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The Community Health Sentinel Network: A Narrative Review of Deploying Aides and Mobile Technology for Early Outbreak Detection and Chronic Disease Management

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Abstract

Background: Persistent gaps in healthcare access in underserved and remote regions hinder timely disease detection and chronic disease control, undermining both individual and public health. Bridging this gap requires innovative models that extend surveillance and care beyond traditional clinical walls. **Aim:** This narrative review analyzes models for deploying community health aides/assistants, equipped with simple diagnostic tools and connected platforms, as an integrated extension of public health surveillance and primary care. **Methods:** A comprehensive search of PubMed, CINAHL, Global Health, and IEEE Xplore (2010-2024) was conducted, integrating literature on community health workers, mHealth, point-of-care testing, and health systems strengthening. **Results:** Evidence supports the viability of trained aides as effective "community sentinels." When supported by mobile health (mHealth) platforms for data transmission, clinical decision support, and supervisory oversight from nursing/administrative hubs, these networks can improve syndromic reporting for outbreaks, enhance management of hypertension and diabetes, and increase healthcare system reach. Key challenges include sustainable financing, data security, and integration with formal health records. **Conclusion:** Aide-led, technology-enabled sentinel networks represent a transformative, people-centered model for decentralized health intelligence and care delivery, effectively merging frontline public health and primary care functions.

Keywords: community health workers; mHealth; disease surveillance; point-of-care testing; health equity

Introduction

Globally, health systems are strained by dual, interconnected burdens: the persistent threat of infectious disease outbreaks and the rising prevalence of chronic non-communicable diseases (NCDs). These challenges are most acute in underserved urban and remote rural areas, where geographic, economic, and social barriers limit access to formal healthcare facilities, creating surveillance blind spots and gaps in longitudinal care (Perry et al., 2014). Traditional, facility-centric models of public health surveillance and chronic disease management often fail to penetrate these communities in a timely or sustainable manner, resulting in delayed outbreak detection, advanced disease presentation, and poor health outcomes (Labrique et al., 2018). There is an urgent need for decentralized, community-embedded models that can function as both an early warning system for population health threats and a proactive management system for individual health conditions.

This review posits that a Community Health Sentinel Network (CHSN), built upon a foundation of trained community health aides/assistants (CHAs) and enabled by appropriate mobile technology, represents a promising paradigm to address this need. We define a sentinel network as a decentralized

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system of trusted, locally-based individuals who perform systematic community-level data collection and basic health interventions, with their activities coordinated and supported by a centralized clinical and administrative hub. The core innovation lies in positioning the CHA not merely as a health promoter, but as a bi-directional sensor and interventionist—a foundational node in a wider health intelligence system (Braun et al., 2013). Equipped with user-friendly point-of-care diagnostic tools and connected via mobile health (mHealth) platforms, these aides can identify syndromic patterns suggestive of an outbreak, monitor key biomarkers for chronic diseases, and facilitate timely referrals, all while maintaining continuity within their communities (Greuel et al., 2023). Figure 1 illustrates the conceptual framework of the Community Health Sentinel Network (CHSN).

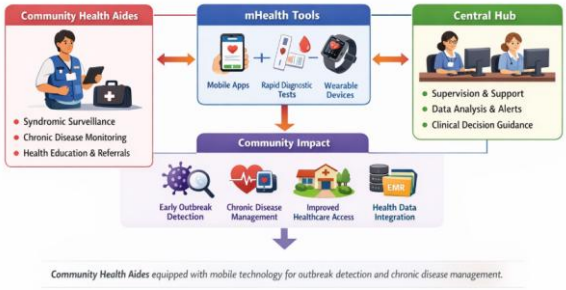

Figure 1. Community Health Sentinel Network (CHSN) Model for Integrated Surveillance and Chronic Disease Management

The aim of this narrative review is to synthesize the evidence from 2010 to 2024 on models that deploy CHAs with mobile technology for integrated early outbreak detection and chronic disease management. We will analyze the training and scope of practice for aides in surveillance, examine the mHealth tools and diagnostic equipment that empower them, explore the supervisory and coordination roles of nurses and medical secretaries in virtual hubs, and address the critical health security and administrative frameworks required for sustainability. Ultimately, this review argues that a well-designed CHSN can effectively bridge the historic divide between public health surveillance and primary care delivery, creating a more resilient, equitable, and responsive health system.

Methodology

This narrative review employed a systematic search strategy to capture interdisciplinary literature on technology-supported community health programs. Databases searched included PubMed, CINAHL, Global Health, and IEEE Xplore for publications between January 2010 and December 2024. The search strategy combined MeSH terms and keywords across five conceptual clusters: (1) Workforce: "Community Health Workers," "Community Health Aides," "Allied Health Personnel"; (2) Technology: "Mobile Health Units," "Telemedicine," "Point-of-Care Testing," "Medical Informatics"; (3) Functions: "Disease Outbreaks/prevention & control," "Chronic Disease/therapy," "Population Surveillance," "Early Diagnosis"; (4) Context: "Healthcare Disparities," "Rural Health," "Underserved Population"; (5) Systems: "Public Health Administration," "Delivery of Health Care/organization & administration." Boolean operators were used to combine clusters.

Inclusion criteria were: peer-reviewed articles in English; empirical (qualitative, quantitative, mixed-methods) or robust review papers; focus on programs using community-based health workers with technological support (mobile devices, point-of-care tools) for surveillance, screening, or management of infectious diseases or NCDs; and studies conducted in low-resource or hard-to-reach settings. Exclusion criteria included: programs based solely in fixed clinics, studies of mHealth for providers other than community-based workers, and protocols without published results. The initial search yielded 535 articles. After deduplication and title/abstract screening, 90 full-text articles were assessed, with 42 selected for in-depth synthesis. Data were extracted thematically, focusing on model design, technology use, workforce roles, outcomes, and implementation challenges.

The Community Health Aide as Public Health Sentinel and Care Extender

The community health aide is the cornerstone of the sentinel network model. These individuals are typically recruited from the communities they serve, granting them intrinsic trust, cultural competence, and an understanding of local contexts that external health workers lack (Ballard et al., 2023). Their role in a CHSN expands beyond traditional health education to include structured data collection and basic clinical tasks.

For outbreak detection, aides are trained in syndromic surveillance. This involves recognizing and reporting clusters of symptoms (e.g., fever with rash, acute watery diarrhea) through standardized forms on mobile devices. By reporting these "signals" in near real-time, CHAs can trigger earlier epidemiological investigations than would occur through passive facility-based reporting, which relies on patients seeking care (Wazny, 2018). For chronic disease management, their role shifts to that of a care extender. They conduct routine screenings for hypertension and diabetes using digital blood pressure cuffs and glucometers, perform medication adherence checks, and provide lifestyle counseling (Joshi et al., 2014). This continuous, community-based monitoring helps bridge the gap between sporadic clinic visits, improving control rates and preventing complications. The dual function transforms the aide into a versatile frontline agent, whose regular community presence allows for the simultaneous tracking of population-level threats and individual-level risks (Kok et al., 2015).

Mobile Health Technology

Mobile technology serves as the critical connective tissue of the CHSN, enabling data flow, decision support, and communication. Basic mobile phones are used for SMS-based reporting and alerts, while smartphones and tablets facilitate more complex applications (mHealth apps). These apps guide aides through structured assessments, embed logic to flag abnormal results or symptom clusters, and allow for the capture of geotagged data (Emmanuel et al., 2019). The platform's backend aggregates individual data to generate community-level dashboards, visible to supervisors and public health officials, which visualize trends in disease incidence, vaccination coverage, or NCD control metrics.

Furthermore, mHealth technology provides clinical decision support (CDS) at the point of care. Simple algorithm-based prompts can guide the CHA: "Blood pressure 165/100 mmHg → Re-check in 5 minutes. If still elevated, refer to clinic and send alert to nurse supervisor" (Agarwal et al., 2015). This standardizes care, reduces errors, and empowers aides to manage within a defined scope of practice. The integration of multimedia tools—videos for patient education, photo capture for wound monitoring—further enhances the quality and scope of community-based interactions (Ilozumba et al., 2018).

Point-of-Care Diagnostic Equipment

Empowering Community Health Aides (CHAs) within a sentinel network necessitates moving beyond subjective clinical assessment to the generation of reliable, objective measurement. This requires the strategic deployment of rugged, portable, and intuitive point-of-care (POC) diagnostic devices, which serve as critical force multipliers that extend the clinical reach of the formal health system deep into the community (Kachimanga et al., 2023). The ideal technological suite for a Community Health Sentinel Network (CHSN) prioritizes devices that are low-cost, battery-operated, durable for field conditions, and require minimal specialized training to operate reliably, thereby aligning with the practical constraints of community-based work. The most established and widely adopted tools in this category are core digital diagnostic instruments, including automated blood pressure monitors, glucometers, and pulse oximeters, which have demonstrated high feasibility and acceptability for use by CHAs in diverse low-resource settings for routine screening and chronic disease monitoring (Kallander et al., 2013).

A second, vital category comprises rapid diagnostic tests (RDTs) for infectious diseases. These lateral flow assays, used for pathogens like malaria, HIV, and certain bacterial infections (e.g., *streptococcus*), enable CHAs to deliver a presumptive diagnosis within minutes during a community visit. This capability allows for the immediate initiation of appropriate treatment or referral according to protocol, a practice that has been shown to significantly curtail disease transmission and reduce the burden on overstretched clinical facilities (Hopkins et al., 2017). Furthermore, the landscape of POC technology is rapidly evolving to include more sophisticated connected devices.

Emerging innovations such as smartphone-connected electrocardiograms (ECG) for atrial fibrillation screening, digital stethoscopes capable of transmitting heart and lung sounds for remote auscultation, and pocket-sized handheld ultrasound devices represent the next frontier (Hunter et al., 2021). While these advanced tools demand more specific training for proper use, they can be successfully operated by CHAs within a well-defined scope of practice, with the acquired data (e.g., a single-lead ECG trace or a saved ultrasound clip) transmitted wirelessly to a clinician at a supervisory hub for remote interpretation and diagnostic guidance. The strategic integration of this spectrum of POC equipment fundamentally transforms the nature of a CHA's home visit or community gathering, elevating it from a counseling session to a functional mini-clinic that generates clinically actionable, objective data. This data simultaneously informs immediate individual care decisions and, when aggregated, contributes vital, real-time biomarkers to the community health intelligence system.

Nursing and Administrative Supervision

The effectiveness and safety of a decentralized CHSN depend on a robust central support system. Here, nurses and medical secretaries/coordinators play pivotal, complementary roles in a virtual supervisory hub.

Nurses provide clinical oversight and triage. They monitor the data dashboard for alerts, conduct remote consultations with CHAs via phone or video to assess complex cases, and make definitive triage decisions (e.g., home management, clinic referral, or urgent evacuation) (O'Donovan et al., 2019). They are also responsible for the ongoing training, competency assessment, and clinical mentorship of the aide network. The nurse supervisor thus acts as the clinical "brain" of the distributed network, ensuring quality and safety.

Medical secretaries or program coordinators handle the operational and administrative backbone. They manage patient follow-up schedules, ensure the coordination of referrals and transportation, maintain community health records within the digital system, and handle logistics for supplies and device maintenance (Adams et al., 2020). This role is essential for maintaining the network's routine function, preventing system breakdowns, and ensuring that data collected translates into coordinated action. Together, this hub creates a sustainable ecosystem where frontline aides feel

supported and clinically backed, reducing burnout and turnover (Table 1).

Table 1: Core Components and Functions of a Community Health Sentinel Network (CHSN)

Network Component	Primary Actors	Key Tools & Technologies	Core Functions	Intended Outcome
Field Sensor Layer	Community Health Aides/Assistants (CHAs)	Smartphone/Tablet with mHealth app; POC devices (BP cuff, glucometer, RDTs); basic PPE.	- Syndromic surveillance & reporting. - Chronic disease screening & monitoring. - Basic health education & counseling. - Data entry & geotagging.	Early signal detection for outbreaks; improved community coverage of screenings; continuity of care for chronic conditions.
Data Transmission & Support Layer	mHealth Platform & Algorithms	Mobile network/internet; secure cloud database; CDS algorithms; dashboard interfaces.	- Secure, real-time data transmission. - Automated alerts for abnormal values. - Guided workflows for CHAs. - Data aggregation & visualization.	Timely data flow; standardized protocols; reduced CHA error; creation of actionable community health intelligence.
Clinical Oversight Hub	Nurse Supervisors, Remote Clinicians	Telemedicine kits; EHR access; communication systems (voice/video).	- Remote triage of flagged cases. - Clinical mentorship & support for CHAs. - Management of complex cases. - Quality assurance & training.	Safe escalation of care; clinical governance; enhanced CHA capacity and confidence.
Administrative & Coordination Hub	Medical Secretaries, Program Coordinators	Health information systems; scheduling software; logistics management platforms.	- Referral coordination & follow-up tracking. - Supply chain management for POC devices/RDTs. - Record management & reporting. - Program monitoring & evaluation.	Operational sustainability; efficient resource use; ensured closure of the referral loop; accountability.

Health Security and Data Governance in Community Networks

Operating a distributed data collection network introduces significant health security and privacy challenges. Data collected in the field—often including personal health information and location data—must be transmitted and stored securely to protect patient confidentiality and comply with evolving regulations (Iwaya et al., 2020). This requires encryption for data-in-transit and data-at-rest, secure authentication for CHAs accessing the apps, and clear data governance policies defining who can access aggregated and individual-level data and for what purpose (Petersen et al., 2017). Breaches can erode community trust, the network's most vital asset. Furthermore, system interoperability—the ability of the mHealth platform to exchange data with national disease surveillance systems and primary care electronic health records—is crucial for the CHSN to inform broader public health action and avoid creating data silos (Muinga et al., 2018). Without integration, the intelligence generated risks being overlooked by formal health systems.

Healthcare Administration in Financing and Sustainability Models

The long-term viability and scalability of Community Health Sentinel Networks (CHSNs) are fundamentally contingent on the development of sustainable financing mechanisms and their formal integration into the overarching health system architecture. A pervasive challenge, often termed the "pilot paradox," sees many successful demonstration projects relying on time-limited donor or research grants, only to collapse when external funding concludes, failing to transition to enduring programs (Olu et al., 2019). To break this cycle, healthcare administrators and policymakers must champion the

creation of domestic financing and reimbursement models that formally recognize and compensate for the value created by community-based sentinel work. Several potential pathways offer promise. One approach involves **capitation or bundled payment models**, where the per-person payment allocated to a primary care network or accountable care organization explicitly includes funding for the preventive, surveillance, and chronic disease management services delivered by the CHSN, incentivizing the network to invest in community health to reduce more costly downstream care.

Another model is **performance-based financing**, which ties a portion of the compensation for CHAs or the supervisory hub to the achievement of specific, measurable health outcomes or process indicators (Gadsden et al., 2021). This could include metrics such as the proportion of a managed hypertensive population with controlled blood pressure, the completion rate of childhood vaccination series in a catchment area, or the timeliness and accuracy of syndromic outbreak reports (Lohmann et al., 2018). This model aligns financial incentives directly with the program's dual public health and clinical goals. A third critical avenue is advocating for **public health insurance reimbursement**. This requires policy changes to allow billing for defined, protocol-driven community-based services—such as a hypertension monitoring visit or a diabetes foot screen—when performed by a certified CHA operating under clinical supervision, thereby creating a direct revenue stream linked to service volume (Kane et al., 2018).

Beyond designing these payment mechanisms, administrators play a crucial role in building compelling business cases that demonstrate the **return on investment (ROI)** of CHSNs to ministries of health and insurers (Winters et al., 2018). This involves quantifying cost savings accrued from the early detection and containment of infectious disease outbreaks, which avert expensive epidemic responses, and from the reduction in hospitalizations and emergency department visits due to better-managed chronic conditions (Ghani et al., 2020). Furthermore, the business case should highlight gains in overall health system efficiency, as CHSNs can triage and manage minor issues in the community, allowing higher-level clinicians to focus on more complex cases. Successfully arguing this economic value proposition is essential for securing the stable, systemic funding required to transition CHSNs from innovative projects to core components of a resilient and equitable health system (Table 2). Figure 2 compares the key benefits and challenges associated with deploying a Community Health Sentinel Network.

Table 2: Evidence and Challenges for CHSN Implementation

Domain	Supporting Evidence	Persistent Challenges	Recommendations for Implementation
Effectiveness in Surveillance	CHA-based reporting reduced time to outbreak detection for cholera in Bangladesh (Van Boetzelaer et al., 2020) and malaria in Zambia (Stanton et al., 2015). Mobile syndromic reporting improved completeness and timeliness vs. paper (Sheel et al., 2019).	Signal validation (distinguishing outbreaks from background noise); potential for over-reporting; dependence on mobile network coverage.	Integrate with lab confirmation systems; use spatial clustering algorithms in dashboards; deploy offline-capable apps with data syncing.
Effectiveness in Chronic Disease Care	CHA-led hypertension programs significantly improved BP control rates in low-income US communities (Fischer et al., 2012) and rural India (Anand et al., 2019). mHealth-supported aides improved diabetes self-management in South Africa (Leon et al., 2021).	Ensuring medication supply continuity; managing complex multi-morbid cases; long-term retention of patients in community programs.	Link CHSNs to reliable medication supply chains; establish clear, simple referral pathways; design patient-incentive or peer-support components.
Technology & Usability	High acceptability of mHealth apps among CHAs for simplifying work and improving credibility (DeRenzi et al., 2012). POC devices (glucometers) shown to be accurate and feasible in community settings (Buss et al., 2019).	Device durability and maintenance in harsh environments; cost of advanced POC tech; digital literacy gaps among older CHAs.	Invest in ruggedized devices; establish local maintenance protocols; use icon-driven, low-text interfaces; provide iterative, hands-on training.
Workforce & Sustainability	CHA programs can improve job satisfaction and create local	High CHA turnover due to low/stipended pay;	Advocate for formal employment and fair

	employment (Mallari et al., 2020). Supervisory support is the strongest predictor of CHA retention and performance (Kok et al., 2015).	burnout from dual roles; lack of clear career pathways.	compensation; design manageable workloads; create tiered career ladders (e.g., CHA to supervisor).
Data Security & Integration	Blockchain and lightweight encryption protocols are being piloted for secure field data (Garg et al., 2020). FHIR (Fast Healthcare Interoperability Resources) standards show promise for mHealth-EHR integration (Muinga et al., 2018).	Lack of national digital health policies; proliferation of non-interoperable vertical mHealth systems; high cost of robust security for low-budget programs.	Advocate for supportive national digital health policies; adopt open data standards from the outset; perform context-specific data protection risk assessments.

Figure 2. Benefits and Implementation Challenges of the Community Health Sentinel Network

Conclusion and Future Directions

The Community Health Sentinel Network model presents a compelling, evidence-based strategy for building more agile, equitable, and integrated health systems. By strategically deploying trusted community members as technology-enabled sentinels and care extenders, backed by virtual clinical and administrative hubs, health systems can achieve earlier detection of public health threats and better management of chronic diseases in the hardest-to-reach populations. This model effectively dissolves the artificial barrier between public health surveillance and primary care, creating a unified, community-facing front line.

Future progress depends on moving from successful but fragmented pilots to scaled, institutionalized programs. Key priorities include: 1) Policy and Financing: Governments and insurers must create durable financing mechanisms that formally recognize and pay for the vital services provided by CHSNs; 2) Interoperability by Design: New mHealth platforms must be built using open standards to ensure seamless data flow into national health information systems; 3) Advanced Technology Integration: Exploring the responsible use of artificial intelligence (AI) to analyze aggregated sentinel data for predictive outbreak modeling or to identify individuals at highest risk of complications (Wahl et al., 2018); and 4) Strengthening the Workforce: Professionalizing the CHA role through certification, fair compensation, and supportive supervision is non-negotiable for sustainability.

Ultimately, the CHSN is more than a service delivery model; it is a philosophy of decentralized, people-centered health intelligence. It recognizes that the first signs of an epidemic or the daily management of a chronic condition happen not in a clinic, but in homes and communities. By empowering those communities with the tools, training, and backup to act, we can create a health system that is not only more efficient but also fundamentally more just and resilient.

References

1. Adams, L. B., Richmond, J., Watson, S. N., Cené, C. W., Urrutia, R., Ataga, O., ... & Corbie-Smith, G. (2021). Community health worker training curricula and intervention outcomes in African American and Latinx communities: a systematic review. *Health Education & Behavior*, *48*(4), 516-531. https://doi.org/10.1177/1090198120959326
2. Agarwal, S., Perry, H. B., Long, L. A., & Labrique, A. B. (2015). Evidence on feasibility and effective use of mH ealth strategies by frontline health workers in developing countries: systematic review. *Tropical medicine & international health*, *20*(8), 1003-1014. https://doi.org/10.1111/tmi.12525
3. Anand, T. N., Joseph, L. M., Geetha, A. V., Prabhakaran, D., & Jeemon, P. (2019). Task sharing with non-physician health-care workers for management of blood pressure in low-income and middle-income countries: a systematic review and meta-analysis. *The Lancet Global Health*, *7*(6), e761-e771. https://doi.org/10.1016/S2214-109X(19)30077-4
4. Ballard, M., Olaniran, A., Iberico, M., Rogers, A., Thapa, A., Cook, J., ... & Perry, H. Community Service or Labour Exploitation? A Systematic Review of'Dual Cadre'Community Health Worker Programmes. https://doi.org/10.1016/S2214-109X(23)00357-1
5. Braun, R., Catalani, C., Wimbush, J., & Israelski, D. (2013). Community health workers and mobile technology: a systematic review of the literature. *PloS one*, *8*(6), e65772. https://doi.org/10.1371/journal.pone.0065772
6. Buss, V. H., Deeks, L. S., Shield, A., Kosari, S., & Naunton, M. (2019). Analytical quality and effectiveness of point-of-care testing in

community pharmacies: a systematic literature review. *Research in Social and Administrative Pharmacy*, *15*(5), 483-495. https://doi.org/10.1016/j.sapharm.2018.07.013

7. DeRenzi, B., Findlater, L., Payne, J., Birnbaum, B., Mangilima, J., Parikh, T., ... & Lesh, N. (2012, March). Improving community health worker performance through automated SMS. In *Proceedings of the fifth international conference on information and communication technologies and development* (pp. 25-34). https://doi.org/10.1145/2160673.2160677
8. Emmanuel, G., Hungilo, G. G., & Emanuel, A. W. R. (2019, April). A mobile application system for community health workers-A review. In *Proceedings of the 2019 5th International Conference on Computing and Artificial Intelligence* (pp. 106-110). https://doi.org/10.1145/3330482.3330485
9. Fischer, H. H., Moore, S. L., Ginosar, D., Davidson, A. J., Rice-Peterson, C. M., Durfee, M. J., ... & Steele, A. W. (2012). Care by cell phone: text messaging for chronic disease management. *The American journal of managed care*, *18*(2), e42-7.
10. Gadsden, T., Mabunda, S. A., Palagyi, A., Maharani, A., Sujarwoto, S., Baddeley, M., & Jan, S. (2021). Performance-based incentives and community health workers' outputs, a systematic review. *Bulletin of the World Health Organization*, *99*(11), 805. https://doi.org/10.2471/BLT.20.285218
11. Ghani, Z., Jarl, J., Sanmartin Berglund, J., Andersson, M., & Anderberg, P. (2020). The cost-effectiveness of mobile health (mHealth) interventions for older adults: systematic review. *International journal of environmental research and public health*, *17*(15), 5290. https://doi.org/10.3390/ijerph17155290
12. Greuel, M., Sy, F., Baernighausen, 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
13. Hopkins, H., Bruxvoort, K. J., Cairns, M. E., Chandler, C. I., Leurent, B., Ansah, E. K., ... & Whitty, C. J. (2017). Impact of introduction of rapid diagnostic tests for malaria on antibiotic prescribing: analysis of observational and randomised studies in public and private healthcare settings. *bmj*, *356*. https://doi.org/10.1136/bmj.j1054
14. Hunter, L. D., Pecoraro, A. J., Doubell, A. F., Monaghan, M. J., Lloyd, G. W., Lombard, C. J., & Herbst, P. G. (2021). Screening for subclinical rheumatic heart disease: addressing borderline disease in a real-world setting. *European Heart Journal Open*, *1*(3), oeab041. https://doi.org/10.1093/ehjopen/oeab041
15. Ilozumba, O., Dieleman, M., Kraamwinkel, N., Van Belle, S., Chaudoury, M., & Broerse, J. E. (2018). "I am not telling. The mobile is telling": factors influencing the outcomes of a community health worker mHealth intervention in India. *PLoS One*, *13*(3), e0194927. https://doi.org/10.1371/journal.pone.0194927
16. Iwaya, L. H., Ahmad, A., & Babar, M. A. (2020). Security and privacy for mHealth and uHealth systems: a systematic mapping study. *IEEE Access*, *8*, 150081-150112. https://doi.org/10.1109/ACCESS.2020.3015962
17. Joshi, R., Alim, M., Kengne, A. P., Jan, S., Maulik, P. K., Peiris, D., & Patel, A. A. (2014). Task shifting for non-communicable disease management in low and middle income countries–a systematic review. *PloS one*, *9*(8), e103754. https://doi.org/10.1371/journal.pone.0103754
18. Kachimanga, C., Divala, T. H., Ket, J. C., Kulinkina, A. V., Zaniku, H. R., Murkherjee, J., ... & van den Akker, T. (2023). Adoption of mHealth technologies by community health workers to improve the use of maternal health services in Sub-Saharan Africa: protocol for a mixed method systematic review. *JMIR Research Protocols*, *12*(1), e44066. https://doi.org/10.2196/44066
19. Källander, K., Tibenderana, J. K., Akpogheneta, O. J., Strachan, D. L., Hill, Z., Ten Asbroek, A. H., ... & Meek, S. R. (2013). Mobile health (mHealth) approaches and lessons for increased performance and retention of community health workers in low-and middle-income countries: a review. *Journal of medical Internet research*, *15*(1), e2130. https://doi.org/10.2196/jmir.2130
20. Kane, S., Gandidzanwa, C., Mutasa, R., Moyo, I., Sismayi, C., Mafaune, P., & Dieleman, M. (2018). Coming full circle: how health worker motivation and performance in results-based financing arrangements hinges on strong and adaptive health systems. *International Journal of Health Policy and Management*, *8*(2), 101. https://doi.org/10.15171/ijhpm.2018.98
21. Kok, M. C., Kane, S. S., Tulloch, O., Ormel, H., Theobald, S., Dieleman, M., ... & de Koning, K. A. (2015). How does context influence performance of community health workers in low-and middle-income countries? Evidence from the literature. *Health research policy and systems*, *13*(1), 13. https://doi.org/10.1186/s12961-015-0001-3
22. Labrique, A. B., Wadhwani, C., Williams, K. A., Lamptey, P., Hesp, C., Luk, R., & Aerts, A. (2018). Best practices in scaling digital health in low and middle income countries. *Globalization and health*, *14*(1), 103. https://doi.org/10.1186/s12992-018-0424-z

23. Leon, N., Namadingo, H., Bobrow, K., Cooper, S., Crampin, A., Pauly, B., ... & Farmer, A. (2021). Intervention development of a brief messaging intervention for a randomised controlled trial to improve diabetes treatment adherence in sub-Saharan Africa. *BMC Public Health*, *21*(1), 147. https://doi.org/10.1186/s12889-020-10089-6
24. Lohmann, J., Muula, A. S., Houlfort, N., & De Allegri, M. (2018). How does performance-based financing affect health workers' intrinsic motivation? A Self-Determination Theory-based mixed-methods study in Malawi. *Social science & medicine*, *208*, 1-8. https://doi.org/10.1016/j.socscimed.2018.04.053
25. Mallari, E., Lasco, G., Sayman, D. J., Amit, A. M. L., Balabanova, D., McKee, M., ... & Palafox, B. (2020). Connecting communities to primary care: a qualitative study on the roles, motivations and lived experiences of community health workers in the Philippines. *BMC health services research*, *20*(1), 860. https://doi.org/10.1186/s12913-020-05699-0
26. Muinga, N., Magare, S., Monda, J., Kamau, O., Houston, S., Fraser, H., ... & Paton, C. (2018). Implementing an open source electronic health record system in Kenyan health care facilities: case study. *JMIR medical informatics*, *6*(2), e8403. https://doi.org/10.2196/medinform.8403
27. O'Donovan, J., O'Donovan, C., & Nagraj, S. (2019). The role of community health workers in cervical cancer screening in low-income and middle-income countries: a systematic scoping review of the literature. *BMJ global health*, *4*(3). https://doi.org/10.1136/bmjgh-2019-001452
28. Olu, O., Muneene, D., Bataringaya, J. E., Nahimana, M. R., Ba, H., Turgeon, Y., ... & Dovlo, D. (2019). How can digital health technologies contribute to sustainable attainment of universal health coverage in Africa? A perspective. *Frontiers in public health*, *7*, 341. https://doi.org/10.3389/fpubh.2019.00341
29. Perry, H. B., Zulliger, R., & Rogers, M. M. (2014). Community health workers in low-, middle-, and high-income countries: an overview of their history, recent evolution, and current effectiveness. *Annual review of public health*, *35*(1), 399-421. https://doi.org/10.1146/annurev-publhealth-032013-182354
30. Petersen, I., Marais, D., Abdulmalik, J., Ahuja, S., Alem, A., Chisholm, D., ... & Thornicroft, G. (2017). Strengthening mental health system governance in six low-and middle-income countries in Africa and South Asia: challenges, needs and potential strategies. *Health policy and planning*, *32*(5), 699-709. https://doi.org/10.1093/heapol/czx014
31. Sheel, M., Collins, J., Kama, M., Nand, D., Faktaufon, D., Samuela, J., ... & Nilles, E. (2019). Evaluation of the early warning, alert and response system after Cyclone Winston, Fiji, 2016. *Bulletin of the World Health Organization*, *97*(3), 178. https://doi.org/10.2471/BLT.18.211409
32. Stanton, M. C., Mkwanda, S. Z., Debrah, A. Y., Batsa, L., Biritwum, N. K., Hoerauf, A., ... & Kelly-Hope, L. A. (2015). Developing a community-led SMS reporting tool for the rapid assessment of lymphatic filariasis morbidity burden: case studies from Malawi and Ghana. *BMC infectious diseases*, *15*(1), 214. https://doi.org/10.1186/s12879-015-0946-4
33. Van Boetzelaer, E., Chowdhury, S., Etsay, B., Faruque, A., Lenglet, A., Kuehne, A., ... & Verdecchia, M. (2020). Evaluation of community based surveillance in the Rohingya refugee camps in Cox's Bazar, Bangladesh, 2019. *PLoS One*, *15*(12), e0244214. https://doi.org/10.1371/journal.pone.0299167
34. Wahl, B., Cossy-Gantner, A., Germann, S., & Schwalbe, N. R. (2018). Artificial intelligence (AI) and global health: how can AI contribute to health in resource-poor settings?. *BMJ global health*, *3*(4), e000798.
35. Wazny, K. (2018). Applications of crowdsourcing in health: an overview. *Journal of global health*, *8*(1), 010502. https://doi.org/10.7189/jogh.08.010502
36. Winters, N., Langer, L., & Geniets, A. (2018). Scoping review assessing the evidence used to support the adoption of mobile health (mHealth) technologies for the education and training of community health workers (CHWs) in low-income and middle-income countries. *BMJ open*, *8*(7), e019827. https://doi.org/10.1136/bmjopen-2017-019827.