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mHealth: A Mediating Tool for Community Health Workers' Transformation in Armed Conflict Zones

Research Paper

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ABSTRACT

Communities affected by armed conflict are striving to provide access to effective healthcare services in countries like Nigeria, where there exists a fragile healthcare system with an acute deficit of manpower and resources. This fragility has a negative impact on child health service delivery. mHealth is considered an excellent platform for enhancing/transforming the activities of community health workers (CHWs) in the delivery of effective health services. This paper aims to explore how mHealth implementation mediates and transforms the activities of CHWs in an armed conflict setting using activity theory as a lens. An interpretive research methodology was used, and the method of data collection was done mainly by participatory observations and interviews. The findings show that the introduction of an mHealth tool can transform the activities of CHWs in various ways. The study contributes to information systems research by broadening our understanding of the implementation of mHealth in armed conflict settings.

Keywords

ALMANACH, mHealth, armed conflict, community health workers, Nigeria.

INTRODUCTION

Community health workers (CHWs) are an essential component of primary healthcare systems (PHCs) in armed conflict settings of countries with developing economies (CDEs; Raven et al., 2020). Armed conflict communities are challenged by an acute shortage of staff because CHWs are either killed during attacks, or they have been forced to flee to safer places (Bernasconi et al., 2019; Byrne & Sahay, 2003; Raven et al., 2020). This could be one of the reasons why these communities have the highest maternal and child mortality rates (Chol et al., 2018). In 2015, for example, about six million children under the age of five died from mostly preventable illnesses in some conflict-affected countries such as Syria, Nigeria, and Niger (Asi & Williams, 2018). CHWs are responsible for providing a range of preventive, promotable and curative medical services in PHCs, especially, in maternal and child health care (Ngoma

& Igira, 2015). It is argued that, unless CHWs are adequately supported, their much-needed services in places that are plagued by armed conflicts will be suboptimal. Mobile health (mHealth) presents opportunity to improve support for CHWs by enhancing their activities (Nyemba-Mudenda & Chigona, 2018). However, the majority of places experiencing armed conflicts in CDEs have not had access to mHealth interventions (Istepanian et al., 2014). Therefore, research on the implementation and survival of mHealth in these peculiar settings is required (Istepanian et al., 2014; Raven et al., 2020; Woodward et al., 2014). mHealth is defined as "Medical and public health practice supported by mobile devices, such as mobile phones, patient monitoring devices, personal digital assistants, and other wireless devices" (World Health Organization, 2011, p. 5).

The widespread use of mHealth among CHWs can potentially enhance the capacity of CHWs to take on challenging and new tasks, particularly in maternal and child health care (Feroz et al., 2020; Lemay et al., 2012). For instance, mHealth can be used to improve the ability of CHWs to diagnose patients, track, and treat diseases. It can also be used as a tool for maternal and child health data collection (Bernasconi et al., 2019; Ngoma & Igira, 2012), thereby transforming the activities of CHWs in practice (Mechael, 2009). Despite the enthusiasm around mHealth implementations for improving the capacity of CHWs in armed conflict settings, empirically informed research about how and whether mHealth implementations affect CHWs in practice remains scarce in the literature (Lapão & Dussault, 2017; Raven et al., 2020; Woodward et al., 2014). It follows that attempts made to salvage child healthcare challenges in these communities through mHealth interventions depends largely on networks of governments, non-governmental organizations, communities and PHCs (Bernasconi et al., 2019). The scenario presents two challenges. First, the challenge of CHWs having to manage the complexities of the involvement of diverse stakeholders in mHealth projects in armed- conflict settings (Bernasconi et al., 2019). Second, the ability of CHWs to effectively use and internalize mHealth in practice in an existing activity system. Thus, the aim of this study is to understand how mHealth implementation mediates and transforms the activities of CHWs in armed conflict settings of CDEs.

Scholars and CHWs have reiterated the importance of having an in-depth understanding of context in the survival of mHealth projects (Byrne & Sahay, 2003; Walsham & Sahay, 2006). However, contextual knowledge is constantly ignored in the literature and in practice. In fact, Thondoo et al. (2015) describes mHealth projects, especially in CDEs, as having been implemented through a "top-down approach". This approach hardly involves the end user (in this case the CHWs) or the beneficiaries of the intervention, thereby neglecting some vital contextual characteristics that need to be considered at both the development and implementation stages.

There are concerns that unless mHealth is implemented following a sound knowledge of the socio-technical, political, and environmental contexts within which it is embedded, it will fail to reach the desired scale-up stage (Baduza & Khene, 2019; Byrne & Sahay, 2003). The term socio-technical is repeatedly used to refer to the interaction between society and people (social) and the technology and machine (technical) (Walker et al., 2008). Although complex regardless of where the mHealth is implemented, paying attention to these factors is fundamental in armed conflict settings of CDEs where most program implementers may not be familiar with the prevailing human, environmental, and political contexts (Istepanian et al., 2014). Therefore, a theoretical perspective that enables us to understand how mHealth can be implemented to add value to the activities of CHWs in practice in a fragile setting is provided in this study. Hence, activity theory was employed as the analytical lens in this study because it is useful for understanding practice (Kaptelinin & Nardi, 2018.; Nardi, 1995). Having stated these, the following research question is addressed: How does mHealth transform the activities of CHWs in practice in armed conflict setting of CDEs?

In addressing the research question, we draw on the ethnographic study of an mHealth implementation; Algorithms for the Management of Acute Childhood Illnesses (ALMANACH). The research was carried out within the PHCs in Adamawa State, Nigeria, to understand how mediated practices in children's clinics are carried out by the CHWs. Theoretically, the research contributes to activity theory by illustrating how mHealth can be utilized by CHWs to enhance their clinical practices in armed conflict settings of CDEs. Also, the study provides a theoretical understanding of how some socio-technical challenges of mHealth in practice can be managed. Generally, the study contributes to information systems research by broadening our understanding of how to address issues around mHealth in practice at PHCs of armed conflict settings of CDEs, where there is a dearth of studies.

RESEARCH CONTEXT

This study was conducted in Adamawa State, Nigeria. Adamawa State is located in the north-eastern region of Nigeria, with about 36,917 square kilometers of land with a population of 3.8 million (Bernasconi et al., 2019). The state is bordered by Taraba to the southwest, Gombe to the west, and Borno to the northwest and it shares an international boundary with the Cameroon republic to the east. Adamawa State has 21 local government areas (LGAs), and these LGAs are further classified into three zones; the northern, southern, and central senatorial zones. The northern senatorial zone and parts of the central senatorial zones have been directly affected by the Boko Haram insurgency while the southern senatorial zone has become home to thousands of internally displaced persons (IDPs) in the state (Yerima & Singh, 2017).

Boko Haram insurgents emerged in Borno State, north-east Nigeria in 2002 (Badau & Abdulrasheed, 2015). Though peaceful at the beginning, it became militant in 2009 after a clash with the Nigerian police which led to the death of more than 1000 people (Badau & Abdulrasheed, 2015). Boko Haram escalated when the Nigerian government killed their leader, Mohammed Yusuf in 2009 (Yerima & Singh, 2017). Reprisal attacks by the Boko Haram sect made many people homeless. Particularly, many women were made widows with no better alternative than to be housed at IDPs camp together with their children in Adamawa, Borno and Yobe states of north-east Nigeria (Yerima et al. 2017).

The unprecedented number of people in the camps coupled with the poor health services have led to the death of thousands and have made many others suffer from several other infectious diseases (Ekhatormobayode & Abebe Asfaw, 2019). The northern senatorial district and some part of the central senatorial district of Adamawa State, Nigeria was captured for six months by the Boko Haram insurgents in 2014 with devastating consequences. Many communities were destroyed including health facilities and massacres of inhabitants carried out leaving the communities under the control of the Boko Haram insurgents. Consequently, by the end of 2014, Adamawa State recorded approximately 450,000 IDPs in places that were considered safer. The effect of these attacks was heavily felt by the already weak health system leading to its destruction or complete shutdown with health workers having fled leaving behind the sick and wounded at their own demise.

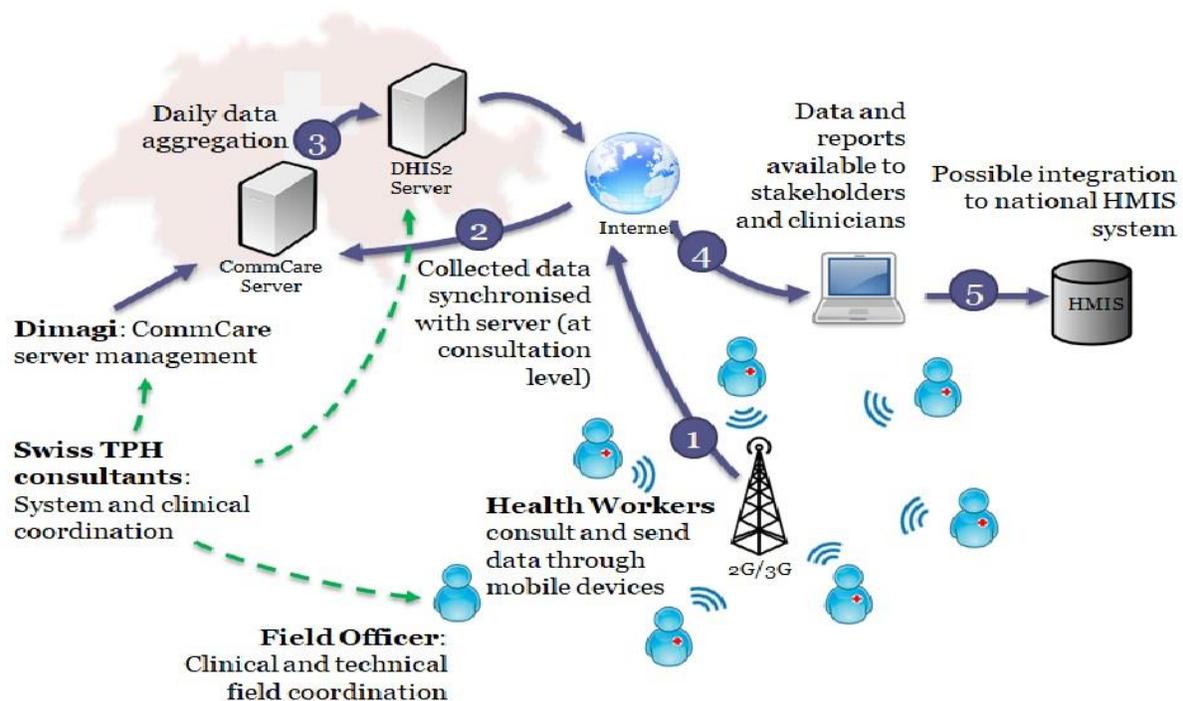
The healthcare system in Nigeria is categorized into three tiers; primary, secondary, and tertiary healthcare. The PHCs are established at the community level. They provide emergency services and handles non-complicated maternal and child health services to the immediate community. They also provide services like immunizations, and they make referrals to secondary healthcare facilities. The secondary healthcare facilities serve as referral centers to the PHCs and they provide a higher level of care. They provide more advanced medical services like surgeries and manages complicated health issues. More advanced medical complications are referred to the tertiary healthcare centers for the highest level of professionalism in Nigeria. An example of a tertiary healthcare center is the teaching

hospital where medical professionals like medical doctors are trained to the highest level in the medical profession (consultants) in a particular medical field. Tertiary healthcare facilities are often linked to universities. For example, the University of Maiduguri Teaching Hospital and the Lagos University Teaching Hospital. The tertiary healthcare facilities have more areas of specialization, not only in manpower but also facilities and equipment.

The empirical basis for this article is based on ALMANACH implementations at PHCs of Adamawa State, Nigeria. ALMANACH is a mobile clinical decision support tool. ALMANACH was piloted in Adamawa State in December 2016 to supply the high demand for an effective medical service to the growing number of children with medical needs resulting from incessant attacks by Boko Haram. ALMANACH intervention was implemented through a tripartite collaboration among the Swiss TPH, Adamawa State Primary Healthcare Development Agency (ADSPHDA), and the International Committee of the Red Cross (ICRC). The implementation of the intervention is ongoing, and it is expected to be fully implemented across all the 21 LGAs by the end of the year 2020. ALMANACH is an enhanced digital version of the World Health Organization (WHO) / United Nations International Children's Emergency Fund (UNICEF)'s Integrated Management of Childhood Illness (IMCI) running on android system tablets and smartphones. ALMANACH targets children from two months to five years old and it is aimed at improving the quality of pediatric case management at PHC level towards improving child health outcomes. Figure 1 presents the ALMANACH system architecture.

Figure 1

ALMANACH System Architecture



Note. ALMANACH = Algorithms for the Management of Acute Childhood Illnesses; DHIS2 = District Health Information Software2; HMIS = Health Management Information Systems; Swiss TPH = Swiss Tropical and Public Health Institute.

THE UTILIZATION OF MHEALTH AMONG CHWS

There is a shortage of about 2.5 million health workers (doctors, nurses, pharmacists) in CDEs (Naicker et al., 2009). These statistics are worsened by armed conflicts which has left many health workers with no better option than to flee to safer places (Raven et al., 2020). Therefore, CHWs are often the only health care service providers for millions of people in the CDEs (McCord et al., 2012). They act as a bridge between communities and clinics or hospitals. CHWs play a vital role in resource constrained settings, hence enhancing their capacity to deliver effective services to patients is crucial (Perry & Zulliger, 2012). One effective way in which this could be achieved is by equipping them with mHealth tools at the point-of-care (Liu et al., 2020). The use of mHealth is arguably a cost-effective and an immediate way through which the services of the CHWs could be enhanced (Perry & Zulliger, 2012). mHealth would advance point-of-care support whilst aiding quicker emergency response times (Mechael, 2009).

Diverse ways in which CHWs use mHealth in practice is acknowledged in the literature. The most popular mHealth implementations in CDEs include tools for disease surveillance and data collection (Ngoma & Igira, 2012), decision support systems (Bernasconi et al., 2019), and serving as a medium for delivering health informative messages to nursing mothers and pregnant women (Wolff-Piggott & Rivett, 2016). The majority of mHealth studies that specifically focus on CHWs tend to pay more attention to its impact on health outcomes. In those studies, mHealth interventions have been compared to paper-based (traditional) service delivery systems. Most often, positive mHealth impacts have been established largely in the area of maternal and child healthcare. For example, in a study on maternal health with specific focus on monitoring pregnant women by CHWs in Rwanda, an increase in clinic - based deliveries from 72% to 92% was recorded within a year of utilizing an mHealth intervention (Ngabo et al., 2012). Also, in Nigeria, a study on child healthcare service delivery by CHWs reported improvement in diagnostic accuracy. For instance, evaluation of danger signs at the beginning of consultation improves from 37% to 60% (Bernasconi et al., 2019). Similarly, findings from Medhi et al. (2012) in research on child health monitoring by CHWs in India, reported that the use of mHealth by CHWs has reduced the time spent collecting health data from 45 days to eight hours. It was also reported in the same study that patient form completion rates increased from 67% to 84%, and it has also minimized error rates from 9% to less than 1%. Additionally, a qualitative study by Thondoo et al. (2015) reveals some salient roles of mHealth in improving CHWs motivation and performance by reducing the need for travel and improving communication between supervisors and other CHWs. Istepanian et al. (2014) carried out a study on the potential of mHealth systems for diabetes management in armed conflict regions of Iraq. The key outcome of this study indicates the potential of deploying such innovations in these settings, where providing health resources is challenging and limited. The study however, laments on the lack of these technologies in armed conflict and post conflict settings.

While scholars present examples of positive outcomes of mHealth interventions in CDEs, more attention is paid to the technology than its users, to whom patient healthcare delivery is entrusted (Källander et al., 2013). There is little evidence of why or how mHealth can functionally support CHWs in practice. Moreover, there is a dearth of evidence of how interaction between mHealth and CHWs in practice must be evaluated (Haines et al., 2007). In addition, there is a need for a better understanding of how to design and implement mHealth that fits the requirements of the CHWs and the community (Braun et al., 2013; Byrne & Sahay, 2003). Furthermore, literature suggests the need for more mHealth implementations and studies in armed conflict and post conflict settings where these technologies are needed the most (Istepanian et al., 2014; Woodward et al., 2014). Consequently, two important concerns inform this study. First, there is a need for a detailed understanding of how mHealth intervention supports or transforms the activities of CHWs in practice. Second, this understanding could be used to

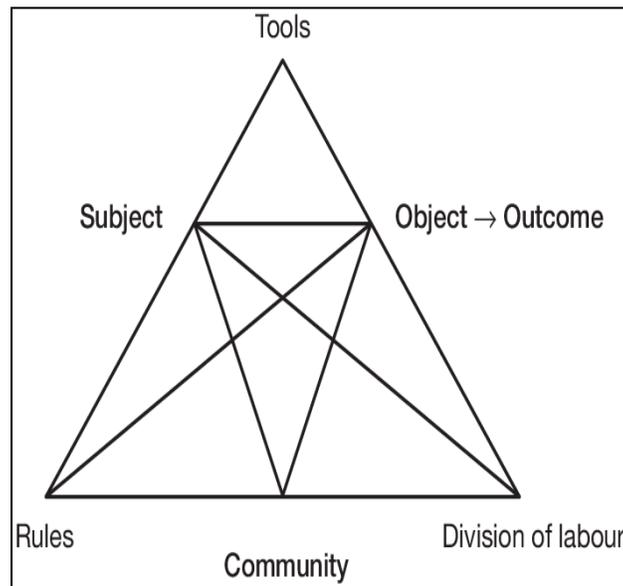
buttress the urgent need for the implementation of digital health in armed conflict settings. Furthermore, this study could be used as a guide to subsequent mHealth implementations in armed conflict settings.

THEORETICAL FRAMEWORK

Activity theory provides the theoretical lens that can be used to understand mediated practice (Kaptelinin, 2005; Korpela et al., 2000). For example, activity theory has been used in information systems studies to understand changes in practice and the challenges therein (Igira & Aanestad, 2009; Shidende, 2014). Activity theory also provides a holistic insight into the outcomes of collaborative activities. It also offers understanding of the political, economic, historic, and social-cultural factors constituting an activity, as well as the changes that occur as subjects interact with a new intervention (Gretschel et al., 2015).

According to Engeström (1996), activity theory has its roots in the works of German philosophy by name Lev Vygotsky and Russian social science Alexei Leontiev. It is a psychological theory that helps to explain the consciousness of human mind and activity. Activity theory accounts for the inseparable influence of our culture and histories on our actions, and how culture and history shape how we act in a situated context through the mediating activity (Engeström, 1996; Engeström & Middleton, 1996). The unit of analysis in activity theory is the activity system. An activity system is comprised of three main constituents: actors, practical activities in which they engage, and the context in which the activity is carried out (Jarzabkowski, 2005).

Activity theory has evolved through three generations. The first generation is based on a triangular model representing a triad relationship between subject, tools, and object. This basic representation of the activity system did not recognize the interaction between an individual and the environment. Engeström (1987) contextualized activity by extending the notion of the first generation of activity theory to comprise six components. Under this conceptualization, individual actions are now embedded within a community of people who are directed towards the same object (Kaptelinin, 2005). Leontiev succeeded in changing the notion of the object as an individual representation to a shared representation of the object between the community and the subject. The second generation of activity theory did not recognize cultural diversity and as activity theory spreads beyond the boundaries of the Soviet Republic where it was first developed, questions on cultural and traditional diversity as well as dialogue among the different traditions began to emerge (Engeström, 2001). These limitations led to the emergence of the third generation of activity theory. In the third generation of activity theory, Engeström and Middleton (1996) suggested an expanded version of activity theory that introduces the concept of community together with the object, tool, and subject, originally present in the first and second generations of activity theory. This is done so that the theory can capture all the complexities and dynamics in organizational context. The community captures the social, cultural, and human aspects of the activity system. This proposed conceptual model has found acceptance in the activity theory research community as a useful concept (Kaptelinin & Nardi, 2018). The Engeström (1999) model shown in Figure 2 shows the different aspects of the social world that provides resources for activities. The third generation of activity theory suggests two interacting activity systems as a minimal unit of analysis. Activity theory posits that the cultural-historical context of an activity is key to understanding its dynamics and characteristics (Engeström & Glăveanu, 2012). In other words, activity systems exist in a societal and an organizational context. This is an essential consideration when investigations are done in the context of countries with developing economies (Karanasios & Allen, 2014) and helps in addressing health-specific contextual issues (Wolff-Piggott & Rivett, 2016).

Figure 2*Activity Theory Framework*

Note. Adapted from Engeström, 1999.

The most central concept in activity theory is that of purposeful activity (Engeström, 2001; Kaptelinin & Nardi, 2018). Figure 2 represents an activity when a person or a group of people (subjects) are motivated towards finding a solution to an identified problem (object). This process is mediated by the use of tools to achieve the goal (outcome) of the entire activity in a social context (Kaptelinin & Nardi, 2009). A tool is not necessarily a physical object such as a hammer or mobile phone; a tool may be an idea or a concept that is used to advance ways of reasoning or action (Leonardi et al., 2012). The collective activity of the subjects is governed by cultural and socio-historical factors (rules) and the social organization of roles (division of labor) within the context (community) in which the activity occurs. Relationships between and among elements of activity systems is mediated not directed (Virkkunen & Kuutti, 2000). For instance, the rules mediate the relationship between the community elements and subject. The systemic stance of activity system implies that a change in one element, would produce changes in other elements as well (Nicolini & Monteiro, 2016). For example, a change in community elements, will affect the rules governing the activity and consequently the tool which mediates the relationship between object and subject.

Another fundamental concept in activity theory is that of contradictions (Allen et al., 2011; Ngoma & Iqra, 2012). Activity theory emphasizes that activity systems generally contain contradictions that manifest as stress within the system and can lead to changes (Engeström, 2001). An organization could be understood as a series of nested activity systems which may contain contradictions both within activity systems and between the different systems. Activity theory understands all practices as a process, since change is unavoidable in activity systems (Kaptelinin et al., 1995). Change in activity systems happens through contradictions which manifest themselves as tensions, disturbances, problems, or inconsistencies between the components of an activity system (Engeström, 2001). We use the lens of activity theory in this study to analyze the dynamics and mediation of mHealth by CHWs. Activity

theory allows us to consider the influence of the mHealth intervention in existing work practices, and the broader context of the health systems.

Two main actions comprised the ALMANACH activity system at the PHC level: pediatric consultation and treatment of children under the age of five, and real-time data generation from consultation reports. At the PHCs, CHWs would conduct clinical consultations, diagnosis, and treatment of children under the age of five with the aid of ALMANACH while at PHCs without ALMANACH, patients were diagnosed and treated with the aid of the manual treatment protocols.

RESEARCH METHODOLOGY

The research methodology employed in this study is interpretive in nature and the method of data collection was inspired by ethnographic fieldwork. This study was conducted in 11 local government areas (LGAs) of Adamawa State, Nigeria. The LGAs selected are Yola-North, Yola-South, Mubi-North, Girei, Mubi-South, Maiha, Song, Hong, Gombi, and Michika, Fufore. These LGAs formed the investigative context of the study based on the argument that these LGAs have been directly or indirectly affected by the Boko Haram insurgency, making them either communities that have been directly hit and displaced by Boko Haram from 2014 to date, or communities that have housed or are housing IDPs. Table 1 summarizes this classification. In these LGAs, 24 PHCs where ALMANACH intervention has been implemented and nine PHCs where ALMANACH is yet to be implemented were studied. This was done to capture the historic component of activity theory. Also, to allow us to understand how CHWs manage change in their activities while moving from a traditional to an innovative system (Engeström, 2001). The data collection for this study was done through different overlapping phases. Data collection was done from February 2018 to June 2019, from November 2019 to January 2020 and then, from February 2021 to March 2021. We employed a qualitative research approach, because the research was concerned with exploring mHealth in practice (Silverman, 2005). Ethnography inspired the data collection methods. Ethnography is fundamental to understanding practice by focusing on how practitioners accomplish practices in their cultural context (Draper, 2015). In this ethnographic study, participant observation, semi-structured interviews, and document reviews were used as data collection techniques. These are recognized common data collection methods for ethnographic studies (Hammersley, 2018).

Participatory observations were made in ten PHCs to observe pre and post ALMANACH implementation processes. Each session of participatory observation lasted between 45 minutes to two hours. Our observations covered the traditional method of clinical consultation of children (the use of IMCI chart), the processes of implementing ALMANACH including the training sessions, and pediatric consultations with the aid of ALMANACH. Activities such as training of CHWs and the implementation of ALMANACH at the PHCs were also observed at different times over a period of about 60 months. Clinical consultations, data recording, and how data is transferred into the ALMANACH main database were also observed. We participated in three steering committee meetings in June 2019, December 2019, and February 2021. In these meetings, details around ALMANACH were discussed and reflected on among all the key stakeholders.

A total of 55 one-on-one semi-structured interviews were conducted with the health workers. The interviews were conducted in Hausa and English languages, as necessary. During these participatory observations, we interacted with CHWs and with the ALMANACH project donors at meetings and during the training sessions. We also conducted some semi-structured interviews to get an understanding of CHWs work practices around child health care services. In some cases, we performed group interviews for a group of CHWs doing certain activities like training. In most cases we performed in-situ

interviews with the CHWs. We had encounters with 18 CHWs, four nurses, two laboratory technicians, and seven patient relatives. A summary of the interviewees is presented in Table 1. Rigorous observations and data triangulation were important techniques used to strengthen the credibility of this ethnographic research (Sandelowski, 2010).

Table 1
A Summary of Research Participants

Type of Informant	No. of Informants	Total No. of Interviews
CHWs	18	40
Nurses	4	6
Laboratory Technicians	2	2
Patient Relatives	7	7
Total	31	55

Note. CHW = Community health workers.

Purposive sampling was used in this study to set the criteria for selection. The criteria for selection included being a stakeholder in the ALMANACH project for Adamawa State, Nigeria. PHCs selected are those that have implemented ALMANACH as a new model of activity, and PHCs currently using IMCI but marked for ALMANACH to be scaled to those PHCs. Participants must be 18 years and above and inhabitants in the Boko Haram affected areas. These criteria apply to both PHCs where the new model of activity has been introduced and PHCs where they still use the traditional model of child health care service delivery (IMCI chart).

The interview sessions were recorded using a handheld recorder. Notes were taken during observation and interview sessions. The qualitative data collected using interviews were audio recorded and were then transcribed in a written format using an exercise book. In total, 24 pages of notes of qualitative data were written, grouped, and analyzed using the principles of thematic analysis (Braun & Clarke, 2006). This included thorough and repeated readings and listening to the transcribed data to get a summary of the main themes as discussed by the participants. Next, a set of themes and relevant quotations from interviews and observations were produced. Conclusions are then drawn based on the identification of these themes. The key concepts of activity theory were used to summarize segments and identify themes and patterns in the qualitative data.

A research proposal for conducting the research was submitted to and approved by the research and planning department of the ADSPHDA. Ethical issues were addressed during data collection and analysis. The researchers obtained prior oral consent from research participants to conduct interviews or observation. The participants were also informed about the purpose of the research, the potential benefits of the findings, and that their anonymity would be preserved.

ANALYSIS OF FINDINGS

Concepts from activity theory as seen in Table 2 were used to inform the analysis of empirical data which may constrain or may enable CHWs' transformation. Results from the empirical data provides the

historical account of ALMANACH, the synergy between the IMCI and ALMANACH activity systems, the production of ALMANACH and behavioral patterns in adherence to new rules as elaborated next.

Table 2

Description of the Components of ALMANACH Activity Systems

Components of Activity Theory	Description of Components	Components in ALMANACH Activity System
Object	Why is the activity taking place?	To improve the diagnostic and treatment accuracy of CHWs.
Subject	Who is involved in carrying out this activity?	CHWs and ALMANACH project donors.
Tool	By what means are the subjects performing this activity?	Mobile tablets (ALMANACH) and IMCI chart.
Rules	Are there any cultural norms, rules or regulations governing the performance of this activity?	All clinical consultation of children under the age of five at PHCs must be aided by the ALMANACH.
Division of Labor	Who is responsible for what, when carrying out this activity and how are the roles organized?	ADSPHDA for policies, training of CHWs and providing an enabling environment for ALMANACH to function. Swiss TPH for technical support. ICRC for the provision of mobile tablets and training of CHWs on how to use ALMANACH in practice. CHWs for provision of child health services using ALMANACH at PHCs. Community volunteers for community enlightenment.
Community	What is the environment in which activity is carried out?	Catchment population, ADSPHDA, Swiss TPH, ICRC, community volunteers, CHWs, researchers.
Outcome	What is the desired outcome from carrying out this activity?	To improve child health outcomes and reduce child mortality figures.

Note. ALMANACH = Algorithms for the Management of Acute Childhood Illnesses; CHW = Community health workers; IMCI = Integrated Management of Childhood Illness; PHC = Primary health care; ADSPHDA = Adamawa State Primary Healthcare Development Agency; ICRC = International Committee of the Red Cross; Swiss TPH = Swiss Tropical and Public Health Institute.

The Historical Account of the Tool (ALMANACH)

Analysis of the empirical data began by drawing insights from the traditional activity system (IMCI). This is done because historicity is an important tenant of activity theory (Engeström, 2001). Historicity is understood in this study as the activities that occurred before and during the ALMANACH pilot

implementation phase. Thus, the historical account of implementing ALMANACH begins from having a clear understanding of the scenarios and activities that led to the introduction of ALMANACH as an innovative tool for CHWs transformation in child health work practice in armed conflict settings of CDEs.

In the late 1990's, UNICEF and WHO developed guidelines for the management of acute childhood illnesses in resource-constrained settings (IMCI). The aim of developing IMCI is to reduce mortality in children under the age of five. Unfortunately, IMCI comes with some major drawbacks. Some of these drawbacks are that it only assesses a small number of the several causes of acute childhood illnesses. The illnesses captured on IMCI are malaria, measles, malnutrition, pneumonia, and diarrhea. These are considered the five major childhood killer diseases in CDEs. Also, it has been discovered that the IMCI has the tendency to lead CHWs to wrong drug prescriptions (Bernasconi et al., 2019). Overall, IMCI has the challenge of being a paper-based guide which may prove cumbersome and sometimes difficult to manipulate during clinical consultation. Consequently, UNICEF is still struggling to implement and scale-up IMCI especially in fragile communities due to the scarcity of CHWs. Additionally, the established system of clinical supervision, training, and data collection has been badly disrupted by the armed conflicts. Until today, Adamawa State, Nigeria is still witnessing frequent internal clashes between farmers and clans. Also, some communities are still being threatened and attacked by the Boko Haram insurgents.

Following these trends of activities and its observed challenges, in 2015 the ICRC provided support for the development of ALMANACH, which is an electronic and extended version of the IMCI. Adamawa State, Nigeria was chosen to gain experience with ALMANACH by implementing it as the standard tool for child consultation in its PHCs. This support follows the implementation of ALMANACH in conflict and post-conflict settings of Tanzania and Afghanistan. ALMANACH is considered a dependable solution to improve the quality of care of children under the age of five in a volatile security context and it is based on two basic activities. First, it is to provide accurate clinical diagnosis and treatment. Second, ALMANACH is designed to be able to collect real-time data on children under the age of five. ALMANACH was designed to guarantee an improved quality of care with minimal supervision due to shortage of manpower at the PHCs or inaccessibility to the health facilities. Furthermore, it contains an on-the-job training element, through routine use of its algorithms. To enhance training and specialization of the CHWs, educational materials have been imbedded in the algorithm and mobile tablets (guidelines, footages, videos, pictures, PowerPoint, and presentations). Under these premises, ICRC's vision was supported by the ADSPHDA for the implementation of ALMANACH in all its PHCs, with the Swiss TPH providing the technical support. Starting in December 2016, ALMANACH was piloted in twelve rural PHCs in Adamawa State. These PHCs were located in IDPs host communities and communities that have been recaptured by the Nigerian military after they were completely raided and sacked by the insurgents in 2014. The recaptured communities will henceforth be referred to as the "returnee" communities in this study.

At the initial stage of ALMANACH project, activities were planned, roles assigned to each stakeholder, rules and regulations governing all the ALMANACH activity systems were set, and timelines were developed. This was done to tackle the concerns of "multi-voices" which may arise from diverse opinions of the stakeholders and possible tensions that may arise as the multiple stakeholders' implement and interact with the tool. Consequently, ADSPHDA was assigned the responsibility of training CHWs on the use of ALMANACH in practice. ADSPHDA was also responsible for piloting and scaling up the project to cover all PHCs in the state. ICRC had responsibility for the purchase and maintenance of the mobile tablet. The Swiss TPH is responsible for the system design, hosting,

maintenance, and managing the database. Monitoring and evaluation of the project was done in collaboration amongst all stakeholders of the project.

In the major IDP host communities where there were high cases of childhood illnesses, two ALMANACH devices were given, where one was always at the clinic while the other was taken into the community and to the IDP camps by community volunteers and CHWs. The community volunteers are members of the community who have received training in this regard. They serve as a bridge between communities, especially the IDPs and the PHCs, by enlightening the members of the community, especially the IDPs, on the importance of ALMANACH. A baseline study was conducted after a year of pilot implementation to monitor and evaluate the impact of ALMANACH on the quality of care provided to patients attending these PHCs. Findings from the baseline study were gathered through a before-and-after assessment of the consultation processes of the CHWs and the health outcomes of the patients. Based on the findings of the study, modifications in the content of the algorithm or in the implementation strategy was undertaken, to further improve the clinical efficiency of the CHWs. Thereafter, some remarkable improvements on CHWs clinical accuracy were identified. Also, improved child health outcomes were also recorded at the pilot sites of ALMANACH implementation. It was then decided that ALMANACH will be scaled- up to state-level to cover all the PHCs in the state.

The Synergy and Variances Between IMCI and ALMANACH

The processes described in the preceding and following sections show that there is some level of synergy between the traditional and innovative activities. In similarity with the IMCI protocol, ALMANACH begins consultation with the screening of the four leading “general danger signs”: (a) the child is unconscious/lethargic, (b) the child has had convulsion or is convulsing, (c) the child is not able to breastfeed/drink, and (d) the child is vomiting everything that is swallowed. In cases where danger signs are present, an urgent referral of that patient is triggered. Each process of consultation requires that the bodyweight of each patient be measured. With patients who are older than six months and patients who weighed more than 3.5 kg, the health worker is instructed to measure the child’s mid upper arm circumference for malnutrition screening. This is done manually with IMCI while ALMANACH electronically calculates the therapeutic doses according to the weight of the patient.

Suspected cases of malaria are confirmed by laboratory test results. Further information required in the process includes the immunization status of the patient. The consultation process with both tools ends with data entry that provides feedback, disease monitoring, research, and surveillance.

CHWs were asked during interview sessions, to describe the differences and similarities between IMCI and ALMANACH. A typical response is as shown below:

The ALAMANCH well matched the settings and philosophy of the IMCI and both systems have the same treatment protocol. The major difference is that consultation with the ALMANACH is done electronically while consulting with the IMCI is done on a hard copy file. The similarities between them made it much easier for the health workers to accept and internalize the innovative activity without it having to meet too much resistance.

However, some areas of conflict between the traditional and innovative activities were identified. The PHCs, under the traditional activity, generate medical data on children under the age of five from their records of consultation which is done using the “pen on paper approach”.

The data is supplied to the relevant authorities only when they demand it or during their routine visits. This functioned within the framework of IMCI. CHWs interviewed felt posting and regular updates of data electronically was inconsistent with the traditional activity, even though they concur that it is the

most effective method for disease surveillance and response. When we asked further, in trying to understand why this was considered a conflict, CHWs had this to say: `

Uploading data electronically can only be done where there is an internet connection. This we do not have since Boko Haram attacked many of our villages and destroyed many facilities. So, we have to travel some distance to where we can access internet services before we can upload our data. This is stressful and our safety on these roads is not guaranteed!

The quote above suggests that both the traditional and innovative systems of regular electronic updates of data are affected by poor infrastructure. ALMANACH delivers an inconsistency due to its built-in data consistency nature which does not adequately take account of external influences like reoccurring attacks by Boko Haram insurgents.

Again, another conflict that was identified during our data collection was that some PHCs do not provide funds for data upload to the server even though it was ascertained that each PHC has been mandated to provide the sum of 100 naira (N100) weekly for data bundle subscription. CHWs narrate this:

Because I understand the importance of ALMANACH in our facility, I have decided that I will be buying a data bundle of 100 naira weekly only to be uploading the data that has been generated from our PHC. This I have been doing for over two years now, and I am not complaining.

The research team believes that this situation is not sustainable and hopes that the anomaly is corrected as it will bring about inconsistencies between the PHCs.

Several health workers expressed their dissatisfaction of each of the activity systems existing as a stand-alone intervention. They claim that there is no harmony between the IMCI and ALMANACH interventions as each intervention donor has its monitoring and supervisory team, who are always out on routine supervision to check whether or not the CHWs are still adhering to their protocols. Therefore, the CHWs expressed that:

We are always caught in a dilemma of having to use either IMCI or ALMANACH and this affects our overall performance as a facility. On this account, we see other PHCs where ALMANACH is yet to be implemented to score higher points than us because they are not faced with this confusion.

Despite this challenge most of the health workers are happy with the introduction of ALMANACH as a mediating tool in practice and they believe it has made them better health workers.

CHWs Perspective on the Creation of Tools

ALMANACH was introduced to 59 CHWs from three different LGAs (Maiha, Girei and Yola-South) in 2018 during a three-day training session. The CHWs subsequently use this mHealth system each time they needed to diagnose and treat children under the age of five at their respective PHCs in Maiha, Girei and Yola-South LGAs. Some CHWs narrated their ordeal to us by saying this:

We never heard of ALMANACH until our boss was invited for a training at the state headquarters. Our fears are; is this ALMANACH better than the other treatment protocols we have here in our clinics? Have they adequately captured the peculiarities of our communities?

Although literature suggests that scalable and sustainable mHealth should be designed and implemented in a participatory manner (Byrne & Sahay, 2003), the narrative above indicates that participatory

approaches have not been employed in the process of implementing ALMANACH: Neither the community nor the CHWs were involved in the planning and implementation of ALMANACH. Nonetheless, it was observed that CHWs are using the ALMANACH in their routine child health service delivery. Analysis of interviews with CHWs who have been trained to use ALMANACH during pediatric consultations has revealed evidence that they found ALMANACH to be an important tool. They also said ALMANACH has played an important role in transforming their routine child health clinical practices. For instance, it was observed at the pre-implementation phase at PHCs where ALMANACH was yet to be implemented that CHWs have been repeatedly omitting or ignoring some vital consultation steps in the IMCI. This act is in line with Bernasconi et al. (2019) where they argue that the CHWs find it difficult to comply by the rules of IMCI. The CHWs also attested to us that:

The IMCI is a complicated chart. In fact, flipping through the pages before our patients sometimes make us look incompetent. Also, following the IMCI protocol can be time-consuming especially in our facility where we record a high turn-out of patients because of the IDPs.

The statement above confirms the need for developing a more user-friendly protocol which could overcome the challenges of the traditional system of pediatric consultation. Hence, the need for creating an innovative tool like ALMANACH. The production of ALMANACH represents a transferal of some health worker power to technology (Woodside, 2016). The new tool regulates the activity of pediatric consultation and management by adequately ensuring that all steps of consultation are strictly adhered to. With ALMANACH, it is impossible to skip a step of consultation because the algorithm follows a step-by-step approach towards completing a consultation process that has been initiated. Therefore, the CHWs are forced to rely on the technology as well as allow the technology to shape their thought process. The CHWs are gradually internalizing ALMANACH in their practice as a mediating tool. Internalizing tools forms a part of the process of becoming an expert (Sellman, 2003), in the case of this study a transformed health worker.

Some trainees spoke to us during interviews on how they were beginning to use the ALMANACH in other contexts. A health worker described how she was beginning to use and reproduce the internalized knowledge by saying this:

I am so used to ALMANACH to the extent that I now find it difficult to consult any child whether or not the child is above five years without carefully taking his/her vital signs. In short, I use the skills I have learned from ALMANACH to consult adults as well. This I hardly do in the traditional activity even with children under the age of five. I also take out time more often now to counsel parents on health-related issues, as well as nutrition. All these I have learned from ALAMANCH.

The accounts of these CHWs suggest that many characteristics of this innovative tool have been internalized. This is evident in the ability of CHWs to apply the knowledge gained from ALAMANCH in a new context. Therefore, the first step to externalization has been initiated (Vygotsky, 1978). If the approach to diagnose and treat in the new context is accepted, it implies that the tool has shaped some of their thought processes by influencing the way they act. Furthermore, the account of the CHWs above confirmed assertions by other scholars on the scarcity of health workers in armed conflict settings (Raven et al., 2020; Thondoo et al., 2015). Comments by the CHWs have shown that they lack a particular field of expertise as a particular health worker could be seen providing health support that includes consultations and counseling to adults and patients' relatives. These, on the other hand, show that the creation of tools has helped augment the challenge of qualified staff shortages in a way that was narrated by a laboratory technician:

Although I am a technical staff, I am the only staff in this facility and this means I have to treat all patients that come to this clinic for medical services and with ALMANACH, work is easy for me. It has significantly improved my diagnostic and treatment skills. I am able to learn certain consultation guidelines on my own and I now treat my patients with confidence.

The technical staff are aware that he is not a clinical staff. However, he is the only person in that clinic as all other staff have fled the village because of insecurity. Therefore, technical staff play the dual role of being both technical and clinical staff, even though it is against medical ethics.

The production of tools in the child activity system is further discussed to identify the procedural and behavioral patterns involved.

Behavioral Patterns in Adherence to New Rules

The implementation and use of ALMANACH places greater emphasis on the dependence on technology rather than on an individuals' knowledge. Therefore, the CHWs had to lay down some of their methods of consultation and treatment to adopt the consultation steps that are embedded within the ALMANACH. For example, we observed at some PHCs during observations and interviews that many patients resist referral to a higher facility of care. Resistance has been mostly based on financial security, and a more tedious protocol that they would have to pass through at the secondary care facilities. PHCs that have not yet implemented ALMANACH experienced more resistance. A reason for resisting referral, which is not peculiar to the context of this study, is related to the security risks present on the roads leading to the higher healthcare facilities, especially at night when the roads are deserted. It is based on these complaints that some health workers gambled on keeping the patients at the PHCs. However, the innovative activity has changed this thought process by having a better understanding of the consequences of keeping such patients under observation at the PHCs instead of insisting on referrals. In the innovative activity, many CHWs have now devised means of convincing patient relatives about the dangers of keeping complicated medical emergencies at the PHC level. The health workers confirmed to us that the new strategy is working for them and that they have succeeded in changing the perceptions of many patients' relatives towards referral. Thus, ALMANACH is considered a medium through which behavioral patterns are changed. An interesting aspect of this new form of social relations and thought processes is getting the patients' relatives to realize that they are critical stakeholders in the process of providing healthcare service to their wards, rather than having everything being done for them by the CHWs.

Another behavioral pattern discovered in the course of this study is that at the initial stage of ALMANACH implementation in many PHCs, CHWs felt the tool was complicated with too many unnecessary procedures. Many CHWs were concerned about the few minutes that they spend on taking the vital signs of patients as well as the increased number of referrals that they have been making. But with subsequent on-the-job training and supervision, the CHWs understood the relevance of the processes in their practice. This was confirmed to us in the comment below:

When I started using ALMANACH in this clinic, my complaint has been that I spend more time on a patient now than I used to with the IMCI. However, as time goes by, I realized that I spend quality time with my patient trying to understand some important things through taking of vital signs and laboratory findings. ALMANACH has transformed me into a better clinician who is not only bothered about time spent on a patient, but on the health outcome of my patients.

The statement above is a confirmation that mHealth has improved the performance of CHWs across different contexts and that it is a transformative tool in practice (Thondoo et al., 2015). Table 3 below is a summary of major transformative outcomes of ALMANACH on CHWs.

Table 3

Summary of Major Transformative Outcomes of ALMANACH Project on CHWs in Practice

Major Transformative Outcomes of ALMANACH on CHWs	No. of Interviewees who Supported the Statement	Total No. of Interviewees
Improved adherence to globally standardized diagnostic and treatment protocol in child health	17	21
Internalization and externalization of child health diagnostic and treatment protocols	14	21
Enhancing the skills of technical staff at PHCs where there are no CHWs	8	15
Emergence of social relations between CHWs and patient relatives'	20	31
Improved advocacy through community engagement	14	21

Note. ALMANACH = Algorithms for the Management of Acute Childhood Illnesses; CHWs = Community health workers; PHC = Primary health care.

DISCUSSION

In similarity with the works of Kenny et al. (2017) and Nyemba-Mudenda and Chigona (2018), empirical data presented in this study proposes that the implementation of an mHealth tool (ALMANACH) in PHCs transforms the practices of CHWs. The majority of the trained CHWs in conflict settings are excited about the creation and introduction of ALMANACH as a mediating tool in child health clinical practice. This can be understood as a shift in the division of labor and in the creation of new rules, in which CHWs modify their principle of power and control to give technology greater responsibilities. In this regard, the CHWs use ALMANACH to effectively diagnose and treat children as well as to provide an important source of data for epidemiological and disease surveillance. This was not the case with the IMCI protocol. Results from the current study concur with the findings from extant literature which posits that, with ALMANACH, pediatric consultation complies with the globally standardized guidelines of diagnosis and treatment of children (Bernasconi et al., 2019; Braun et al., 2013). Other outcomes of health worker transformations which were explored in the study included gains in self-confidence of health workers. The innovative activity also produced some unexpected outcomes at several PHCs. Examples of such outcomes was the emergence of social relations between patient relatives and health workers externalizing the innovative activity, and evidence of CHWs self-sponsoring the cost for data upload to the central database. The collective ownership of intervention was also seen when PHCs devised means of securing the mobile tablets in a security challenged environment. These outcomes were most evident at PHCs where health workers were prepared to modify their thought process.

This study is situated in a conflict setting, which is largely characterized by a noticeable lack of qualified health workers and health facilities that could support the provision of effective health care services (Bernasconi et al., 2019). Our empirical findings align with this assertion where it was revealed to us at some returnee PHCs. As a result, some of these PHCs devised an unacceptable means of solving the problem of a complete lack of qualified health workers. In these PHCs, technical staff were seen using the ALMANACH to clinically diagnose and treat children. The technical staff are specifically laboratory technicians whose roles are supposed to be only at the laboratory. But because these communities also need to access health care services, the available service providers must be patronized, even though inappropriate. Empirical observations show that ALMANACH has been providing high-level support to these category of health workers and that it has helped in improving their general diagnostic and treatment skills. Nonetheless, such existing practices, if not discouraged, may exacerbate the already fragile health systems in armed conflict settings of CDEs and subsequently worsen health outcomes. Our study also reveals some level of resistance demonstrated by the community. This was seen mostly at the initial stage of implementation (pilot sites) and these were basically communities housing the IDPs. To overcome this major challenge, some community members, who are also IDPs volunteered, and they were trained to serve as mediators between the IDPs and the PHCs. Their roles include enlightening their people on the need to take their wards to the clinics once they notice some symptoms. Also, they re-orient the community about their initial perception of ALMANACH. At some point, the community volunteers were permitted to take the ALMANACH device to the IDP camps, although this was done alongside the CHWs. In such instances, sick children were treated at the camps and subsequently acceptance among the IDPs increased and higher numbers of patients were recorded at the PHCs. This narrative implies that contextual factors like culture were not considered at the planning and initial stage of developing ALMANACH. It is also a confirmation that most of mHealth interventions in CDEs are deployed following the “top-bottom approach” (Thondoo et al., 2015). Furthermore, analysis of findings suggests that ALMANACH was not designed and implemented in a participatory manner as recommended by scholars (Byrne & Sahay, 2003; Lemaire, n.d.).

Activity theory was used as a lens in this study to explore the outcomes of CHWs transformation in the provision of child health care services. For instance, the concepts of tools, division of labor, and the interrelationship between IMCI and ALMANACH activity systems have helped us to gain deep insights into how CHWs transformation was achieved through ALMANACH. Activity theory also provides us a lens to analyze the past and current state of pediatric practices. Considering people as drivers of the activity, with the emphasis on researching mediating components such as tools, division of labor, and rules, presents the researchers the structure to observe and analyze activities within a defined context. By applying this theoretical lens, various activities within the complex work system were observed and analyzed dependently, but the interactions among the work activities became evident. The gaps, conflicts, and breakdowns in the interactive activity systems were identified. Although activity theory is useful and relevant in this study, it is essential that researchers keep an open mind during data collection and analysis. This is because many data may not fit into the activity theory framework. It is therefore important that careful planning for data collection, revision, and data analysis are undertaken (Lin et al., 2013).

CONCLUSION

Using activity theory, we were able to analyze how the introduction of the mHealth initiative has transformed CHWs in practice in a fragile community. An ethnographic study of the implementation of ALMANACH in armed conflict settings of Nigeria is used to illustrate this perspective. The contribution of this study is to apply the concept of activity theory by providing a lens to enable deep understanding

of the mediating role of mHealth on CHWs in armed conflict settings of CDEs. However, the study is limited by its inability to generalize its research findings, considering the research approach employed.

In contexts of armed conflict, child health care, mHealth, and CHWs, the mediating role of mHealth between CHWs, patients, and the health system is critical because of its benefits of providing an effective and standardized quality of care. The role of mHealth is further amplified due to the acute human resource shortages particularly in communities that have been affected by armed conflict. All CHWs have a common need for support from scalable and sustainable digital health interventions to help them fulfil their much-needed role. CHWs, particularly in armed conflict settings, have the most challenging of jobs and this is where digital health services like mHealth are lacking. Finally, the potential for CHWs to use mHealth to improve child health service delivery in security challenged settings is undoubtedly great; however, more evidence-based studies are necessary to guide policy and program implementation.

Finally, our future work will employ a participatory approach by stakeholders in order to explore systemic challenges to the sustainable scalability of mHealth in armed conflict settings of CDEs.

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