating a strong national shift toward digital immunization data systems, substantial variability in system maturity, and an overall conducive environment for evaluating the EIR's impact on data accuracy, timeliness, and immunization coverage outcomes.

Figure 5: ***Facility usage of EIR***

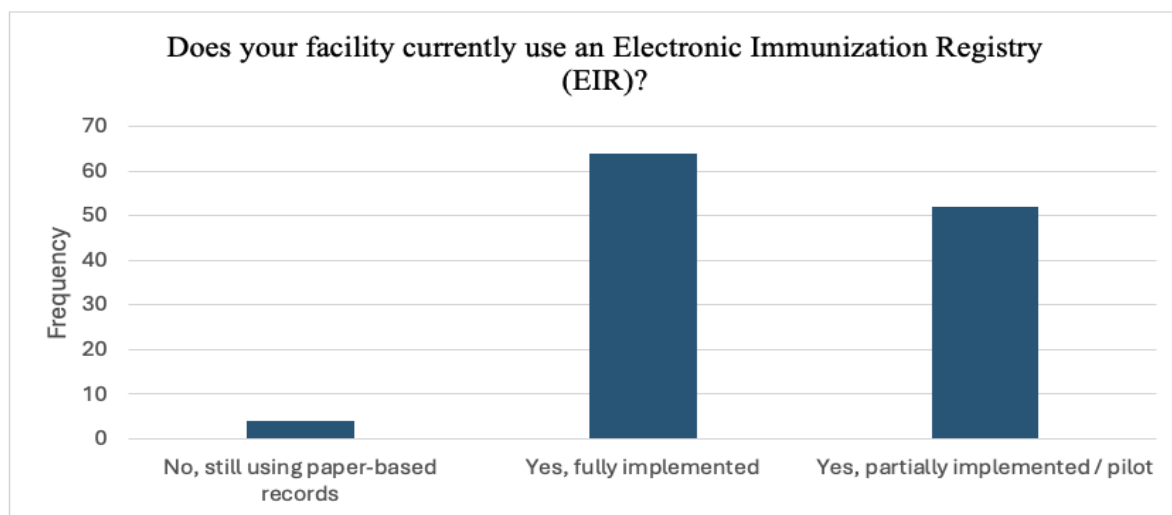


Table 6: ***Facility usage of EIR***

Does your facility currently use an Electronic Immunization Registry (EIR)?		
	N	%
No, still using paper-based records	4	3.3%

Yes, fully implemented	64	53.3%
Yes, partially implemented / pilot	52	43.3%

Descriptive Statistics Overview on Variables

Descriptive analysis of the EIR impact variables showed complete responses across all measures (N = 120), with mean scores ranging from 1.72 to 1.92 on a dichotomous scale, indicating generally positive perceptions of the EIR's influence on accuracy, timeliness, and coverage. All variables exhibited negative skewness and, in some cases, high kurtosis, demonstrating that responses were strongly clustered toward the most positive category with limited variability. Overall, the distribution patterns reflect broad agreement among respondents that the EIR contributes positively to immunization service delivery, particularly in enhancing record accuracy and decision-making efficiency.

Table 7: *Descriptive Statistics Overview on Variables*

		Accuracy	Timeless of Immunization	Coverage rate	Independent Variable
N	Valid	120	120	120	120
	Missing	0	0	0	0
Mean		1.72	1.79	1.92	1.90
Skewness		-.974	-1.455	-3.053	-2.701
Std. Error of Skewness		.221	.221	.221	.221
Kurtosis		-1.070	.118	7.447	5.382
Std. Error of Kurtosis		.438	.438	.438	.438
Minimum		1	1	1	1
Maximum		2	2	2	2

Accuracy

Analysis of respondents' perceptions revealed overwhelmingly positive views regarding the accuracy of immunization records following EIR implementation, with 100% of participants agreeing or strongly agreeing that the system improved data accuracy. The high level of endorsement indicates that healthcare providers regard the EIR as a reliable tool for reducing documentation errors, enhancing record completeness, and ensuring accurate patient histories during clinical encounters. These findings suggest that the transition from paper-based to electronic records has meaningfully strengthened data quality, supporting effective immunization decision-making and program management.

Figure 6: *Accuracy*

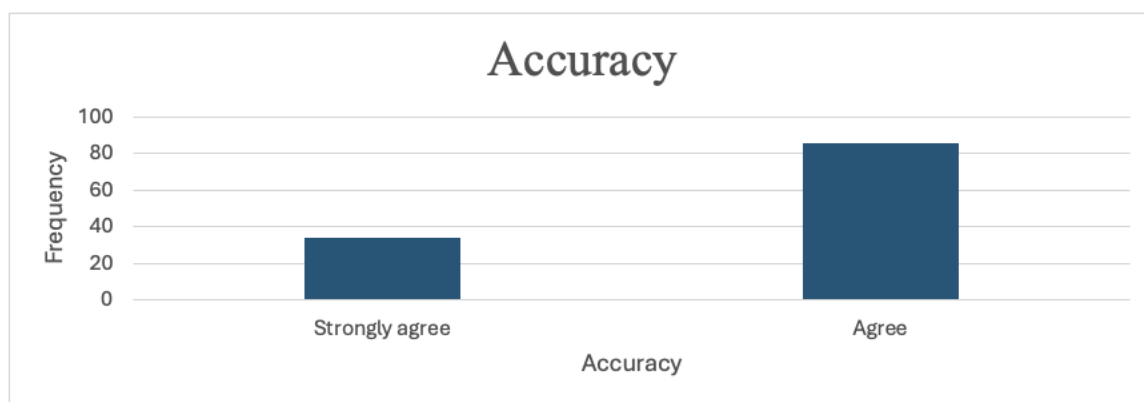


Table 8: *Accuracy*

Accuracy		
	N	%
Strongly agree	34	28.3%
Agree	86	71.7%

Timelines of Immunization

Analysis of respondents' perceptions indicated overwhelmingly positive views regarding the timeliness of immunization-related decision-making following EIR

implementation, with 100% of participants agreeing or strongly agreeing that the system expedited clinical processes. Participants highlighted the EIR's role in facilitating faster retrieval of immunization histories, quick identification of missed doses, and more rapid determination of vaccines due at the point of care. These findings suggest that the EIR has substantially enhanced workflow efficiency and evidence-based decision-making, supporting timely and effective immunization service delivery.

Figure 7: *Timelines of Immunization*

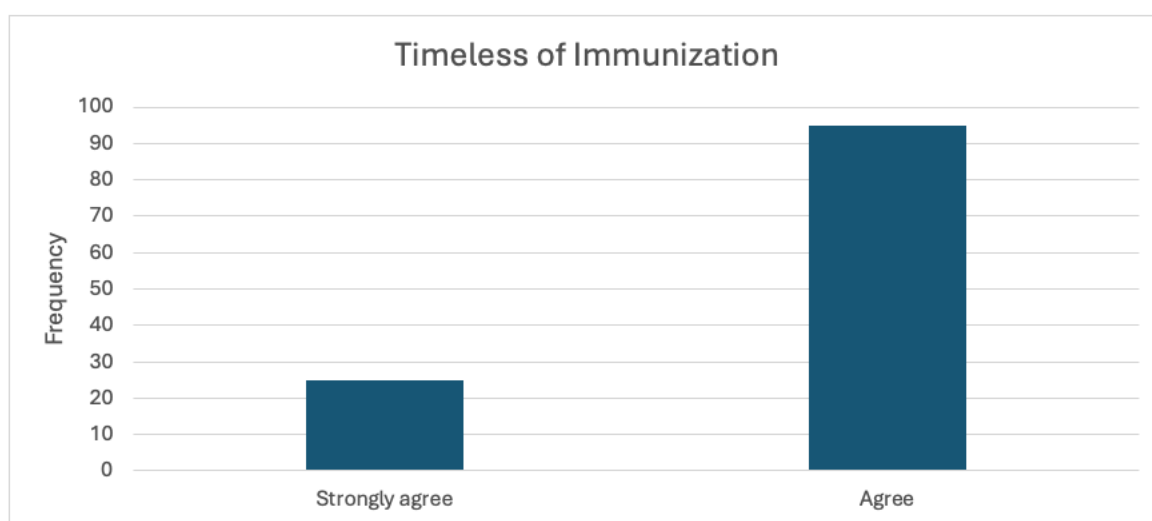


Table 9: *Timelines of Immunization*

Timeless of Immunization			
	N	%	
Strongly agree	25	20.8%	
Agree	95	79.2%	

Coverage Rate

Analysis of respondents' perceptions showed uniformly positive views regarding the EIR's impact on immunization coverage rates, with 100% of participants indicating that the

system contributes to improved coverage. Most respondents agreed or strongly agreed that the EIR enhances the ability to identify defaulters, track vaccinations, and support timely follow-up, thereby reducing missed opportunities for immunization. These results suggest strong confidence among healthcare providers that the EIR meaningfully strengthens coverage outcomes and supports data-driven interventions that improve population-level immunization performance.

Figure 8: *Coverage Rate*

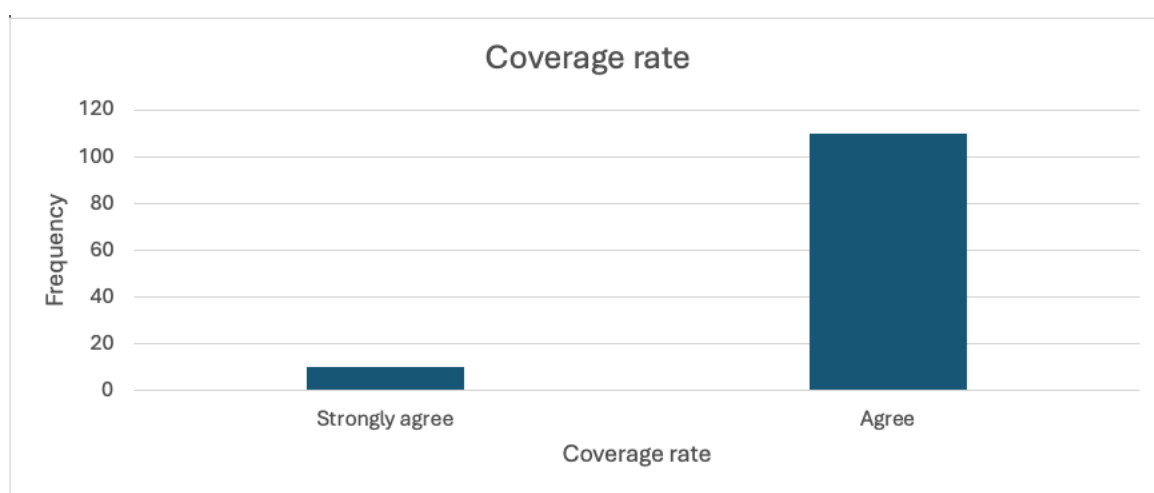


Table 10: *Coverage Rate*

	Coverage rate	
	N	%
Strongly agree	10	8.3%
Agree	110	91.7%

Implementation of Electronic Immunization Records

Analysis of respondents' perceptions regarding the implementation of the Electronic Immunization Registry (EIR) revealed overwhelmingly positive views. A majority of

respondents agreed that the EIR had been effectively implemented in their facilities, with 90.0% (n = 108) selecting *Agree*. Additionally, 10.0% (n = 12) indicated *Strongly agree*, reflecting strong endorsement of the system's operational presence and integration into routine immunization service delivery. The distribution of responses indicates that 100% of participants expressed positive perceptions of EIR implementation, with no respondents disagreeing or expressing neutrality. This uniformity suggests that participants recognize the EIR as a fully operational tool within their facilities, supporting the management of immunization records and facilitating clinical workflows.

The high level of agreement underscores that implementation has likely addressed key operational objectives, including:

- Transition from paper-based to electronic immunization records
- Standardization of immunization documentation
- Reduction in record duplication and errors
- Streamlined retrieval of patient immunization history

These benefits are consistent with the objectives of digital health interventions aimed at strengthening health information systems and supporting data-driven decision-making in clinical practice.

From the perspective of the Technology Acceptance Model (TAM), the strong positive perceptions reflect high perceived usefulness and may enhance behavioral intention to use the EIR consistently. Users who acknowledge that the system is well-implemented are more likely to integrate it into daily practice, thereby sustaining its impact on record accuracy, timeliness of decision-making, and coverage outcomes.

Overall, the findings indicate that healthcare providers perceive the EIR as effectively implemented, providing a strong foundation for its use in improving immunization service delivery and supporting evidence-based decision-making within the participating facilities.

Figure 9: *Implementation of Electronic Immunization Records*

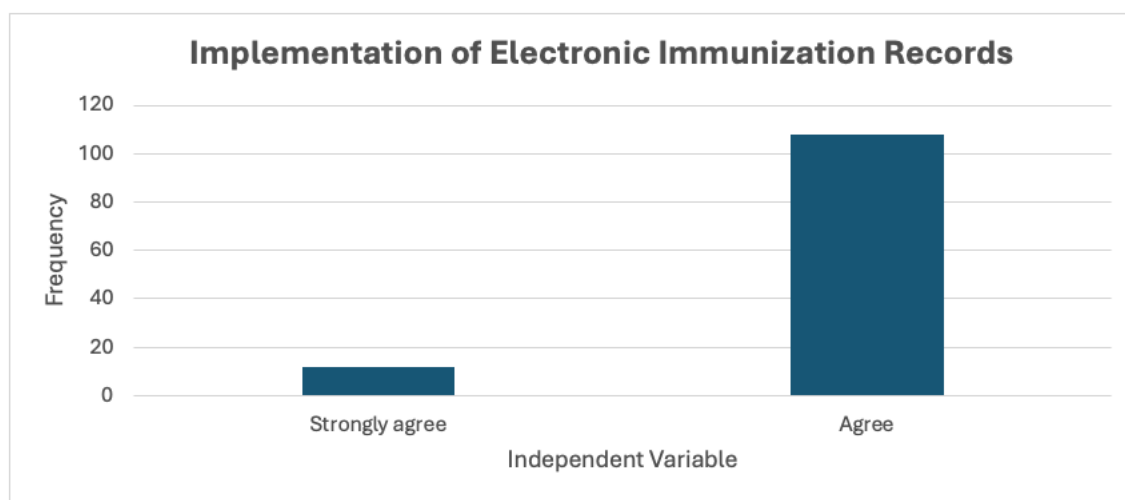


Table 11: *Implementation of Electronic Immunization Records*

Implementation of Electronic Immunization Records			
		N	%
Strongly agree		12	10.0%
Agree		108	90.0%

Descriptive Statistics of Key Study Variables

Descriptive statistics were computed to examine respondents' perceptions regarding the implementation and impact of the Electronic Immunization Record (EIR) on immunization service delivery. Table 12 summarizes the mean scores and standard

deviations for the independent variable (EIR implementation) and the three dependent variables: accuracy of immunization records, timeliness of immunization-related decision-making, and immunization coverage rates. All variables had complete responses (N = 120), ensuring full representation of the study population.

Implementation of EIR

Respondents overwhelmingly perceived that the EIR was implemented in their facilities. Specifically, 90.0% (n = 108) agreed and 10.0% (n = 12) strongly agreed that the system had been effectively integrated into routine immunization services. The mean score for EIR implementation was 1.90 (SD = 0.301), indicating a strong consensus among participants regarding the operational presence and functionality of the registry. The high level of agreement suggests that healthcare providers recognize the EIR as a fully operational tool supporting immunization documentation and workflow management.

Accuracy of Immunization Records

Regarding the accuracy of immunization records, all respondents reported positive perceptions, with 71.7% (n = 86) agreeing and 28.3% (n = 34) strongly agreeing that the EIR improved data accuracy. The mean score of 1.72 (SD = 0.453), the lowest among the measured variables, indicates that respondents perceived the EIR as particularly effective in enhancing the precision, completeness, and reliability of patient immunization records. This finding highlights the system's role in reducing duplication, minimizing errors, and improving the verification of patient vaccination histories.

Timeliness of Immunization-Related Decision-Making

The timeliness of decision-making variable showed that 79.2% (n = 95) agreed and 20.8% (n = 25) strongly agreed that the EIR contributed to faster clinical decisions during immunization encounters. The mean score was 1.79 (SD = 0.408), indicating generally favorable perceptions with moderate consensus. This suggests that the EIR enhances operational efficiency by enabling quick retrieval of patient records, identifying missed doses, and facilitating prompt interventions, both in routine and outreach immunization services.

Immunization Coverage Rates

Respondents also perceived that the EIR positively impacted immunization coverage, with 91.7% (n = 110) agreeing and 8.3% (n = 10) strongly agreeing. The mean score was 1.92 (SD = 0.278), the highest among all variables, with a very low standard deviation, indicating strong consistency in positive perceptions. This demonstrates that the EIR supports broader programmatic outcomes, including identifying defaulters, ensuring complete vaccination schedules, and improving follow-up strategies, thereby enhancing overall coverage.

Overall Interpretation

The descriptive statistics indicate that healthcare providers perceive the EIR as both effectively implemented and beneficial across key domains of immunization service delivery. Among the dependent variables, accuracy of records and timeliness of decision-making reflect operational efficiency at the point of care, while coverage rate demonstrates

broader program-level impact. The low standard deviations across all variables suggest high consensus and reinforce the credibility of respondents' perceptions.

These findings align with the Technology Acceptance Model (TAM), where high perceived usefulness and ease of use are strong predictors of adoption and sustained use. They also support the principles of Data-Driven Decision-Making (DDDM), showing that access to accurate and timely immunization data facilitates evidence-based decisions, enhances workflow efficiency, and improves overall immunization outcomes.

Table 12: *Descriptive Statistic*

Descriptive Statistics			
	Mean	Std. Deviation	N
Implementation of Electronic Immunization Records	1.90	.301	120
Accuracy	1.72	.453	120
Timeless of Immunization	1.79	.408	120
Coverage rate	1.92	.278	120

Correlation Analysis

Pearson correlation analysis was conducted to examine the relationships between the implementation of the Electronic Immunization Record (EIR) and the three dependent variables: accuracy of immunization records, timeliness of immunization-related decision-making, and immunization coverage rates. All analyses were based on the full sample (N = 120), with significance assessed at the 0.05 level (1-tailed).

Relationship Between EIR Implementation and Dependent Variables

Accuracy of Immunization Records - The implementation of EIR showed a moderate positive correlation with the accuracy of immunization records ($r = 0.345$, $p < 0.001$). This indicates that facilities with fully implemented EIR systems were more likely to have accurate patient immunization records. The significance value ($p < 0.001$) confirms that this relationship is statistically significant, supporting the assertion that EIR implementation positively influences the quality and reliability of immunization data.

Timeliness of Immunization-Related Decision-Making - A weak positive correlation was observed between EIR implementation and timeliness ($r = 0.171$, $p = 0.031$). Although the relationship is statistically significant, the strength of the association is low, suggesting that while EIR use contributes to faster clinical decision-making, other factors (e.g., staff experience, workflow practices) may also play important roles in influencing timeliness.

Immunization Coverage Rates - The implementation of EIR showed a strong positive correlation with immunization coverage rates ($r = 0.503$, $p < 0.001$). This finding indicates that facilities with better-implemented EIR systems tend to achieve higher vaccination coverage, reflecting the system's effectiveness in tracking defaulters, monitoring patient schedules, and supporting timely follow-up. The high correlation coefficient and strong statistical significance underscore the critical role of EIR in improving program-level immunization outcomes.

Interrelationships Among Dependent Variables

Accuracy and Timeliness - Accuracy of immunization records were strongly correlated with timeliness ($r = 0.770$, $p < 0.001$). This strong association suggests that improved accuracy of records contributes substantially to faster clinical decision-making, likely because providers can retrieve complete and reliable information quickly, minimizing delays during immunization encounters.

Accuracy and Coverage Rate - The correlation between accuracy and coverage rate was weak and not statistically significant ($r = 0.145$, $p = 0.057$), indicating that while accurate records are necessary for immunization tracking, they may not directly translate into higher coverage without complementary programmatic interventions.

Timeliness and Coverage Rate - Similarly, timeliness of decision-making showed a weak and non-significant correlation with coverage rate ($r = 0.142$, $p = 0.061$), suggesting that faster decisions alone may not automatically improve overall immunization coverage, which may also depend on patient follow-up, outreach strategies, and vaccine supply.

Interpretation

The correlation analysis highlights several key findings:

- EIR implementation positively influences all outcome variables, with the strongest impact observed on coverage rates.
- Accuracy of records is strongly linked to timeliness, demonstrating that reliable data facilitates prompt clinical decision-making.

- Weak correlations between accuracy or timeliness and coverage suggest that improving operational efficiency alone may not guarantee higher population-level immunization; systemic and program-level factors also play critical roles.
- These findings provide empirical support for both the Technology Acceptance Model (TAM) **and** Data-Driven Decision-Making (DDDM) frameworks, emphasizing that effective digital system adoption enhances operational efficiency and contributes to improved health outcomes.

Table 13: **Coefficients**

Model		Unstandardized		Standardized		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	.724	.175		4.145	<.001
	Accuracy	.322	.078	.484	4.142	<.001
	Timeless of Immunization	-.199	.086	-.269	-2.301	.023
	Coverage rate	.511	.082	.471	6.250	<.001

a. Dependent Variable: Implementation of Electronic Immunization Records

The regression coefficients provide insight into how each predictor variable uniquely influences the implementation of Electronic Immunization Records (EIR) while controlling for the other variables in the model. The constant represents the predicted level of EIR implementation when all predictor variables are held at zero. The significant constant indicates that baseline perceptions of EIR implementation are above zero even before accounting for accuracy, timeliness, or coverage rate.

Accuracy - Accuracy emerged as a significant positive predictor of EIR implementation. The unstandardized coefficient (**B = .322**) indicates that, with each one-unit

increase in perceived accuracy of immunization records, the level of EIR implementation increases by 0.322 units, holding other factors constant. The standardized coefficient (Beta = .484) shows that accuracy is the strongest individual predictor in the model. This finding underscores the importance of reliable and error-free immunization data in shaping healthcare workers' acceptance and perceived success of the EIR system. This aligns with the Data-Driven Decision-Making (DDDM) frame

Timeliness - Timeliness demonstrated a significant negative association with EIR implementation, as indicated by the negative coefficient ($B = -0.199$), suggesting that higher timeliness scores corresponded with slightly lower perceived implementation levels. The standardized coefficient ($\beta = -.269$) confirmed timeliness as a moderate negative predictor, highlighting a counterintuitive relationship within the model. This pattern may reflect early-stage adoption challenges, partial implementation effects, or existing workflow efficiencies that influenced timeliness independent of the EIR.

Coverage - Coverage rate emerged as a strong and significant positive predictor of EIR implementation, with the unstandardized coefficient ($B = .511$) indicating that perceived improvements in coverage corresponded with higher levels of implementation. The standardized coefficient ($\beta = .471$) further showed that coverage rate was nearly as influential as accuracy in explaining overall EIR adoption. This finding supports existing digital health evidence that electronic registries enhance population-level immunization outcomes through improved tracking, data completeness, and follow-up mechanisms.

Summary

The findings revealed that the implementation of the Electronic Immunization Registry (EIR) was positively associated with all three outcome variables: accuracy, timeliness, and overall immunization coverage rate, with accuracy and overall immunization coverage rate demonstrating the strongest relationships. Correlation results showed that EIR implementation moderately increased the accuracy of immunization records, weakly but significantly improved timeliness, and strongly enhanced immunization coverage rates across facilities. Regression analysis further confirmed that accuracy and coverage were significant positive predictors of EIR implementation, while timeliness emerged as a moderate negative predictor, suggesting nuanced implementation dynamics that may reflect early adoption challenges or workflow differences.

Interrelationships among the dependent variables indicated that accuracy and timeliness were strongly linked, emphasizing that reliable data contributes to faster clinical decision-making. However, accuracy and timeliness showed weak and non-significant relationships with coverage rate, highlighting that operational improvements alone may not automatically translate into population-level immunization gains without broader programmatic support. Overall, the results aligned with both the Technology Acceptance Model (TAM) and the Data-Driven Decision-Making (DDDM) framework, demonstrating that effective digital system adoption can enhance data quality, operational efficiency, and ultimately, health outcomes.

Taken together, these findings provide a comprehensive understanding of how the Electronic Immunization Registry influences data quality, clinical workflows, and program

outcomes in immunization service delivery. The results not only answer the study's research questions but also illuminate key areas where implementation successes and challenges intersect with theoretical expectations from TAM and DDDM.

Chapter 5: Discussion, Conclusions, and Recommendations

Introduction

The purpose of this quantitative quasi-experimental study was to examine the impact of implementing an Electronic Immunization Registry (EIR) on clinical decision-making and immunization outcomes in healthcare facilities across Ghana. The study was conducted to address gaps in the literature regarding how EIR adoption influences the accuracy of immunization records, the timeliness of immunization-related decision-making, and overall immunization coverage rates—key components of data-driven clinical practice and effective immunization service delivery. By comparing facilities that used an EIR with those relying on paper-based systems, the study sought to determine whether digital immunization systems meaningfully improve real-time decision-making and patient-level immunization outcomes in a resource-limited health system.

The key findings indicated that EIR implementation was positively associated with all outcome variables, with the strongest relationships observed for accuracy of immunization records and immunization coverage rates. Accuracy demonstrated a moderate positive correlation with EIR use and emerged as the strongest predictor in the regression model, highlighting the role of reliable data in supporting effective clinical decisions. Coverage rate also showed a strong positive correlation and was a significant predictor of EIR implementation, suggesting that electronic systems enhance follow-up, defaulter tracking, and population-level vaccination outcomes. Although timeliness demonstrated a weak positive correlation with EIR use, its regression coefficient revealed a moderate negative predictive relationship, suggesting that workflow factors, partial implementation,

or early adoption challenges may influence decision-making speed during clinical encounters.

Overall, the findings support the Technology Acceptance Model (TAM) and the Data-Driven Decision-Making (DDDM) framework by demonstrating that digital systems such as EIRs improve data quality and contribute to stronger immunization program performance. The results provide empirical evidence to guide policymakers, implementers, and healthcare leaders in strengthening digital health initiatives and optimizing EIR integration within Ghana's immunization system.

Interpretation of the Findings

The findings of this study largely confirm existing peer-reviewed literature described in Chapter 2, while also extending disciplinary knowledge regarding the influence of Electronic Immunization Records (EIRs) on clinical and program-level outcomes in Ghana. Consistent with prior studies in Ghana and other Sub-Saharan African settings (Abagye et al., 2021; Agyekum et al., 2022; Osei-Akoto & Yawson, 2020), the present results demonstrated that EIR implementation is positively associated with improved accuracy of immunization records. The moderate correlation and strong predictive influence of accuracy align with published evidence indicating that electronic systems reduce transcription errors, improve data completeness, and strengthen health worker confidence in recorded information. These findings therefore confirm that EIRs address long-standing data quality challenges identified in the literature and reinforce the value of digital health interventions in improving record reliability.

The strong positive correlation between EIR implementation and immunization coverage rates also supports existing evidence from Ghana, Tanzania, and Rwanda showing that electronic registries can enhance follow-up, defaulter tracking, and timely outreach (Dolan et al., 2022; Uwera et al., 2024). This study's regression results, which identified coverage rate as a significant predictor of perceived EIR implementation, extend the literature by quantifying the unique contribution of coverage-related improvements after accounting for accuracy and timeliness. These findings highlight the importance of electronic tracking systems in strengthening program-level outcomes—an area previously noted in the literature as needing further empirical exploration. In this regard, the study contributes new evidence to the Ghanaian context by demonstrating that EIRs not only improve operational processes but also correspond with population-level immunization performance.

The weak but significant correlation between EIR implementation and timeliness partially confirms earlier studies that reported time savings and workflow efficiencies with digital systems. However, the negative regression coefficient represents a departure from the predominant narrative in the literature. Although counterintuitive, this finding aligns with emerging research noting that early phases of EIR adoption can introduce additional steps, increase documentation time, or require staff to operate parallel systems (Kumasi et al., 2021; Mustapha & Abubakari, 2023). Thus, the results do not disconfirm the literature but rather extend it by highlighting transitional workflow challenges that may influence perceptions of timeliness before full system integration is achieved.

The strong correlation between accuracy and timeliness further supports theoretical and empirical literature linking reliable data to faster decision-making (Pavia et al., 2024). This relationship validates the idea that accurate, complete, and easily accessible records reduce time spent verifying patient histories or resolving inconsistencies. In contrast, the weak and non-significant relationships between accuracy or timeliness and coverage rate reflect findings from prior studies suggesting that operational improvements alone are insufficient to increase population-level coverage without broader programmatic elements such as outreach strategies, vaccine availability, and community engagement.

Interpreted through the Technology Acceptance Model (TAM), the results reinforce that perceived usefulness—reflected in improved accuracy and enhanced coverage—is critical to shaping health workers' acceptance and perceived success of an EIR system. Accuracy emerged as the strongest predictor of EIR implementation, indicating that when users experience trustworthy and error-free data, they are more likely to perceive the technology as beneficial and fully adopt it. This aligns with TAM's assertion that perceived usefulness predicts attitudes toward digital systems and their integration into routine practice.

From the perspective of the Data-Driven Decision-Making (DDDM) framework, the findings provide compelling evidence that high-quality data (accuracy) and actionable population-level indicators (coverage rates) play pivotal roles in enabling informed clinical and managerial decisions. The strong association between accuracy and timeliness further supports DDDM by demonstrating that decision-making speed improves when data are complete and reliable. However, the weak associations between operational variables and

coverage underscore a key tenet of DDDM: high-quality data are necessary but not sufficient; broader system-level enablers must support their use for population-level improvements.

Overall, this study's findings confirm much of the existing literature regarding the benefits of EIRs, extend knowledge regarding their predictive influences on implementation perceptions, and refine understanding of challenges related to early-stage adoption. The interpretations remain grounded in the empirical data and theoretical frameworks while acknowledging the operational context of Ghana's health system.

Limitations of the Study

Several limitations emerged during the execution of the study that restrict the generalizability, validity, and reliability of the findings. First, the quasi-experimental design did not include a true control group that operated without any form of EIR exposure. Although the study compared facilities with full, partial, and no implementation, the absence of a strictly controlled comparison group limits the ability to attribute all observed differences in accuracy, timeliness, or coverage solely to the EIR. This limitation is consistent with concerns raised in the digital health literature, which emphasizes that controlled conditions are often necessary to isolate the effects of electronic systems on clinical outcomes.

Second, the study relied on a relatively small sample size ($N = 120$), which may reduce statistical power and limit the detection of subtle relationships among variables. While adequate for the chosen statistical procedures, a larger sample drawn from a wider range of facilities would improve the confidence and generalizability of the findings. The sample was

also limited to selected regions and facility types, introducing the possibility that the experiences of respondents may not represent the broader national health system.

Third, the potential for selection bias must be acknowledged. Participants were recruited from facilities already engaged with or preparing for EIR implementation, which may have resulted in overrepresentation of healthcare workers who are more technologically inclined or supportive of digital health systems. This may have inflated positive perceptions of EIR usefulness, accuracy, or coverage-related benefits. Additionally, self-reported survey data are inherently subject to response bias, including social desirability bias, which could affect the reliability of participants' assessments of EIR performance.

Fourth, contextual factors such as varying levels of digital literacy, inconsistent training, disparities in infrastructure, and differences in workflow practices across facilities may have influenced the findings. For example, facilities with limited internet access or insufficient hardware may not experience the same EIR benefits as better-resourced settings. These variations reduce internal validity and make it difficult to attribute outcomes entirely to the EIR rather than to underlying structural differences.

Finally, the cross-sectional design prevented the study from capturing changes over time or establishing causal relationships. Longitudinal data would be needed to assess whether improvements in accuracy, timeliness, or coverage persist as EIR implementation matures.

In summary, although the study provides meaningful insights into the impact of the EIR on immunization-related decision-making in Ghana, limitations related to design, sampling, potential bias, infrastructural variation, and the use of self-reported measures reduce the ability to generalize the findings or infer causality. Future research addressing these

limitations will be essential to strengthening the evidence base on digital health interventions within the Ghanaian healthcare context.

Recommendations

Based on the findings, limitations, and existing literature, several recommendations for future research are warranted to strengthen the evidence surrounding Electronic Immunization Registry (EIR) implementation in Ghana. First, future studies should incorporate a more robust quasi-experimental or controlled comparative design to better distinguish the effects of EIR use from existing workflows, staffing patterns, or external system improvements. Including clearly defined comparison groups across multiple facility types would provide stronger evidence regarding the causal impact of EIRs on accuracy, timeliness, and immunization coverage.

Second, future research should expand sample sizes and geographic representation to increase the generalizability of findings. A larger and more diverse sample—including rural, peri-urban, and underserved settings—would capture variations in digital infrastructure, workflow practices, and staff capacity, thereby offering a more comprehensive understanding of EIR performance across the health system. Such expansion would also enhance statistical power to detect smaller but meaningful trends in user perceptions and system effectiveness.

Third, longitudinal research is needed to track changes in clinical decision-making and immunization outcomes over time as EIR implementation matures. The literature consistently notes that early-stage implementation often introduces workflow disruptions before benefits are fully realized; therefore, studying EIR effects across multiple time points

would help determine whether improvements in accuracy, timeliness, and coverage are sustained.

Fourth, further research should investigate sociocultural and behavioral factors that influence healthcare workers' acceptance and ongoing use of EIRs. Building on the findings from this study—which indicate that perceptions strongly shape implementation—future studies should examine how digital literacy, staff training adequacy, leadership support, and attitudes toward technology affect EIR adoption. Understanding these factors is essential to designing targeted capacity-building approaches that enhance system utilization.

Fifth, future studies should explore system-level challenges that may moderate the effectiveness of EIRs, including digital infrastructure limitations, system downtimes, and interoperability with other national health information platforms. As highlighted in the literature, technical constraints continue to influence data quality and user satisfaction, making it important to assess how these constraints shape EIR-related outcomes in real-world settings.

Finally, further research should examine the relationship between EIR implementation and immunization outcomes such as default rates, follow-up completion, and population-level coverage. While this study assessed healthcare workers' perceptions, future research should supplement these findings with objective immunization performance metrics to better determine the extent to which improved data management translates into measurable public health gains.

In summary, future research should employ stronger study designs, larger and more diverse samples, longitudinal approaches, behavioral and contextual analyses, and deeper

system-level evaluations to build a more comprehensive understanding of EIR effectiveness in Ghana. These efforts will support ongoing national digital health initiatives and inform strategies to optimize immunization delivery in resource-limited settings.

Implications

Positive Social Change

The findings of this study have the potential to contribute meaningfully to positive social change within healthcare delivery systems in Ghana, particularly in the management of immunization services. By examining healthcare professionals' perceptions of Electronic Immunization Records (EIRs) and how these perceptions influence immunization-related decision-making, this study provides insights that can enhance clinical practice, strengthen data-driven decision-making, and support improved public health outcomes. The implications outlined below remain within the boundaries of the study and reflect its methodological, theoretical, and empirical contributions.

Implications for Positive Social Change

Individual-Level Impact

The study suggests that improved access to accurate and timely immunization data through EIRs enhances healthcare professionals' confidence and efficiency in clinical encounters. This contributes to positive social change by:

- enabling providers to make informed and timely decisions,
- reducing errors associated with paper-based record keeping, and

- improving individual patient care through precise vaccine scheduling and follow-up. Better clinical decisions directly contribute to improved health outcomes for individual patients, especially children who rely on timely immunization.

Family-Level Impact

At the family level, enhanced immunization practices supported by EIR use may reduce missed vaccinations and prevent vaccine-preventable diseases. As a result:

- caregivers receive more reliable information on their child's immunization needs,
- families experience fewer disruptions due to preventable illnesses, and
- trust in the healthcare system is strengthened.

These outcomes contribute to improved family well-being and reduced emotional and financial burdens associated with childhood illnesses.

Organizational-Level Impact

Organizationally, the study's findings point to ways EIRs can strengthen workflow efficiency and data accuracy within health facilities. The positive social change impact includes:

- improved coordination among facility staff responsible for immunization services,
- reduced duplication and administrative burden,
- stronger data systems that support planning and resource allocation, and
- enhanced accountability and monitoring of immunization activities.

These improvements contribute to a more resilient healthcare system that is better equipped to meet immunization targets.

Societal/Policy-Level Impact

At the societal level, a better understanding of how healthcare professionals perceive and use EIRs can inform national policies aimed at strengthening immunization systems. The study can:

- support policy refinement related to digital health strategies,
- provide evidence to guide investments in training and digital infrastructure, and
- strengthen Ghana's broader public health goals related to reducing vaccine-preventable diseases.

These societal-level changes align with national priorities to improve child health outcomes and modernize health information systems.

Methodological Implications

Methodologically, this study contributes to the limited body of quantitative research examining EIR implementation in low-resource settings. Key implications include:

- demonstrating the value of a quasi-experimental design for assessing EIR-related outcomes,
- highlighting the importance of comparing facilities using EIRs with those that do not,
- offering a replicable methodological approach for future studies evaluating digital health interventions.

The study strengthens methodological understanding of how digital health tools can be evaluated in real-world clinical settings.

Theoretical Implications

Using the Technology Acceptance Model (TAM) and Data-Driven Decision-Making (DDDM) framework, the study offers several theoretical contributions:

- It supports TAM's central proposition that perceived usefulness and perceived ease of use influence system adoption among healthcare professionals.
- It extends the DDDM framework by showing how access to high-quality digital data can influence clinical decision-making in immunization service delivery.
- It offers context-specific evidence that technology acceptance in low-resource settings is influenced not only by system features but also by training, infrastructure, and organizational support.

These insights help refine the theoretical understanding of how digital health innovations are adopted in resource-limited environments.

Empirical Implications

Empirically, the study adds to growing research on EIRs in Sub-Saharan Africa by:

- providing evidence on healthcare workers' perceptions of the EIR in Ghana,
- highlighting factors that influence EIR adoption and use in clinical encounters,
- demonstrating the relationship between digital data access and immunization decision-making quality.

These findings help fill identified gaps in the literature related to real-time data use during clinical encounters.

Recommendations for Practice

Grounded in the study findings, the following practice-oriented recommendations remain within the scope of the study:

Strengthen EIR Training Programs: Health facilities should invest in continuous, hands-on training to improve digital literacy and reinforce confidence in using the EIR system for clinical decision-making.

Improve Infrastructure to Support EIR Use: Reliable internet connectivity, functional devices, and system uptime must be prioritized to improve user experience and maximize system benefits.

Integrate EIR Data More Fully Into Daily Workflow: Encouraging routine use of EIR data during clinical encounters can improve accuracy in vaccine scheduling, reduce duplications, and enhance decision quality.

Implement Supportive Supervision and Feedback Loops: Regular feedback on data quality and system performance may encourage consistent EIR use and reinforce positive attitudes toward digital record systems.

Promote Stakeholder Engagement: Engaging frontline workers, district health managers, and community stakeholders in EIR-related decisions can improve acceptance and system sustainability.

Conclusion

This study set out to examine how the implementation of the Electronic Immunization Registry (EIR) in Ghana influences healthcare professionals' immunization-related decision-making, with particular attention to accuracy, timeliness, and coverage

outcomes. The findings demonstrate that the perceived accuracy and coverage improvements associated with EIR use are strong, positive predictors of implementation success, emphasizing the value of reliable, complete, and accessible immunization data for frontline clinical decisions. Conversely, the modest negative association between timeliness and EIR implementation suggests that early-stage adoption challenges—such as workflow adjustments or partial deployment—may temporarily hinder perceived efficiency, underscoring the need for continued support, training, and system optimization.

The results show that improvements in perceived accuracy have the strongest effect on EIR implementation. Healthcare professionals view accurate records as essential for identifying defaulters, reducing duplication, and supporting confident clinical decisions. This confirms the theoretical expectation that decision quality strengthens when clinicians have access to error-free, real-time data.

The study found a small negative relationship between timeliness scores and EIR implementation, suggesting that some providers perceive the system as introducing additional steps or delays. This finding highlights the importance of addressing implementation barriers—such as inconsistent infrastructure, device availability, and varying digital literacy levels—to ensure that EIRs truly enhance the speed and efficiency of service delivery.

Coverage emerged as a strong positive predictor of implementation, nearly equal to accuracy. Providers who believed the EIR improved their ability to track schedules, identify defaulters, and monitor population-level data were more likely to perceive the system as successfully integrated. This aligns with global evidence demonstrating that electronic

registries enhance immunization program performance when used consistently and effectively.

Taken together, these findings reveal that the success of digital health tools such as EIRs depends not only on technology design but on how end users perceive their value to daily clinical tasks. Accuracy and coverage benefit drive confidence and adoption, while timeliness concerns point to operational challenges that require targeted improvements. The study contributes meaningful empirical evidence to Ghana's evolving digital health landscape, offering practical insights for strengthening the sustainability and effectiveness of EIR systems.

Ultimately, the key message is clear, when healthcare workers trust and effectively use electronic immunization systems, the result is stronger data, better decisions, and improved immunization performance, laying a foundation for continued progress in Ghana's public health sector.

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Appendix A: Structured Audit Tool

(Designed to systematically assess completeness and accuracy of immunization data recorded in the Electronic Immunization Registry (EIR))

Item	Criteria	Yes	No	Comments
1	Patient demographic information fully recorded			
2	Vaccine type correctly recorded			
3	Date of vaccination entered			
4	Dose number consistent with schedule			
5	Follow-up appointment scheduled			
6	Record free of obvious data entry errors			

Pilot testing: Tool refined after testing with 8 healthcare professionals and reviewed by 2 immunization data management experts for content validity.

Appendix B: Timing Log

(Used to document the time spent by healthcare professionals during clinical encounters using EIR vs. non-EIR records)

Participant ID	Start Time	End Time	Total Time (minutes)	Notes on workflow interruptions

Purpose: Quantitatively measure impact of EIR on decision-making time. Developed and pilot tested with same sample as above.

Appendix C: Participant Consent Form

Title: Impact of Electronic Immunization Registry (EIR) on Data-Driven Decision-Making in Ghana

Anonymous Survey Consent Form

You are invited to complete an anonymous survey for a Walden University doctoral study. To provide your informed consent, please review the information below and continue on the survey if you choose to proceed.

Your role:

- is entirely voluntary and can end at any time you wish
- is anonymous (your name will not be requested)
- involves completing a questionnaire
- involves little or no risk

Privacy:

To protect your privacy, the researcher will not collect, track, or store your identity or contact info. In place of a consent signature, your completion of the survey would indicate that you consent to your responses being analyzed in the study.

Data will be kept secure by using password-protected devices and platforms. Data will be kept for a period of at least 5 years, as required by the university.

Once the doctoral student graduates, the study's results will be posted online in [Scholarworks](#) (a searchable publication of Walden University research).

Contacts and Questions:

Questions about the study can be emailed to the student researcher via jacob.arhin@waldenu.edu. If you want to talk privately about your rights as a participant or any negative parts of the study, you can call Walden University's Research Participant Advocate at 612-312-1210 or email IRB@mail.waldenu.edu. Walden University's approval number for this study is 11-03-25-0617715.

You might wish to retain this consent form for your records. You may ask the doctoral student or Walden University for a copy at any time using the contact info above.

By signing below, you consent to participate in this study.

Participant Signature & Date

Appendix D: Recruitment Script

Hello, my name is Jacob Arhin. I'm conducting a study examining how the Electronic Immunization Records (EIR) affects clinical decision-making in Ghana. We are inviting healthcare professionals to participate by reviewing anonymized data entries (audit) and completing a short timing log. Participation is voluntary and responses will be confidential.

Appendix E: Research Questionnaires

Impact of Electronic Immunization Record (EIR) on Accurate Clinical Decision-Making in Ghana

Anonymous Survey Consent Form

You are invited to complete an anonymous survey for a Walden University doctoral study. To provide your informed consent, please review the information below and continue on the survey if you choose to proceed.

Your role:

- is entirely voluntary and can end at any time you wish
- is anonymous (your name will not be requested)
- involves completing a questionnaire
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Privacy:

To protect your privacy, the researcher will not collect, track, or store your identity or contact info. In place of a consent signature, your completion of the survey would indicate that you consent to your responses being analyzed in the study.

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You might wish to retain this consent form for your records. You may ask the doctoral student or Walden University for a copy at any time using the contact info above.

By clicking here, I am agreeing to participate

Agree

After section 1 Continue to next section ▼

Section 2 of 5

Section A: Demographic Information

(Please select or fill in the appropriate option.)

2. What is your professional role in the healthcare facility?

- General Nurse
- Midwife
- Medical Doctor
- Disease control officer
- Health Records Officer
- Other (please specify): _____

If **Other** (Please specify)

Short answer text
.....

3. How many years have you worked in clinical immunization services?

- Less than 1 year
- 1–3 years
- 4–6 years
- 7–10 years
- More than 10 years

4. How long have you personally used the EIR (if applicable)?

- Less than 6 months
- 6–12 months
- 1–2 years
- More than 2 years
- Not applicable / I do not use EIR

B1. The Electronic Immunization Record (EIR) helps reduce duplication of immunization records *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

B2. Using the EIR increases my confidence that patient immunization histories are accurate. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

B3. The EIR reduces errors compared to the traditional paper-based immunization records. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

B4. The EIR makes it easier to detect missing doses in a child's immunization schedule. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

B5. The EIR reduces data entry errors during clinical encounters. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

B6. Immunization records retrieved from the EIR are more complete than paper-based records. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

...

B7. The EIR helps reconcile discrepancies between historical and new immunization data. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

B8. I am able to verify patient immunization status faster when using the EIR. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

:::

B9. The EIR helps ensure consistent documentation across different providers in the facility. *

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

Other:

B10. Since adopting the EIR, our facility has reported fewer record-related immunization errors. *

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

Other:

Section 4 of 5

Section C: Timeliness of immunization-related decision-making v :::

(For each statement, please indicate your level of agreement.)

C1. The EIR allows faster retrieval of patient immunization records during consultations *

Strongly disagree

Disagree

Neutral

Agree

Strongly agree

Other:

C2. The EIR reduces the time spent searching for previous vaccination history *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C3. Using the EIR speeds up decision-making about which vaccines are due. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C4. The EIR makes it quicker to identify defaulters or missed doses. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C5. The system reduces patient waiting time during immunization visits. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C6. The EIR improves the efficiency of daily immunization workflow *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C7. The EIR helps make immunization decisions more promptly during outreach services. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C8. Real-time access to patient data through the EIR supports quicker decisions. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C9. The EIR helps prioritize patients needing urgent follow-up *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

C10. Overall, the EIR has improved the speed of immunization-related decision-making in clinical practice. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree
- Other:

After section 4 Continue to next section ▼

Section 5 of 5

Section: D: Usability of the Electronic Immunization Record



(Please select or fill in the appropriate option.)

D1. The EIR makes my work easier when delivering immunization services *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D2. The EIR provides helpful reminders and alerts for due or overdue vaccines *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D3. The EIR is user-friendly and easy to navigate. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D4. I find the EIR useful in improving immunization service delivery. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D5. The EIR supports better planning for vaccine supply and stock management. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D6. The EIR helps improve overall immunization coverage in the facility. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D7. Using the EIR enhances communication within the immunization team. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D8. I feel confident using the EIR in my daily tasks. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D9. The EIR helps identify trends in immunization coverage and defaulter rates. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree

D10. Overall, I believe the EIR has positively impacted immunization service outcomes in this facility. *

- Strongly disagree
- Disagree
- Neutral
- Agree
- Strongly agree