Lessons and Implementation Challenges of Community Health Information System in LMICs: A Scoping Review of Literature

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Abstract

Background: Accurate and timely information on health intervention coverage, quality, and equity is the foundation of public health practice. To achieve this, countries have made efforts to improve the quality and availability of community health data by implementing the community health information system that is used to collect data in the field generated by community health workers and other community-facing providers. Despite all the efforts, evidence on the current state is scant in Low Middle Income Countries (LMICs).

Objective: To summarize the available evidence on the current implementation status, lessons learned and implementation challenges of community health information system (CHIS) in LMICs.

Methods: We conducted a scoping review that included studies searched using electronic databases like Pubmed/Medline, World Health Organization (WHO) Library, Science Direct, Cochrane Library. We also searched Google and Google Scholar using different combinations of search strategies. Studies that applied any study design, data collection and analysis methods related to CHIS were included. The review included all studies published until February 30, 2022. Two authors extracted the data and resolved disagreements by discussion consulting a third author.

Results: A total of 1,552 potentially relevant articles/reports were generated from the initial search, of which 21 were considered for the final review. The review found that CHIS is implemented in various structures using various tools across different LMICs. For the CHIS implementation majority used registers, family folder/card, mobile technologies and chalk/white board. Community level information was fragmented, incomplete and in most cases flowed only one way, with a bottom-up approach. The review also indicated that, technology particularly Electronic Community Health Information System (eCHIS) and mobile applications plays a role in strengthening CHIS implementation in most LMICs. Many challenges remain for effective implementation of CHIS with unintegrated systems including existence of

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parallel recording & reporting tools. Besides, lack of resources, low technical capacity, shortage of human resource and poor Information Communication Technology (ICT) infrastructure were reported as barriers for effective implementation of CHIS in LMICs.

Conclusion: Generally, community health information system implementation in LMICs is in its early stage. There was not a universal or standard CHIS design and implementation modality across countries. There are also promising practices on digitalizing the community health information systems. Different organizational, technical, behavioural and economic barriers exist for effective implementation of CHIS. Hence, greater collaboration, coordination, and joint action are needed to address these challenges. Strong leadership, motivation, capacity building and regular feedback are also important to strengthen the CHIS in LMICs. Moreover, CHIS should be transformed in to eCHIS with integration of different technology solutions. Local ownership is also critical to the long-term sustainability of CHIS implementation.

Keywords: CHIS, Community Health Workers, HIS, LMICs, Scoping Review

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Background

A health information system (HIS) refers to a system designed to manage healthcare data. Now, the significance of HIS has become a common knowledge and it is acknowledged by all stakeholders as an essential public health tool that provides both historical and real-time data to support healthcare delivery [1]. A well-functioning HIS is an integrated effort to collect, process, report and use health information to influence policy and program decision-making [2]. The main goal of HIS in any health care organization setting is to contribute to an efficient and high quality healthcare with basic health informatics competencies [3]. Besides, it supports the health workers to organize and coordinate treatment processes, improve patient safety, enhance patient care, transfigure clinical procedures, circumvent medical errors, minimize operational expenses, save time and increase satisfaction [4-6].

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The Community Health Information System (CHIS) is a type of health information system that links all community stakeholders and healthcare providers in a given community [7]. It is a grass root and family-centered health information management system designed for community workers to manage and monitor their work in educating households and delivering an integrated package of promotive, preventive, and basic curative health service to families [8]. It has also strengthened the decision-making process at the community level by providing the data needed by each decision-maker and making the process explicit [9].

The CHIS has multiple functions in terms of generating evidence to improve program performance and inform decisions. It is essential for promoting community engagement in health, identifying people in need of services, supporting case management and care coordination, and ensuring accountability [10]. The data collected in a CHIS can be used to inform programming and policy, identify populations in need, monitor the continuum of care, and address equity, access, and accountability. When community members have access to information in a CHIS, they have the potential to define and prioritize the community's needs; set objectives and targets for meeting those needs; and participate in planning, implementing, and monitoring programs. A well-functioning CHIS can also support civil registration and vital statistics, by providing information on births and deaths.

Information technology plays an important role in the health care sector with its final goal, improving health care [11]. Delivering good quality care is a complex endeavor that is highly dependent on patient information [12]. Previously household data were collected using family cards and aggregated using tally sheets. Thus, data were not being utilized by program implementers adequately [13]. Following that, tremendous efforts were exerted globally to harness the ICT development to digitalize the CHIS. With the availability of phone and tablets, some countries have begun to move away from manual systems and digitize the data collection process at the community level. Thus, countries have collected client data using tablets and phones instead of family folders and paper recordings. Then, data were transferred to the national server that would be ready for use by program implementers, and decision-makers at different levels [14,15].

Accurate and timely information on health intervention coverage, quality, and equity is the foundation of public health practice [16]. As a result, countries have made efforts to improve the quality and availability of community health data by implementing the CHIS [13]. However, evidence showed that it has been fragmented and does not have standardized data elements, which has hampered efforts to harmonize the health systems [17]. Moreover, the implementation modality, the type of information collected, the education and certification of health workers for CHIS and the commitment of governments in the implementation of CHIS varied from place to place. Despite all the efforts, information on the current state, lessons and implementation challenges in the developing countries is scant. Therefore, this paper aimed to review the lessons learned and implementation challenges of the CHIS across LMICs.

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Objective

Our review aimed to summarize the available evidence on the current implementation status, lessons learned and implementation challenges of community health information system in low middle-income countries

Methods

Data sources and searching strategy

We searched electronic databases; Pubmed/Medline, WHO Library, Science Direct, Cochrane /Wiley Library. We also searched specific journals, including the Journal of Health Informatics in Developing Countries, International Journal of Medical Informatics, and Electronic Journal of Information Systems in Developing Countries, as well as Google and Google Scholar. The review included those papers published until February 30, 2022. We used different combinations of keywords and texts to build the search strategy and identify relevant articles. The searching techniques considered Boolean operators with the following search terms.

> *(((((((Community-based information) OR (Community health services information systems)) OR (Community-based information systems)) OR (Community based health information management system)) OR (Community based health information system)) OR (CBHI)) AND (((((((Implementation) OR (Evaluation)) OR (Status)) OR (Case study)) OR (Lessons learned)) OR (Lessons)) OR (Challenge))) AND (((((Developing countries [MeSH Terms]) OR (Developing countries)) OR (LMICs)) OR (Low Middle Income Countries))*

Studies eligibility criteria

Inclusion criteria

- Studies on community health information system (manual and electronic) in LMICs
- Reports which highlighted lessons learned or implementation challenges of CHIS in LMICs
- Studies that applied any study design, data collection and analysis methods related to CHIS
- Both published and unpublished studies/reports that focused on implementation of CHIS
- Studies/reports in English language

Exclusion criteria

- Off topic studies that do not relate to CHIS implementation
- Studies with no accessible full text

Study selection and data extraction

We performed initial searches by two review authors with extensive experience in reviews. Screening of titles, abstracts, and full texts was conducted independently by two review authors (MA & ZA). In addition, we developed a data extraction form to summarize the study findings. Data extraction and critical appraisal were carried out for each included study/report. The data extraction template included study characteristics such as: author/organization, year, country, setting/population, study design, lesson learned and identified implementation challenges. Data extraction was done by the two authors (Moges Asressie and Zeleke Abebaw) independently. The two authors resolved disagreements by discussion consulting a third author (Shegaw Mengistie) for any persistent disagreements.

Analysis and reporting

We were able to present our narrative account of findings in two ways. First, attention was given to basic analysis of the extent and distribution of the studies included in the review. We produced the distribution of geographical locations, publication years, study designs and types of publications using tables and graphs. Second the study findings from the existing literature were presented based on themes. Our narrative literature was then structured around the themes derived from the study results or outcomes. The themes emerged from the study included current status of CHIS implementation, lessons learned and implementation challenges.

Results

Flow of the searching process and study characteristics

A total of 1,552 potentially relevant studies were generated from the initial search. After, duplicates were excluded 1,298 studies were remained. Then, we excluded 1,270 records based on title and abstract review. Overall, 28 studies were eligible for full-text screening. Afterwards, 7 studies were excluded by reading the full text due to scope not directly related to CHIS (n=3), reviews (n=2), setting not in LMICs (n=2). Eventually, 21 articles were retained for the final review (Figure 1).

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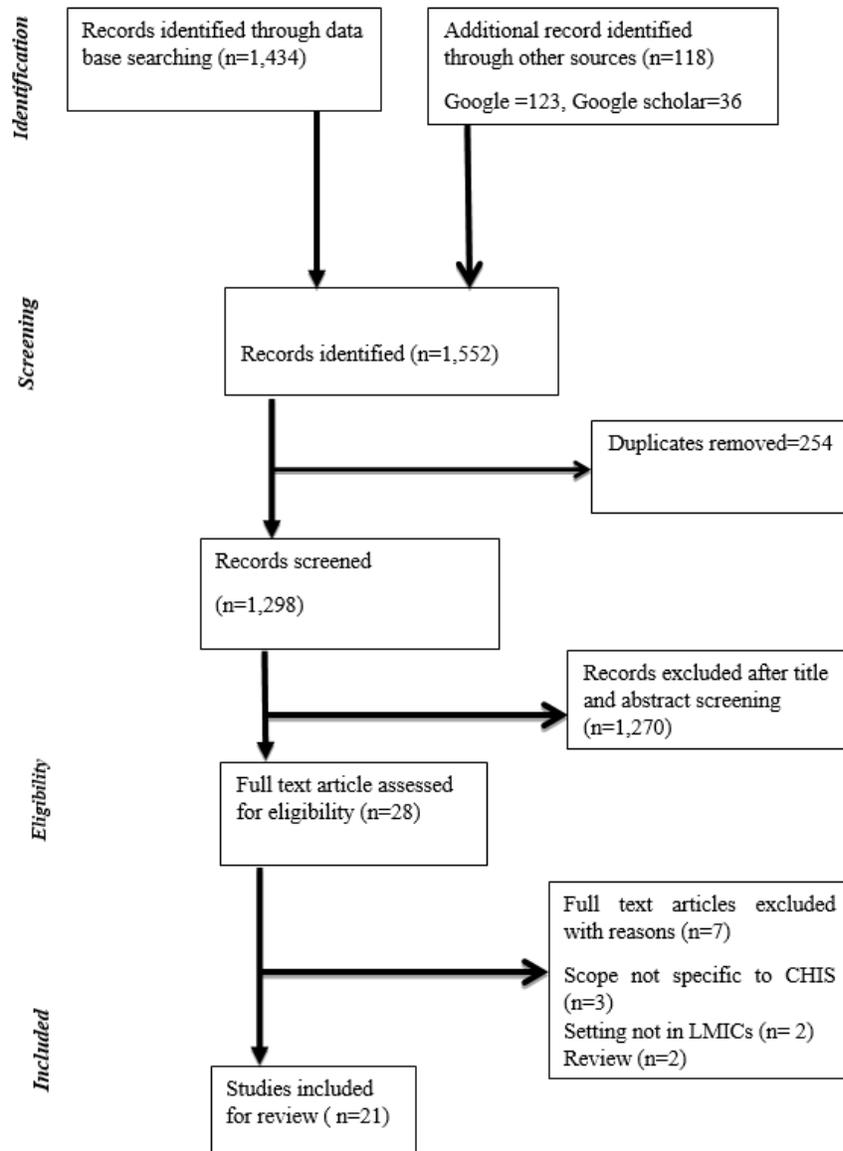
Figure 1: Flow Diagram for the scoping review process adapted from the PRISMA statement Characteristics of included studies

In this review, six studies were from Ethiopia [18] [19] [20] [21] [22] [23], two from Tanzania [24,25], six from Kenya [26] [27] [28] [29] [30] [31], one from South Africa [32], one from Rwanda [33], one from Nigeria [34], two from Zambia [35,36], one West and central Africa [37] and one from Malawi [38] (Table 1).

Table 1: Characteristics of included studies for the review

Author	Country	Year	Study	State of CHIS and lessons learnt	Challenges identified
Damtew et al	Ethiopia	2013	Qualitative case study	• Health Extension Workers (HEWs) use different data collection tools to document and report the health data • Offering extra data collection and reporting tools for HEWs, other than the family folder creating additional burden to their regular work • HEWs are spending time in collecting and reporting redundant data instead of serving the community • Absence of simple and unified data collection tools at community level	• The repetitive nature of the data registration and reporting processes to satisfy the information demand of different health partners • Problems related to data collection tools, basically manual and characterized by high fragmentation and cumbersome data elements with duplication of effort
Kare et al	Ethiopia	2013	Qualitative	• The vast majority of the Health Posts (HPs) in the region are implementing CHIS using the Family Folders • Various registers and reporting formats are still seen in many HPs • The use of tally sheet, with recording of the household number against the services provided by the HEW, is proving very valuable in assuring data quality • The eHMIS in Southern Nations, Nationalities and Peoples Region (SNNPR) has proved to be very handy in allowing the program managers to access monthly data of every individual HP	• Remoteness of some health posts with subsequent difficulty in ensuring regular supervisory visits and support • Lack of skills of HEWs on how to properly record data on Family Folders and use the CHIS • Difficult access to some health posts and the non-continuous supply of printed tally sheets • Continuation of parallel recording and reporting requirements
Godfrey et al	Zambia	2017	Pilot study	• Paper-based CHIS is not fully functional due to the challenges of sustaining availability of reporting forms and delivering completed forms to the HCs • Using mobile technology (simple-feature phones) was feasible and viable for the provision of real-time community-based health information to all levels of the health care system in Zambia • But, smartphones, laptops, or desktop computers are needed to perform data analysis and visualization	• Fragmentation and disjointed efforts to strengthen community-based health information systems • Need for ongoing technical support to troubleshoot challenges with mobile phones and software • Limited mobile network and internet connectivity • Recurring costs for data bundles and financial sustainability might be a limitation in the future

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Elizabeth etal	Malawi	2017	Process evaluative	• Use of simple wall charts by community health workers to collect and visualize data helped inform data-based decision making for community health education activities, tracking stock-outs and staffing decisions • Provision of wall charts to community and facility workers to organize and view monthly data leads to more data-based decision making	• Continued use of the wall charts will require additional investments in supervision and reinforcement • Turnover may limit the potential effect of any data improvement program
Scott et al	West and Central Africa	2019	Cross sectional	• The development and implementation of a CHIS is still largely nascent • The data shows that these governments are severely under resourced to support robust community health information systems • General appetite for a government owned CHIS that reflects all community data integrated in to the national HMIS is strong	• Countries face significant budget limitations to the development, deploy, and sustain a CHIS • CHIS governance and system design problems • Still major limitations exist in engaging with community stakeholders themselves in CHIS development
Kalle Et al	Ethiopia	2020	Cross sectional	• The records kept at the health post in rural Ethiopia are incomplete • Significant improvements could be made by making sure that Family Folder system are used at the health posts • Shifting to more efficient record keeping systems like electronic or mobile phone-based applications could result in further improvements	• Limited access to reliable electricity • Poor mobile phone network at many health posts are major barriers for scaling up
Hilina et al	Ethiopia	2017	Report	• CHIS as part of the broader HMIS was designed and implemented within the framework of the Health Extension Program • CHIS implemented via unified data collection tool called family folder • Implemented in 90% of health posts • Introduce and scale up digitizing CHIS for timely and quality data reporting	• Completeness and timeliness problems • High staff turn over • Inadequate supply of recording forms • Inadequate mentoring and supportive supervision • Low coverage of electric power supply • Poor internet connectivity for e-CHIS
George et al	Kenya	2005	Implementation science research	• The current status of CHMIS is worse than facility-based HMIS • The method of data collection for CHWs was a family or household card • This CHMIS empowered the local communities through provision	• Inadequacy of qualified and dedicated community volunteers to run the CHMIS • Lack of incentives and supervisors for community health workers and

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				of accurate and timely information • There is need to harmonize district HMIS and CHIS in order for each one of them to complement the other	• Inadequate financing • Issues of data validity, reliability, accuracy and completeness
Asangan si et al	Nigeria	2013	Implementa tion science research	• Mobile technology can facilitate the reporting of community data • Two android mobile applications were developed to supplement the ODK • The mobile data collection was easy, friendly and efficient • mHealth can reduce the complexity of community data collection • The mobile solution helped in significantly improving the information quality by ensuring consistency, completeness and timeliness of data collection	• Poor network coverage can delay data transfer • Irregular power supply • Weak local organizational capacity • Data security & privacy issues • Issues of integration with existing system
Mesaud etal	Ethiopia	2016	Process evaluation	• The implementation status of CHIS is very good • The availability of manual CHIS tools was 88.7%, compliance 92.54%, completeness 95.8% & consistency is 68.16% • 30% of the HEWs were using field book as a replacement of FF • The consistency of the data between family folder and master family index was 97.7% and between family folder and households was 80%	• In some health posts there was difference between expected and actual households registered in family folder • Parallel registration books & reports were their main burdensome in their daily recording & reporting activities
Tsedeke et al	Ethiopia	2015	Cross sectional	• Availability of CHIS training manual, tally sheets and supportive supervision had significant association with CHMIS performance • The CHMIS is good in report completeness (87.9%) content completeness of report (87.3%), calculating indicators (92.2%) and data display (95%) • But low in data accuracy (32.7%) discussions on performance (40.6%) and decisions made (24.3%) • Majority of the HP are using both Family folder and Registers 75.8% • 66.7% HEW has adequate confidence on CHMIS tasks	• The study findings show there is critical shortage of tally sheet and Integrated maternal and child health card (IMCH) • Organizational technical and behavioral determinants affect CHIS implementation • Parallel data recording tool that is creating additional burden on the HEW and also has contributed for poor data quality

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Michael Et al	Kenya	2015	Qualitative	• Designed and piloted a simple SMS-Based reporting system for the community health volunteers (CHVs) • The system improved CHVs reporting rate by 16% for 3-month period and eliminate inaccurate manual aggregation • Potential of mobile technology in enhancing CHIS process flow in low resource settings if CHVs are empowered with mobile phones • The research showed that technology offers an alternative approach that's cheaper to exclusive paper-based tools	• Challenges with data collection tools, data quality and reporting rates • Making the CHVs stick to the SMS format when many indicators are being reported • Limited GSM network connection at times was also seen as a challenge towards making the system achieve its objectives
Bimere w et al	South Africa	2019	Qualitative	• The current practices of recording patient information and processing are done manually and to a lesser degree electronic means • Client information was fragmented, incomplete and in most cases flowed only one way, with a bottom-up approach • The study demonstrated that there was poor verification of community mental health information processing and lack of feedback on mental health analyzed data to all users at mental health services level • The way forward is computer technology, to keep accurate patient recording and communicating patient information with health facilities	• Many health facilities didn't have information infrastructure for processing health information • There were challenges with validation of information • Lack of skills in collecting, processing and utilization of health information • Most health facilities have financial constraints in terms of buying computers
Nzanzu et al	Kenya	2015	Qualitative	• The community-based health information reflected on the Ministry of Health tool, the chalkboard • The study found out the need for targeted information to households by CHWs, based on evidence from registers to guide their discussions • CHWs need access to the household registers periodically to help them to determine dialogue topics during household visits • Visual display prompts joint discussions towards consensus for action	• Unavailable data collection tools • Poor information flow • Inadequate support of the CHWs by the CHCs • Lack of coordination between the CHWs and CHEWS for referrals • Decisions by communities on health actions are not always based on the chalkboard evidence as experienced by CHWs
Otieno et al	Kenya	2019	Qualitative	• Sources of data for CHIS included the CHW log-book, the household register and the assistant chief's register	• Lack of resources and harmonized tools • Weak linkages and coordination between the

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					facility and community and with other partner organizations
				• The CHWs are the wheels that drive information use at community levels • Dialogue was the main way of information utilization in the community • Clearly the use of information for planning and decision-making was not a culture among community level respondents • The information-seeking behaviour and use of information was poor	• The CHWs mentioned poor coordination between them and the CHEWs, especially in referrals. • A major challenge was the lack of knowledge on data analysis and interpretation
Kristen et al	Tanzania	2017	Landscape assessment	• CHWs collect data using household registers, stock management forms, and other simplified health management information system tools designed for the program • CHWs complete monthly reports and send them to health facility in-charges • Each level of the system is expected to share data for feedback purposes. For instance, CHWs are to share health information with communities and households during regular formal sessions	• Different CBHP documents were developed and guidance sometimes varies • CBHP implementation design reflects slight inconsistencies from earlier documents on the roles and responsibilities of some health system actors, including community groups • Often uncoordinated programs
Wanjala et al	Kenya	2016	Cross-sectional	• Community health workers are volunteers with responsibilities and accountability was not definite • Information was regularly shared during community dialogues • Most community units (95%) analyzed their data using the CHEW summaries (79.5%) and provided feedback through monthly review meetings (38.6%) using chalkboards (20.5%) • A third 14(31.7%) of the units had neither trained nor were able to analyze their data promptly	• The availability of data collection and reporting tools was inadequate • Majority of the community units did not have mechanisms for institutionalizing CHIS • The technical capacities for data management was weak • The CHIS system was not resourced, uncoordinated, lacked structured information to be shared regularly and mechanisms for sustainability.

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Kimberly et al	Rwanda	2017	Landscape assessment	• Two main cadres of volunteer community health providers operate for community health service in Rwanda • CHWs collect data using home visit registers and stock cards. • CHWs consolidate data into a monthly village paper-based reporting form • Data collected are interpreted locally and used to inform decisions	• Poor service integration and inadequate coordination between health facilities and the local community • Limited financial and geographic access to healthcare • Insufficient local human and financial resources
Mutale et al	Tanzania	2013	Pilot study	• Used simplified paper registries to collect data on community service • The Connect Project links community data collected by community health agents (CHAs) with the district and national HMIS through its aggregate data from community registers • To facilitate the health facility communication, community health agents and supervisors have been provided closed-user phone groups to communicate without incurring costs	• There are notable challenges in collecting and using community-based health information • Variation in CHA supervisor leadership qualities and motivation • Problems concerning the uniformity and proper use of the registers
Furth et al	Zambia	2012	Implementation science research	• CHIS programs tended to keep data on numbers of clients served, but not on how many visits or counseling sessions were provided to each client or on how much work each CHW was undertaking • Organizational investments in CHW programs varied among sites • Paying CHWs and providing them the information, skills and environment they require to spend the necessary time with each client will improve performance	• Data on clients served by CHWs often do not accurately reflect the workload of CHWs • Sustaining community involvement, and how to troubleshoot problems with community support of CHWs • Convincing communities to invest time or resources to support CHWs is challenging
Nzanzu et al	Kenya	2014	Cross sectional	• CHIS has been very helpful in providing information which they use in the health facility to improve quality of health care • The system enables the community to follow up on the progress of implementation of planned activities and to determine their successes • The sources of information included the chalk board, maintained by CHWs • This study revealed that utilization of data at community level remain an important pillar of community primary health care	• Lack of integration among the many parallel data collection systems and inadequate coordination • The aspect of financial commitment from the government has been a great challenge Sources of information at the grass root level are many and varied, likewise the subject matters relating to health are many

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The review comprised of five cross-sectional studies, two pilot studies, two qualitative studies, three implementation science researches, two process evaluations, two landscape assessments and one national report (Figure2).
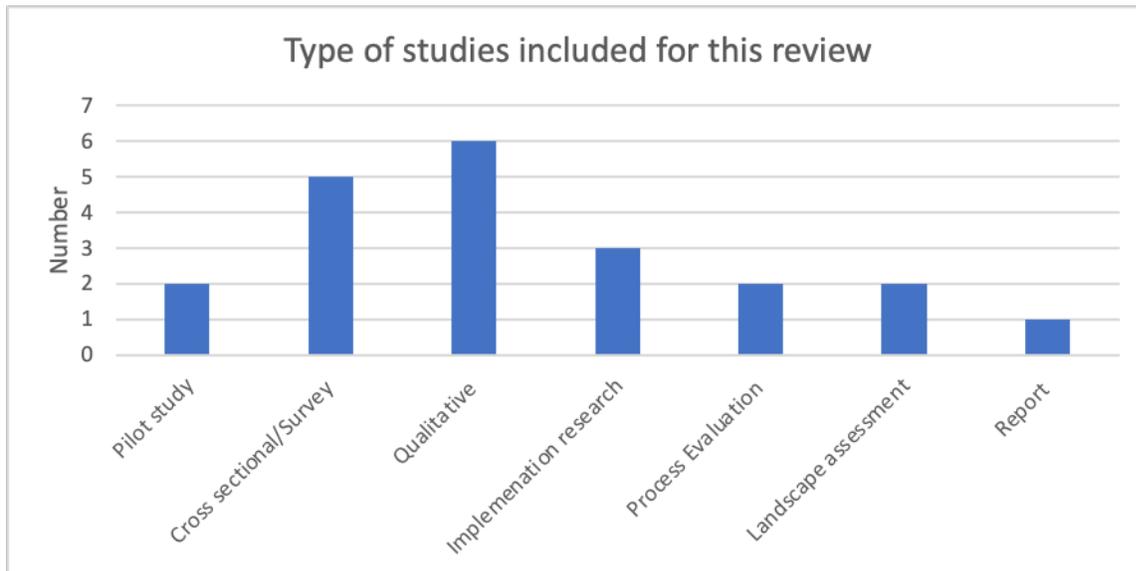
Figure 2. Types of studies included for this review

The included studies in this review were published between 2005 [26] and 2020 [23]. Among the included studies for this review most were published by the year 2017 (Figure 3).
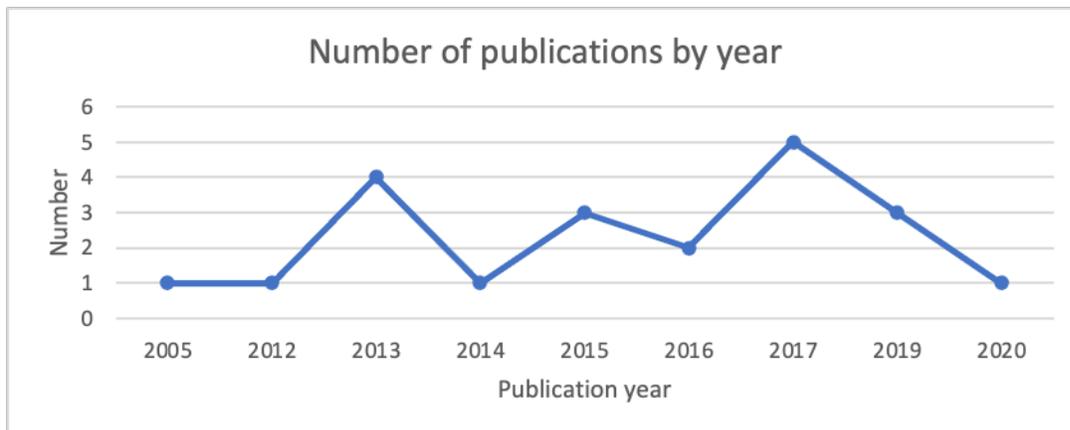
Figure. 3 Number of published studies on CHIS per year

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Implementation status of CHIS in LMICs

The review indicated that LMICs have developed community-based health services, which are delivered by community health workers in close connection to primary care facilities. According to this review, CHIS come in various structures and cover diverse health areas with different types of health workers across different countries. In LMICs, CHISs are managed by trained health extension workers, community health workers, community health agents and community volunteers who have different educational background with different duration of education & training including different certification approaches across countries. The implementation modality, the type of information collected, and the tools used for CHIS also varied from place to place. For the CHIS implementation, majority used registers, family folder/card, mobile technologies, chalk/white board and multiple data collection and reporting tools at the community level (Figure 4).
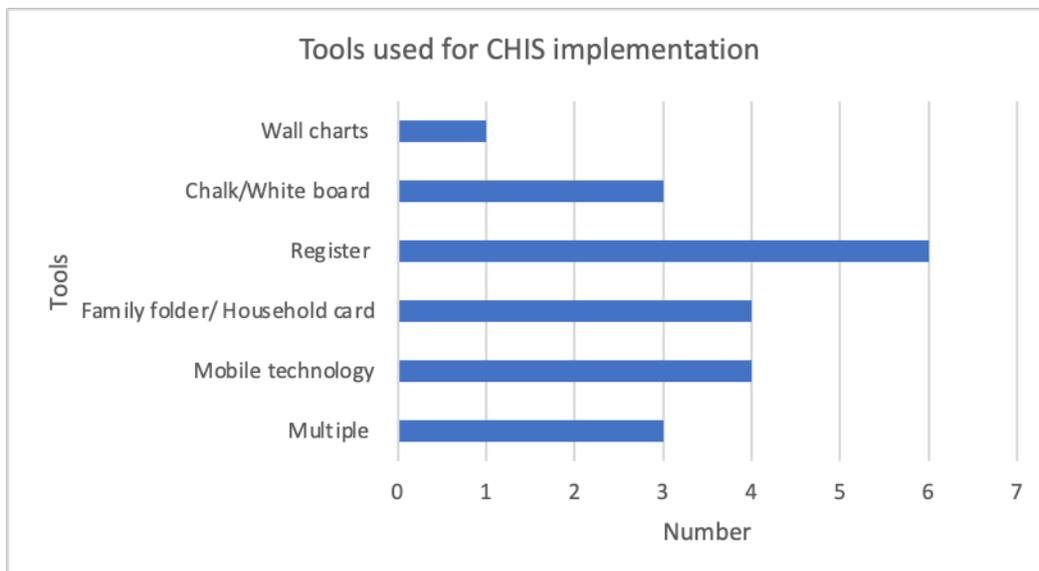
Figure 4: Types of tools used for CHIS implementation in LMICS

Most of the community information systems in LMICs were still manual and data could not be shared easily for evidence-based decision making. According to this review, the current practices of recording information and processing are done manually and to a lesser degree electronic means. Community level information was fragmented, incomplete and in most cases flowed only one way, with a bottom-up approach [19] [21] [30] [32] [39].

In Ethiopia, CHIS as part of the broader HMIS was designed and implemented within the framework of the Health Extension Program implemented via unified data collection tool called family folder [22]. A family folder is a pouch, which is the main part of CHIS, a data collection tool designed by the Federal Ministry of Health (FMoH) for the HEWs to document both individual and household level data to be utilized as a source of information at the grass root level. Alongside this, CHIS was designed to standardize data collection and integrate data systems to provide relevant information for decision-making at the health posts and to feed the

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HMIS on a regular basis. HEWs report the data they collect to the nearest health centers monthly [19] [21].

Process evaluation done in 2016 in Ethiopia also showed that the implementation status of CHIS was good. The availability of CHIS tools was 88.7%, compliance 92.54% and completeness 95.8%. The consistency of the data between family folder and master family index was 97.7% and between family folder and households was 80% [20]. Another cross-sectional study in Ethiopia showed that availability of CHMIS training manual, tally sheets and supportive supervision had significant association with CHMIS performance. The CHMIS was good in report completeness (87.9%) content completeness of report (87.3%), calculating indicators (92.2%) and data display (95%). But low in data accuracy (32.7%) discussions on performance (40.6%) and decisions made (24.3%). Majority of the HP were using both Family folder and Registers 75.8% [18].

The Connect Project, in Tanzania, links community data collected by community health agents (CHAs) with the district and national HMIS through its aggregate data from community registers. CHA supervisors at the facility level were responsible for meeting with CHAs to create action plans, and for reporting data collected by CHAs to the district level. There, a council health management team develops comprehensive council health management plans and reports to the national level [39]. Another study in Tanzania also showed that CHWs collect data using household registers, stock management forms, and other simplified health management information system tools designed for the program [24].

In Kenya the current status of CHMIS was reported as worse than facility-based HMIS. According to this study, the simplest method of data collection for CHWs and their supervisors was a family or household card [26]. In Rwanda, two main cadres of volunteer community health providers operate for community health service. CHWs collect data using home visit registers and stock cards. In the village, CHWs consolidate data into a monthly village paper-based reporting form and submit it to their cell coordinators & health center [33].

Moreover, this review demonstrated that mobile technology can facilitate the reporting of community data. The Nigeria Evidence-based Health System Initiative (NEHSI) used CommCare to connect its CHIS with the provincial and national HMIS for planning. Community field workers were given Android mobile devices, which they used to register people, automatically synchronizes and link that data to the larger information systems [34]. It was also reported that using mobile technology (simple-feature phones) was feasible and viable for the provision of real-time community-based health information to all levels of the health care system in Zambia [35]. Similarly in Kenya, a mobile technology designed with simple SMS-Based reporting system for the CHVs facilitates the reporting of community data to higher levels [27].

This review showed that use of information for evidence-based decision making and community engagement is still weak amongst this group of LMICs. Two studies from Kenya revealed that the use of information for planning and decision-making was not a culture at the community level [29] [30]. On the other hand, data-driven participatory action planning by the community and health centers helped to improve services in some settings. For example, in Kenya community health workers inform community health committees on key community health

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indicators, whereupon data collection is planned. Data collected are then fed back to the facility to identify health utilization gaps and outbreaks, and ultimately to improve services [28]. In Rwanda, data collected at the cell and sector levels are interpreted locally and used to inform decisions [33]. In Malawi use of simple wall charts by community health workers to collect and visualize data helped inform data-based decision making for community health education activities, tracking stock-outs and staffing decisions [38].

Lessons learnt from CHIS implementation

Effective community health management information systems (CHMIS) are important in low-resource countries that rely heavily on community-based health care providers. The introduction of the CHMIS was an innovative idea aimed at enriching the data and improving the collection and use of health information at community level. A study from Kenya revealed that utilization of data at community level remain an important pillar of community primary health care [28].

In LMICs, substantial progress has been made to strengthen community health information systems, with most efforts focusing on digitization, improving data quality and analysis. However, the review indicated that that continuation of parallel recording and reporting requirements with subsequent over burden on community health workers imposed by various departments and partners is threatening the sustainability of CHIS [19] [20]. In one of the studies, it was indicated that absence of simple and unified data collection tools at community level and offering extra data collection and reporting tools for HEWs, other than the family folder creates additional burden to their regular work [21]. Moreover, in two separate CHIS efforts in Ethiopia, the need for a streamlined physical system is highlighted [19] [21]. The family folders were bulky and vulnerable to damage from rain when carried from house to house, so HEWs ended up recording in registers instead and transferring the data to folders later on [21]. In the Southern Nations, Nationalities and People's Region (SNNPR) of Ethiopia, each health post generated a large amount of data, which became manually unmanageable [19].

Largely implemented by donors and NGOs, these community based tools have been observed as forming community data silos that rarely feed into the national health management information system (HMIS). Ultimately, discordant and fragmented CHW reporting systems result in little in stitutional buy-in and low community data use.There is a clear need for community-based reporting systems to feed into a single centralized, government owned information systems like the DHIS2. In Kenya, it was suggested to harmonize district HMIS and CHIS in order for each one of them to complement the other [26].

The review also emphasized that, technology plays a role in strengthening CHIS implementation in most LMICs. Alongside this, eCHIS and mobile applications have been increasingly developed and deployed to quantify and support the services delivered by community health workers. Multiple studies included for this review have reported the use of digital health technology to strengthen CHIS implementation in LMICs [27] [34] [35]. The pilot studies revealed that integration of digital technologies to existing CHIS were feasible and effective in resource limited setting. In Nigeria, the mobile data collection was easy, friendly and efficient. mHealth can reduce the complexity of community data collection. The mobile solution helped in

significantly improving the information quality by ensuring consistency, completeness and timeliness of data collection and submission [34].

The review also showed that in Kenya, technology offers an alternative approach that's cheaper to exclusive paper-based tools. The research showed the potential of rapid user acceptance to any mHealth system if it matches the user and infrastructural requirements of the given context and there is user involvement [27]. In studies from Ethiopia, authors proposed shifting to more efficient record keeping systems, for example, to electronic or mobile phone-based applications that could result in further improvements for CHIS implementation for timely and quality data reporting [22] [23]. The eHMIS in SNNPR of Ethiopia has also proved to be very handy in allowing the program managers to access monthly data of every individual health post [19].

Challenges of CHIS Implementation

As with any system, CHIS implementation is not without challenges. The review showed that organizational, technical, behavioural, economic and capacity building barriers exist for effective implementation of CHIS in LMICs.

The need for human resources and capacity building remains as one of the major challenges for successful implementation of CHIS in LMICs. In Rwanda, insufficient local human resources [33], in Kenya, inadequacy of qualified and dedicated community volunteers to run the CHIS [26] [28] and in Ethiopia lack of technical capacity of community health workers on how to properly record and report CHIS data and high staff turnover [19] [32] [22] were reported as barriers. Additionally, difficulty in ensuring regular supervisory visits and continuous support were reported as barriers of CHIS implementation in Ethiopia [19] [22] and Kenya [26] [31].

There are notable challenges in collecting and using community-based health information. Among these, problems concerning the uniformity and proper use of the registers were mentioned as barriers in Tanzania [25] and Kenya [28]. The availability of data collection and reporting tools was also inadequate in Kenya [30] and Ethiopia [19] [22]. Besides, data quality, timeliness and accessibility of the minimum data sets were reported as barriers to utilization of CHIS data [30]. The repetitive nature of the data registration and reporting processes to satisfy the information demand of different health partners was mentioned as a major challenge in Ethiopia [19] [21] [23].

In South Africa, many health facilities didn't have information infrastructure for processing health information [32]. In Kenya a major challenge was the lack of knowledge on data analysis and interpretation. Similarly, there was a lack of timely use of information which may have led to haphazard planning and health interventions that were unrelated to household health needs [29]. Moreover, issues of data validity, reliability, accuracy, completeness and poor information flow were reported in Kenya [26] [31] [27]. Likewise, in Ethiopia, completeness and timeliness problems has been identified as CHIS implementation problems [22].

Still major limitations exist in engaging with community stakeholders themselves in CHIS development and sustaining community involvement [36] [37]. Along this, weak local organizational capacity for institutionalizing CHIS and issues of integration with existing system

has been reported from studies in Nigeria [34], Kenya [28] [29] [30] [31],Tanzania [24] and Rwanda [33].

The lack of capacity for adapting and implementing software solutions was also reported as a challenge in most of the studies. Poor ICT infrastructure, access to cell phones, access to reliable electrical power supply, and mobile network issues were mentioned as major barriers for digitalization of CHIS activities. According to this review, mobile network and internet connectivity limited the use of the ICT technology for CHIS implementation and further scale up in LMICs [22] [23] [27] [34] [35] [37]. Countries also face significant budget limitations to develop, deploy and sustain a CHIS and the aspect of financial commitment from the government has been a great challenge [26] [28] [33] [37].

Discussion

Community health workers play a crucial role in providing primary health care to communities and a CHIS generates information through sources at the community level. As this review demonstrates CHIS designs vary across countries and can be used for different goals. A review of health information systems also reported that interventions to improve routine health information system in low- and middle-income countries differ in design, methods, and scope [40].

Our review finding showed that the community-based reporting systems in LMICs has been observed to be inadequate in supplying community stakeholders and governments with the information they desire. As increased healthcare coverage and health equity become more important to countries, the role of community health systems and their information systems will continue to increase [37] [41]. Lippeveld et al also argued that the availability of information on health services performance can empower community health workers to improve the quality of community-based health services [42]. It is also indicated that CHIS should enable information to be shared among community-based services and they should feed into national health management information systems [10] [43] [44] [45] [46] [47].

A CHIS must collect only relevant information needed by the community for their own use and should avoid gathering too much unnecessary information which is not of immediate use. One potential solution to cumbersome physical data is use of electronic data collection systems, but this is not always possible in low-resource settings, and priority should be placed on collecting the right data [43]. Key to such efforts is the development and strengthening of CHISs as an integral part of national health information systems to improve the availability, accessibility, qualityand use of community health data [42] [48] [49] [50]. With this regard, technology plays a role in strengthening CHIS in most LMICs. This has been also observed in other studies in LMICs where the value of digital health technologies in delivering vital health care interventions, especially in low resource settings is increasingly appreciated [48] [51] [52]. The advent of mobile technology with its increasing penetration into the rural areas has permitted a re-envisioning and redesign of CHMIS data collection. However, this should be supported by enhancing a culture of information use.

Moreover, this review demonstrated that mobile technology can facilitate the reporting of community data. Benefits of the mHealth system were ease of use, savings both in material and human resources and improved data quality [34]. Evidence also showed the potential of rapid user acceptance to any mHealth system if it matches the user and infrastructural requirements of the given context and there is user involvement [27] [47]. Designing or adapting technologies to the limited infrastructures of LMICs are needed to circumvent the lack of certain resources [51].

In the development and deployment of digital health solutions, continuous support is required at all levels from the development of user-friendly and easy-to-use applications to implementation [52]. To take advantage of the maximum benefit provides by digital health information systems and technologies, there is a need to adopt an interoperability standard for eCHIS implementation. If any technology is to be of use it should be able to be suitably integrated into the workflow and social environment of the users [41] [53]. Another review also showed that combinations of technology enhancement along with capacity building activities, and data quality assessment and feedback system were found useful in improving data quality [40].

According to this review, many barriers to CHIS implementation are linked to organizational, technical and behavioral factors which is in accordance with reports from multiple evidence [42] [46] [51] [54]. Among the challenges, there has been fragmentation and disjointed efforts to strengthen community-based health information systems in LMICs. Without complete integration, there are duplicative efforts in data collection, analysis, and reporting [21] [29]. In Ethiopia, the parallel data recording tool is creating additional burden on the HEW and also has contributed for poor data quality [18] [20]. On another study, it has been reported that no population-based community health system can successfully stand alone [37]. Lippeveld et al indicated that there is a need to link the health information generated by CHWs to the facility-based routine health information systems. Yet, in most countries, this vital information on health services provided by CHWs is not routinely captured and integrated [42]. This calls for the need for more community-friendly methods of collecting health information and closer coordination among various information systems should be encouraged [44] [51].

The challenge of lack of capacity for adapting and implementing software solutions persists in LMICs. Hence, efforts at establishing community-based information systems are beset by challenges with supporting infrastructure such as erratic power supply and poor telecommunication [35]. In Zambia, ongoing technical support to troubleshoot challenges with mobile phones and software were suggested to strengthen the CHIS implementation [35]. Although the connectivity is poor in many rural areas, the networks are improving [52]. There is also a need for ongoing technical support to address the hardware and software challenges faced by the community health workers [42]. Lack of clear policy frameworks for the implementation and use of Community Health Information Systems is also another challenge. Asangansi et al addresses challenges unique to those CHIS using mobile technology, including the potential for lost or stolen phones and lack of existing policy around electronic data privacy and security [34].

In this review, the technical capacities for data management were weak and inadequate to collect, analyze and share comprehensive information that may be required for decision-making at community level. A common challenge experienced was lack of technical capacity of community health workers [19] [32], burden of new data collection responsibilities on CHWs

and redundant data collection [21] and cumbersome paper-based data CHIS system [19] [21]. Time spent collecting and harmonizing redundant or nontransferable data is time that could otherwise be spent serving the community [21]. Another challenge regarding the CWs or volunteers is the added workload of data collection and associated activities.

There was a lack of timely use of information which may have led to haphazard planning and health interventions that were unrelated to household health needs [29] [42] [55] [47]. In other studies, gaps in the HMIS are linked to lack of training, inactive supervision, staff workload pressure, and the lengthy and laborious nature of the system [51] [56]. An evaluation of a CHIS in Kenya also highlights the need for intensive training with periodic refresher courses for CHWs involved in data collection [28]. Findings from another studies demonstrate the importance of resourcing, management of teams, and attitudinal change among community health workers [47] [49].

In terms of financing CHIS implementation, this review showed that countries are severely under resourced to support robust community health information systems which is in line with other reports which showed that CHIS system was not resourced and lacked mechanisms for sustainability [30] [37] [51]. Other challenges mentioned include lack of data collection supplies in remote areas [19]. With regard to digitalization, recurring costs for data bundles and financial sustainability might be a limitation in the future [35].

The sustainability of CHIS faces many challenges, which could be addressed through systems' technical design, stakeholder coordination, and the building of organizational capacity to maintain and enhance such systems [42] [57]. Greater collaboration, coordination, and joint action are needed at global and particularly country levels to address these challenges, accelerate progress, and achieve national health priorities. An integrated CHIS requires a long-term, high-level focus on good HMIS governance, capacity building for data management and information use, and strong commitment to change by leadership across stakeholder groups. CHIS has lot of potentials; however, it needs to be properly scaled-up, owned and used for realizing its potentials and for its sustainability.

Limitation

This review is not without limitations. It primary included only published articles and gray literature. It is likely that other CHIS exist that have not yet been discussed in the literature or presented on a website.

Conclusion and recommendations

Generally, community health information system implementation in LMICs is in its early stage. This review showed that use of community level information for evidence-based decision making is still very weak in LMICs. Most of the CHIS in LMICs were still manual and data could not be shared easily for evidence based-decision making. There was not a universal or standard CHIS design and implementation modality across countries that vary depending on what services are provided at the community level. While CHIS are relatively nascent, this

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review has shown that there are promising practices on digitalizing the community health information systems with technology playing a role in strengthening CHIS in most LMICs.

In LMICs, many challenges remain for effective implementation of CHIS with uncoordinated and unintegrated systems including existence of parallel recording & reporting tools. Besides, lack of resources, low technical capacity and shortage of human resource were the main challenges in LMICS. Low data quality and poor culture of information use at local levels were also the problems reported as challenges for CHIS implementation. Poor ICT infrastructure including electricity and network related barriers were also the main obstacles for digitalization of CHIS in LMICs.

Hence, greater collaboration, coordination, and joint action are needed to address these challenges. Strong leadership, motivation, capacity building and regular feedback are also important to strengthen the CHIS in LMICs. Moreover, CHIS should be transformed in to e-CHIS with integration of different technology solutions. Design of the CHIS should also include a clear policy, strategy and guidelines for improved performance. There is clearly a need for governments and implementers to invest from domestic resources and to advocate donors to refocus their funding to core CHIS funding. Local ownership is also critical to the long-term sustainability of CHIS implementation in LMICs.

Availability of data and materials

The datasets supporting the conclusions of this article are included in the review

Competing interests

None

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Authors'contributions

ZAM, MAC and SAM designed the study, reviewed literature, selected and appraised the articles, extracted and analyzed data, interpreted results and drafted the manuscript. BT and MK guided the study and reviewed the manuscript for its scientific content. All authors have read and approved the manuscript.

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