International Journal of Scientific Research and Modern Technology (IJSRMT) ijsrmt.com
Volume 4, Issue 9, 2025
DOI: https://doi.org/10.38124/ijsrmt.v4i9.818

Designing Interoperable his for Maternal and Child Health Tracking Across Informal Health Providers

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Publication Date: 2025/09/20

Abstract

Informal care providers are critical in providing maternal and child health (MCH) services, especially in underserved populations in most low- and middle-income countries (LMICs). Nonetheless, these providers are often left out in the national Health Information Systems (HIS), fragmenting data, a lack of coordination in the health systems, and underrepresenting important health indicators. This conceptual review addresses the design of an interoperable HIS incorporating informal health providers to ensure greater tracking and outcomes for MCH. The paper resorts to digital health, health systems strengthening, and informatics literature to establish major inclusion barriers, including digital illiteracy, poor infrastructure and mistrust towards institutions. A stakeholder-based conceptual approach should comprise the following components: data gathering and verification, integration pathways, governance procedures, and community involvement. That model is supported by socio-technical systems theory, which highlights human, technological, and organisational interactions in systems design and adoption. Such interoperability standards as HL7, FHIR, and OpenHIE are among the key enablers of data exchange inside the formal and informal systems. The review shows that integrating digital health policies to be inclusive, designing technology on a human scale, and investing in coordination are needed to experience interoperable, equitable HIS within LMIC scenarios. Policymakers, NGOs, and developers can use the practical implications to make sustainable improvements in the visibility of health data, improve the health system's performance, and health equity. This research offers a practice-informed and theoretically based research model advancing an inclusive digital health infrastructure of maternal and child health.

Keywords; *Interoperability; Health Information Systems; Maternal and Child Health; Informal Health Providers; Socio-Technical Systems Theory.*

I. INTRODUCTION

The issue of maternal and child health (MCH) is a perennial problem in any low-resource setting because widespread maternal and neonatal morbidity and mortality rates are still high despite numerous initiatives to enhance health outcomes (World Health Organization [WHO], 2021). The lack of integration of health services between health care institutions, especially those found in the rural and peri-urban settings that rely on informal health care providers like traditional birth attendants, patent medicine vendors, and faith-based healers, who are frequently the initial access point to maternal and child care, is one of the consistent problems (Sacks et al., 2017). Such providers are highly important in delivering healthcare but have become mostly left out of national Health Information Systems (HIS), thus causing massive data gaps that inhibit effective planning, monitoring, and response (Abimbola et al., 2022). This conceptual review is a timely study that adequately incorporates an interoperable HIS to enable the combination of formal and informal healthcare stakeholders to track MCH and make the necessary decisions. Having interoperability between health information platforms also eliminates inefficiencies, redundancy, and suboptimal continuity of care. There is the potential that an inclusive and interoperable HIS can facilitate smooth data sharing, enhance referral patterns, and make sure that essential health information among informal providers is being recorded and monitored. The purpose of this review is to synthesise existing literature on HIS, interoperability, and informal healthcare provision, and to propose a conceptual framework for designing an interoperable HIS tailored to the realities of low-resource settings. The review explores key concepts, identifies existing gaps, and outlines a theoretically grounded model for system design. A narrative synthesis approach is adopted to collate and interpret relevant findings from multidisciplinary sources, with the goal of

Obodo, O. R. (2025). Designing Interoperable his for Maternal and Child Health Tracking Across Informal Health Providers. *International Journal of Scientific Research and Modern Technology*, *4*(9),122–125. https://doi.org/10.38124/ijsrmt.v4i9.818

guiding future empirical studies and implementation efforts.

- *Conceptual Clarifications & Review of Existing HIS Interventions for MCH*

Health Information System (HIS) is the system comprising of an inbuilt or integrated combination that gathers, stores, handles, and communicates information that is associated with health of individuals or the actions of organisations operating in the health area (WHO, 2020). To the context of maternal and child health (MCH), a well-functioning HIS can allow real-time decision-making, promote evidence-based policy formulation, and leading to an improvement in the delivery of health services across the continuum of care (Abouzahr & Boerma, 2021). The concept behind interoperability in HIS is that various information systems, devices or applications may access, exchange and share data in an orchestrated manner (Bhattacharyya et al., 2021). This encompasses technical (data transmission), semantic (common meaning of data) and organisational interoperability (policy and procedure agreement). Interoperability is of particular importance in connecting fragmented sources of data, such as data produced by informal provision sources (Labrique et al., 2018). Maternal and Child Health Tracking refers to the process of the systematic data collection and monitoring of major indicators that determine whether the given individual is pregnant, undergoes successful childbirth, received relevant care and immunisation, is monitored in terms of their growth and frequent childhood diseases (UNICEF, 2022). Efficient monitoring allows identifying complications in a timely manner, consistent treatment, and adequate resource distribution (Scott et al., 2019). Informal Health Providers are actors that perform health services informally and are not recognized nor well-regulated. These are conventional birth attendants, religious healers, and patent medicine dealers (Sacks et al., 2017). Although these individuals are marginalised individuals in health policy, they are extremely critical to service delivery, especially to underserved residents (Beyeler et al., 2021). Their integration in HIS is essential to reflect all the possible ranges of healthcare interactions and enhance the outcomes of MCH (Abimbola et al., 2022).

Numerous measures in HIS have been adopted to ensure that MCH gets the required support particularly in formal establishments. District Health Information System 2 (DHIS2) is a popular tool used in most low and middle-income countries to summarise the facility-level data (Braa et al., 2020). Real-time data entry, appointment reminder, and health education also rely on mobile health (mHealth) applications (Mehl et al., 2020). Some of the systems are aimed at tracking antenatal care (ANC), immunization, and even birth notifications (WHO, 2021). Though, the majority of these systems are bound by low interoperability, data siloes, and the nonexistence of community-based or informal agents (Kumar et al., 2021). Consequently, essential information on the grassroots engagement is not recorded, which negatively affects the comprehensive surveillance of maternal and child health (Scott et al., 2019). It is crucial to integrate informal providers into the MCH data ecosystems by incorporating interoperable HIS frameworks because this will help address these gaps (Labrique et al., 2018).

- *Bridging the Gap: Interoperability and the Integration of Informal Health Providers into HIS*

Excluding informal health providers on a national scale with regards to the Health Information Systems (HIS) is one of the most significant and unaddressed issues of health system strengthening. Although informal providers play a critical role in maternal and child health (MCH) services delivery, particularly in low- and middle-income countries (LMICs), they do not feature in the formal health data ecosystems at all (Beyeler et al., 2021). The result of such exclusion is the shortage of quality data that affects the health indicator precision and ruptures care continuity and timely interventions (Abimbola et al., 2022). In the absence of the integration of these providers, a national health system does not draw the whole picture of the MCH realities, specifically in rural and underserved localities (Scott et al., 2019). The differences that exist on the barrier to inclusion are complex. To begin with, the lack of trust between informal providers and formal health institutions usually impedes collaboration and interchange of data (Sacks et al., 2017). Second, the digital literacy of informal providers is low, so they can communicate on digital platforms much less (Labrique et al., 2018). Third, cracks in infrastructure, including internet connectivity problems, missing cellphones, and poor power supply, only complicate their involvements in digital HIS activities (Mehl et al., 2020). Other LMICs, such as Uganda and Bangladesh, have already started pilot programs that involve community-based workers in mHealth systems, which show better coverage of health indicators in the maternal population (Braa et al., 2020). Nevertheless, such examples are not comprehensive and sustainable ones (Kumar et al., 2021).

To accommodate this integration challenge, promoters of successful interoperability strategies should be adopted. Interoperability allows independent systems and providers to communicate and share information that is meaningful (Bhattacharyya et al., 2021). Three levels; first, the technical interoperability is guaranteed to be able to transmit data; second, the semantic interoperability will guarantee the meaning of data to be preserved across platforms, and last but not least, the organisational interoperability will be used to align policies, roles and processes of the stakeholders (OpenHIE, 2023). There is already existing structures of interoperability that provide directions of implementation. HL7 (Health Level Seven) offers standards on health data exchange, whereas, FHIR (Fast Healthcare Interoperability Resources) is more recent and offers flexibility that can support mobile and cloud-based setups (Vorisek et al., 2022). OpenHIE (Open Health Information Exchange) is exceptionally applicable in the low-resource runtime, and it has a set of modular tools to combine data on facilities and community levels (OpenHIE, 2023). The successfully employed examples of these standards include the countries of Rwanda and

Mozambique where national health information exchanges were developed, involving the contribution of the community (WHO, 2021). The possibility of integrating informal providers within an interoperable HIS framework, is not just a technical challenge. It is also a social and an institutional undertaking. It needs the development of trust, training, user interface simplification, and information protection (Abimbola et al., 2022). Finally, an appropriately developed interoperable HIS that would include informal actors can substantially boost the expandability and actionability of maternal and child health services in resource-limited settings (Labrique et al., 2018).

II. CONCEPTUAL FRAMEWORK DEVELOPMENT AND THEORETICAL UNDERPINNING

The targeted nature of maternal and child health (MCH) monitoring systems and the absence of informal health providers have prompted this review to present a conceptual framework of designing an interoperable Health Information System (HIS) and that is coherent, sustainable, and in-tune with what is happening on the ground (Labrique et al., 2018). The framework is aimed at enabling the integration of data, coordinating all systems, and making real-time decisions through the connection of formal and informal health providers in low-resource environments (Abimbola et al., 2022). The central element of the model is stakeholder involvement that entails the inclusion of all actors, including government health agencies, informal providers, technology developers, community representatives, and non-governmental organizations, in the process since the very beginning (WHO, 2019). When the involvement is meaningful, it creates trust, simplifies the training process, and makes sure that systems considerations are based on needs of different users (Scott et al., 2019). WHO (2019) reports that system design led by the stakeholders makes it more acceptable and sustainable in the long run. The second fundamental element is data collection and validation that should consider both structured contributions of formal providers and flexible and simplified approaches to informal players (Mehl et al., 2020). Digital literacy can be closed using mobile tools that include pictorial guidance and voice assistance and data validation by peers or community health workers (Labrique et al., 2018; Braa et al., 2020). The integration pathways are the tools used to align information in one source to be shifted and communicated through other platforms (Bhattacharyya et al., 2021). This can include the scripting of the practices related to data within the neighborhood to the national measures of health and compatibility with standards and formats like HL7 or FHIR (HL7 International, 2022). Such tools as OpenHIE provide modular services through which it can be integrated (step-by-step and in stages) with new sources of data, including informal providers (OpenHIE, 2023). The last ingredient is the protocols of governance and privacy that concern ownership of data, confidentiality, and ethical utilization (Kumar et al., 2021). A transparent shared agreement on data use, restricted access on a role-based basis, and community-based informed consent are crucial in terms of compliance and health data regulations (Abimbola et al., 2022). The Socio-Technical Systems Theory is the most suitable conceptual framework in this case, as it underlines the integration of technological instruments and human beings as well as the organisational setting (Berg, 2019). According to the theory, the effectiveness of health information systems has little to do with the technical functionality of the systems but the efficiency with which technology is indigenised within the social systems, workflows, and cultural behaviours (Beyeler et al., 2021). When it comes to informal provider integration, socio-technical theory will aid in explaining why socio-technical engineering to fully integrate the providers should aim at creating a system, which is not only technologically robust, but also socially flexible, site-specific, and user-centered (Braa et al., 2020). Altogether, such a framework and its theoretical basis can contribute to providing a comprehensive model to construct interoperable HIS that foster inclusion, data equity, and better outcomes of MCH (WHO, 2021).

III. IMPLICATIONS FOR POLICY AND PRACTICE

The review can be used as a critical guide to governments, NGOs and digital health developers interested in building maternal and child health (MCH) systems. The incorporation of informal health providers into interoperable Health Information Systems (HIS) is a realistic move to health equity, as any care provided within the marginalised communities would not be ignored and have no factual data to sustain its existence. The model under consideration provides the enhancement of the community data possession by communication with stakeholders to create mutual trust and the feeling of shared responsibility when it comes to reporting on health. The model is sustainable and scalable in low-resource conditions because of the ability to use the open standards such as FHIR and OpenHIE. In addition, it will attract attention to national digital health strategies, thus integration efforts do not create parallel systems built on top of existing health infrastructure. Governments are advised to incorporate informal provider data pathways in the health policy, and NGOs and tech developers should ensure that such a process is implemented successfully by concentrating on being locally adaptive and letting human-centred design.

IV. RECOMMENDATIONS

To arrive at an inclusive and interoperable Health Information System (HIS) in matters related to maternal and child health (MCH), governments must devise policies that legalise informal health providers and make them a part of national statistics. These providers should improve their digital literacy by offering capacity-building programmes to create locally-based training and mentorship. Developers should create affordable, easy-to-use digital tools that can work offline and meet world

interoperability standards, such as FHIR or OpenHIE. Also, donors and NGOs should finance pilot projects in low-resource settings to test the integration strategies. Such pilots can feed up scalable models that assist sustainability, position them to national health objectives, and ultimately makeup data equity and service provision.

V. CONCLUSION

In this conceptual review, we have discussed the necessity of interoperable Health Information Systems involving informal health providers in tracking maternal and child health (MCH). The study proposes a stakeholder-driven framework based on the socio-technical systems theory by reviewing the available HIS interventions and defining important concepts and barriers to integration. The model provides handy items like information verification, integration routes, and valance practices. Finally, the inclusive HIS design can be used to transform MCH data ecosystems, leading to the cessation of gaps in visibility, enhanced service coordination, and equity. This vision will need the efforts of policy-making, technical innovation, and long-term investment in the interoperability of health systems.

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