Jurnal Pustaka Indonesia (JPI)
2026, Vol. 6, No. 1, 536–551
https://doi.org/10.62159/jpi.v6i1.2931

OPEN ACCESS
Research Article

Digital Posyandu for Community-Based Maternal and Child Health Information Management Education: An Offline Application to Strengthen Cadre Digital Literacy and Service Efficiency

Ikhsan[1*] and Kani[2]
[1,2] Universitas Terbuka, Indonesia

ABSTRACT
Posyandu (Integrated Health Service Post) is a community-based platform for maternal and child health services, yet manual recording can constrain data quality, reporting timeliness, and routine monitoring. This community-engaged implementation evaluation developed and field-tested an offline digital Posyandu application across 12 Posyandu sites in Rawakalong Village. The system integrates records for children under five and pregnant women, growth monitoring, immunization scheduling, monthly reporting, and local data storage. Development proceeded through needs assessment, iterative system refinement, functional testing, cadre validation, training, and field monitoring. Pre- and post-training evaluation recorded an 80% increase in cadre digital-literacy performance. During implementation, recording speed increased by 63%, data-entry errors decreased by 45%, and monthly reporting time was reduced from three to five days to less than 24 hours. The findings indicate that an offline, locally deployable digital health-information system can support cadre capacity and improve operational efficiency in community-based maternal and child health services. Because the evaluation did not directly measure parental health literacy or child-development outcomes, the contribution is interpreted in terms of information management, cadre digital literacy, and service efficiency rather than direct parent- or child-level effects.

ARTICLE HISTORY
Received : 15 January 2026
Revised : 17 March 2026
Accepted : 11 April 2026

KEYWORDS
Community Health Workers; Digital Health Information System; Digital Literacy; Maternal and Child Health; Posyandu; Service Efficiency

CORRESPONDING AUTHOR
***Ikhsan**, Universitas Terbuka, Indonesia. Email: ikhsan@ecampus.ut.ac.id

Introduction

Posyandu (Integrated Health Service Post) is a community-based health service institution designed to address maternal and child health needs at the community level. By integrating health services such as immunization, monitoring of child growth and development, and nutrition education, Posyandu serves as a frontline mechanism for improving public health in Indonesia. However, major operational challenges remain. One of the most significant is that data recording and reporting are still largely conducted manually. This method is not only time-consuming but is also vulnerable to errors, such as lost documents and inaccurate data (Sullivan et al., 2020; Harrison et al., 2020; Khubone et al., 2020).

This situation affects the effectiveness of Posyandu services. For example, in immunization programs, recording errors may result in children not receiving vaccinations on schedule. In addition, limited real-time data accessibility makes it difficult for decision-makers to formulate appropriate intervention strategies based on the specific needs of an area. This condition widens the gap between the substantial potential of Posyandu as a health institution and its actual capacity to deliver high-quality services (Knop et al., 2024; Kabongo et al., 2021).

In recent years, developments in information technology have created various opportunities to improve the efficiency and effectiveness of health services. Studies have shown that the digitalization of Posyandu services, including the use of web-based information systems and mobile applications, can generate significant positive impacts. Recent research reports indicate that digitalization can improve data-recording efficiency by up to 40% and reduce recording errors by up to 60% (Chen et al., 2018; Knop et al., 2024; Mishra et al., 2023). Technology-based systems enable more structured data management, automated recording, and real-time access to information. These capabilities facilitate the work of Posyandu cadres while supporting data-based decision-making by relevant stakeholders.

Nevertheless, technology adoption in Posyandu is not without challenges. Many Posyandu operate in areas with limited technological infrastructure and limited human resources with adequate digital competence. Moreover, not all community members are accustomed to using digital applications, making education and training essential components of implementation (Bakibinga et al., 2020; Jacob et al., 2020; Early et al., 2019).

In the current digital era, the use of information technology in health services has become increasingly necessary. Digital transformation is important not only for improving efficiency but also for ensuring inclusive and responsive services that address community needs (do Nascimento et al., 2023; Ahmed et al., 2022; Greuel et al., 2023). Therefore, developing a digital Posyandu application designed for use at the neighborhood level is a relevant solution. Such an application can facilitate maternal and child health services and monitoring, improve data accuracy, and create opportunities for more in-depth data analysis (Greuel et al., 2023; Charanthimath et al., 2021).

The application evaluated in this study is primarily a cadre-facing health-information tool. Its growth-monitoring and reporting functions can support the organization and communication of maternal and child health information, but parental access, parental health literacy, and child-development outcomes were not directly measured. Digital interventions may support caregiver knowledge when they are explicitly designed and evaluated for that purpose; such effects should not be inferred from system availability alone (Mörelius et al., 2021; Zaidman et al., 2023; Zhang et al., 2019; Morrison et al., 2019; Lee et al., 2021; El Benny et al., 2021).

Developing this application requires close collaboration among multiple stakeholders, including government institutions, academics, and technology partners. Through a planned approach that involves all relevant stakeholders, the development of a digital Posyandu application can become a strategic step toward strengthening community health systems at the grassroots level. Posyandu is a community-based health service unit focusing on monitoring the growth and development of children under five, maternal health, immunization, and nutrition. A major challenge for Posyandu in Indonesia is the continued dominance of manual recording using register books, which is vulnerable to delays, input errors, and difficulties in rapidly compiling data (Scott et al., 2018; Ahmed et al., 2022). Posyandu digitalization is viewed as a strategic step for improving recording effectiveness, accelerating reporting, and supporting data-based decision-making (Sullivan et al., 2020; Khubone et al., 2020). Various studies have shown that digital health applications can improve operational efficiency and service quality at the community level (Knop et al., 2024; Chen et al., 2018).

An offline desktop architecture was selected as a context-sensitive implementation choice rather than as a universally superior platform. Digital-health adoption in community settings is shaped by connectivity, device availability, user workflow, technical support, and local capacity;

therefore, systems that can operate without continuous internet access may be advantageous where infrastructure is constrained (Bakibinga et al., 2020; Sullivan et al., 2020; Jacob et al., 2020; Khubone et al., 2020). Lazarus/Free Pascal was used to build the desktop interface because the project required a lightweight, locally deployable application compatible with the available Posyandu computers. In this manuscript, the technology is treated as an implementation component rather than as the theoretical contribution of the study. Firebird was used as the local relational database in embedded mode so that records could be stored and retrieved without a dedicated server. This design decision responds to the project's offline-use requirement; claims about data security and reliability are limited to the safeguards actually documented in the study and require fuller technical reporting in the Method section.

The scholarly contribution is therefore not the programming tools themselves, but the integration of offline community-health information management, participatory workflow refinement, cadre capacity building, and routine service monitoring within one implementation process. This orientation is consistent with evidence that digital tools for community health workers are most useful when technical functions are aligned with training, workflow, usability, and health-system integration (Winters et al., 2019; Early et al., 2019; Bakibinga et al., 2020; Greuel et al., 2023; do Nascimento et al., 2023; Ahmed et al., 2022).

Across maternal and child health, digital interventions have supported monitoring, immunization follow-up, caregiver communication, and community health-worker decision support, although effects vary with implementation context and evaluation design (Knop et al., 2024; Kabongo et al., 2021; Mishra et al., 2023; Yunusa et al., 2021; Eze et al., 2021; Mahmood et al., 2020; Nyang'echi & Osero, 2021; Westgard & Orrego-Ferreyros, 2022). Three gaps are especially relevant to Posyandu settings: many systems presume sustained connectivity; technical performance is often examined separately from workforce capability and routine workflow efficiency; and downstream constructs such as parental health literacy are sometimes discussed without direct measurement. Accordingly, this study examined the development and field implementation of an offline digital Posyandu system at 12 sites in Rawakalong Village, focusing on user needs, functional performance, cadre digital-literacy change, recording efficiency, data-entry errors, and reporting time. Its contribution lies in context-sensitive health-information management and cadre capacity building rather than in unmeasured parent- or child-level effects.

Method

Activity Approach

This study is reported as a community-engaged implementation evaluation conducted within a participatory community-based development program in Rawakalong Village. The implementation setting comprised 12 active Posyandu sites. The evaluation examined available program evidence across needs assessment and workflow analysis, iterative development of the offline application, functional testing and user validation, cadre training, and field monitoring of operational indicators. The design was intended to assess implementation and observed pre-post change in routine service indicators; it was not a controlled effectiveness trial and therefore does not isolate the application effect from training, facilitation, or workflow changes (Scott et al., 2018; Ahmed et al., 2022; Mupara et al., 2023; Ludwick et al., 2020; Pinto et al., 2020).

Table 1. First-Year Community Service Activities

Activity	Activity Description	Target Output

Partner Exploration and Site Identification	Conduct initial coordination with the Rawakalong Village Government and Posyandu management to determine needs, site readiness, and Posyandu willingness to participate as community service partners.	Partner Agreement Document
Signing of the Partner Agreement	Prepare and sign a cooperation agreement between the community service team and the partner in Rawakalong Village.	
Official Program Launch and Socialization	Conduct an official launch involving village government representatives, Posyandu cadres, and community members to explain the objectives, benefits, and implementation plan for the digital Posyandu application.	
Field Needs Analysis	Conduct direct observation and interviews with cadres to map the manual recording workflow, identify existing constraints, and determine the types of health data that need to be accommodated in the application.	
Application Design and Development	Design the application and develop core features such as data recording for children under five and pregnant women as well as the database structure.	
Functional Testing and Validation	Test the application internally and with cadres to ensure that all functions operate properly, validate workflow suitability, and correct bugs.	
Posyandu Cadre Training	Train cadres in application use, health-data management, and independent operation of the application.	Application
Implementation at 12 Posyandu Sites	Distribute the application and support implementation at 12 targeted Posyandu sites in Rawakalong Village as the initial implementation locations.	

Implementation Stages

The community service team conducted initial coordination with the Rawakalong Village Government and Posyandu management. The initial assessment indicated a need to digitalize health-data recording and reporting across Posyandu sites in the village. The community service team and the Rawakalong Village Government signed a Letter of Agreement defining the scope of activities, the responsibilities of each party, and implementation at 12 Posyandu sites. The community service program was officially launched through a meeting involving village government representatives, cadres, and community members. During this session, the team explained the objectives, benefits, and development plan for the digital Posyandu application. The team observed manual recording processes at Posyandu sites and interviewed cadres. The analysis identified the need for features covering data on children under five, pregnant women, immunization, automated growth charts, and automated reporting.

Application System Development

The team designed the database structure using Firebird, including tables for children under five, pregnant women, immunization, and report summaries. The user interface was designed using Lazarus/Free Pascal visual components to make the application easier to use for cadres with limited experience using digital applications.

The application was developed as a desktop system to ensure stability and offline operation. An incremental development model was used so that features could be tested progressively. The

completed application includes data entry for children under five and pregnant women, automated growth charts, immunization schedules, monthly report summaries, and local data storage using embedded Firebird.

Internal functional testing examined the basic operations reported in the source manuscript, including data entry, editing, deletion, and report generation. The available records indicate successful execution of these tested functions during internal testing; however, the source does not report the number of test cases, edge-case scenarios, acceptance criteria, or tester roles required for a stronger validation claim.

User validation was conducted by allowing Posyandu cadres to test the application and provide feedback on interface layout, data-entry sequence, and reporting needs. Their feedback informed subsequent refinements. The source manuscript does not specify the number of cadres involved, validation indicators, rating scale, or summary scores, so the user-validation findings are reported qualitatively rather than as a quantified usability effect.

Training and Implementation at 12 Posyandu Sites

Application Training

Cadres received application-use training covering data entry and report generation. The source reports an 80% increase in digital-literacy performance in the pre- and post-training evaluation. Because the cadre sample size, instrument, scale, pre/post score distribution, calculation formula, and inferential analysis are not reported, the 80% value is preserved as an observed program indicator rather than interpreted as a causal effectiveness estimate.

The application was installed and used at 12 Posyandu sites in Rawakalong Village. Assistance was provided during routine Posyandu activities, and cadres were able to use the application independently to record data on children under five and pregnant women. Periodic field monitoring documented the reported operational changes: recording speed increased by 63%, data-entry errors decreased by 45%, and monthly reporting time decreased from three to five days to less than 24 hours. These original figures are retained unchanged. The source manuscript does not specify the monitoring period, measurement frequency, unit of analysis, comparator denominator, or calculation procedure; therefore, the indicators are presented descriptively and require fuller methodological documentation before publication. Based on the field evaluation, the team refined several elements of the application, particularly the data-entry interface and report structure. At the end of the activity, the application, user documentation, and community service report were officially handed over to the Rawakalong Village Government.

Data sources documented in the source manuscript comprised direct observation of manual workflows, interviews with Posyandu cadres, internal functional testing, cadre feedback during user validation, pre- and post-training questionnaires and practical tasks, and routine field-monitoring indicators. Quantitative outcomes reported in the source were summarized descriptively as percentage change in cadre digital-literacy performance, recording speed, data-entry errors, and report-preparation time. Qualitative feedback was used to refine the interface, data-entry flow, and reporting functions. The source file does not specify the total cadre sample, instrument validation and scoring procedures, interview duration or transcription procedures, or the monitoring denominator and calculation formula; these items require author confirmation before submission.

For technical reproducibility, the manuscript should report the exact Lazarus/Free Pascal and Firebird versions, operating system and test-device specifications, database architecture,

authentication and role permissions, backup procedures, and acceptance criteria for functional testing. These details are not available in the source manuscript and have therefore not been invented in this revision. Contemporary digital-health evaluation frameworks emphasize usability, implementation context, security, and transparent technical reporting (Llorens-Vernet & Miró, 2020; Azad-Khaneghah et al., 2021; Wei et al., 2020; Jacob et al., 2020).

The source manuscript also does not provide an ethics-approval identifier, informed-consent procedure, or complete data-governance protocol. Before submission, the authors should document institutional permission, consent for cadre participation, authorization for use of operational health data, anonymization procedures, access control, data backup, and safeguards for child and parent identifiers. Ethical and privacy reporting is essential when digital tools handle community health data (Gopichandran et al., 2023; Llorens-Vernet & Miró, 2020).

Results and Discussion

Results

Initial stakeholder engagement confirmed 12 active Posyandu sites and persistent reliance on manual records. The needs assessment identified recurring workflow requirements for integrated records of children under five and pregnant women, immunization scheduling, automated growth visualization, and monthly reporting. These analytical findings, rather than the administrative sequence of partnership activities, defined the functional requirements used in application development.

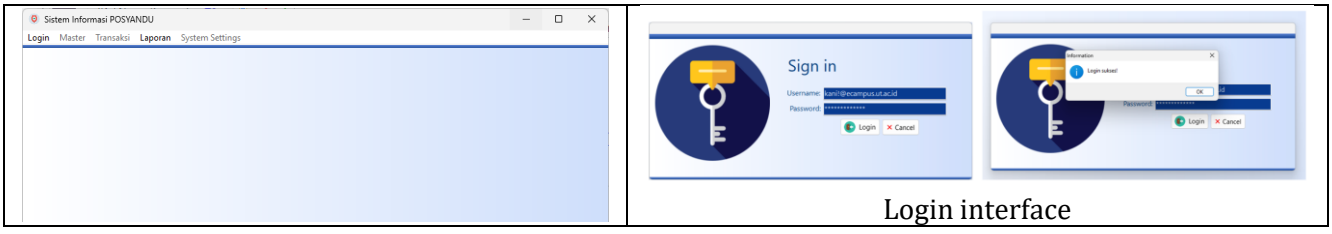
Development of the Digital Posyandu Application

Based on the field needs analysis, the team developed a desktop-based digital Posyandu application using Lazarus/Free Pascal for the interface and Firebird as the database. Lazarus was selected because of its stability, lightweight operation, and compatibility with the computers available at Posyandu sites. Firebird enables local storage through embedded mode without requiring a dedicated server. This combination produced an application that can operate offline and is well suited to the Posyandu environment.

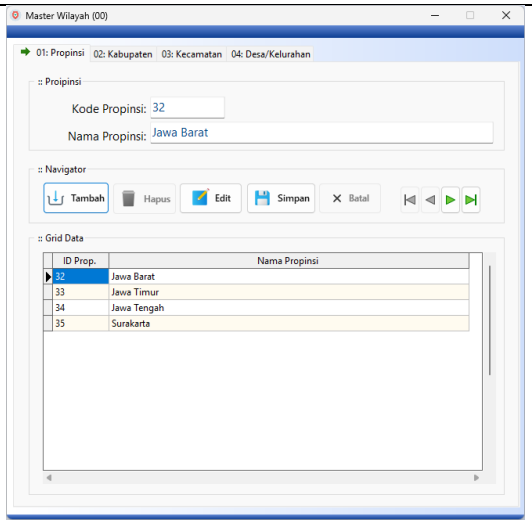
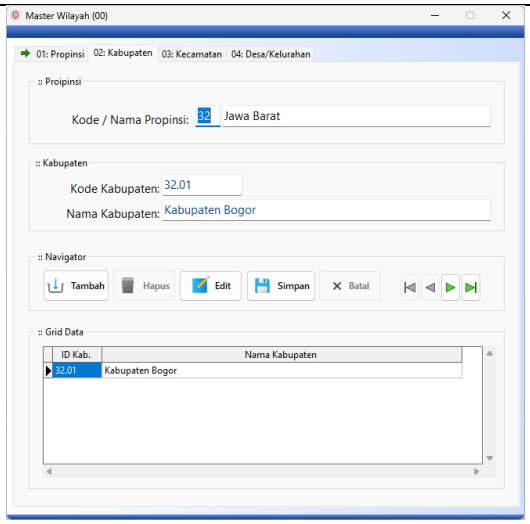
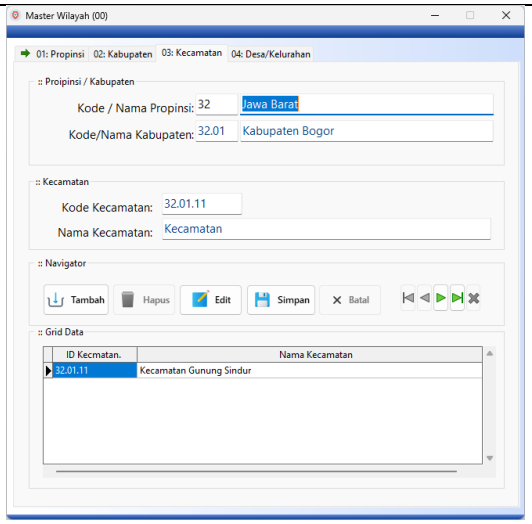
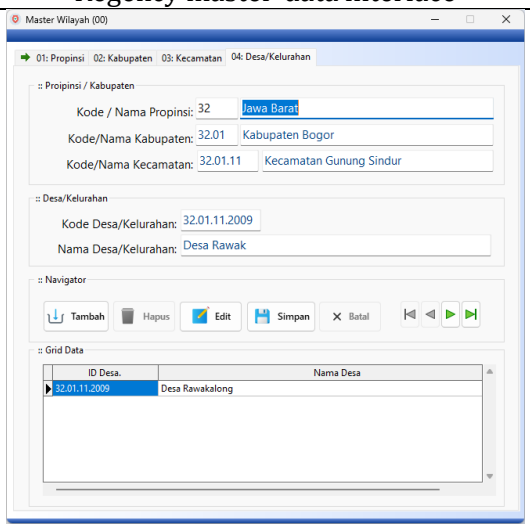
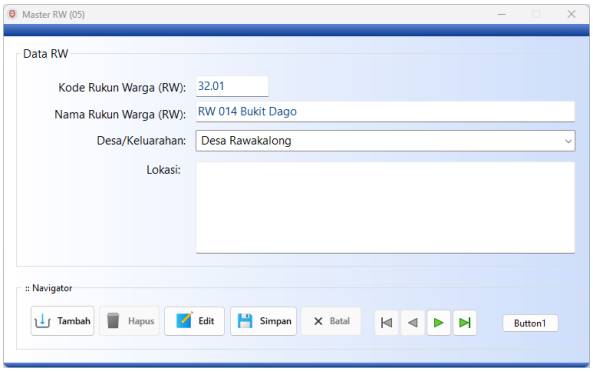
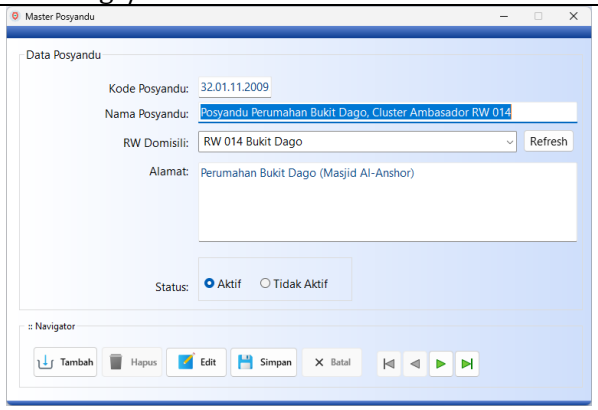
Application development was conducted incrementally, beginning with core modules for recording data on children under five and pregnant women. After the core modules were completed, the team added automated growth charts, immunization schedules, and monthly reporting modules. This staged approach allowed internal testing at each phase, minimizing the risk of bugs and helping maintain application stability as new features were added.

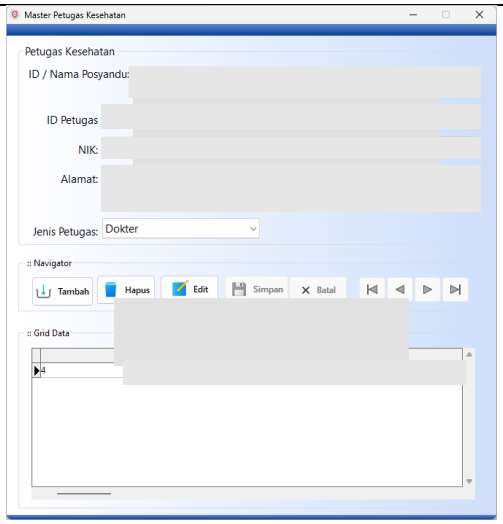
All application modules were successfully developed with a simple interface that was easy for cadres to understand. Navigation features were made more intuitive based on cadre feedback obtained during the needs-analysis stage. Accordingly, the application was designed not only to meet technical recording requirements but also to be usable by users with varying levels of digital literacy. The developed Posyandu application includes the following interfaces and functions.

Table 2. Core, administrative, and personnel interfaces of the digital Posyandu application

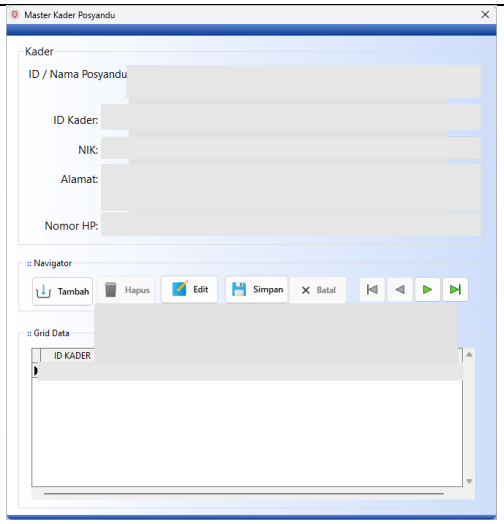


Login interface

Main interface	
	
Province master-data interface	Regency master-data interface
	
District master-data interface	Village/Subdistrict master-data interface
	
Neighborhood-unit master-data interface	Posyandu master-data interface

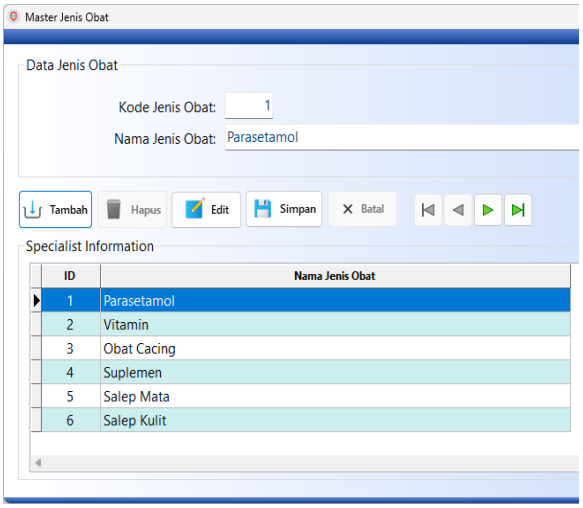


Health worker master-data interface

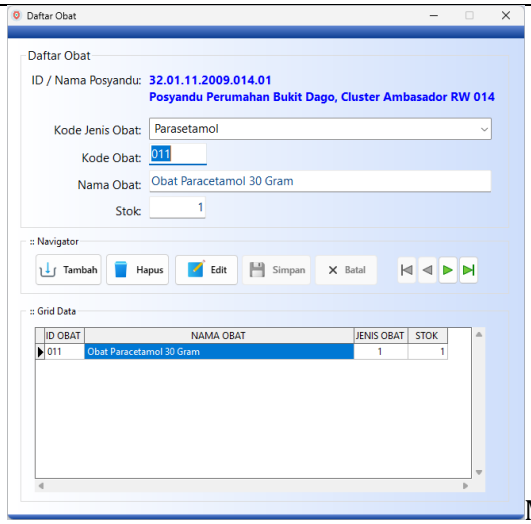


Posyandu cadre master-data interface

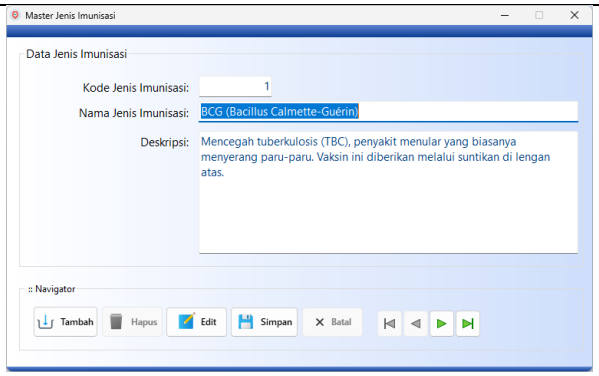
Table 3. Health-service and child-monitoring interfaces of the digital Posyandu application



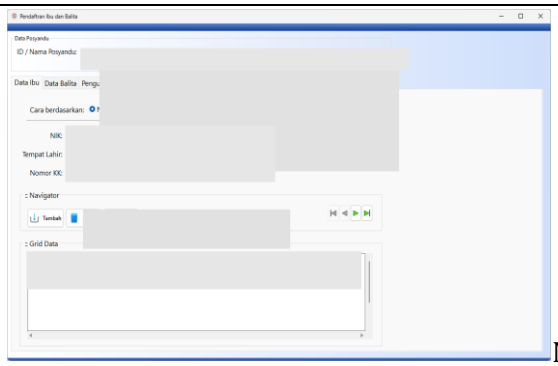
Medicine type master-data interface



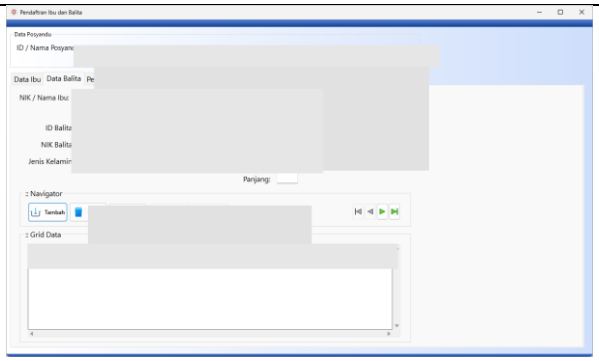
Medicine list interface



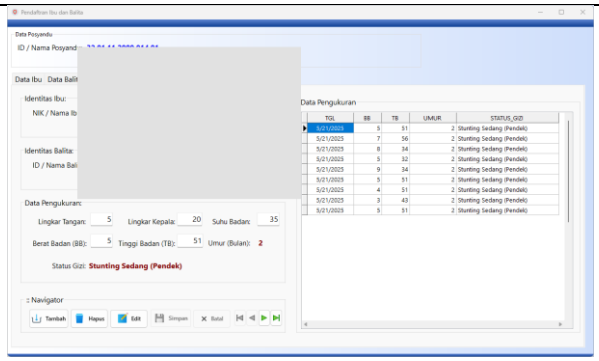
Immunization type master-data interface



Mother of child data-entry interface

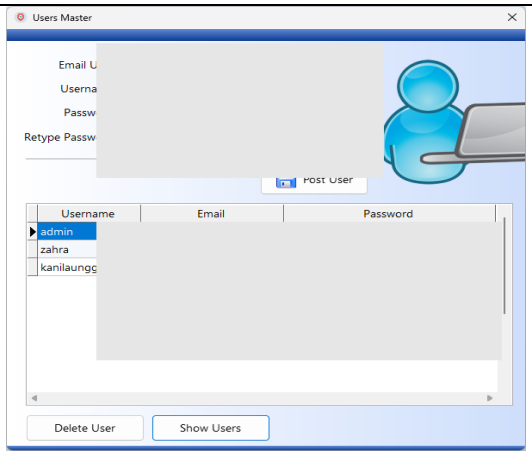


Child data-entry interface

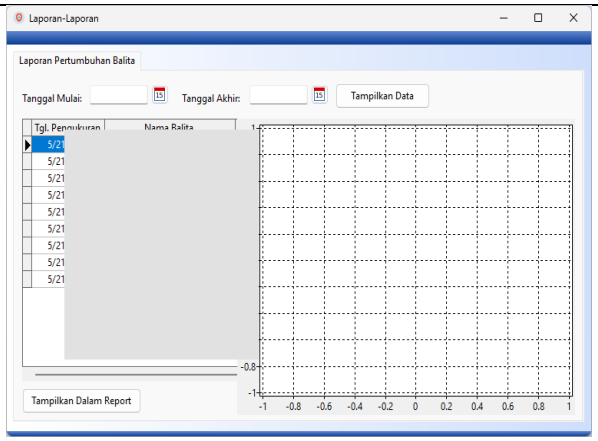


Child measurement data-entry interface

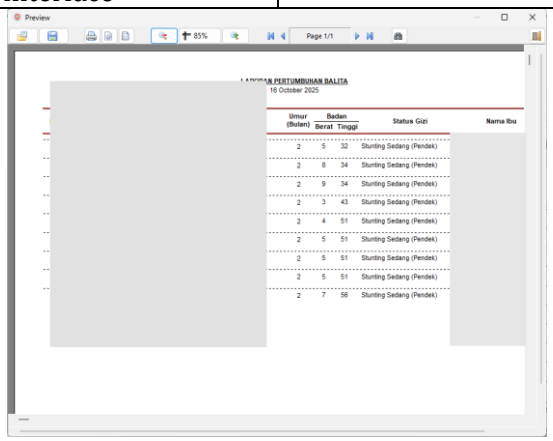
Table 4. User-management and reporting interfaces of the digital Posyandu application



User master-data interface



Report-generation interface



Report-output interface

Personally identifying fields in the interface screenshots were irreversibly masked in this revision for privacy. The underlying application functions, quantitative results, and analytical findings were not altered.

Functional Testing and User Validation

Functional testing covered data entry, growth-chart calculations, database storage, and report generation. The source records report successful operation of these functions in the scenarios that were tested. Because a full test-case matrix, edge-case protocol, and formal acceptance criteria were not included in the source manuscript, the result is interpreted as successful internal functional testing rather than proof of error-free performance.

User validation was distinct from internal functional testing: Posyandu cadres tested the application and provided feedback on the interface, data-entry flow, and report format. The feedback supported refinements to font size, button placement, and workflow simplification. Because the source does not report the number of validating cadres or a standardized usability score, these findings are treated as qualitative user-validation evidence.

Based on cadre feedback, the team made several refinements, including adjusting font size, rearranging button positions, and simplifying the data-entry flow. These improvements demonstrate that the application was developed not solely on the basis of technical assumptions but also by considering the comfort and actual needs of users.

Training and Implementation at 12 Posyandu Sites

Cadre training was an important stage in ensuring that the application could be operated independently. Training was delivered through demonstrations and hands-on practice so that cadres could understand each step from data entry to report generation. The activity proceeded effectively because the cadres were enthusiastic and already had experience with manual recording.

The pre- and post-training evaluation recorded an 80% increase in digital-literacy performance. This original value is retained unchanged. In the absence of a reported sample size, validated scale, pre/post descriptive scores, and inferential testing, it is interpreted as an observed training-associated improvement rather than a definitive estimate of training effectiveness.

After training, the application was implemented at the 12 targeted Posyandu sites. The team provided assistance during routine Posyandu operations to ensure that cadres could use the application without significant barriers. During implementation, cadres also provided additional feedback that was used for minor application improvements.

Monitoring and Evaluation

Monitoring was conducted periodically to assess the effectiveness of application use during routine Posyandu activities. The team made field visits and conducted direct interviews with cadres to evaluate ease of use, technical constraints, and perceived benefits. Monitoring was intended to ensure that the application operated stably and positively supported the recording process.

Field monitoring documented substantial operational change during implementation: recording speed increased by 63%, data-entry errors decreased by 45%, and monthly report-preparation time decreased from three to five days to less than 24 hours. These values are preserved exactly as reported. Because the implementation combined the application with training and facilitation and did not include a comparator group, the changes are described as implementation-associated rather than attributed solely to the application.

In addition to the quantitative data, cadres reported that the application helped reduce their administrative burden, enabling them to devote greater attention to health services. The evaluation concluded that the application not only improved efficiency but also simplified workflows and increased cadre motivation.

Following field monitoring, the team completed final interface, navigation, and reporting refinements and transferred the application and user documentation to the Rawakalong Village Government as part of implementation sustainability.

Discussion

The application implementation results indicate that Posyandu digitalization is highly relevant for addressing persistent problems associated with manual recording. Before the application was introduced, cadres recorded all information manually in register books, a process that was time-consuming and vulnerable to writing errors and lost data. With a digital application designed on the basis of field needs, the recording process became faster, more structured, and easier to trace. This condition is consistent with the national trend toward digital transformation in primary health services. Similar implementation literature shows that digital community-health tools can improve information availability and workflow, but their value depends on data quality, integration, and local implementation conditions (Sullivan et al., 2020; Harrison et al., 2020; Khubone et al., 2020; Knop et al., 2024).

The relevance of digitalization is also evident in the improved accuracy of maternal and child health data. Previously, monthly summaries were prepared manually, creating a high possibility of inconsistencies among registers. After the application was introduced, data were automatically summarized by the system, reducing human error. Digitalization therefore helped cadres accelerate their work while improving data integrity, which is important for reporting to Community Health Centers and local government. This pattern is consistent with the broader role of electronic health information systems in strengthening routine data use, while also underscoring the need for explicit definitions of data quality and verification procedures (Harrison et al., 2020; Khubone et al., 2020).

The present evaluation did not directly measure parental perceptions, parental health literacy, caregiver behavior, or child-development outcomes. The application's growth-monitoring and reporting functions may provide infrastructure for clearer communication of child-health information, but any downstream effect on caregiver knowledge or behavior remains a hypothesis for future evaluation rather than a demonstrated outcome. This distinction is important because parental health literacy and eHealth literacy are measurable constructs that require direct assessment with appropriate instruments (Mörelius et al., 2021; Zaidman et al., 2023; Zhang et al., 2019; Morrison et al., 2019; Lee et al., 2021; El Benny et al., 2021; Lin & Lou, 2021; Wijaya & Kloping, 2021; Mialhe et al., 2021).

The use of Lazarus/Free Pascal and embedded Firebird was contextually suitable for the operational conditions reported in Rawakalong because the system was designed for local, offline use on available computers. This should not be interpreted as evidence that the platform is superior to web or mobile alternatives. Digital-health adoption depends on infrastructure, workflow fit, user support, interoperability, and organizational conditions (Bakibinga et al., 2020; Jacob et al., 2020; Greuel et al., 2023).

Firebird as an embedded database provides substantial advantages for local data storage. Without requiring a separate server, all data can be managed in a single database file that can be backed up easily. This differs from web-based systems that depend on stable internet connectivity, which is not always available at the neighborhood level. With a local database approach, Posyandu can continue operating even when the network is unavailable, ensuring that service continuity is not dependent on external infrastructure. Offline capability may be particularly useful where continuous connectivity is uncertain, although local storage also heightens the importance of backup, access control, and privacy safeguards (Sullivan et al., 2020; Gopichandran et al., 2023; Llorens-Vernet & Miró, 2020).

The combination of Lazarus and Firebird also demonstrated good integration for features such as automated growth charts, data validation, and report summaries. All features operated smoothly without performance problems. This suggests that lightweight open-source technologies can provide a strategic solution for community service programs in resource-constrained settings. Usability and quality should therefore be interpreted from explicit user-validation evidence rather than from technical functionality alone (Azad-Khaneghah et al., 2021; Wei et al., 2020). Cadre training accompanied the observed 80% pre-post increase in digital-literacy performance. The direction of change is consistent with evidence that digital and mobile training can strengthen community health-worker competencies when tools are integrated with practice and ongoing support (Winters et al., 2019; do Nascimento et al., 2023; Porterfield et al., 2023). However, because the source does not provide the cadre sample size, validated instrument, score distribution, or inferential test, the 80% value should be interpreted descriptively rather than as a causal estimate of effectiveness.

Training effectiveness was also reflected in cadres' ability to operate the application independently after several assistance sessions. Cadres were able to enter data on children under five, print reports, and interpret growth charts without assistance from the community service team. This indicates that the application interface was aligned with cadre workflows and facilitated adaptation. This aligns with evidence that community health-worker digital interventions are more sustainable when technology is fitted to role expectations, supervision, and health-system integration (Early et al., 2019; Scott et al., 2018; Ahmed et al., 2022; Mupara et al., 2023; Knowles et al., 2023).

From a psychological and empowerment perspective, cadres became more confident in performing Posyandu administrative functions. Training provided not only technical skills but also an awareness that technology can serve as a tool to simplify their work. This condition strengthens the sustainability of application use after completion of the community service program. Similar workforce-focused studies emphasize that confidence and practical capability are implementation mechanisms, but they should be measured separately from system performance (Charanthimath et al., 2021; Rossouw et al., 2021; Sabo et al., 2021; Blanchard et al., 2019; Werner et al., 2023).

Implementation across the 12 Posyandu sites was accompanied by a 63% increase in recording speed. This observed improvement is operationally meaningful because reduced administrative time can create greater capacity for service delivery; however, the design does not isolate the contribution of the application from training, facilitation, or workflow redesign. Comparable digital-health literature similarly treats implementation context and workforce integration as central to observed performance change (do Nascimento et al., 2023; Pinto et al., 2020; Early et al., 2019).

Data-entry errors also decreased by 45%. Before digitalization, common errors occurred because of repeated writing, misreading, or inconsistent summaries. After the application was introduced, automated validation reduced the risk of errors. Data became more organized, structured, and easier to verify. The 45% reduction should be interpreted alongside the need for transparent operational definitions of an error and a documented denominator, because data-quality limitations can persist even after digitization (Harrison et al., 2020).

The greatest efficiency gain was observed in monthly reporting, which previously required three to five days but could be completed in less than 24 hours after implementation. Automated summaries benefited both Posyandu and the village government by enabling timely report

preparation. This result demonstrates the contribution of the application to improving the quality of health-service administration. The reduction in report-preparation time is consistent with the potential of electronic information systems to accelerate routine reporting, while robust evaluation still requires standardized timing procedures and longer-term follow-up (Khubone et al., 2020; Sullivan et al., 2020).

The Rawakalong experience suggests potential transferability to Posyandu settings with comparable cadre roles, device availability, offline requirements, governance, and support capacity, rather than broad generalizability. Community health-worker programs are highly context dependent, and scale-up should account for organizational integration, equity, supervision, and local infrastructure (Scott et al., 2018; Ahmed et al., 2022; Mupara et al., 2023; Ludwick et al., 2020; Knowles et al., 2023).

The system also has opportunities for further development. Cadre feedback identified the need for additional features such as complete immunization histories, schedule reminders, data export integration with Excel and Community Health Centers, and a mobile version for parents of children under five. Because the application was designed modularly, additional features can be developed without changing the core structure. Future caregiver-facing features should be evaluated independently because evidence on reminders and maternal-child mHealth indicates that intervention effects depend on design, access, and implementation conditions (Yunusa et al., 2021; Eze et al., 2021; Dol et al., 2019; Saronga et al., 2019).

Further development also includes research opportunities for building a big-data-based Posyandu system that can support government health-policy decisions. Thus, the application is relevant not only locally but may also contribute to broader efforts to digitalize the Indonesian health system. Any future interoperability or analytics expansion should also be accompanied by explicit governance, data-quality, and privacy evaluation (Gopichandran et al., 2023; Llorens-Vernet & Miró, 2020; Harrison et al., 2020).

This evaluation has several limitations. It was conducted in one village across 12 Posyandu sites; the source manuscript does not specify the total cadre sample or provide full psychometric and scoring information for the pre-post digital-literacy assessment. There was no comparator group, the evaluation focused on short-term implementation indicators, and the reported 63% increase in recording speed and 45% reduction in data-entry errors require fuller operational definitions and calculation procedures. The study also did not directly measure parental health literacy, caregiver behavior, child growth or development outcomes, or long-term system sustainability. Accordingly, the findings should be interpreted as context-specific implementation evidence and observed process change rather than causal evidence of downstream parent- or child-level effects.

Conclusion

The community-engaged implementation of an offline digital Posyandu application across 12 sites in Rawakalong Village was associated with improvements in the operational indicators reported in the source data. The system integrated maternal and child records, growth monitoring, immunization scheduling, and reporting; cadre training recorded an 80% increase in digital-literacy performance; recording speed increased by 63%; data-entry errors decreased by 45%; and monthly reporting time decreased from three to five days to less than 24 hours. These findings support the practical value of context-sensitive digital health-information management and cadre capacity building for Posyandu service workflows. Because the study did not directly assess parental health literacy or child-

development outcomes and did not use a comparator group, conclusions are limited to implementation performance, cadre digital literacy, and service efficiency. Future evaluation should report validated measurement procedures, longer-term system use, caregiver-facing outcomes, and privacy-preserving interoperability before broader transfer is considered.

References

Ahmed, S., Chase, L. E., Wagnild, J., Akhter, N., Sturridge, S., Clarke, A., Chowdhary, P., Mukami, D., Kasim, A., & Hampshire, K. (2022). Community health workers and health equity in low- and middle-income countries: Systematic review and recommendations for policy and practice. International Journal for Equity in Health, 21(1), 49. https://doi.org/10.1186/s12939-021-01615-y

Azad-Khaneghah, P., Neubauer, N., Cruz, A. M., & Liu, L. (2021). Mobile health app usability and quality rating scales: A systematic review. Disability and Rehabilitation: Assistive Technology, 16(7), 712–721. https://doi.org/10.1080/17483107.2019.1701103

Bakibinga, P., Kamande, E., Kisia, L., Omuya, M., Matanda, D. J., & Kyobutungi, C. (2020). Challenges and prospects for implementation of community health volunteers' digital health solutions in Kenya: A qualitative study. BMC Health Services Research, 20(1), 888. https://doi.org/10.1186/s12913-020-05711-7

Blanchard, A. K., Prost, A., & Houweling, T. A. J. (2019). Effects of community health worker interventions on socioeconomic inequities in maternal and newborn health in low-income and middle-income countries: A mixed-methods systematic review. BMJ Global Health, 4(3), e001308. https://doi.org/10.1136/bmjgh-2018-001308

Charanthimath, U., Katageri, G., Kinshella, M.-L. W., Mallapur, A., Goudar, S., Ramadurg, U., Vidler, M., Sharma, S., Derman, R., Magee, L. A., von Dadelszen, P., Bellad, M., & Payne, B. A. (2021). Community Health Worker Evaluation of Implementing an mHealth Application to Support Maternal Health Care in Rural India. Frontiers in Global Women's Health, 2, 645690. https://doi.org/10.3389/fgwh.2021.645690

Chen, H., Chai, Y., Dong, L., Niu, W., & Zhang, P. (2018). Effectiveness and appropriateness of mHealth interventions for maternal and child health: Systematic review. JMIR mHealth and uHealth, 6(1), e7. https://doi.org/10.2196/mhealth.8998

do Nascimento, I. J. B., Abdulazeem, H. M., Vasanthan, L. T., Martinez, E. Z., Zucoloto, M. L., Østengaard, L., Azzopardi-Muscat, N., Zapata, T., & Novillo-Ortiz, D. (2023). The global effect of digital health technologies on health workers' competencies and health workplace: An umbrella review of systematic reviews and lexical-based and sentence-based meta-analysis. The Lancet Digital Health, 5(8), e534–e544. https://doi.org/10.1016/S2589-7500(23)00092-4

Dol, J., Richardson, B., Murphy, G. T., Aston, M., McMillan, D., & Campbell-Yeo, M. (2019). Impact of mobile health (mHealth) interventions during the perinatal period for mothers in low- and middle-income countries: A systematic review. JBI Database of Systematic Reviews and Implementation Reports, 17(8), 1634–1667. https://doi.org/10.11124/JBISRIR-2017-004022

Early, J., Gonzalez, C., Gordon-Dseagu, V., & Robles-Calderon, L. (2019). Use of mobile health (mHealth) technologies and interventions among community health workers globally: A scoping review. Health Promotion Practice, 20(6), 805–817. https://doi.org/10.1177/1524839919855391

El Benny, M., Kabakian-Khasholian, T., El-Jardali, F., & Bardus, M. (2021). Application of the eHealth Literacy Model in Digital Health Interventions: Scoping Review. Journal of Medical Internet Research, 23(6), e23473. https://doi.org/10.2196/23473

Eze, P., Lawani, L. O., & Acharya, Y. (2021). Short message service (SMS) reminders for childhood immunisation in low-income and middle-income countries: A systematic review and meta-analysis. BMJ Global Health, 6(7), e005035. https://doi.org/10.1136/bmjgh-2021-005035

Gopichandran, V., Subramaniam, S., & Thiagesan, R. (2023). Ethical issues in m-Health applications in community health work in India—A scoping review. Indian Journal of Medical Ethics, 8(4), 266–273. https://doi.org/10.20529/IJME.2023.037

Greuel, M., Sy, F., Bärnighausen, T., Adam, M., Vandormael, A., Gates, J., & Harling, G. (2023). Community Health Worker Use of Smart Devices for Health Promotion: Scoping Review. JMIR mHealth and uHealth, 11, e42023. https://doi.org/10.2196/42023

Harrison, K., Rahimi, N., & Danovaro-Holliday, M. C. (2020). Factors limiting data quality in the expanded programme on immunization in low and middle-income countries: A scoping review. Vaccine, 38(30), 4652–4663. https://doi.org/10.1016/j.vaccine.2020.02.091

Jacob, C., Sanchez-Vazquez, A., & Ivory, C. (2020). Social, Organizational, and Technological Factors Impacting Clinicians' Adoption of Mobile Health Tools: Systematic Literature Review. JMIR mHealth and uHealth, 8(2), e15935. https://doi.org/10.2196/15935

Kabongo, E. M., Mukumbang, F. C., Delobelle, P., & Nicol, E. (2021). Explaining the impact of mHealth on maternal and child health care in low- and middle-income countries: A realist synthesis. BMC Pregnancy and Childbirth, 21(1), 196. https://doi.org/10.1186/s12884-021-03684-x

Khubone, T., Tlou, B., & Mashamba-Thompson, T. P. (2020). Electronic Health Information Systems to Improve Disease Diagnosis and Management at Point-of-Care in Low and Middle Income Countries: A Narrative Review. Diagnostics, 10(5), 327. https://doi.org/10.3390/diagnostics10050327

Knop, M. R., Nagashima-Hayashi, M., Lin, R., Saing, C. H., Ung, M., Oy, S., Yam, E. L. Y., Zahari, M., & Yi, S. (2024). Impact of mHealth interventions on maternal, newborn, and child health from conception to 24 months postpartum in low- and middle-income countries: A systematic review. BMC Medicine, 22(1), 196. https://doi.org/10.1186/s12916-024-03417-9

Knowles, M., Crowley, A. P., Vasan, A., & Kangovi, S. (2023). Community Health Worker Integration with and Effectiveness in Health Care and Public Health in the United States. Annual Review of Public Health, 44, 363–381. https://doi.org/10.1146/annurev-publhealth-071521-031648

Lee, J., Lee, E.-H., & Chae, D. (2021). eHealth Literacy Instruments: Systematic Review of Measurement Properties. Journal of Medical Internet Research, 23(11), e30644. https://doi.org/10.2196/30644

Lin, Y.-H., & Lou, M.-F. (2021). Effects of mHealth-based interventions on health literacy and related factors: A systematic review. Journal of Nursing Management, 29(3), 385–394. https://doi.org/10.1111/jonm.13175

Llorens-Vernet, P., & Miró, J. (2020). Standards for Mobile Health-Related Apps: Systematic Review and Development of a Guide. JMIR mHealth and uHealth, 8(3), e13057. https://doi.org/10.2196/13057

Ludwick, T., Morgan, A., Kane, S., Kelaher, M., & McPake, B. (2020). The distinctive roles of urban community health workers in low- and middle-income countries: A scoping review of the literature. Health Policy and Planning, 35(8), 1039–1052. https://doi.org/10.1093/heapol/czaa049

Mahmood, H., McKinstry, B., Luz, S., Fairhurst, K., Nasim, S., & Hazir, T. (2020). Community health worker-based mobile health (mHealth) approaches for improving management and caregiver knowledge of common childhood infections: A systematic review. Journal of Global Health, 10(2), 020438. https://doi.org/10.7189/jogh.10.020438

Mialhe, F. L., Moraes, K. L., Sampaio, H. A. C., Brasil, V. V., Vila, V. S. C., Soares, G. H., & Rebustini, F. (2021). Evaluating the psychometric properties of the eHealth Literacy Scale in Brazilian adults. Revista Brasileira de Enfermagem, 75(1), e20201320. https://doi.org/10.1590/0034-7167-2020-1320

Mishra, M., Parida, D., Murmu, J., Singh, D., Rehman, T., Kshatri, J. S., & Pati, S. (2023). Effectiveness of mHealth interventions for monitoring antenatal care among pregnant women in low- and middle-income countries: A systematic review and meta-analysis. Healthcare, 11(19), 2635. https://doi.org/10.3390/healthcare11192635

Morrison, A. K., Glick, A., & Yin, H. S. (2019). Health Literacy: Implications for Child Health. Pediatrics in Review, 40(6), 263–277. https://doi.org/10.1542/pir.2018-0027

Mupara, L. M., Mogaka, J. J. O., Brieger, W. R., & Tsoka-Gwegweni, J. M. (2023). Community Health Worker programmes' integration into national health systems: Scoping review. African Journal of Primary Health Care & Family Medicine, 15(1), e1–e16. https://doi.org/10.4102/phcfm.v15i1.3204

Mörelius, E., Robinson, S., Arabiat, D., & Whitehead, L. (2021). Digital Interventions to Improve Health Literacy Among Parents of Children Aged 0 to 12 Years With a Health Condition: Systematic Review. Journal of Medical Internet Research, 23(12), e31665. https://doi.org/10.2196/31665

Nyang'echi, E., & Osero, J. (2021). Effects of mobile health technologies on uptake of routine growth monitoring among caregivers of children aged 9 to 18 months in Kenya. Journal of Primary Care & Community Health, 12, 21501327211010995. https://doi.org/10.1177/21501327211010995

Pinto, D., Carroll-Scott, A., Christmas, T., Heidig, M., & Turchi, R. (2020). Community health workers: Improving population health through integration into healthcare systems. Current Opinion in Pediatrics, 32(5), 674–682. https://doi.org/10.1097/MOP.0000000000000940

Porterfield, L., Warren, V., Schick, V., Gulliot-Wright, S., Temple, J. R., & Vaughan, E. M. (2023). Addressing Training Gaps: A Competency-Based, Telehealth Training Initiative for Community Health Workers. Telemedicine Reports, 4(1), 126–134. https://doi.org/10.1089/tmr.2023.0007

Rossouw, L., Burger, R. P., & Burger, R. (2021). Testing an incentive-based and community health worker package intervention to improve maternal health and nutrition outcomes: A pilot randomized controlled trial. Maternal and Child Health Journal, 25(12), 1913–1922. https://doi.org/10.1007/s10995-021-03229-w

Sabo, S., Wightman, P., McCue, K., Butler, M., Pilling, V., Jimenez, D. J., Celaya, M., & Rumann, S. (2021). Addressing maternal and child health equity through a community health worker home visiting intervention to reduce low birth weight: Retrospective quasi-experimental study of the Arizona Health Start Programme. BMJ Open, 11(6), e045014. https://doi.org/10.1136/bmjopen-2020-045014

Saronga, N. J., Burrows, T., Collins, C. E., Ashman, A. M., & Rollo, M. E. (2019). mHealth interventions targeting pregnancy intakes in low and lower-middle income countries: Systematic review. Maternal & Child Nutrition, 15(2), e12777. https://doi.org/10.1111/mcn.12777

Scott, K., Beckham, S. W., Gross, M., Pariyo, G., Rao, K. D., Cometto, G., & Perry, H. B. (2018). What do we know about community-based health worker programs? A systematic review of existing reviews on community health workers. Human Resources for Health, 16(1), 39. https://doi.org/10.1186/s12960-018-0304-x

Sullivan, E., Masood, T., Javed, W., Bagshaw, K., Ollis, S., Regmi, P., & Gardezi, S. M. A. (2020). Electronic immunization information systems: A case report of lessons learned from implementation in Pakistan. mHealth, 6, 31. https://doi.org/10.21037/mhealth.2020.01.07

Wei, Y., Zheng, P., Deng, H., Wang, X., Li, X., & Fu, H. (2020). Design Features for Improving Mobile Health Intervention User Engagement: Systematic Review and Thematic Analysis. Journal of Medical Internet Research, 22(12), e21687. https://doi.org/10.2196/21687

Werner, K., Kak, M., Herbst, C. H., & Lin, T. K. (2023). The role of community health worker-based care in post-conflict settings: A systematic review. Health Policy and Planning, 38(2), 261–274. https://doi.org/10.1093/heapol/czac072

Westgard, C. M., & Orrego-Ferreyros, L. A. (2022). An mHealth tool for community health workers to improve caregiver knowledge of child health in the Amazon: An effectiveness-implementation hybrid evaluation. PLOS Global Public Health, 2(9), e0001118. https://doi.org/10.1371/journal.pgph.0001118

Wijaya, M. C., & Kloping, Y. P. (2021). Validity and reliability testing of the Indonesian version of the eHealth Literacy Scale during the COVID-19 pandemic. Health Informatics Journal, 27(1), 1460458220975466. https://doi.org/10.1177/1460458220975466

Winters, N., Langer, L., Nduku, P., Robson, J., O'Donovan, J., Maulik, P., Paton, C., Geniets, A., Peiris, D., & Nagraj, S. (2019). Using mobile technologies to support the training of community health workers in low-income and middle-income countries: Mapping the evidence. BMJ Global Health, 4(4), e001421. https://doi.org/10.1136/bmjgh-2019-001421

Yunusa, U., Garba, S. N., Umar, A. B., Idris, S. H., Bello, U. L., Abdulrashid, I., & Mohammed, J. (2021). Mobile phone reminders for enhancing uptake, completeness and timeliness of routine childhood immunization in low and middle income countries: A systematic review and meta-analysis. Vaccine, 39(2), 209–221. https://doi.org/10.1016/j.vaccine.2020.11.043

Zaidman, E. A., Scott, K. M., Hahn, D., Bennett, P., & Caldwell, P. H. Y. (2023). Impact of parental health literacy on the health outcomes of children with chronic disease globally: A systematic review. Journal of Paediatrics and Child Health, 59(1), 12–31. https://doi.org/10.1111/jpc.16297

Zhang, Y., Li, M., Jiang, H., Shi, H., Xu, B., Atkins, S., & Qian, X. (2019). Development and validation of a Chinese parental health literacy questionnaire for caregivers of children 0 to 3 years old. BMC Pediatrics, 19(1), 293. https://doi.org/10.1186/s12887-019-1670-9