Revisiting Strategies: A Hybrid Study on the Effective Implementation of the Electronic Community Health Information System for Enhanced Data Quality and Service Provision

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Abstract

Background: Implementing an Electronic Community Health Information System (eCHIS) is a high-priority initiative of the Ethiopian Ministry of Health (MOH). Beyond serving as data capturing and reporting tool, it acts as a job aid for Health Extension Workers (HEWs) and enhances the provision of health services at the community level. However, the current implementation process is causing delays in household profiling, and the service provision through eCHIS is limited. This implementation research was planned to evaluate the effectiveness of eCHIS implementation strategies, skill-oriented training, and regular mentorshipof HEWs.

Methods: A hybrid study design, evaluating the effectiveness of both intervention and implementation strategies, was applied in a phase-based and iterative approach from January, 2021- December, 2022. Fourteen health posts from 2 woredas, Dangla zuria and Welmera, were included in the study, with all HEWs in the selected health posts as the target populations. Four rounds of survey- baseline and three rounds of mentorship- were conducted to measure changes over time. Consequently, the analysis was focused on the changes in output and outcome indicators.

Results: After implementation of the selected strategies, HEWs skill in App initialization, managing the digital family folder, using the reproductive, maternal, newborn and child health (RMNCH) module, referral and communication, and utilizing eCHIS app were significantly improved. Significant improvement ($P<0.001$) were also observed in all indicators of service provision scores, including ANC packages (from 44% to 56.8%), ANC counseling score (from 37% to 59.6%), PNC counseling score from (36% to 47.9%) and ANC service quality score (from 38% to 58.2%) Completeness of data elements at health posts significantly improved whencomparing endline with baseline data. The average lag time, for all forms, form completion on the HEWs tablets to submission to eCHIS server reduced from 11.5 days at baseline to 4.1 daysat the end of the follow up period (last round of survey). Among the reasons for incompleteness, "not understanding data elements" was the most significant. Both over and under- reporting weremajor data accuracy issues.

Conclusion: Implementation of eCHIS showed significant improvement in service provision and data quality. Combining skill-oriented training and regular mentorship for HEWs proves to be effective eCHIS implementation strategies. [*Ethiop. J. Health Dev.* 2024; 38(SI-2)]

Key words: Health extension workers (HEWs), eCHIS, skill-oriented training, mentorship,implementation research.

Contribution to the literature

- This implementation research provides s new insights for public health practitioners, healthinformation experts and policy- makers to use better strategies to resolve eCHIS implementation challenges.
- Training alone cannot bring the desired changes or address eCHIS implementation challenges; at least three rounds of mentorship are needed to consolidate the skills of HEWs.
- eCHIS requires an enabling environment, including infrastructure and strong leadership, toeffectively plan and monitor the implementation.

Reporting standards

We followed the Standards for Reporting Implementation Studies (StaRI) checklist to clarify the details of the intervention and implementation strategies, methodologies, and evaluation of effectiveness.

Introduction

The Ethiopian health extension program (HEP) is a successful initiative that has provided community based preventive and curative services to the public for more than two decades (1, 2). Currently, more than 42,000 government-salaried female HEWs are deployed across the country. HEWs map households, prioritize community health problems, and draft action plans. They provide key health services through static, health posts, and outreach activities (3, 4). Recently, Ethiopia developed

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„HEP Optimization Roadmap 2020-2035" to serve as a major strategy for achieving Universal Health Coverage (UHC) in the country (5). However, evidences indicate that there are several implementation challenges persist, requiring innovative approaches at the grassroots level (6).

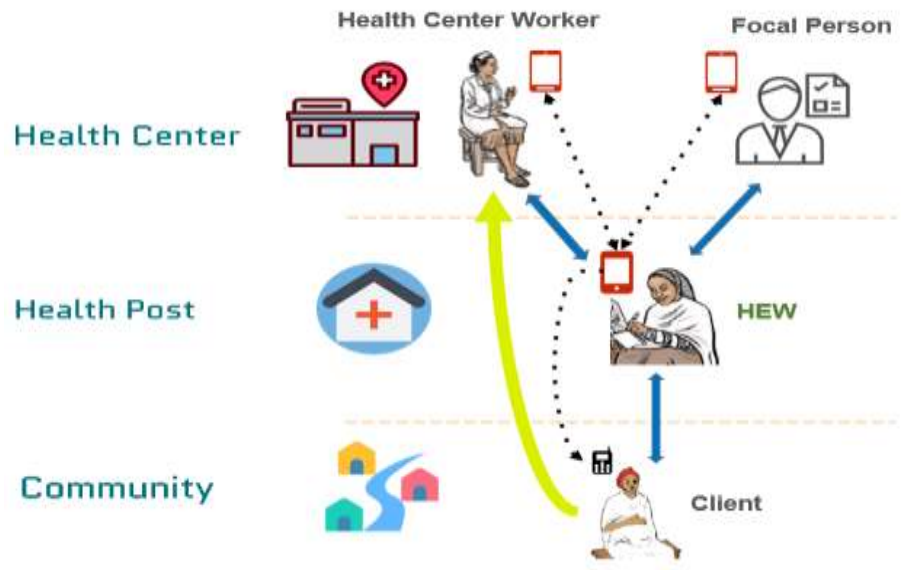
To meet the information needs of the HEWs for achieving their objectives, the Ministry of Health (MOH) designed and implemented the Community Health Information System (CHIS). CHIS is a part of the Health Management Information (HMIS) and serves as a family-centered health information system that enables for HEWs to manage and monitor their work in educating households and delivering an integrated package of health services to families (7). The family folder, a comprehensive data collection and documentation tool centered on family health, is the centerpiece of CHIS (8).

Since 2016, the Electronic Community Health Information System (eCHIS) has been a high-priority initiative of the Information Revolution, demonstrating the Ministry of Health (MOH) intentions to further utilize technology and data to achieve the goal of universal coverage of primary health care in Ethiopia. The country has taken lessons in operationalizing digital tools to optimize HEWs" functioning for Covid-19 tasks and other essential health services (9) and drawing insights from countries with similar contexts, such as India (10).

The eCHIS digitizes family folders and other CHIS contents into a mobile platform for use by HEWs as a job aid throughout the country. Implementing eCHIS can achieve several objectives, including automating reporting, monitoring, and performance analysis, and while enhancing efficiency in service delivery and referral linkage. This allows HEWs, their supervisors, health managers, and other healthcare providers to easily review household and individual data to deliver tailored services (11).

The eCHIS mobile application suite consists of three mobile applications. The first is the primary application designed for HEWs, The application supporting them in family folder (pouch) management, service delivery, and follow-up. Each HEW has its own device with this mobile application. The second application is designed for health center Outpatient Department (OPD) workers, enabling them to accept referrals from HEWs and provide referral feedback to HEWs. The Health center personnel are expected to use shared devices. This application is not intended to serve as a real-time service delivery job aid. The third application is the focal person application, designed for Health Extension Program (HEP) focal persons who support and supervise Health Extension Workers (HEWs) from the health center or Primary Health Care Unit (PHCU). This application aims to assist HEP focal persons in following standard checklists when supervising HEWs at their health post (Fig 1).

Figure 1: **The electronic community health information system (eCHIS) application system**



The Ministry of Health (MOH) continued executing the eCHIS project, focusing on product development, landscaping, piloting, and capacity development and scaling up. Development of several eCHIS modules has been completed, but only selected ones- the Release-1 of eCHIS which includes the Digital family folder, Antenatal (ANC), Postnatal Care (PNC), Expanded Program on Immunization (EPI), and Family planning- are being considered due to resource limitations.

Starting from 2022, progress of eCHIS implementation has been monitored using three indicators: Number of Health Posts (HPs) that began household registration, the number of HPs that registered more than 85% of their catchment population, and the number of households that started service provision using eCHIS app. According to these indicators, the implementation of eCHIS has made significant progress over the past few years. By the end of 2022, a total 7,806 HP

(43% of 17,903 eligible HPs) had begun household registration, 1,743HPs registered more than 85% of their catchment population, and 2,220 HPs had started capturing the services provided using eCHIS app (12).

In this course, it was learned that eCHIS has a significant potential to improve in community health service provision and subsequent outcome. However, it needs to be properly managed, scaled-up, owned, and utilized to realize its full potential and ensure sustainability. For example, the Health Extension Workers (HEWs) took more than six months to complete household registration, and the service provisions recorded through the application are very limited, even in the health posts that perform best in household registration. Overall, the usage of the application as a job aid and for reporting is limited. The implementation also suffers from lack of uniformity in implementation approach among regions. Such challenges related to variations in the way the community structures , the operationalization of HEW‟s, the readiness of infrastructure, the level of support required, and other parameters, has been observed elsewhere (13-15).

This study was designed to identify and evaluate suitable implementation strategies for the effective use of eCHIS to support Health Extension Workers (HEWs) as job aid and improve service quality. This manuscript summarizes the effectiveness of selected strategies, including skill-oriented training and regular mentorship of HEWs for eCHIS implementation. Additionally another linked manuscript focused on the factors affecting implementation of eCHIS was prepared as part of the study's outputs.

Methods

Study design and period

A hybrid study design, evaluating the effectiveness of both intervention and implementation strategies, was applied in a phase-based and iterative approach. In the first phase, a baseline survey and situational analysis were conducted to identify technological and implementation gaps. Phase-two focused on understanding the details of implementation barriers and facilitators, as well as identifying key implementation strategies; the Consolidated Framework for Implementation Research (CFIR) was utilized for this purpose.

The third phase involved the implementation of the intervention (eCHIS) using strategies identified based on evidence gathered in the first and second phases. In the final evaluation phase, implementation outcomes were measured using output and outcome indicators which uses RE-AIM framework. Four rounds of survey (baseline and after three rounds of mentorship) were conducted to measure changes over time (Figure 2). The baseline and endline survey data were compared to evaluate effectiveness of the eCHIS and the strategies using output and outcome indicators outlined below data analysis section. The study period spanned from January, 2021to December, 2022.

Figure 2**: Study and implementation framework**

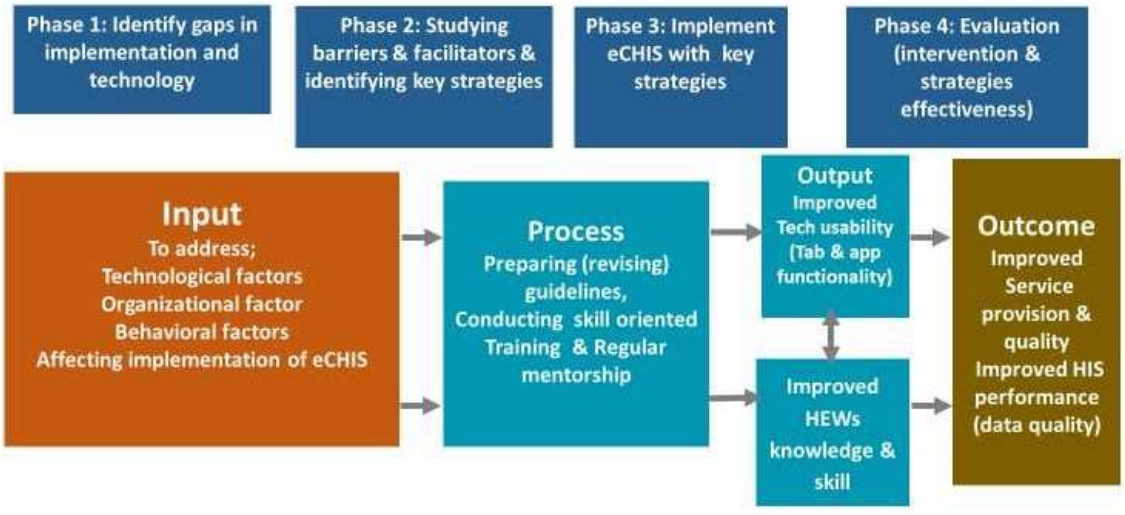


Figure 2: Study and Implementation Framework

Study setting and target population

Two woredas, Dangla zuria from the Amhara region and Welmera woreda from Oromia region along with 14 health posts (seven from each woreda) served as the study sites. Considering cost implications, the study was conducted in only these two woredas of the big regions to understand the implementation challenges as a learning site. The target populations included all Health Extension Workers (HEWs) in the selected health posts, with nearly all HEWs possessing their own tablet.

Selected Implementation Strategies

Analysis of the barriers and facilitators, along with a review of the pilot work, indicated that the key

bottlenecks for implementing eCHIS were skill and knowledge gaps of HEWs. Accordingly, skill-oriented training and regular mentorship of HEWs were identified as key implementation strategies to enhance eCHIS technology usability, improve service provision and ensure data quality. In this study, our focus is on household profiling, service delivery and communication aspects of eCHIS.

The training manual has been revised with significant improvements in quality and coverage. Similarly, a mentorship manual has been prepared to consolidate the skills of HEWs in household profiling and service delivery using eCHIS. (table 1)

Table 1: **Major issues addressed in the guideline contents of the key implementation strategies**

Key implementation strategies	
Skill oriented training	**Quality** • Revised training days to 7 days • Provided by public health professionals and Health information technicians who have previous expertise supporting HEWs • Added practical scenarios to the training • Good quality internet connection for training • Pre and Post test • Cascade approach - Woreda Provide TOT to HC and HC cascade the training to HEWs **Coverage** • All HEWs • HC team (HEP focal, MCH coordinator, HIT, & HC head), • Woreda (HEP focal, Woreda Health Office Head, MCH coordinator, Plan head, HIT) • Resolving application and user configuration issues immediately after training • Tablet (Android) Troubleshooting training • Tablet (Smart phone) management training
Regular Mentorship	• Three rounds of mentorship (monthly for 3 months) • Used local mentors from Health center • Mentorship check lists prepared to cover the following areas ✓ Manual CHIS, eCHIS tablet use ✓ eCHIS app use ✓ HH profiling and service provision using eCHIS ✓ eCHIS data quality assurance & data use • In average about 75% of the mentorship checklists are applied by mentors

Data collection tools and procedures

A checklist adapted from Community Performance of Routine Information System Management (CPRISM) assessment tools was used for the four rounds of quantitative data collection. Overall, the tool includes questions about the background information of health posts and health extension workers (HEWs), as well as their knowledge, practices, and heath service provision by HEWS and data observation checklists for service provision by HEWs and data quality assessments. An assessment tool was developed to monitor whether mentors are adhered the guideline or not. In this study, the average adherence was approximately 75%, Indicating that 75% of the mentorship checklists were applied by mentors. A qualitative data collection guide (discussed in another article) was also prepared to identify determinants using the Consolidated Framework for Implementation Research (CFIR). Both document review and interview with 32 key informants- from Health post (HEWs) to the Ministry of Health (MOH) level-were conducted. The five dimensions of CFIR, including intervention characteristics, outer setting, inner setting, characteristics of individuals, and process, were assessed.

After preparation of the data collection tools, a five-day training session was conducted, along with a pretest of the programed questionnaires using tablets. Data collection carried out usingSurvey CTO application, which provides real time data and reduce potential errors that could occur during data entry by data clerks.

Data analysis

Data analysis was based on changes in output and outcome indicators to evaluate the effectiveness of the intervention as well as the implementation strategies. In all statistical tests, p-value <0.05 was considered significance for accepting or rejecting the null hypothesis.

Calculating changes in key output/outcome indicators (scores)

1. eCHIS usability

HEWs were asked to perform (demonstrate) selected representative tasks from different modules to measure their skills of using eCHIS. Accordingly, there were five composite indicators computed from list of performance measures; 1) App initialization score (five items, 2) family folder management score (14 items, 3) RMNCH service registration score (12 items, 4) HEWs knowledge on referral and communication score (four items, and 5) eCHIS app usage score (fouritems).

2. Service provision and quality

Four indicators were computed based on 100 points; 1) ANC assessment score-10 service components (danger signs, weight, MUAC, temperature, BP, pulse, pallor, fundal height, etc.), 2)ANC counseling score (15 service components, 3) ANC quality score (25 service components, 4) PNC counseling score (10 service components).

3. Data quality

Data quality was evaluated based on the completeness of data elements in the source document, data accuracy and lag time.

Completeness of data elements was measured for seven indicators (household registration, member registration, household properties, HEP package, ANC, PNC, and FP). Data elements were considered complete if it they reached 90% or above from the total samples (total = number of *selected cards or folders* x *data elements*). This was assessed for the reporting month of May 2021 (Ginbot 2014) 2021 at baseline and for the three reporting months of September, October and November 2022 (Meskerem, Tikimt and Hidar 2015) at the end line (table 2)

Table 2: **Indicators and data elements used for calculation of source document completeness**

Indicators	**Required data elements**
Family folder	'Gote', HH number, Date copied on revised Family Folder, Name of head of the family, Father name, Grandfather name
Household member	Individual ID, Name, Sex, Date of Birth/Age
Household property	Latrine availability, waste disposal availability, drinking water source, LLITN availability
HEP package	Food and water hygiene, Solid and liquid waste management & disposal, Maternal and neonatal health, Child health, Family planning, Immunization
Pregnancy information completeness	Date of visit, Gravidity, Parity, LMP, IFA, Danger sign
PNC information completeness	Place of delivery, Date of visit, Place of PNC, Counseling on BF
Family planning	Name, Individual ID, New/repeat, Age, LMP, method/amount, next visit appointment

Data accuracy was evaluated based on the verification factor, which measures numerical consistency between the paper CHIS report and the data reported in the central data base (DHIS2). According to Ministry of Health (MOH), the acceptable range is +/- 10% (from 90% - 110%). Reporting is considered over-reporting if it is below 90% and under-reporting if it exceeds 110%. Paper CHIS report is the sum of *Tally & field book records.* Three indicators (FP, Penta 3 and Measles) were assessed for the reporting months of September, October & November 2022 (Meskerem, Tikmt & Hidar 2015).

Lag time refers to the time required between completing the form on the HEWs tablets and its submission to the eCHIS server.

Results

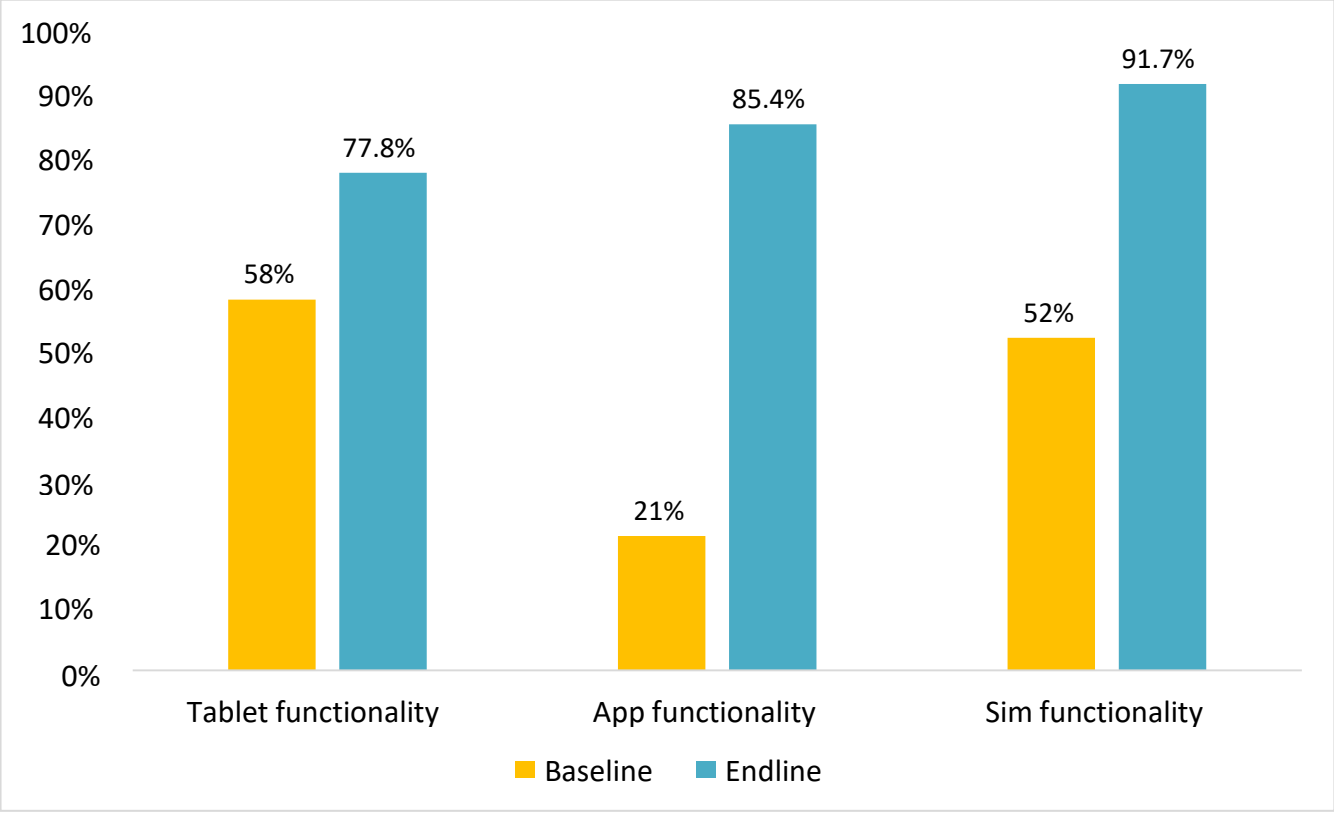
HEWs Background Characteristics

The Majority (75%) of Health Extension Workers (HEWs) were Level IV (equivalent to bachelor's degree) and most (79%) of them live in the nearby towns. Except one HEW, all received training on eCHIS. More than 90% have their own tablets with most (73%) of the tablets were Lenovo, while the rest were Huawei.

Tablet and application functionality scores

The change in the composite scores for tablet functionality (58 to 77.8%), app functionality (21 to 85.4%) and SIM functionality (52 to 91.7%), indicate significant improvement ($p<0.01$) when comparing the pre and post intervention results (Figure 3).

Figure 3: **Tablet and application functionality scores of tablets owned by Health Extension Workers; baseline compared with endline, 2022.**



eCHIS Software Usability

The five composite indicators measuring HEW"s skill in eCHIS usability showed significant improvement ($p<0.001$) when assessed and compared across the three rounds of mentorship and baseline data. The changes from baseline to third mentorship were as follows: 72% to 100% for App initialization, 69% to 100% for managing the digital family folder, 62% to 100% for the RMNCH module, 43% to 100% for referral & communication, and 15% to 48% for eCHIS App usage (Table 3).

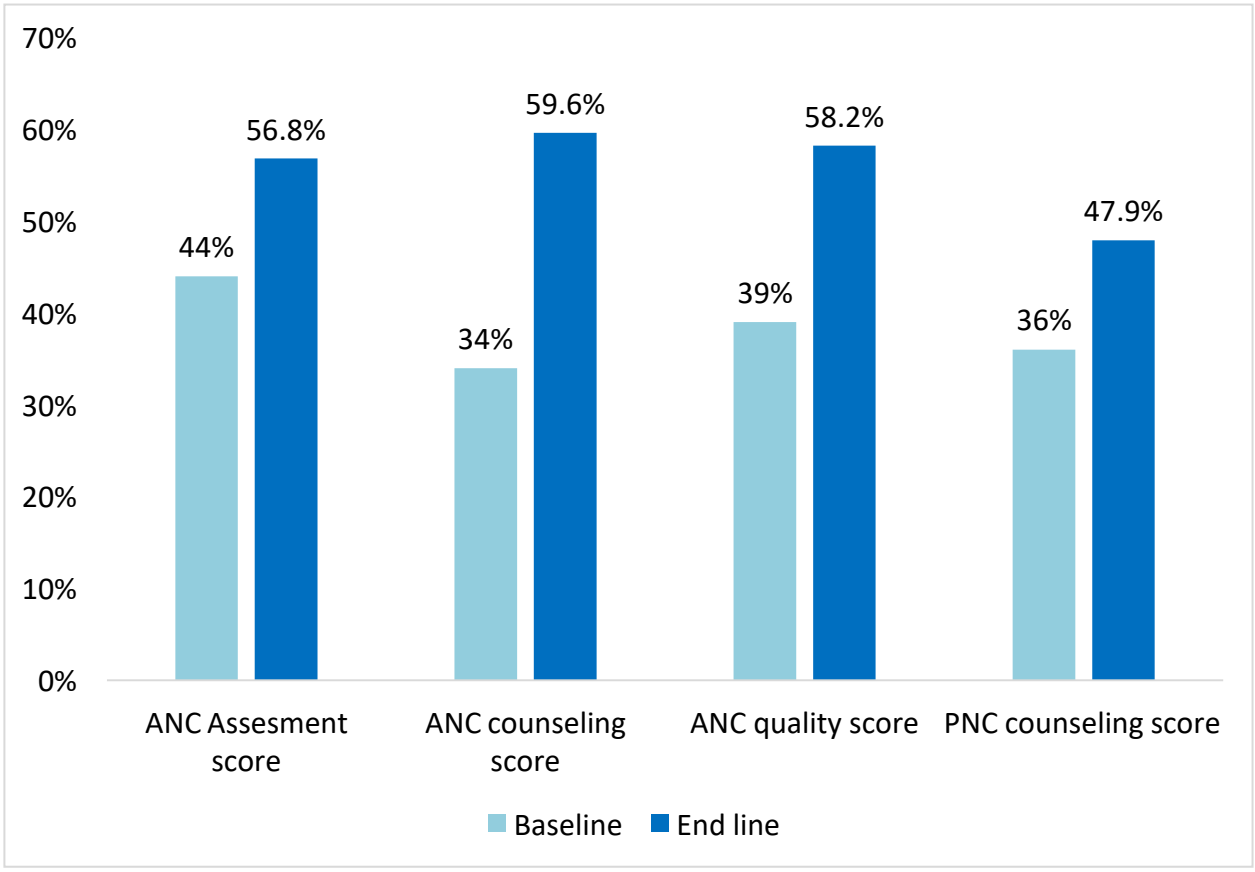
Table 3: **Health extension worker (HEW) skill score at baseline and after different rounds of mentorships, 2022.**

Skill score	Baseline	After 1st mentorship	After 2nd mentorship	After 3rd mentorship	Significant test
App Initialization	72%	96%	100%	100%	P<0.000
Digital Family folder	69%	89%	100%	100%	P<0.000
RMNCH module	62%	76%	99%	100%	P<0.000
Referral & Communication	43%	82%	98%	100%	P<0.000
eCHIS app usage	15%	44%	51%	48%	P<0.000

Service provision and quality

The indicators of HEW"s service provision and service quality showed significant improvements after the mentorship intervention (p<0.0001). Service provision scores, including ANC packages (from 44% to 56.8%), ANC counseling score (from 37% to 59.6%), PNC counseling score from 36% to 47.9%) and ANC service quality score (from 38% to 58.2%) exhibited these changes when comparing endline data with baseline data (Figure 4).

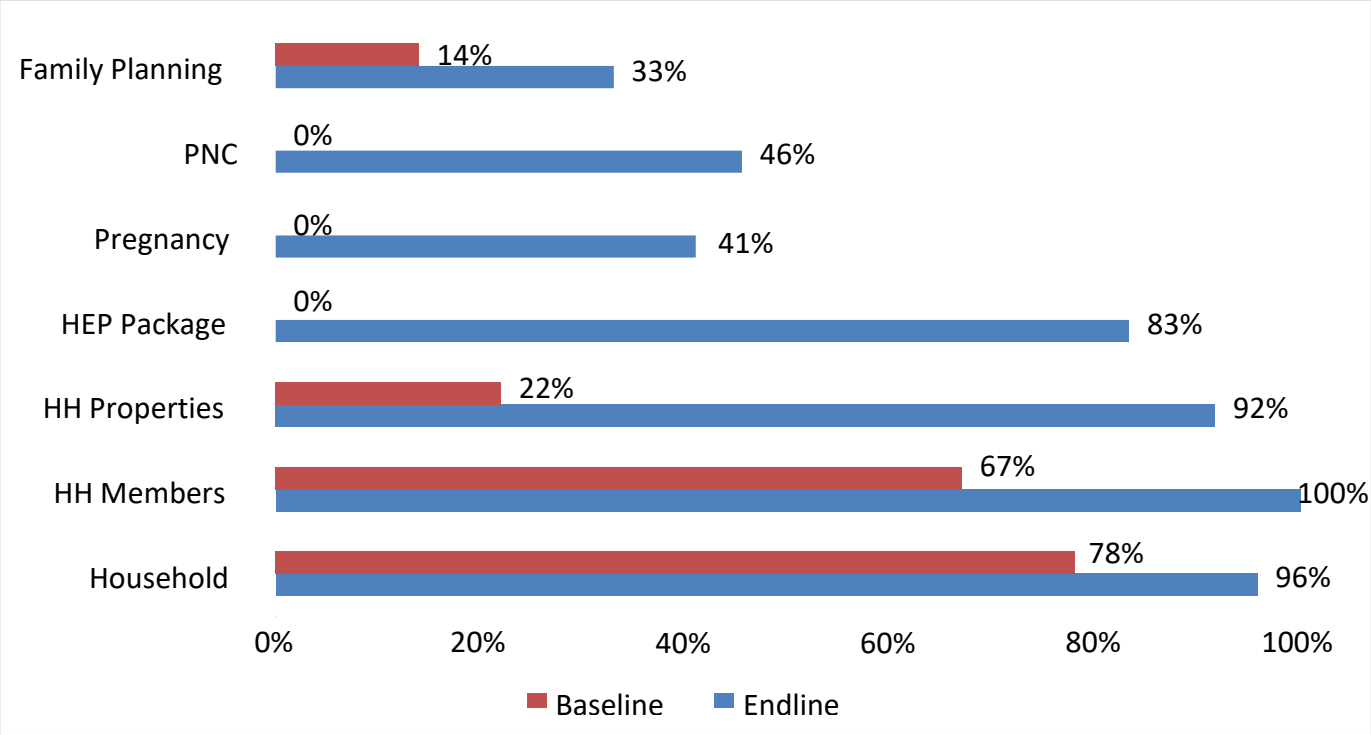
Figure 4: **Health extension workers (HEW"s) service provision and service quality; baseline compared with endline, 2022.**



Data quality: Completeness of data elements

The completeness of data elements significantly improved (p<0.01) across all seven indicators (HH registration, member registration, HH properties, HEP package, ANC, PNC, and FP) when comparing endline with baseline data. As indicated on the graph, data for some indicators is zero at baseline due to the recent initiation of services in the health posts (ANC, ANC) or the lack of registration of provided services (Figure 5). Among the reasons for incompleteness, "not understanding data elements" was the main issue.

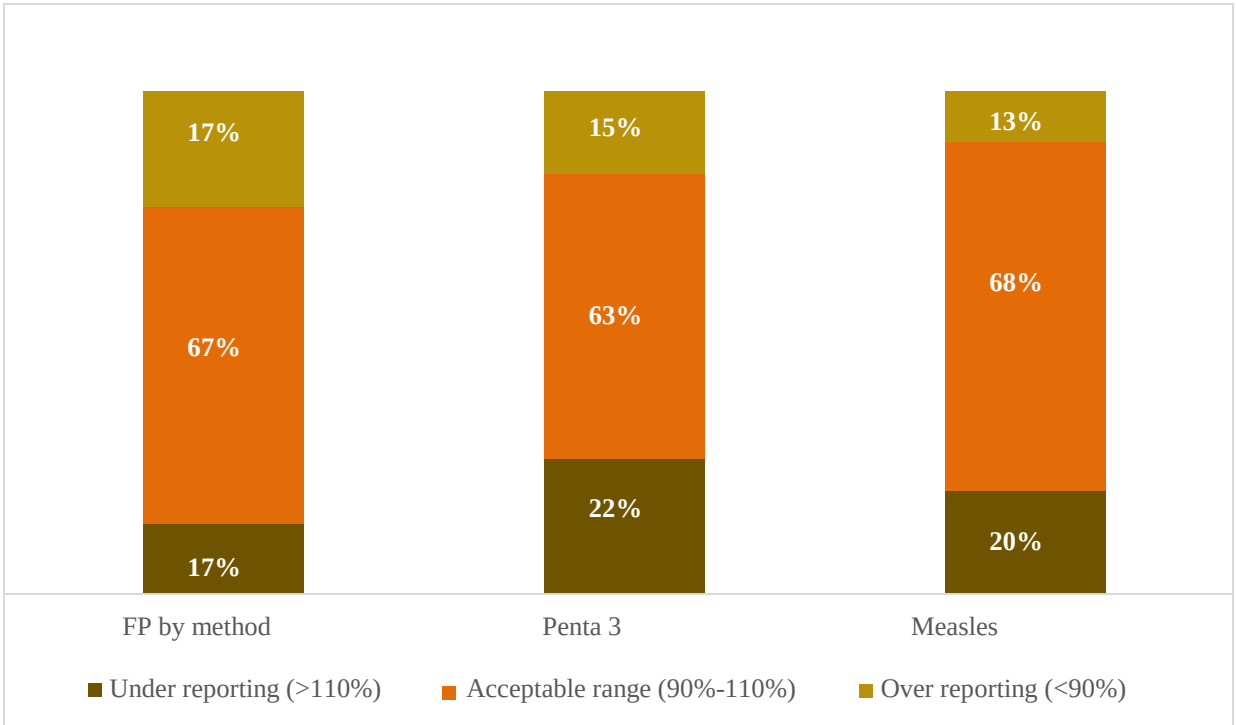
Figure 5: **Completeness of data elements at health posts according to selected indicators, 2022.**



Data quality: Reporting accuracy

The numerical consistency between the paper CHIS report and DHIS2 was assessed using three indicators (Family Planning, Penta 3, and Measles) for the reporting months of September, October & November 2022 (Meskerem , Tikmt & Hidar 2015). The results indicated that both over-reporting and under- reporting are significant problems (Figure 6).

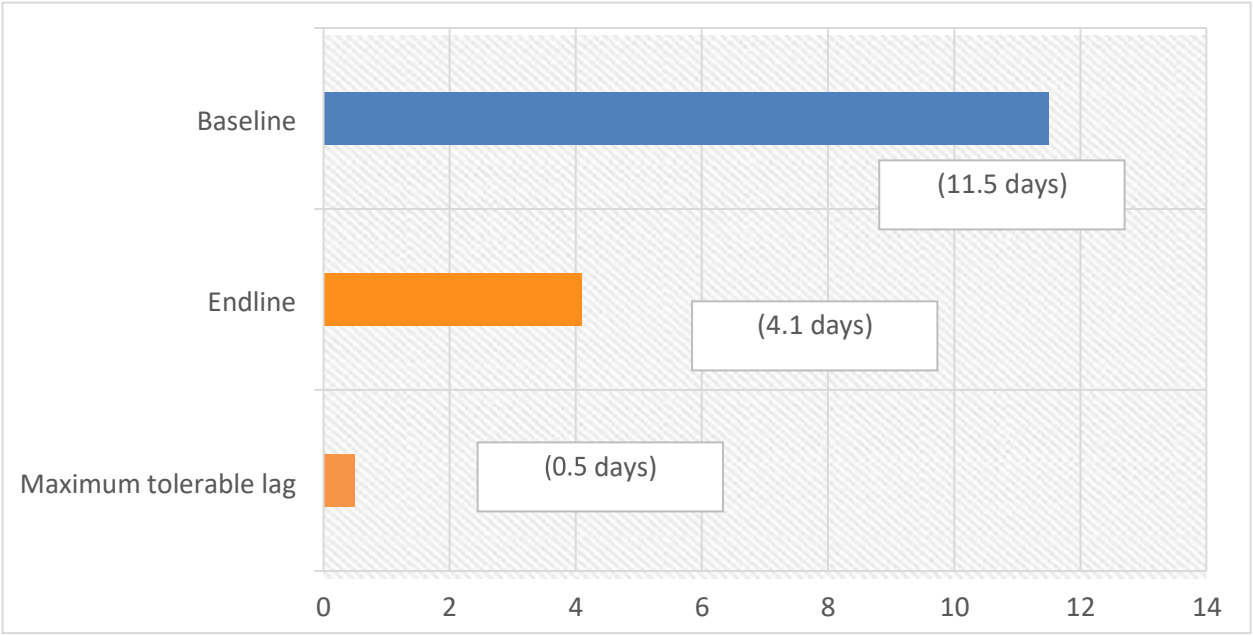
Figure 6: **Level of reporting accuracy in the endline survey using selected indicators at the study health posts, 2022.**



Lag time between form completion to submission to eCHIS server

The average lag time for all forms, form completion on the HEWs tablet to submission to eCHIS server, has improved significantly, Decreasing d from 11.5 days at baseline to 4.1 days by the end of the follow- up period (last round of survey). The recommended lag time is 0.5 days (Figure 7).

Figure 7**: The lag time between form completions to the submission to eCHIS server at baseline compared with endline and recommended time, 2022.**



Discussion

This implementation research demonstrated how the use of technology enhances HEW‟s functions and improves service provision and quality. The study provided an excellent opportunity to understand the specific implementation challenges of eCHIS and to identify key strategies for addressing them. Throughout the study process, the research team learned how implementation challenges were resolved at different stages and how the progressive changes were monitored.

The significant improvements in all the five eCHIS usability composite indicators indicate that the knowledge and skills of HEWs can be effectively developed through a combination of skill- oriented training and multiple rounds of mentorship. Lack of digital skills among health professionals is the major challenge when utilizing digital health solutions for service delivery in developing countries, including Ethiopia (13, 16). This digital skill gap is particularly pronounced among Community Health Workers (CHWs) with lower educational backgrounds (17). Building the capacity of HEWs to use digital tools like eCHIS for service provision should be a top priority before scaling up of the initiative more broadly (18). Enabling conditions, such as functional tablets/Android mobile, infrastructure (internet connectivity, power sources), and technical and leadership support, are also critical to the successful implementation of eCHIS. Similar eHealth challenges have been observed elsewhere (9, 15).

Another key finding of this study was the significant improvements of HEW‟s service provision and service quality. The role of eHealth in support Community Health Workers (CHWs) and enhancing service provision and service quality has been reported in several studies in developing countries (9-11, 13, 19). The finding suggests that eCHIS is effectively serving as a job aid for HEW‟s to provide essential services such as Antenatal Care (ANC) and PostnatalCare (PNC).

The contribution of eCHIS to improve data quality, particularly the completeness of source documents, was also a major finding of this study. The completeness of data elements across seven indicators including HH registration, member registration, HH properties, HEP package, ANC, PNC, and FP showed significant improvement. However, data accuracy measures using three indicators (family planning, pentavalent-3 and measles vaccine) indicated that both over reporting (13-17%) and under reporting (17-22%) are high. Previous studies indicated the qualityof data and the use of routine health information by health workers and health managers are low (20-22). A systematic review of literature suggested that technology improvements can increase the quality and use of data. Combinations of technological improvements, capacity building activities, and data quality assessment and feedback system were recommended to enhance data quality (23). It is believed that the observed changes in this study resulted from the implementation of eCHIS and the selected strategies.

Implementing eCHIS also helped HEW‟s facilitate referral system and communication. Strengthening referral system and communication is essential for saving lives and ensuring quality and a continuity of care (24). In this study, the knowledge and skill of HEWs regarding referral and communication significantly improved (increased from 43% to 100%). Additionally, the average lag time (*time from eCHIS form completion to submission)* was significantly reduced from 11.5 to 4.1 days. The reduction in lag time ensures timely data reporting as well as prompt referral communication to health centers. eCHIS has a relative advantage over paper-based CHIS due to its quick communication and client referral capabilities, along with benefits such as reducing workload, facilitating standardized service, and promoting data quality.

The findings of this study should be interpreted by consideration of the following limitations. First, the study sites which are agrarian may not represent different contexts like pastoral and urban settings. Second, due to resource and time constraints, the follow-up period included only three rounds of mentorship, which does not provide insight into how the frequency of further mentorships can be planned. Third, for most composite indices, calculations were based on series of questions with binary outcomes. These questions typically assigned equal weight, with "0" for "No/absent" responses and "1" for "Yes/present" responses. This equal weighting may not accurately reflect the contributions of certain measurements.

Conclusions and key lessons

Implementation of eCHIS, utilizing selected strategies, such as skill-oriented training and regular mentorship of HEWs, demonstrated significant improvements in eCHIS usability skills. This strategy helped HEWs enhance service provision and quality, in delivering essential components of ANC and PNC. The impact on data quality, particularly regarding the completeness of source documents, was also significant. Overall, the selected strategies proved effective for implementing eCHIS.

One of the key lessons is that only training cannot bring about the desired change. The training also requires careful planning to achieve the anticipated knowledge and skills needed to use the technology effectively. At least three rounds of mentorship are needed to consolidate skills of HEWs. Finally, further investigations are recommended to understand the issues of under and over- reporting and how eCHIS incorporates data from field books.

List of Abbreviations

ANC: Antenatal care
CHIS: Community Health Information System
eCHIS: electronic Community Health Information System
EPI: Expanded Program on Immunization
HC: Health Center
HEP: Health Extension Program
HEW: Health Extension WorkerHH: Household
HIT: Health Information Technician
HP: Health Post
IFA: Iron with Folic Acid
LLITN: Long Lasting Insecticide Treated Net
LMP: Last Menstrual Period
MCH: Maternal and Child Health
MOH: Ministry of Health
OPD: Out Patient Department
PHCU: Primary Health Care Unit
PNC: Postnatal careTOT: Training of Trainers

Declarations

Ethics approval and consent to participate

Ethical clearance was obtained from the Institutional Review Board (IRB) of Ethiopia Midwives Association (EMwA) with protocol number EMwA-IRB-SOP/015/02.0. Support letters were also received from the Ministry of Health (MOH) and Regional Health Bureaus. Informed consent and permission for interviews were obtained from all key informants prior to the interviews. All the required ethical procedures were carried out in accordance with ethicalguidelines and regulations.

Consent for publication: Not applicable.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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