UC Berkeley
UC Berkeley Electronic Theses and Dissertations

Title
Where There Are No Landlines: Mobile Technology, Community Health Workers and Family Planning

Permalink
https://escholarship.org/uc/item/81t1v3kg

Author
Braun, Rebecca

Publication Date
2013

Peer reviewed|Thesis/dissertation

Where There Are No Landlines:
Mobile Technology, Community Health Workers and Family Planning

By

Rebecca Ann Goldberg Braun

A dissertation submitted in partial satisfaction of the

requirements for the degree of

Doctor of Public Health

in the

Graduate Division

of the

University of California, Berkeley

Committee in charge:

Professor Malcolm Potts, Chair
Professor Emily Ozer
Professor John Canny
Professor Tracy Weitz

Fall 2013

Abstract

Where There Are No Landlines:
Mobile Technology, Community Health Workers and Family Planning

by

Rebecca Ann Goldberg Braun

Doctor of Public Health

University of California, Berkeley

Professor Malcolm Potts, Chair

Access to family planning has powerful health, social and economic benefits for families and communities. Family planning use protects the health of women and their children by spacing births, preventing unwanted or high-risk pregnancies, reducing the need for abortions and helping to fight HIV/AIDS. Further, family planning use supports women's rights and opportunities for education, employment, and full participation in society, and protects the environment by stabilizing population growth. In high fertility societies, slowing rapid population growth through voluntary means greatly facilitates economic and social development. While significant progress has been made in the provision and uptake of family planning, an estimated 222 million women around the globe who want to avoid pregnancy are not using an effective, modern method of contraception. Community based family planning (CBFP) programs can successfully reach remote, resource-constrained populations with high unmet need for family planning. The most common approach to CBFP is the community-based distribution of contraceptives, in which community health workers (CHWs) provide family planning education and counseling, contraceptive methods, and referrals for clinic-based services.

The past decade has seen worldwide rapid growth in the delivery of health services via mobile communication devices, collectively known as mHealth. With the increased availability, adaptability and capability of mobile phones come new prospects for improving the quality of and access to health care. Increasingly, these new technologies are being developed, tested, and deployed with CHWs in developing countries. mHealth tools could enhance community-based approaches to family planning, yet this potential is only beginning to be explored. Accordingly, FHI 360, the Tanzania National Institute for Medical Research, Pathfinder International, and D-Tree International collaborated on the development of a mobile phone job aid for family planning service delivery by CHWs in Tanzania. The introduction of this mobile job aid presents an exciting, innovative opportunity to increase knowledge about, access to and use of family planning information and services. This dissertation aims to provide data that can improve the design, implementation, monitoring and evaluation of mHealth projects targeted for CHWs, and can inform program and policy decisions to implement mHealth technologies into future family planning efforts, in Tanzania and beyond.

Acknowledgements

To Malcolm Potts, thank you for your trust, support and inspiration over many years. It is people like you who make this world a better place. I can only hope to follow in your footsteps – and maybe blaze a few new ones along the way. To Tracy Weitz, Emily Ozer and John Canny, thank you as well for your insight and guidance in this process. And to Cheri Pies, my dear friend and mentor, thank you for always believing in me.

To my parents Peter and Roberta, and my brother Dan, I simply could not have done this without you. I am thankful for your love every day. And to my grandparents Milton, Harriet, Jennings and Tamar, and all my frousins, I am blessed that you are in my life.

To my DrPH classmates Joe, Sophia, Heena and Tony, hands down the best part of this experience was sharing it with you. Thank you for your friendship and support.

To Katie, across the room, the continent or the globe, we did this together! All my love.

To Sylvia, my neighbor, my teammate, my editor, my friend. So many thanks are due.

To Jenny, our bet paid off! Thank you for keeping me on track and in good sprits too.

To Mitzi, you were here from the night I applied to this program to the night I finished it. Thank you for your insistence that I take good care of myself. Two paws way up to you!

To Courtney and Divya, I could never have completed my doctorate without you, whether we were at the gym, the pool, the coffee shop or the Bixby Center basement.

To Archana, Greg & Gwen, Monica & Ricky and Sarah & Aaron, thank you for literally putting a roof over my head and continuing to let me raid the fridge. You are family too.

To my Guate Girls, I hold the memories we share so close to my heart. I love you all.

To James and Jamie, my Men of Leisure, thank you always for making me laugh.

To Misti, Madeline, Jess, Claire, Aimee, Silvia, Michelle, Sally and Julia, you are the women that inspire me. Thank you for showing me the true meaning of friendship.

To Ali and Mary, I am so lucky that NC brought you into my life and you're here to stay!

To Lis, Jess & Riss, so many years of juicy mangoes gone by, and I still cherish you all.

To my colleagues at CFHC, thank you for your flexibility and patience. You're the best!

To my colleagues at FHI 360, and the participants in our study, thank you for working tirelessly to improve access to family planning for women in Tanzania and across the globe. This work belongs to you all as much as it does to me, and I am forever grateful.

Table of Contents

Chapter 1. Introduction

Access to family planning has powerful health, social and economic benefits for families and communities. Family planning use protects the health of women and their children by spacing births, preventing unwanted or high-risk pregnancies, reducing the need for abortions and helping to fight HIV/AIDS. Further, family planning use supports women's rights and opportunities for education, employment, and full participation in society, and protects the environment by stabilizing population growth. In high fertility societies, slowing rapid population growth through voluntary means greatly facilitates economic and social development. While significant progress has been made in the provision and uptake of family planning, an estimated 222 million women around the globe who want to avoid pregnancy are not using an effective, modern method of contraception (Singh, 2012).

Community based family planning (CBFP) programs can provide family planning services in remote, resource-constrained areas that often lack hospitals and clinics. CBFP programs are often initiated within national heath systems using existing resources, yet as community needs exceed capacities, these systems increasingly turn to local community members to provide access to these services (Prata, 2005). The most common approach to CBFP is community-based distribution of contraceptives, in which community health workers (CHWs) provide family planning information and counseling, a range of contraceptive methods, and referrals for clinic-based services via home visits and individual and group meetings to women and men in their own neighborhood or village (Foreit, 2011).

CHWs most commonly distribute condoms and oral contraceptives (Babalola, 2001; Burket, 2006), though in the past few years a significant amount of success has been seen with the community-based distribution of longer-acting reversible contraceptives, namely injectable contraceptives (Stanback, 2007; Hoke, 2011), a policy now fully supported by the WHO (Stanback, 2010). More recently, pilot studies have explored the community-based distribution of implants and intra-uterine devices (Wesson, 2007; Aradhya, 2009). These changes in service provision represent a significant advancement for family planning access, as longer-acting contraceptive methods have been found to be both more cost-effective and more effective at preventing pregnancy in typical use, than shorter-term methods (Mavranezouli, 2008).

By bringing information and contraceptives directly into households, CHWs can increase access to family planning for groups who are particularly difficult to reach, such as secluded women, the extremely poor, or the lowest classes of society. CHWs can be particularly effective in ensuring access to family planning despite traditional, social, or religious customs that discourage family planning, prevent discussion of sex and reproduction, or define childbearing as an issue that pertains only to women. In these instances, CHWs can advocate that family planning be viewed as both a personal and a community development issue, encouraging debate and fostering acceptance. Further, as community members, CHWs can reach those who directly influence reproductive

opinions and behaviors, such as religious leaders, village chiefs, husbands, and mothers-in-law (Burkett, 2006).

There has been considerable debate on the role of incentives for CHWs participating in CBFP programs, with a wide variety of alternatives, both financial and non-financial (Chenge, 1998; Janowitz, 2000; Bhattacharyya, 2001; Abbott, 2011). CHWs can operate as volunteers, often receiving non-monetary reimbursement, including the provision of durable goods such as bicycles, or preferential participation in other income-generating projects, such as community savings schemes or educational opportunities. This type of program is the least expensive to operate as there is no monetary reimbursement, but there are often persistent problems with retention of volunteers and control over quality of services provided. CHWs can also operate as salaried employees, employed either by the government or non-profit sector. Due to financial constraints, this type of program is often limited to staffing local Ministry of Health outpost clinics, but is less effective at reaching into rural areas. While there are enhanced opportunities for training as well as monitoring and evaluation, this type of program is the most expensive to operate and are not typically sustainable over time. In addition, CHWs can operate as small-business vendors, taking advantage of the growing role of the private sector in health care delivery, and also providing an opportunity to generate income. However, in order for this type of CBFP program to become self-sustainable, start-up capital must be provided, and strong supply chain operations must be in place to avoid contraceptive stock-outs; without reliable products to sell, these vendors will not be able to sustain their businesses.

The past decade has seen worldwide rapid growth in the delivery of health services via mobile communication devices, collectively known as mHealth. With the increased availability, adaptability and capability of mobile phones come new prospects for improving the quality of and access to health care. Mobile phones can support effective and efficient health care delivery and use of human resources in the health sector in many different ways. For example, a number of mobile phone-based projects and products have been developed to aid patient screening and diagnosis, to improve logistics and commodity-supply systems, to support clinical decision-making for treatment, to monitor and follow-up patients, and to collect patient data (Chetley, 2006). Increasingly, these new technologies are being developed, tested, and deployed with CHWs in developing countries. Providing CHWs with the mobility of handheld information and communication technology is an intuitive and hopeful approach. mHealth tools could also greatly enhance community-based approaches to family planning services. However, this potential is only beginning to be explored.

To explore this innovative approach, this dissertation proposes three papers. The first paper, *Community Health Workers and Mobile Technology: A Systematic Review of the Literature*, presents a systematic review of existing, peer-reviewed literature to identify the ways in which the implementation of mobile health technology affects CHW programs. The subsequent papers use a case study of a pilot family planning mobile job aid designed for CHWs in Tanzania to explore the potential for mHealth technology to impact family planning services. Thus the second paper, *The Development and*

Implementation of a Family Planning Mobile Job Aid for Community Health Workers in Tanzania, examines the development and implementation of the mobile job aid, aiming to inform future program and policy decisions, using survey, focus group and observation data. And the third paper, *"They Call Me a One-Woman Army": A Qualitative Evaluation of a Family Planning Mobile Job Aid for Community Health Workers in Tanzania*, examines the acceptability, feasibility and impact of the family planning mobile job aid designed for CHWs in Tanzania from their perspective, using interview data.

The theoretical approach to this dissertation research draws from the Interactive Systems Framework (ISF) for Dissemination and Implementation, developed to bridge the gap between research and practice, with a particular focus on implementing new innovations. There is a growing demand for evidence-based practices in public health, yet despite advances in research on effective interventions, the most-effective innovations are not necessarily those most commonly used in the field. Thus the authors developed this framework to provide an "examination of the systems and processes involved in moving from the development and testing of innovations to the widespread use of effective innovations" (Wandersman, 2008). The ISF is designed to accommodate multiple perspectives, acknowledging the importance of collaboration and communication among stakeholders.

The ISF consists of three interactive systems that together illustrate the movement of research into practice, as well as the broader context in which the framework exists, as shown here:
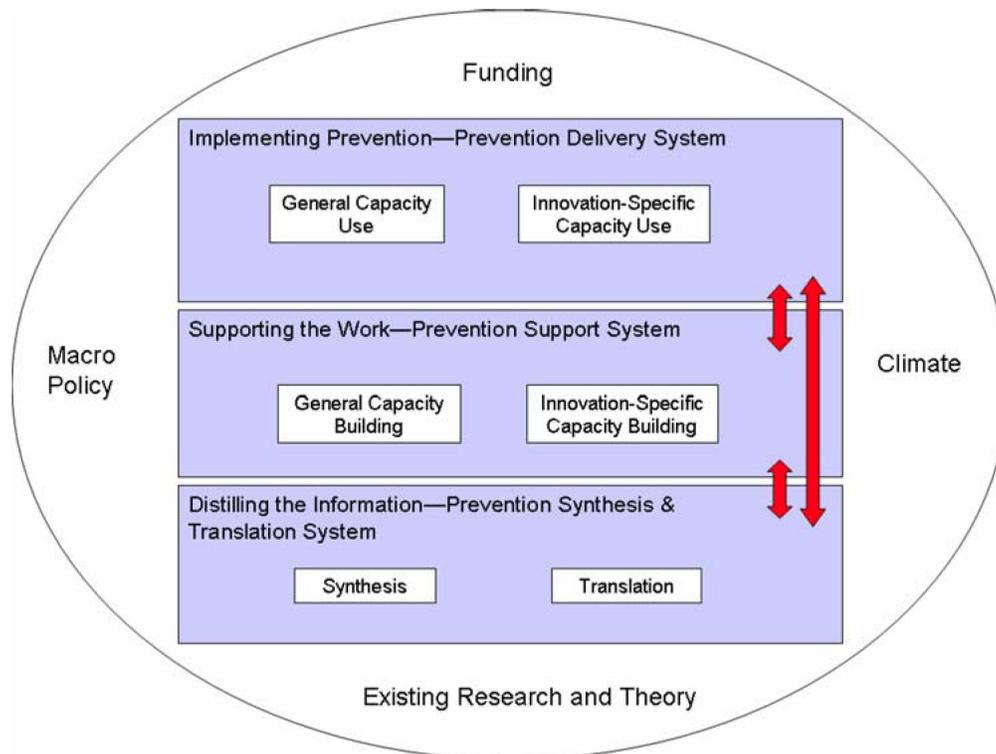
Briefly, the Prevention Synthesis & Translation System distills existing research and translates it for use by practitioners. The goal of this system is to identify the key characteristics and core elements that underlie an effective intervention. The Prevention Support System focuses on building capacity for those who will implement an intervention at two distinct levels: general capacity, which "enhances the infrastructure, skills and motivations of an organization" and innovation-specific capacity, which is "related to using a specific innovation." The Prevention Delivery System focuses on the activities necessary to implement an innovation, involving actions at the individual, organizational and community level. Beyond these three interactive systems, the ISF exists inside of a broader set of contextual factors that need to be taken into account, including existing research and theories, climate, macro-policy, and funding.

My dissertation work will include research at each level of the ISF in order to explore the implementation of a new innovation for CBFP, mHealth technology, focusing on producing research that can be transformed into public health practice. Through my first dissertation paper, I will focus on the Prevention Synthesis & Translation System, identifying the impact of mobile health technology on CHW programs, and then producing a review to distill the key findings of this literature for practitioners. Through my second dissertation paper, I will focus on the Prevention Delivery System, exploring the development and implementation of mHealth technology for CBFP at individual, organizational and community levels, to inform future programmatic and policy decisions. Through my third dissertation paper, I will focus on the Prevention Support System, exploring the process of building capacity among CHWs to be able to implement mobile health technology into their family planning work.

Chapter 2. Community Health Workers and Mobile Technology: A Systematic Review of the Literature

Abstract

Introduction: In low-resource settings, CHWs are frontline providers who shoulder the health service delivery burden. Increasingly, mobile technologies are developed, tested, and deployed with community health workers to facilitate tasks and improve outcomes. We reviewed the evidence for the use of mobile technology by community health workers to identify opportunities and challenges for strengthening health systems in resource-constrained settings.

Methods: A systematic review of peer-reviewed literature from health, medical, social science, and engineering databases was conducted, using PRISMA guidelines. A total of 25 unique full-text research articles on CHWs and their use of mobile technology for the delivery of health services were identified.

Results: CHWs have used mobile tools to advance a broad range of health aims throughout the globe, particularly maternal and child health, HIV/AIDS, and sexual and reproductive health. Most commonly, CHWs use mobile technology to collect field-based health data, receive alerts and reminders, facilitate health education sessions, and conduct person-to-person communication. Programmatic efforts to strengthen health service delivery focus on improving adherence to standards and guidelines, community education and training, and programmatic leadership and management practices. Those studies that evaluated program outcomes provided some evidence that mobile tools help community health workers to improve the quality of care provided, efficiency of services, and capacity for program monitoring.

Discussion: Evidence suggests mobile technology presents promising opportunities to improve the range and quality of services provided by CHWs. Small-scale efforts, pilot projects, and preliminary descriptive studies are increasing, and there is a trend toward using feasible and acceptable interventions that lead to positive program outcomes through operational improvements and rigorous study designs. Programmatic and scientific gaps will need to be addressed by global leaders as they advance the use and assessment of mobile technology tools for CHWs.

Introduction

Nearly all countries are challenged by shortages of health workers (Narasimhan, 2004). For the world's poorest countries, the scarcity of human resources is a crisis fueled by the migration of qualified health workers to richer countries, inadequate investment in national health systems, and devastation of major epidemics such as HIV/AIDS, tuberculosis, and malaria (Chen, 2004). Meanwhile, global health donors and advocates, ministries of health, and local leaders have higher demands and more ambitious hopes for health systems in resource-constrained settings than ever before (Hongoro, 2004). To achieve the Millennium Development Goals and other global aims, several health policy organizations are leading campaigns to further engage CHWs through task shifting (World Health Organization, 2010), decentralized distribution of health services (Price, 2010) and other mechanisms to galvanize local communities to provide health services.

In low resource settings, CHWs build bridges between formal health systems and communities, working to improve the relevance, acceptability, and accessibility of health services (World Health Organization, 2006). CHWs serve many functions, including conducting home visits, assessment and treatment of disease, data collection, education and counseling and referrals for further care. By directly visiting households, CHWs can increase access to care for groups who are particularly difficult to reach, such as secluded women, the extremely poor, or the lowest classes of society. With their links to the health system, CHWs can also offer an entry point for and at times directly provide health services, such as contraceptive methods, home-based care for people living with AIDS, directly observed therapy of tuberculosis, and community-integrated management of childhood illnesses (Burket, 2006).

Proponents argue engaging CHWs expands the pool of human resources for health, improves the productivity of health systems, and lowers the cost of providing services by shifting tasks from highly trained physicians and nurses to less specialized community members (Chen, 2004; Hongoro, 2004; Price, 2010). The evidence for the effectiveness of CHW programs varies. Much research demonstrates that health interventions integrating CHWs can lead to positive behavior changes and lower morbidity and mortality rates, while moving services closer to the communities where they are actually needed. Further, some CHW programs report equally high quality of care at lower cost when compared to traditional approaches (Islam, 2002) Among other programs, however, data show that quality of health services delivered, by CHWs may be compromised without proper investments in supportive organizational policies, adequate supervision and mentorship, quality trainings, and sufficient program resources (Lehmann, 2007).

Increasingly, new mobile information technologies are being developed, tested, and piloted with CHWs. The use of mobile technology by CHWs to improve healthcare services has intuitive appeal. mHealth tools enable CHWs to provide health services far from the clinical setting, in remote areas, and among hard to reach communities. Under this decentralized approach to service provision, health care can become more

6

accessible to patients due to reduced time and expense of travel (Mahmud, 2010) and due to the ability to seek out patients who are the targets of stigma and discrimination (Curioso, 2005). These tools may help CHWs overcome many of the barriers they face in the field, including balancing multiple priorities, lacking appropriate tools to provide services and collect data, and limited access to training and supervision. As CHWs are generally the most frequent connectors of communities to formal health systems, the use of mobile tools to enhance CHW performance warrants further study. The explosive innovation in technology has led to a proliferation of pilot initiatives and heterogeneity of research designs and outcome measures. Thus we systematically reviewed the literature to provide a critical assessment of the evidence to date on the use of mobile technology to help improve the services delivered by CHWs and the health of the communities they serve.

Methods

Search Strategy

A systematic review of literature published in English between January 1, 2000 and June 30, 2012 was conducted, using the PRISMA statement as guidance (Moher, 2009). First, to capture the multidisciplinary evidence of this field, the following medical, public health, engineering, and global development databases were searched: Pubmed/Medline, CAB Global Health, Web of Science, and INSPEC. Second, the following targeted institutional databases were seacrhed: WHO publication database, Health UnBound (HUB) Content Library, and Royal Tropical Institute resource database. Third, we citations within the first round of articles to identify additional relevant literature were searched.

Inclusion and Exclusion Criteria

Articles referring to both mHealth and CHWs in the title or abstract were selected. To refer to mHealth, articles either had to include the term 'mHealth', or include both the term 'health' and one of the following search terms: handheld computer, mobile phone, cellular phone, mobile device, patient monitoring device, mobile telemedicine, MP3 player, mobile operating system technology, 3G, SMS, text message, IVR, interactive voice response, GPS or global positioning system. To refer to CHWs, articles had to include one of the following search terms: community health worker, frontline health worker, midwife, outreach worker, community health education worker, lay health worker, promotora, village health worker, volunteer health worker, community health distributor, community health surveyor, community health assistant, community health promoter, community health agent, rural health auxiliaries, traditional birth attendant, or health promoter.

This initial search strategy yielded 347 articles. Duplicate citations across databases were identified and excluded, and relevant citations from bibliographies and targeted institutional databases were identified and included. An in-depth review of the full text of this subsequent set of articles was conducted. Those articles that specifically focused

on the use of mHealth technology by CHWs were included, and those articles that did not meet the definition of research, such as commentaries, policy briefs, systematic reviews and other summary-type articles, were excluded. After further excluding articles without available full text, the final collection for review included 25 articles (Figure 1).

Figure 1. Literature search strategy.
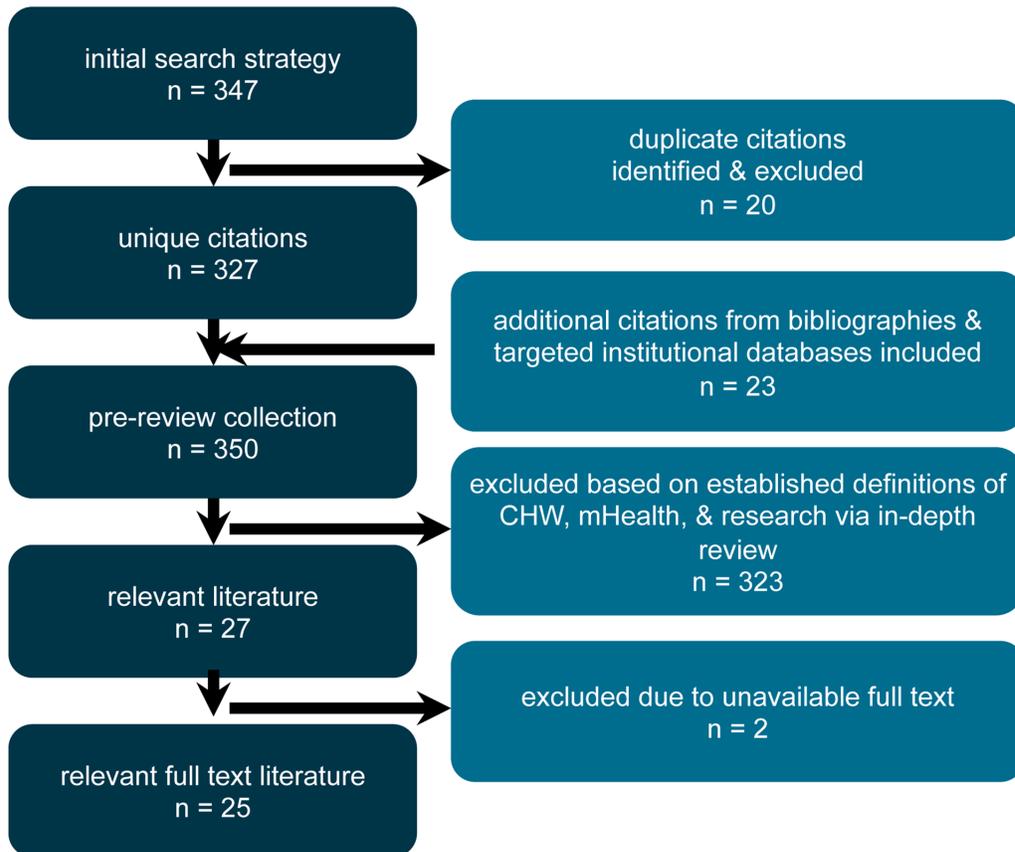
Data Collection

To assess the literature, two analysts systematically coded articles to describe the following topics: study design, methods, unit of analysis, number of participants, findings, purpose of technology, mHealth platforms/applications, theoretical framework, location, population served, health issues addressed, information architecture, open source tools, interoperability, engagement/participation of CHWs, strategies for organizational strengthening, outcomes for organizational performance, and conclusions. As a team, analysts defined and discussed key topics listed above, compiled findings by populating tables according to key topics, and discussed and reconciled any differences.

Data Synthesis & Analysis

To provide a conceptual framework for the review and enable comparison across projects, the World Bank's Improving the Delivery of Health Services: A Guide to Choosing Strategies (Berman, 2011) was used, commonly used in global health and development to guide programmatic and policy decisions. Recommended outcomes for organizational performance (quality, efficiency, utilization, access, learning, and sustainability) and strategies for improving organizational performance (standards and guidelines, organizational design, education and training, process improvement and technology and tool development, incentives, organizational culture, and leadership and management) were selected, as a means of categorizing, synthesizing, and assessing each programs' reported processes and outcomes. A complete summary of all articles in the systematic review is included (Appendix I).

Results

Scope of Research

The 25 articles reviewed reported on 28 unique studies, as one article described four distinct studies. Most articles reported on projects in developing countries particularly Africa, with several focused on Asia, and a few in Latin America. There were more programs in rural than urban areas, though a few studies operated in both. A broad range of health issues were addressed; the most common included the interrelated set of issues around sexual, reproductive, maternal and child health, of which more than half focused specifically on HIV/AIDS. Other key issues included tuberculosis and malaria. mHealth technology was most commonly used for data collection, decision support, alerts and reminders, and information on demand, facilitating CHW activities associated with field-based research and direct provision of medical care (Table 1).

Table 1. Overview of Scope of Research.

Category	Subcategory	Result (n)	Result (%)
Rural/Urban	Rural	15	54%
	Urban	9	32%
Region	Africa	19	68%
	Asia	5	18%
	Latin America	3	11%
Health Issue Addressed	Sexual, Reproductive, Maternal & Child Health	11	39%
	HIV/AIDS	10	36%
	Tuberculosis	3	11%
	Malaria	2	7%
Purpose of Technology	Data Collection	16	57%
	Decision Support	6	21%
	Alerts & Reminders	6	21%
	Information on Demand	5	18%

Research Design and Methods

This review revealed that research and evaluation related to CHWs and mHealth had substantial variation in design and methods (Table 2). More of the studies were quantitative than qualitative, while several articles employed both methodologies. Ten studies were non-experimental, typically including a descriptive assessment of an mHealth technology or program without any assessment of outcomes or impacts. Ten studies were quasi-experimental, designed with a control group, frequently comparing the computer-based experimental intervention to a traditional paper-based control intervention--but without randomization of participants.

Table 2. Overview of Research Design & Methods.

Category	Subcategory	Result (n)	Result (%)
Methods	Quantitative	15	54%
	Qualitative	7	25%
	Both	6	21%
Design	Non-Experimental	10	36%
	Quasi-Experimental	10	36%
	Experimental	8	29%

Eight studies were experimental, designed with randomized selection of control and intervention groups. All of these studies were published after 2010. These include a description of a cluster-randomized controlled trial with CHWs to evaluate effects of a health data collection and decision support system on health outcomes of mothers living with HIV (Rotheram-Borus, 2011) a cluster randomized controlled trial to evaluate effects of alerts and reminders on CHWs adherence to malaria treatment guidelines (Zurovac, 2011) and a randomized crossover study to evaluate use of mobile multimedia for simulated patient interactions to enhance performance of CHWs (Florez-Arango, 2011). These also include a mixed methods evaluation of a cluster-randomized trial to evaluate use of mHealth tools by peer health workers providing services to HIV infected clients (Chang, 2011) and a series of randomized-control studies investigating use of automated short message services (SMS) to improve CHW performance when delivering general health services (DeRenzi, 2012).

Overall, the literature revealed a general tendency toward increased use of experimental research designs. Standards for reporting results differed between articles, however, and often reflected differences in journal requirements and style standards between disciplines from computer engineering to social science to medicine.

Strategies for Strengthening Health Organizations & Systems

There were four key strategies to improving the delivery of health services by CHWs through use of mHealth tools: (1) process improvement and technology development, (2) standards and guidelines, (3) education and training, and (4) leadership and management. First, process improvement through technology development was

inherent to almost all studies (n=27, 96%) and the literature supported the aim of developing interventions that are more efficient and less susceptible to human error through the creation of better tools and workflow systems. The most typical task for CHWs is the collection of field-based data, whether for client care, program monitoring, or health research. According to the literature, when equipped with mobile devices, CHWs became capable collectors of complete, high quality, and timely data from the field. More specifically, as compared to paper-based data collection, data collected by CHWs using mHealth tools had fewer errors (Bernabe-Ortiz, 2008) and less data loss (Tomlinson, 2009) Further, these mobile tools can enable real-time quality review and analysis for decision-making (Curioso, 2005) as well as rapid response to cited health issues (Tomlinson, 2009).

Second, a third of the studies (n=9, 32%) used mHealth tools to ensure CHW compliance to standards and guidelines for health services in the field, most prominently through decision support, and alert and reminder tools. For example, a study using text messaging to improve outpatient malaria care in 107 government health facilities in Kenya led to improvements in drug management both immediately after the intervention, and six months post-intervention (Jones, 2012). Qualitative interviews demonstrated high levels of satisfaction with all aspects of the intervention.

Third, 28% (n=8) of studies described the use of mHealth tools to support education and training for CHWs. Studies assessed the use of mHealth tools to reach geographically dispersed CHWs with accurate and timely clinical information, shared through multimedia formats (Florez-Arango, 2011; LeMay, 2011). mHealth tools were also used to facilitate the creation of professional networks, both among CHWs and between CHWs and their supervisors, providing real-time advice, information, and support for frontline health workers. In the Aceh-Behar midwives study in Indonesia, the use of mobile phones was positively associated with access to institutional and peer information resources, which was in turn positively associated with an increase in knowledge about best practices for providing obstetric care (Lee, 2011) Similarly, the k4Health project in Malawi recently introduced an SMS text-messaging network to improve the exchange and use of reproductive health and HIV/AIDS information among CHWs. After an 18-month pilot period, the authors found that CHWs who used the text-message network were more likely to contact supervisors for clinical support from the field. The authors argue that timely exchange of information led to improved quality of care, particularly in cases of obstetric emergency (LeMay, 2011).

Fourth, a quarter (n=7, 25%) of the studies suggest that mHealth tools can be used to facilitate better practices in leadership and management, particularly in terms of providing remote supervision to CHWs. A salient example, the Tanzania CommCare project, used an automated text-message system to remotely monitor real-time job performance of midwives and to provide workers with alerts and reminders to their mobile phone about past-due patient visits (Svoronos, 2010). Compared to a group of midwives who did not receive alerts and reminders, midwives who received these messages improved the number of timely visits to expectant mothers. In further studies, researchers found the comparative effect of adding a phone call from supervisors to

alert midwives about missed and late visits was associated with an 86% reduction in the number of days that CHWs were overdue in visiting their clients. Finally, in-depth interviews with CHWs and supervisors revealed high rates of acceptability, use, and satisfaction with the alert and reminder system (DeRenzi, 2012). The evidence suggests that mHealth tools, in hands of CHWs and committed supervisors, can facilitate real time supervision of teams of health workers that are distributed widely in geography.

Although there are several examples from the literature of tools used to improve supervision of CHWs, there are very few instances of interventions to improve CHW leadership. In one of the few articles to explore the use of mHealth tools to enhance CHW leadership, researchers spent six months working with frontline health workers and hospital staff to design a pilot tuberculosis program in Malawi. Taking advantage of the leadership and expertise of frontline workers, the team designed and developed a system for patient adherence reporting, appointment reminders, and physician queries (Mahmud, 2010). Similarly, in a small pilot study of a maternal health project in Tanzania, researchers met with five CHWs weekly over four months to collaboratively design and develop a tool for use in delivery maternal and child health services. They also conducted field-observations of CHWs providing household visits for prenatal care. Authors concluded that their design process resulted in building a tool that was responsive to CHW needs facilitating locally driven innovation and ownership (Svoronos, 2010).

Health Organization & System Outcomes

Several studies provided evidence that mHealth tools can improve outcomes related to CHW performance, most principally: quality of care, efficiency of services, CHW learning, and utilization of services. The outcome most frequently measured among studies (n=20, 71%) was improvements in quality of care when CHWs use mobile tools, most commonly measured in terms of compliance to accepted standards of care. For example, a simulated experimental study used mobile multimedia devices to support point-of-care clinical decisions by CHWs in Colombia and found that CHWs had significantly fewer errors and better compliance with care protocols over a range of clinical care situations. The authors argued that although CHWs are the backbone of health care delivery in developing countries, they too often have little formal education and training, and so devices that use a combination of text, audio, images, and video can be used to improve their ability to provide quality community based care (Florez-Arango, 2011).

Use of mHealth tools was frequently measured with regard to general improvements in efficiency. There was no consensus, however, as to the definition and best measures for CHW efficiency across the literature reviewed. In one study, improvements in efficiency were measured in terms of savings in cost and time and increased work capacity. At the end of the pilot study in Malawi, mobile phones with FrontlineSMS used by 75 CHWs over the course of six months saved approximately 2,048 fewer hours of worker time and $2,750 less in fuel and operational costs, which in turn led to the ability to double the number of clients served by CHWs (Mahmud, 2010).

Learning as an outcome was cited in a third of the articles (n=9, 32%). In the Aceh-Behar study, mobile phones use was positively associated with higher self-efficacy (.25, p<.001) among CHWs, as measured through a series of items regarding confidence about their abilities. Higher self-efficacy was positively associated (.16, p<.05) with health knowledge of maternal health practices in the areas of family planning practices, prenatal, and child delivery processes (Lee, 2011). Further, the traditional birth attendants in the study explained that use of mobile phones enhanced their ability to independently meet the clients' health care needs through more timely access to relevant information (Chib, 2008).

Discussion

Overall, this systematic review revealed that the number and types of mHealth-focused CHW project evaluations have grown during the past twelve years. There has been a positive trend toward increased use of experimental designs and methods, particularly in the past three years. The findings of this review demonstrate that CHWs are using mHealth tools with increasing effectiveness to improve the delivery of maternal and child health, HIV and other sexual and reproductive health services, and other general health services in the developing world, mainly in Africa. Moreover, given the great potential for mHealth tools to be incorporated into customary workflows of CHWs, it is expected that the use of mobile technologies can be broadened to support and empower CHWs in their role as a bridge between formal health systems and communities.

Social, policy, and technical challenges remain. The majority of studies were pilots and provided little or no information about the effectiveness or impact of the use of mobile technologies when included in large-scale implementations of well-architected electronic health strategies. More than just multiplying the size of pilot programs, large scale or national implementations of CHW mHealth programs may require policies to support the integration of CHWs into national strategies for health system strengthening (Bhutta, 2010), more attention to adoption of shared technical standards, consistent use of open standards and open source tools, and a promotion of interoperable information systems that can comprehensively address the full spectrum of needs around health information exchange (World Health Organization, 2008). A recently published article on the RapidSMS system to monitor pregnancy and reduce MCH deaths in Rwanda demonstrates the potential for successful scale-up of mHealth tools used by CHWs when there is strong government ownership of the process (Ngabo, 2012).

The literature demonstrates the usefulness of mHealth tools to facilitate process improvements and compliance with standards and guidelines. Moreover, significant potential remains in the areas of education and training, organizational culture and design, leadership and management (Berman, 2011). Several CHW advocates argue that the most successful projects engage CHWs as leaders and experts (Bernabe-Ortiz, 2011), minimal evidence exists on engaging CHWs as leaders, however, and scarcely

any articles mentioned involving organizational cultures to improve performance outcomes.

Mobile technologies show great potential to enhance CHWs' opportunity to participate in design, implementation and evaluation processes, yet the literature reveals that this user centric design is more the exception than the rule. mHealth initiatives more commonly result from a top-down approach to organizational change that aims to ensure CHW adherence to existing guidelines, policies and procedures but with minimal support from home institutions, supervisors, or other CHWs. Thus per "Conway's Law" (Conway, 1968), the deployment of mHealth tools to support CHWs are likely to mirror the communication structures of the organizations that design them. Greater than the challenges related to the technology design and computer engineering are the policy barriers to institutionalizing CHWs as an accepted part of the health system.

Although CHWs are increasingly using mHealth tools to enhance delivery of community-based healthcare services and to access continued learning in the field, there remains a need for more rigorous measurement of improvements in performance and outcomes, eg. service utilization, access, productivity, quality and sustainability. Cost effectiveness analysis would be helpful for program staff and policy makers, as they must decide the value of national implementations and make operational decisions about using mobile technology to deliver program targets. The existing literature provides little or no evidence around calculating costs, including both initial investments and maintenance over time, and measuring efficiency or benefits.

Limitations

This review is limited by the scope of our literature search, which included articles in English collected through scholarly and organizational databases. As most projects are focused on deployment of tools to enhance service delivery rather than scientific interests, it is likely many mHealth projects are not reported, presented at prominent conferences or published in peer-reviewed journals. Although overviews of the field indicate that CHWs are very commonly engaged in mHealth projects, this collection of only 25 articles is not likely to represent the full range of projects being implemented. Among those that are reported, negative results are less likely to be published. As such, this review may be biased toward more affirmative results and substantial impacts. Further, due to the heterogeneity of methods, units of analysis, and design approaches in this newly evolving field of research, a meta-analysis was not feasible or meaningful.

Conclusions

There is a growing body of evidence for the use of mHealth tools to improve effectiveness of CHWs in resource-constrained settings. Use of mobile technology can potentially enhance the capacity of CHWs to take on new and challenging tasks, particularly collecting complete, timely and accurate health data for field-based research and providing health care services in the field with fewer errors and higher adherence to protocols. Given the gaps in the literature, future research efforts should include a focus

on qualitative analysis, in order to better understand how mHealth tools may be better designed to enable the performance of CHWs globally. Further, a focus on impact evaluation using comparable standards and indicators across studies would accelerate the evidence base needed to inform implementations of systems of care that incorporate mobile technologies. The potential for CHWs to use mobile tools to improve health service delivery in resource limited settings is certainly great; however, a stronger evidence base is necessary to guide global health policy and program implementation.

Chapter 3. The Development and Implementation of a Family Planning Mobile Job Aid for Community Health Workers in Tanzania

Abstract

Introduction: Family planning use is low in Tanzania. CHWs can help increase access to family planning, yet expanding community-based service delivery will require innovative approaches. The past decade has seen worldwide rapid growth in the delivery of health services via mobile communication devices, collectively known as mHealth. Increasingly, these new technologies are being developed, tested, and deployed with CHWs. mHealth tools could enhance community-based approaches to improving the knowledge about, access to and quality of family planning services. Accordingly, FHI 360, the Tanzania National Institute for Medical Research, Pathfinder International, and D-Tree International collaborated on the development of a mobile phone job aid for family planning service delivery.

Methods: Development began in June 2011. The mobile job aid was designed to facilitate evidence-based counseling, screening and service provision, as well as improve data collection and program management. Once the initial programming was completed in July 2012, six CHWs were selected to test the mobile job aid. Usability testing was conducted via a focus group and field observations to identify areas for improvement; design changes were made subsequently. In January 2013, 50 CHWs and their supervisors participated in a job aid training and were administered a brief baseline survey to assess participant characteristics. In February 2013, the finalized mobile job aid was deployed into the field for a six-month pilot study.

Results: The focus group yielded suggestions to improve job aid usability, language, and client referral and follow-up. The field observations revealed positive changes made in response to the job aid, and identified barriers to effective service delivery. The baseline revealed that CHWs in the pilot study were primarily age 40 or older, female and married. Most obtained a secondary school education and had significant CHW experience. They also reported considerable comfort with and knowledge about family planning, and high levels of access to and use of mobile phones.

Discussion: Findings from this study can serve to inform the design, implementation, monitoring and evaluation of mHealth projects targeted for CHWs, and impact future efforts to implement mobile technology into community-based family planning.

Introduction

According to the 2010 Tanzania Demographic and Health Survey, current use of family planning is low; 34.4% of women of reproductive age are using any form of contraception, and only 27.4% are using modern contraceptive methods. Further, 25.3% of these women report unmet need for family planning. Among women not using contraceptives, 78% have never discussed family planning with a fieldworker or healthcare staff at a health facility, while only 4% reported being visited by a family planning service provider in their home who engaged them in a discussion of family planning (NBS Tanzania, 2011). In addition to contact with a family planning provider, effective counseling is fundamental to enabling women to make informed decisions about their contraceptive method of choice and to effectively continue with their selected method over time.

In 2010, the Tanzanian Ministry of Health and Social Welfare launched the National Family Planning Costed Implementation Program (NFPCIP), in order to "reposition and reinvigorate access to and use of family planning services in Tanzania". This program set an aggressive target of reaching a contraceptive prevalence of 60 percent by 2015. To achieve this goal, over five million women must initiate use of contraceptive methods (Ministry of Health and Social Welfare, Government of Tanzania, 2010). To reach this scale, CBFP approaches will be needed.

In Tanzania, CHWs participate in family planning service delivery by offering health education and counseling, providing condoms and birth control pills, and making referrals for other contraceptive methods. While there are many local and regional programs throughout the country, CHWs are not currently integrated into the national health system. However, the NFPCIP highlights CBFP as an important approach to increasing family planning uptake in Tanzania, explaining: "The decentralization of responsibility for health care to the community level in Tanzania opens the door for expansion of community-based services…includ[ing] community-based distribution of short-acting [contraceptive] methods now underway in a limited number of regions" (Ministry of Health and Social Welfare, Government of Tanzania, 2010). The NFPCIP identifies specific challenges that must be addressed before expanding community-based services to other geographic areas or providing methods other than condoms or contraceptive pills. These include the necessity for CHW training and supervision, and the related costs this will incur, as well as the long-term retention of CHWs, using both monetary and non-monetary incentives. As such resources are not likely to be secured quickly, expanding CBFP service delivery in Tanzania will require innovative approaches.

The past decade has seen worldwide rapid growth in the delivery of health services via mobile communication devices, collectively known as mHealth. With the increased availability, adaptability and capability of mobile phones come new prospects for improving the quality of and access to health care. Mobile phones can support effective and efficient health care delivery and use of human resources in the health sector in many different ways. For example, a number of mobile phone-based projects and

products have been developed to aid patient screening and diagnosis, to improve logistics and commodity-supply systems, to support clinical decision-making for treatment, to monitor and follow-up patients, and to collect patient data (Chetley, 2006).

Increasingly, these new technologies are being developed, tested, and deployed with CHWs in developing countries. Providing CHWs with the mobility of handheld information and communication technology is an intuitive and hopeful approach. Mobile phones have supported CHW efforts around HIV/AIDS, maternal health and childhood illness (Braun, 2013). mHealth tools could also greatly enhance community-based approaches to family planning services. However, this potential is only beginning to be explored.

Accordingly, FHI 360, the Tanzania National Institute for Medical Research (NIMR), Pathfinder International, and D-Tree International have collaborated on the development of a mobile phone job aid for family planning service delivery by CHWs, with funding from the United States Agency for International Development (USAID). A job aid is any tool that simplifies tasks by providing easy access to needed information, such as a flowchart or checklist (Tumlinson, 2010). This pilot project aims to evaluate the acceptability, feasibility and impact of the job aid on service provision, data collection, and program management. The long-term goal of implementing the job aid is to improve contraceptive method selection, uptake and continuation among clients. While this impact data is not yet available, a study of the process of developing the family planning mobile job aid will help inform future mHealth efforts in other settings. The purpose of this paper is therefore to describe the development of the family planning mobile job aid including its initial testing and refinement with CHWs, the design of the pilot study and the CHWs who will participate in it. Additionally, the evaluation plan for the pilot study and the implications for future community-based efforts to increase access to and use of family planning information and services will be discussed.

Methods

Job Aid Development

In June 2011, FHI 360, NIMR, Pathfinder International and D-Tree International began initial development of a family planning mobile job aid for CHWs in Tanzania. At that time, CHWs were using paper-based job aids and recording forms that posed significant challenges for counseling, screening and service provision, as well as data management and reporting. The paper flip chart for counseling women on contraceptive methods contained outdated information and was logistically difficult to use; it did not provide step-by-step guidance for the provider. CHWs were also required to record client data using multiple paper forms and physically submit these to the health facility nurse, who would then physically submit the information to the district reproductive health coordinator. This led to considerable lag time between patient data collection and reporting at the district level, significant potential for data loss, and excessive time for form completion.

The mobile job aid was designed to facilitate evidence-based practice by supporting effective counseling, screening and service provision in client-provider interactions. The job aid enables data collection through structured question and response fields for real-time reporting and management, aiming to save time both in the field and in follow-up. The family planning mobile job aid was built using CommCare (Mangilma, 2012), an open-source mobile and web platform designed for gathering and distributing healthcare-related information with extreme flexibility, and deployed on Nokia X2-02 phones, provided to CHWs at time of training.

The family planning mobile job aid was designed to provide three main functions. First, it includes an algorithm to enable CHWs to effectively counsel, screen, provide and refer clients for family planning services, as well as HIV and Sexually Transmitted Infection (STI) services, as appropriate. The algorithm was adapted from two evidence-based tools, the Balanced Counseling Strategy Plus[1] and the Checklists for Contraceptive methods[2], both of which reflect best practices in family planning service delivery. It is designed to assist the CHW to perform the following key functions and job tasks:

1. Assess client reproductive needs, fertility desires, and risk of an unintended pregnancy;
2. Assist the provider to be reasonably sure the client is not pregnant;
3. Provide brief information on all methods of contraception available in Tanzania, including information on mechanism of action, benefits and side effects;
4. Counsel and assist the client to make an informed decision on their preferred method of choice;
5. Screen and initiate safe and effective use of client's chosen method according to the WHO medical eligibility criteria (limited to methods that can be provided by CHWs, in Tanzania this includes condoms and pills only);
6. Refer clients to other methods only offered by facility-based health providers;
7. Register and track clients for follow-ups on referral completions;
8. Provide counseling support for continuing users;
9. Counsel on dual protection;
10. Conduct risk assessments for STIs and HIV, including counseling and referrals for HIV testing and Prevention of Maternal to Child Transmission (PMTCT) for pregnant women who are HIV positive.

Second, the mobile job aid records routine data on client information and services, including use of contraceptive method and referrals to other health services. These data

---

[1]The Balanced Counseling Strategy Plus: A Toolkit for Family Planning Service Providers Working in High HIV/STI Prevalence Settings (BCS+) is an interactive, client-friendly approach for improving counseling on family planning and prevention, detection, and treatment of sexually transmitted infections including HIV. This Toolkit, developed and tested in Kenya and South Africa, provides the information and materials needed for health care facility directors, supervisors, and service providers to implement the BCS+ in their family planning services.

[2] Provider Screening Checklist: A series of easy-to-use screening checklists to help both clinical and non-clinical providers determine if a woman is medically eligible to initiate use of any of four popular contraceptive methods: combined oral contraceptives, injectables, the copper intrauterine device, and implants. A fifth checklist, entitled "How to Be Reasonably Sure a Client is not Pregnant," enables providers to rule out pregnancy among non-menstruating women seeking to initiate a contraceptive method at the time of their visit.

are collected using electronic forms where information about each client is recorded at the point-of-care and then either sent through a general packet radio service (GPRS) linkage to a central data base hosted at the Pathfinder server, or stored in the phone to be downloaded when the CHW returns to clinic.

Third, the mobile job aid operates as a short message system (SMS, ie. text)-based management tool, designed to support both the supervisors and the CHWs by issuing reports and reminders about the performance of the CHWs in the field. For example, the phone is designed to send SMS-based weekly status reports to CHW supervisors including the number of clients visited, number of new family planning users by method, and number of referrals and completed follow-up visits made by CHWs. It is also designed to send SMS-based reminders to CHWs for follow-up visits to specific clients.

Job Aid Testing and Refinement

D-Tree International completed the programming of the family planning mobile job aid in July 2012, and worked with supervisors to identify six highly motivated CHWs from the Ilala municipal district in Dar-es-Salaam, Tanzania to test the initial version for a period of six months. During this time, D-Tree International and FHI 360 staff conducted usability testing, including a focus group discussion and field observations with each of the six CHWs, to understand how the mobile job aid was being used in the field, and identify areas for improvement. FHI 360, NIMR, Pathfinder International and D-Tree International staff met regularly during this initial period to refine the job aid in response to feedback from the six CHWs and to develop a training curriculum and user manual for the pilot study phase.

Job Aid Pilot Study and Participants

After this initial period of testing and refinement, the mobile phone family planning job aid was introduced to local community leaders to be piloted in six Government health facilities in six different wards of the Ilala municipal district in Dar-es-Salaam, Tanzania. These were purposely selected as sites where Pathfinder International had established community-based family planning services, yet CHWs were not using the CommCare program. The six facilities were matched to create three pairs that were similar in terms of facility size, number of providers, number of clients served, and type of services offered. Within each matched pair, one clinic was randomized to receive the mobile tool, while the other clinic was randomized to use the standard paper tool to allow for comparison between the two groups. Teams of CHWs were randomized to either the mobile phone-based or standard paper-based job aid group at the facility-level. Each health facility had one CHW supervisor and a range of five to 13 CHWs. A total of 50 CHWs were available for participation in the pilot study across the six health facilities.

In January 2013, FHI360, NIMR, Pathfinder International and D-Tree International staff jointly conducted a five-day training for the 50 CHWs and 6 supervisors involved in the pilot study. Before beginning the training, ten research assistants administered a brief baseline survey to each participating CHW. The survey tool included demographic

information (age, gender, marital status, education, CHW experience); key source(s) of health information; family planning knowledge, comfort, training, and experience; and mobile phone ownership access, ownership and use. After this data collection was completed, the CHWs and their supervisors received a two-day refresher training on family planning, followed by a three-day training on their respective job aid. In February 2013, the finalized mobile job aid was deployed into the field for a six-month pilot study. Participating CHWs were provided mobile phones, minutes and a monthly stipend.

Ethical Approval

'Evaluating the Use of Mobile Phone-based Job Aids by Community Health Workers to Counsel on Family Planning and Reproductive Health' (Proposal # 10357) was approved by the FHI 360 Protection of Human Subjects Committee (PHSC) on July 16, 2012. The FHI 360 PHSC and the University of California at Berkeley Committee for Protection of Human Subjects (CPHS) signed an Institutional Review Board (IRB) Independent Ethics Committee (IEC) Authorization Agreement on September 17, 2012.

Results

Usability Testing[3]

During the initial period of testing and refinement, D-Tree International and FHI 360 staff conducted a focus group with the six CHWs to gather information regarding the usability of the job aid, in an effort to engage them directly in the design of this tool. Participants reviewed all of the questions in the job aid, determining which ones should be compulsory and which ones could be optional during the visit. For example, one participant thought that it was important to collect the address of her clients so that she could easily go back for follow-up. In response, this field was made compulsory to prompt the CHWs to record this data for every client. Another participant thought that it was important to track the outcome from a client after being given a referral, explaining "We give referrals to our clients to go to the health facility to receive family planning methods, but it is important we follow-up to make sure they received the method." A referral form was created for the mobile job aid in response to this request.

Participants had several suggestions for ways to make the job aid easier to use and ensure quality. One participant suggested adding constraints on several questions, for example specifying a particular range of dates for fields such as date of birth, to avoid a data entry error. Another participant suggested some changes to the way that client records were kept on the phone to allow her to more easily provide follow-up with her clients. For example, the initial version of the first data collection screen showed the name and date of birth of a client, but this participant suggested it should show the name, age, sex, and village of the client to allow her to more easily identify her clients during their follow-up visits.

---

[3]Data compiled from D-Tree International Final Program Report, submitted June 2013.

Participants also had suggestions for changes to the way statements were made on the job aid in order to better suit their clients in the community. For example, in the follow up form there was one prompt that stated: "Inform the client that you are going to discuss HIV/STI information." One participant suggested that a script be provided: "Tell the client: Now I am going to tell you about protecting yourself from getting a sexually transmitted infection (STI) and HIV. If you are having unprotected sex, you are at risk of getting an STI, including HIV." Several participants also suggested that a selection of different sexual and reproductive health topics should be included that they could discuss with their clients, rather than use the same topic every time they met.

Several participants explained that a key challenge they faced in providing family planning services was a lack of sufficient contraceptive supplies, including condoms and birth control pills -- the two methods they are permitted to dispense in Tanzania, to give to their clients. One participant further explained that even if she had supplies, it would often have taken so long for the supplies to be delivered that by the time they arrived, they were near their expiration date. Participants insisted that it was important for the facilities/NGOs to ensure that there were enough supplies to provide to their clients, or they would not want to go visit them, because they could not meet their needs.

In addition to the focus group, D-Tree International and FHI 360 staff conducted field visits with each of the six CHWs during the initial testing and refinement period. The visits revealed that CHWs had made several changes to family planning service provision. Before using the mobile job aid, the CHWs were providing condoms and birth control pills without doing any follow-up with their clients. Now, with the mobile job aid, the CHWs followed up every month, prompted by the SMS reminder system, to specifically ask about problems or challenges. Similarly, prior to using the mobile job aid, when the CHWs referred a client to the facility, they did not follow-up to check if the client had gone to the facility and what was the result of that visit. Now, the CHW had to follow-up in order to close the referral form on the mobile job aid.

Several problems with using the mobile job aid for family planning service delivery were also identified during field visits. Two CHWs reported that their phone chargers were not working which required them to borrow chargers. The length of time needed to find another working charger sometimes caused delays in their ability to do their work. In addition, several CHWs again complained about delays in getting a resupply of condoms and birth control pills from their health centers, which resulted in visits to clients without sufficient supplies.

Baseline Survey

All 50 CHWs who would participate in the pilot study of the family planning mobile job aid completed a brief baseline survey; their characteristics are as follows. Approximately three-quarters of the CHWs were age 40 or older, with only one CHW below the age of 30. The majority of CHWs were female (82%) and married (56%). The CHWs were most likely to have obtained a Secondary School education, either O-Level (58%) or A-Level (34%); only two CHWs had attended vocational school, and two had attended

university. Most had either two to five (54%) or six to ten (42%) years of experience as a CHW, with two CHWs having more than 10 years of experience (Appendix II, Demographics).

When asked where they go for health information, CHWs most frequently cited radio (n=25), health organizations (n=22), television (n=20), friends and family (n=19) and newspaper/magazine (n=18). Other less frequently cited sources of health information included community meetings (n=11), people at work (n=11), dispensaries (n=6), health facilities (n=6) and advertisements (n=4). The least frequently cited sources of health information included the internet (n=3) and mobile phones (n=2) (Appendix II, Source(s) of Health Information).

Almost all CHWs (98%) stated they had previously received training on family planning before the job aid training; the majority had two to five years of experience providing family planning services (86%). CHWs reported high levels of comfort discussing family planning and reproductive health with their clients, either that they were comfortable (56%) or very comfortable (42%). CHWs also reported considerable knowledge about family planning, with the majority of participants reporting some (50%) or a lot (42%) of knowledge (Appendix II, Family Planning).

CHWs reported high levels of access to mobile phones. All CHWs reported that they had their own personal mobile phone. Further, many had additional access to a phone through a family member (94%) or some other source (62%). Half of the CHWs had been using a mobile phone for six to ten years, while others had been using a phone for either two to five years (32%) or more than ten years (18%). The majority (78%) of CHWs reported that the mobile phone they use most frequently is always charged and able to receive calls and text messages. Finally, the majority also (72%) reported that they used a mobile phone for their job as a CHW (Appendix II, Mobile Phone Use).

Discussion

Much can be learned from the process of developing the mobile family planning job aid for CHWs in Tanzania. It was built through a unique partnership between a global development organization with significant in-country research and programmatic experience, a high-level governmental health research institute, a global organization with more than 30 years of managing CHW programs in Tanzania and a technology company with significant experience developing and implementing mHealth projects designed for CHWs in Tanzania. However, in spite of the strength and depth of this partnership, significant questions remain about the ability to scale-up and sustain the mobile job aid. Experience demonstrates that much will still depend on in-country resources and political will. And despite the potential positive impact of the mobile job aid, further integration of CHWs into the national health care system will be critical to advance community-based access to family planning information and services across Tanzania.

Usability testing over a six-month period to refine the initial version of the mobile job aid was a crucial step toward developing a tool that would best meet the needs of CHWs in the field. It allowed for problems to be identified and resolved, and desired functions to be built, all in real-time. This step of engaging participants in the design of mobile health tools built for their own use is surprisingly missing from many current mHealth innovations, particularly those involving CHWs (Braun, 2013); ideally this iterative processes will yield a more effective tool. Usability testing also identified that maintaining access to sufficient contraceptive supplies is a key concern for the CHWs. Resolving this issue goes beyond the scope of this project, and will invariably require significant national resources and support, but is ultimately key to successfully expanding access to family planning, particularly for women in rural or underserved areas.

The profile of the CHWs developed from the baseline survey suggests that they can support a successful pilot of the mobile family planning job aid. Most participants had significant experience as CHWs, many with specific experience proving family planning information and services. Further, they all received prior family planning training, and self-report considerable comfort with and knowledge about family planning. In addition, every participant owns a mobile phone, and most expressed at least five previous years of use. Many participants in fact acknowledged that they already use their own mobile phone for their work as a CHW, yet the specific capacity in which they do this is unknown. These characteristics are likely to positively impact the mobile job aid pilot. Further evaluation of job aids in these settings should also consider how CHWs with little experience with family planning or mobile phones can be supported.

Despite the rapid expansion of this field, there are limited studies that measure the outcomes of implementing mHealth projects with CHWs. Thus this pilot study will use multiple qualitative and quantitative methods of primary and secondary data collection to evaluate the utility, feasibility and impact of the mobile family planning job aid on service provision, data collection, and program management. After using the job aid for six months, follow-up interviews with CHWs will be conducted, including general questions about their role as CHWs in providing family planning services as well as questions about the feasibility, acceptability and impact of using the family planning mobile job-aid. Their supervisors will also be interviewed; topics will include their role in the intervention process, supervision provided, and attitudes about the use of the mobile phone-based job aid, including benefits and challenges faced on the quality of supervision of CHWs.

In addition, a representative sample of clients who have been counseled using the mobile phone job aid will be asked to complete a survey about their experience with and perceptions on the use of the mobile phone job aid by CHWs, quality of counseling received, and the support they received during their visit. Secondary data will also be evaluated over the six-month pilot study period. This will include routine client visit data, such as the number of new clients by contraceptive method, the number of clients referred for services, and number of completed referrals. This will also include cost data, to calculate the incremental resource costs associated with various intervention

elements and to determine the potential cost-savings of a mobile job aid over a paper-based job aid for family planning service provision. Finally, an intervention-tracking tool will be used to collect data on the field implementation of the mobile job aid.

Limitations

A limitation of this research concerns the ability to collect accurate, unbiased data. Data from focus groups and surveys are subject to response bias, researcher reflexivity, and inaccuracy due to poor recall; data from participant observation can be subject to bias from the presence of the researcher. Thus several strategies were employed during data collection to reduce the risk that the data reflect systemic biases or were limited by specific data collection methods. For the usability testing, D-Tree International has extensive experience working with CHWs to implement mHealth projects in Tanzania, thus they have developed a strong ability to build trust and rapport with their participants, and collect useful and reliable information from focus groups and in field observations. As for survey data collection, a weeklong training was conducted with the 10 research assistants who administered the baseline survey to develop an accurate understanding of all study procedures. Further, the research assistants administered the survey one-on-one with each CHW, so as to ensure that all questions were answered and that participants understood each question.

There are several limitations to address with regards to use of the family planning mobile job aid itself. There is the potential that the job aid will in fact interrupt or over-complicate the processes of family planning service provision, data collection, and program management, reducing the impact on CHWs and their clients. This concern has been raised previously in the larger context of CBFP (Potts, 1997). Thus it will be important to follow the use of the job aid over time to allow the CHWs and their supervisors to become accustomed to its use, and also employ a variety of evaluation methods to measure its impact. Further, if guidelines for the job aid are not based on the most current evidence available for CBFP, the impact of the job aid may be further limited. Although the job aid was designed using two widely accepted evidence-based family planning tools, national CBFP policies in Tanzania do pose a concern, for example that CHWs cannot administer injectable contraception despite the fact this practice is now fully supported by the WHO. Another limitation to consider is that the three-day training may be insufficient for CHWs to successfully learn to use the mobile job aid. As these CHW mobile tools are recent innovations, there is limited documentation of how much training is sufficient for successful implementation. Thus D-Tree International staff will provide field support throughout the duration of the pilot study to ensure that any questions can be answered and problems in the field can be solved quickly. Ultimately, these limitations will be particularly important in considering the scale-up and sustainability of this pilot project.

Conclusions

The introduction of a mobile family planning job aid for CHWs presents an exciting, innovative opportunity to increase access to, knowledge about and use of family

planning information and services in Tanzania. Results from the forthcoming mixed-method evaluation of the six-month pilot study will provide a opportunity to demonstrate the impact of the job aid, incorporating the perspectives of the CHWs, their supervisors and their clients, as well as clinical and cost-effectiveness data. These findings should serve to inform the design, implementation, monitoring and evaluation of mHealth projects targeted for CHWs across a variety of health sectors, and inform future program and policy decisions to implement mobile technology into community-based family planning efforts, in Tanzania and beyond.

Chapter 4. "They Call Me a One-Woman Army": A Qualitative Evaluation of a Family Planning Mobile Job Aid for Community Health Workers in Tanzania

Abstract

Introduction: The global rapid growth in mHealth technology provides key opportunities to support CHWs in providing family planning services, particularly in low resource settings. This paper provides a qualitative evaluation of the acceptability, feasibility and impact of a family planning mobile job aid designed for CHWs in Tanzania, from their perspective.

Methods: After six months in the field, all CHWs participating in the pilot study were contacted for a follow-up interview; 20 CHWs who had used the mobile job aid participated. All interviews were conducted in Kiswahili, digitally audio recorded and transcribed, and translated into English. Data was analyzed with a thematic analysis approach, using Dedoose qualitative analysis software.

Results: Findings suggest that participants play an important role in expanding access to family planning information and counseling, contraceptive methods and service referrals for women in their communities. Participants found the mobile job aid to be highly acceptable, preferring it to the paper-based job aid and unanimously requesting to continue its use. Further, the mobile job aid simplified their work and increased their efficiency, particularly for data collection and reporting, as well as improved their compliance with standards and guidelines. However, participants faced many challenges, including technical problems, cost, and concerns over safety and theft. Participants showed evidence for feasibility by consistently demonstrating appropriate use of the mobile job aid, as per their training. Most participants needed help while working in the field, and the mobile job aid itself simultaneously created opportunities to access real-time support, both through supervisors and colleagues. Finally, findings indicate that the mobile job aid impacts participants' self- and community-perception, service provision and interactions with clients.

Discussion: Findings from this qualitative evaluation of the mobile job aid reinforce previous research on CHW mHealth projects, yet add new insight for the specific application to community-based family planning, demonstrating many opportunities to improve quality, access and care. These findings can help improve the mobile job aid, building a tool that is responsive to CHW input, and ultimately leading to improved family planning service delivery at the community-level.

Introduction

The global rapid growth in mHealth technology provides key opportunities to support CHWs, particularly in low resource settings. CHWs commonly use mobile tools to collect data for health research, program monitoring, and client care. Using these tools, CHWs can collect high quality data, with fewer errors (Bernabe-Ortiz, 2008) and less data loss (Tomlinson, 2009) when compared with traditional data collection methods. CHWs also provide direct medical services from the field using mobile devices, most prominently through decision support as well as alerts and reminder tools. These tools encourage compliance with standards and guidelines (Florez-Arango, 2011; Jones, 2012) as well as increase efficiency of service delivery (Mahmud, 2010). Further, these tools can lead CHWs to feel more confident in their abilities to meet their clients' needs (Lee, 2011) and access appropriate information (Chib, 2008).

mHealth technology can also create opportunities for effective supervision of CHWs, who often work far from their supervisors and have very limited opportunities for face-to-face interaction (DeRenzi, 2012; Svoronos, 2010). Further, mHealth technology can facilitate the creation of professional support networks, both among CHWs and between CHWs and their supervisors. These networks provide real-time support for CHWs while working in the field (Curioso, 2005; Tomlinson, 2009), and can lead to improvements in knowledge of best practices (Lee, 2011) and quality of care (Lemay, 2011).

To develop successful mHealth interventions, "end-users must be involved from concept to completion and beyond" (Leach-Lemmons, 2009). Thus mHealth interventions can also create opportunities to engage CHWs in project design, implementation, and evaluation. Though examples of participation are altogether rare in this field, when CHWs are successfully engaged, projects are more responsive to CHW needs (Mahmud, 2010) and also facilitate locally driven innovation and ownership (Svoronos, 2010).

Given these many examples of the impact of mobile technology on CHWs, the clients they serve and the healthcare systems in which they operate, a solid conceptual framing for this work presents the opportunity to look beyond a specific technology-based intervention toward larger lessons for the mHealth field. To that end, Chib and colleagues developed the Information and Communication Technologies for Health (ICT4H) framework (Appendix III), to provide "a more comprehensive understanding of the factors and forces influencing the adoption and impact of ICTs on the provision of health care in the developing world" (Chib, 2008). The framework is based on the Value-of-ICTs-to-Education (VIE) framework, which links education to development through four key pathways, as an opportunity producer, a capability enhancer, a social enabler and a knowledge generator (United Nations Development Program, 2005).

The ICT4H framework posits that ICTs play a similar role in health care, particularly in the CHW context, by improving CHW productivity, increasing CHW capacity and potential, strengthening links between CHWs and their professional and personal communities, and encouraging CHWs to effectively use and share important

information. However, in expanding on the VIE framework, the ICT4H framework also takes into account a set of barriers that must be considered in adopting new mHealth interventions, again particularly salient for the CHW context. These include infrastructural barriers, such as insufficient telecommunications or transportation networks, economic barriers, such as the frequently high cost of ICT implementation, technological barriers, such as low technology literacy, and socio-cultural barriers, such as challenges to traditional cultural values or gender norms. Thus the ICT4H framework integrates the potential benefits of mobile technology for CHWs with the potential barriers they may face in mobile technology adoption.

Lessons learned from prior mHealth interventions provide an opportunity to explore the potential for mobile technology to improve the community-based delivery of family planning information and services in the field. However, this potential is only beginning to be explored. To that end, as previously described in detail, in June 2011, FHI 360, NIMR, Pathfinder International, and D-Tree International began collaboration on the development of a mobile phone job aid for family planning service delivery by CHWs. After a six-month period of usability testing with six CHWs, the mobile job aid was launched in the field in February 2013, and ran for a pilot period of six months. While the overall pilot study uses multiple qualitative and quantitative methods of primary and secondary data collection, the specific purpose of this paper is to provide a qualitative evaluation of the family planning mobile job aid from the perspective of the CHWs themselves. Further, the paper will examine findings from this pilot study in the context of the ICT4H framework, providing a broader exploration of the impact, benefit and challenges of mHealth for CHWs.

Methods

A semi-structured interview guide was developed to explore key themes, including participants' experience as CHWs, as well as the acceptability, feasibility and impact of the family planning mobile job aid. The guide was pilot tested among the target population, and revised based on feedback to improve such features as clarity and relevance of the questions, the accuracy of the translation, and the flow of the interview.

After six months in the field, all CHWs participating in the pilot study were contacted for a follow-up interview. Among the original 50 participants, two had died and seven were unwilling to participate. Interviews were therefore conducted with 41 CHWs, 20 who had used the mobile job aid and 21 who had used the paper-based job aid. This paper reports findings from interviews with the mobile job aid users only. Five bilingual research assistants conducted and digitally audio recorded all interviews, and transcribed them in Kiswahili. Interviews were then translated into English and entered into Dedoose qualitative software for analysis.

Data was analyzed using a thematic analysis approach, with one researcher conducting all analyses. Key themes and an extensive list of codes had been developed a priori based on the interview guide; additional codes were added after multiple readings of the transcripts. Codes were aggregated into a codebook, including code names, definitions

for assigning codes, and examples. All codes were entered into Dedoose qualitative analysis software and tagged to their associated segments of text for all interviews. Text segments were then sorted by codes and reviewed to identify emergent themes, looking for consistency across interviews as well as outlying findings. The results represent findings organized by the final themes identified in the analysis, integrating direct quotes from participants to illustrate the findings.

Results

Health Worker Experience

Participants explained that their main responsibilities as CHWs were to provide family planning education and counseling, contraceptive methods and referrals. Participants made important distinctions between their role as CHWs, and that of other family planning providers in their communities. Several participants cited the importance of the counseling that they provide to their clients, suggesting that their approach to service provision increased the ability of a client to choose the contraceptive method that she prefers, eg. CHW 3 said "What they do different from us is that for us, before we deliver the service we provide counseling, explaining the different contraceptive methods, advantages and side effects of each, but with pharmacies they just buy pills and at time expired pills, and some of these pharmacy people are dishonest." Another important difference cited by several CHWs was that they could provide services more efficiently, eg. CHW 14 said "A person goes to hospital but she is disappointed because of the big queue, so she comes back to me where she gets quicker services. Because they have already got used to me they quickly get the services they want and get back to their cooking."

Participants discussed many benefits that they receive as CHWs. Most participants made a reference to being appreciated or valued by their communities, eg. CHW 2 said "I got a chance to meet and know a lot of people, they like me and they like my service they find me as a valuable person, because I inform them and help them get service at their homes." For other participants, their role as a CHW led to leadership opportunities, eg. CHW 8 said "Recently there was that issue of constitution. They were electing eight people to join the constitution process and I was elected by many votes coming from my clients." Several participants explained that being a CHW also created opportunities for self-improvement, eg. CHW 2 said "I feel like I have received an education, if I compare myself to the previous time, I feel like I have broadened my mind now." Finally, a few participants mentioned the benefit of remuneration for their services, eg. CHW 1 said "We thank our benefactors who give us fares. The job we are doing is pretty hard but it does help us with buying flour for my family at home."

Participants also discussed the many challenges they face as CHWs. Many participants spoke of the competing priorities in their lives, eg. CHW 19 said "You know that I'm a family woman, sometimes I plan to meet with the clients, but sometimes something crops up and I fail to keep the appointment," and the limited remuneration they receive. Other participants mentioned challenges specific to service provision, such as staying

current with health information, the distances they must travel to see their clients or the busy lives that women in their communities lead. Most participants cited the lack of sufficient contraceptive supplies as a major challenge, both those they provide and those for which they refer. Several participants explained that dealing with their clients' husbands was a challenge for providing family planning services, eg. CHW 1 said "I gave family planning pills to a woman after introducing myself to her as a community health worker and we exchanged phone numbers. But when her husband returned and [she] told him what had happened then he got very angry to the extent of throwing away the pills." Finally, participants cited several challenges specific to family planning, including misinformation, eg. CHW 2 said "Some people are reluctant because of some beliefs about family planning, for example that some methods cause cancer", religious opposition, eg. CHW 7 said "We all have religious beliefs but some are complicated. They say using the knowledge of family planning is a sin" and stigma, eg. CHW 14 said "Should I say it is stigma, because at times the patient tells you not to go to her place and she comes to your place. Therefore we go back to square one, confidentiality."

Finally, participants cited several outstanding needs. Almost all participants requested more training, eg. CHW 18 said "Yes, we need refresher course to prop up our memories. You know that education has no end." In addition, many participants explained that they would like to provide other contraceptive methods beyond pills and condoms, eg. CHW 2 said "Some people want us to practice some methods ourselves, like injecting and implantable devices, because people using such methods are many, but I need skills to practice such methods." Additionally, a few participants explained that they need identification when they are working in the field, eg. CHW 15 said "We need to get identity cards so that people trust us more that we are really community health workers" as well as specific material goods, such as eye glasses, bicycles or motorbikes, and laptops.

Acceptability

On the whole, participants had a positive opinion of the mobile job aid, particularly in comparison the paper job aid they had used previously, eg. CHW 8 said "I am very happy and I pray to god that every one should use this mobile job aid and dump away that paper aid." Most participants found the mobile job aid easy to use, yet many also remarked that their experience had changed over time, eg. CHW 10 said "I am satisfied in that when I started using the aid it was difficult but now that I am used to it, it is simple." All participants said that they would like to continue using the mobile job aid.

Participants cited many benefits to using the mobile job aid. Many participants explained that the mobile job aid simplified their work, because everything they needed was in one place, eg. CHW 2 said "All matters concerning family planning are in the phone, you don't need to recall some things on your own, you just trace it on the phone and if the client needs to be referred then the phone will direct you" or because they no longer need to use paper forms, eg. CHW 3 said "Filling papers and carrying them was tiresome." Participants indicated that the mobile job aid improved their program reporting, eg. CHW 1 said "As compared to the past, the job has become easy because

I don't write much as I used to. I don't have to write down what has happened in a day anymore. I don't have to sit down and recollect the monthly data about the work I did in a month." Participants also indicated that using the mobile job aid helped them serve clients in a timelier manner, both for the initial visit, eg. CHW 6 said "It reminds me to visit a client if I forget or I am late to do so," and also for follow-up, eg. CHW 14 said "Because it was only the day before yesterday that I got a message to follow up with certain clients, the dates have passed; it makes it easy for me." Several participants found that using the mobile job aid made it possible to provide services anywhere eg. CHW 6 said "I like it by a hundred percent because I can give services even to a client I meet on the street. If he needs condoms or pills then I go home to write him a referral but I have already given him advice." And a few participants explained that using the mobile job aid led to cost savings, because they weren't spending money on papers and copies, or bus fare to submit reports; rather all of this was achieved through the phone.

Many participants indicated that using the mobile job aid had benefits specific to data collection. Participants explained that the job aid improved data accuracy, because all data was submitted at the time of the visit, eg. CHW 6 said "The phone job aid is more accurate than the one using papers [where] you must write and later you copy again, through the cell phone when you meet the client, you finish everything on the spot." Participates also explained that the mobile job aid increased access to client data, eg. CHW 3 said "It is easy to access data of a client compared to the paper job aid where you may look far the paper and you don't [find] it as they are so many. It is easy to loose a client's data and follow up is difficult. With the phone job aid you just open the client list and you choose the name you want then you continue." Another benefit cited by participants was receiving real-time responses in the field, eg. CHW 5 said "I think it has helped me a lot because when I send collected clients' data then I get feedback. I see this being better than the paper ones which were sent by the end of the month. After a week it gives you a text about the number of people whose data were sent. This will make you to work harder and harder."

However, participants also provided many challenges to using the mobile job aid. All participants cited the challenge of losing phone charge when serving a client, eg. CHW 2 said "It is easy to use it, but one problem with the phone is charge storage, you may be attending a client and before you are done the phone goes off charge, so you have to recharge it and go back to the client." Many participants also cited problems with data transmission, eg. CHW 7 said "Sometimes due to network failure. As in . . .the record is not submitted. You have to wait and send them later, so they are not submitted on time" or data processing, eg. CHW 2 said "The collection of information is easy, just that they are not keen with information handling, and that is why the information submitted is different from the ones we get back, we have notified them already and they have rectified the problem." Many participants worried about phone theft, eg. CHW 18 said "I'm afraid they might grab it from me…especially when I pass dangerous areas" or having their memory card stolen, eg. CHW 6 said "We charge it at the kiosk but we are always very nervous. They normally steal the memory cards." In addition, several participants cited cost as a challenge, explaining that the amount of money they needed

to charge their phone battery or buy airtime for the phone was greater than the remuneration they received.

Feasibility

All participants described their process for using the mobile job aid with a client, eg. CHW 1 said "Firstly I shall make sure that my mobile job aid is charged and has enough money. Then I introduce myself as a community health worker providing family planning service. I shall tell her different issues concerned with family planning and she tells me if she agrees to be with in one of the service whether pills, condoms or injections. I then tell her that I have a mobile job aid and I would like to ask her some few questions and if she agreed then I shall open the mobile job aid. I then put a password and look for the client name to see if she is a new or a returning client. I record her three names in the mobile job aid as well as in the exercise book. I then record her age and birth date. After that I start asking her questions and we shall continue until we reach to the service that she prefers. If it is a referral that she needs, then I shall write it for her and tell her to meet again the next time." Some participants read to their clients from their phone, while others showed their clients their phone and they worked through the information together. Several participants suggested that they weren't supposed to serve clients without the mobile job aid, eg. CHW 12 said "Clients ask you, is it necessary to use a phone to interrogate me; so I have to answer her that that is my job aid and therefore I cannot ask you questions without the job aid."

All participants indicated that they had access to support in the field if they had problems using the mobile job aid. Most participants indicated their supervisor was their main source of support. Some participants would contact their supervisor while serving a client, eg. CHW 5 said "I ask a supervisor when I face some difficulties because he also has a job aid. I can call or beep him and I put him [on] a loud speaker so that a client hears what we are talking about. I tell my clients that he is our senior and I refer to him when I fail to serve her" while others would wait until they had completed their visit with a client to contact their supervisor, eg. CHW 17 said "When I leave the client I tell her that I will answer her issue tomorrow, then I call my supervisor and discuss the issue and the proper response. The next day I call the client." Far fewer participants indicted that they would contact other CHWs in the field for support, but those that did indicated positive results, eg. CHW 2 said "At first it was a bit hard for me to use it, but because we cooperate, when you encounter a problem you just ask your colleague to help you in using the device until you master it, for instance at the beginning I could not fill the service form, so in the report it was showing that I have registered a client but not deliver service to them, but with the assistance of my colleagues I managed to use the job aid." One participant explained that in addition to support while using the job aid, she would meet regularly with other CHWs, eg. CHW 19 said "We get help because we meet together and everyone explains her challenges and we discuss them and come up with solutions." In addition to support from supervisors and peers, many participants cited a need for continued training specific to the mobile job aid, eg. CHW 14 said "I would like it to continue being used. Also after every three months if we could get refresher courses on more efficient use of the job aid."

Participants had many suggestions to improve their experience using the mobile job aid. All participants requested changes to improve the battery or charge of the mobile job aid, also offering suggestions such as providing two batteries, eg. CHW 3 said "For those working in the villages where there is no electricity, it becomes difficult; therefore we could be given two batteries in case of problems" or solar chargers, eg. CHW 3 also said "If possible they could get us those small solar chargers. It would help because you can charge your phone as you are working." Several participants suggested changes to their remuneration, either in general, eg. CHW 12 said "Because you leave behind your daily activities which gives you your daily bread and you go round; the fact that you are told that you get allowances but the allowance is small compared to the volume of work you do" or specifically for increases in phone minutes, eg. CHW 17 said "They should increase the phone vouchers, sometimes you use the phone for other things; we are humans after all" or transportation subsidies, eg. CHW 16 said "Bus fare to be increased, fifteen thousand is very small, at least fifty thousand is reasonable. Mind you, we are volunteers."

Participants also had specific suggestions to improve the content of the mobile job aid. Some had suggestions for data entry, such as specifying the number of boxes of condoms provided, or the specific contraceptive method requested for a referral. Others had suggestions about the specific wording of questions, eg. CHW 14 said "In the section with the question, 'Has your husband ever had sex with a woman apart from you?' I suggest to add another selection – not sure; because saying simply no, it is not correct because he cannot tell his wife that he has had sex outside marriage with another woman, therefore the woman is not sure." Finally, several participants suggested that the overall content needed to be reduced, eg. CHW 17 said "They need to abbreviate some of these words. Some statements are very long. Some statements bore the clients since they are too long and congested. If you intend to finish the whole text you will consume most of the clients."

Impact

Using the mobile job aid impacted participants in multiple ways. First, participants explained that the mobile job aid had impacted their self-perception. Many participants remarked that they were now a more special or important person, for eg. CHW 20 said "It has given me prestige. They call me a one-woman army." Several participants also explained that through using the mobile job aid, they increased their self-confidence, eg. CHW 4 said "I got courage to talk to people and I became confident, right now they are the one calling me to bring to them their medicines and those who were hiding are now open." Participants also explained that using the mobile job aid impacted the way they were perceived by the communities they serve, in both positive and negative ways. Some participants felt supported, eg. CHW 8 said "Yes, it is true they support me and some time they even ask to join me in this work" and respected, eg. CHW 6 said "It gives me respect in the community and people are surprised at how information can be sent which is different from how we used to do earlier." However, other participants experienced envy, eg. CHW 4 said "As you know in villages, they envy me with my

phone, they say that you are a volunteer but now you are showing off with your phone" or suspicion, particularly related to remuneration, eg. CHW 7 said "There are others who don't like how I got this job, they question why I got the job and they didn't, although we are all together and how come they didn't get the chance as I did? And they actually think I get paid a really handsome salary. Maybe due to my outlook? They assume that I definitely get paid very well because it is impossible to work and not get paid dearly."

Further, participants explained that using the mobile job aid impacted their service provision. Participants spoke about changes to client volume in response to using the mobile job aid; some participants referred to increases, eg. CHW 1 said "We used to give service to two or three clients such that you have to return on the next day but with the introduction of this then you can find yourself giving three to four services at a time" while others referred to decreases, eg. CHW 15 said "It has affected, because before the phone aid we had the capacity to provide services to 10 – 15 houses, but since we started to use the phone aid, you cannot reach all those houses, how much you strive at most three houses because there are many things to go through in the phone aid." Many participants also explained that using the mobile job aid had allowed them to provide more in-depth information to their clients, eg. CHW 1 said "I thank God that this has increased my understanding such that when I give advice to clients then I go deep which is different from what we used to do before. This is so because the mobile device reminds us. I can also advice about diseases such as AIDS and other sexually transmitted diseases." And several participants indicated that using the mobile job aid encouraged contraceptive choice, eg. CHW 3 said "The good thing with the phone job aid, it explains everything. The device asks if the client still wants to have children or doesn't want more children, and it gives choices and she decides what family planning method is proper [for her]."

Several participants indicated that by using the mobile job aid, they now followed the correct protocol for family planning service delivery, eg. CHW 7 said "It is a must you pass through all chapters which when reading you cannot simply skip. Because before using the job aid you could patch in a word or two, but with the job aid you have to follow instructions to the letter." Participants also indicated they were less reliant on recall, eg. CHW 1 said "It has changed much because I once didn't ask clients if they had those itching symptoms but I can now do that…This could only be done if the client reminds you but now the mobile device reminds you that." However, several participants were concerned about the amount of time to correctly follow the protocol with a client, eg. CHW 14 said "Because of the long questionnaire a client may think that you are using too much of his time. So you tell the client that because it is the first time, you need to fill in the forms thoroughly."

In addition, participants also explained that using the mobile job aid impacted their interactions with their clients. Many participants felt an increased sense of trust from their clients, eg. CHW 9 said "With the phone aid they believe it, because they are capable of proving what I am telling them doesn't come from my head rather from the phone. So they believe and get influenced. And it helps in winning their trust. They are

happy about it." Participants also felt that the mobile job aid allowed them to interact privately with their clients, eg. CHW 17 said "There are changes, it has become easier, and even if someone passes by he knows that you are just chatting, showing each other messages while you are [in fact] talking about family planning." In addition, participants remarked that by using the mobile job aid, client interactions felt more confidential, eg. CHW 6 said "People are now confident that their information will not be exposed even if a phone is picked up by somebody else unless he knows the password. This is different from the time when we used papers which can be read and picked up by a child or a person such that information is leaked…This is [important] because some use this service secretly without making their husband know about it." Finally, a few participants remarked that using the mobile job aid impacted their clients' participation during interactions, eg. CHW 9 said "They participate well, in the beginning they felt they were being recorded but now they are participating very well. There is more sharing of information [with clients]."

Discussion

To evaluate the mobile job aid, it is important to first understand the CHWs' general experiences providing family planning services. Findings suggest that CHWs play an important role in expanding access to information and counseling, contraceptive methods and referrals for women in their communities. CHWs see many personal and professional benefits to their work, despite essentially operating as volunteers. However, they also face many challenges, from their own competing life priorities to addressing medical misperceptions and opposition from husbands. While the mobile job aid can play a role in overcoming many of these challenges, some will persist, particularly those related to the nature of family planning itself, such as religious opposition or cultural stigma. CHWs cited specific needs, particularly for training, both to reinforce what they had already learned, and to expand into new areas of service provision such as injectable and implantable contraceptives. To continue to support CHWs in effectively providing family planning services, these needs must be addressed separately from the mobile job aid itself.

Overall, CHWs had a positive reaction to the mobile job aid, preferring it over the paper-based job aid and unanimously requesting to continue its use. Most CHWs found the mobile job aid easy to use despite initially facing difficulties, to be expected for any new innovation. As with previous research on mHealth interventions, CHWs found that the mobile job aid simplified their work and increased their efficiency, leading to improved program reporting and more timely care. CHWs identified many improvements specific to data collection and reporting, highlighting the opportunity to receive real-time data feedback while working in the field, which was simply not possible before the introduction of the mobile job aid. In looking to further improve the acceptability of the mobile job aid, project partners should address many of the challenges identified by CHWs, such as technical problems with limited battery charge and data transmission, or the cost of using the mobile job aid as compared to the reimbursement currently received by CHWs. However, other identified issues, such as safety and theft, are outside of partners' control and will remain a challenge for CHWs.

CHWs showed evidence for feasibility by consistently demonstrating appropriate use of the mobile job aid, as per their training. However, several CHWs reported hesitancy in providing family planning services without using the mobile job aid. This does present a concern. It is likely that situations will arise in which the mobile job aid cannot be used, yet these CHWs have both the training and experience to provide services to clients without the job aid, so clients should not be denied services as a result. Thus CHWs need a paper-based backup available, both for service provision and data collection, and this needs to be reinforced in their training. Most CHWs needed support at some point in time in the field, and the mobile job aid itself simultaneously created opportunities to access real-time support. CHWs were more likely to rely on a supervisor than colleague, which may not be sustainable over time, so program partners should find ways to encourage the development and use of peer support networks. CHWs identified many suggestions to improve the mobile job aid. Some of these would be simple for program staff to implement, such as providing solar changers or a second battery for each phone. However other suggested changes, such as specific changes to mobile job aid content, would take more consideration, given the potential drawbacks of these suggestions. For example, while several CHWs suggested that content should be reduced, this may not be feasible given accepted protocols for family planning service delivery. On the whole, addressing CHW suggestions creates an opportunity to encourage engagement with and ownership of the mobile job aid.

In using the mobile job aid, CHWs identified positive impacts on self-perception, such as feeling more important and self-confident. However, the impact on their connection to the communities they serve was more complicated. While some CHWs cited increased trust, support and respect, others spoke of envy and suspicion. It is likely that these negative perceptions could change over time as community members become more accustomed to receiving services via a mobile phone, but it also highlights the importance of exploring the client perspective on the mobile job aid. In terms of service provision, CHWs felt that using the mobile job aid encouraged contraceptive choice among their clients, yet given the stated challenges of insufficient contraceptive supplies both for methods that CHW's can provide and also those for which they refer, the ability for clients to actually receive their chosen method is called into question. Further, again as found in previous research, CHWs indicated that mobile job aid use increased their compliance with standards and guidelines. This potentially creates an opportunity for the mobile job aid to support CHWs in providing more effective family planning methods such as injectable contraceptives, a practice not currently allowed in Tanzania, despite support from the WHO (Stanback, 2010). Thus if the services provided by CHWs are constrained by Governmental policies, mHealth tools can either serve to reinforce a bad system, or create an opportunity to work around it. Finally, CHWs found that mobile tools impacted their interactions with clients in ways that are very important for effective provision of family planning services in this context, such as privacy and confidentiality.

In exploring this pilot study in the context of the ICT4H framework, findings suggest that the family planning mobile job aid provided many of the posited benefits for CHWs. As an opportunity producer, CHWs generally increased the number of clients they could

serve, leading to greater cost and time efficiencies. As a capability enhancer, CHWs improved their ability to provide for their clients needs, effectively relying upon their colleagues and supervisors for support in the field. As a social enabler, in some instances CHWs strengthened their relationships with the communities they serve; yet in others, these relationships became more strained. And as a knowledge generator, CHWs were able to provide more accurate and complete information to their clients, thereby increasing their compliance with accepted protocols for family planning service provision. Further, findings suggest that CHWs face many of the posited barriers in adopting the family planning mobile job aid. CHWs faced infrastructural barriers, citing problems with sending and receiving data, and insufficient network coverage. Yet CHWs also cited infrastructural barriers outside of the use of the mobile job aid itself, for example the challenges of maintaining sufficient contraceptive supplies for their clients. CHWs also faced economic barriers, with several explaining that the costs of using the mobile job aid were greater than the remuneration they receive. CHWs did face technological barriers, mainly in maintaining sufficient battery charge to provide services to their daily client load. However, CHWs generally explained that they did not face many problems with using the mobile job aid itself, and further acknowledged that use became easier over time, through this was related to use of the specific family planning job aid application, rather than the mobile phone in general. CHWs did not appear to face significant socio-cultural barriers to the use of technology; rather the socio-cultural barriers were more specifically related to the provision of family planning information and services, such as familial or religious opposition and cultural stigma. Thus taken on the whole, the findings from the pilot study of the family planning mobile job aid validate the ICT4H framework in the context of community-based family planning, suggesting that new mHealth interventions for CHWs must address these potential barriers to technology adoption in order to reap the benefits of technology introduction.

Limitations

There are several limitations to address in this study. One limitation is the ability to collect accurate, unbiased data. Interview data can be subject to response bias, researcher reflexivity, and inaccuracy due to poor recall. To reduce the risk that the data reflect systemic biases or were limited by the data collection method, the five research assistants had significant experience with qualitative data collection and participated in a weeklong training to further enhance their skills, and tailor them to this specific study. In addition, research assistants conducted interviews in locations and times that were selected by the CHWs, in order to increase comfort and encourage their participation. Another potential limitation is the short time frame for this study, chosen due to the realities of on-the-ground program implementation, which may not have been a sufficient amount of time to fully evaluate the mobile job aid. An additional limitation to address is the representativeness of the sample that participated in the interviews, given that several CHWs were not available to participate in the study. A final limitation is the ability to generalize findings from this study to other settings, given the qualitative approach. However, choosing this methodology provides the opportunity to deeply and openly explore the experiences of the CHW themselves, where previous research has largely focused on quantitative program outcomes.

Conclusions

Findings from this evaluation of the mobile job aid reinforce previous research on CHW mHealth projects, yet add new insight for the specific application to community-based family planning, demonstrating many opportunities to improve quality, access and care. To gain further insight into the mobile job aid, future research can combine these qualitative findings from CHWs with other quantitative methods of primary and secondary data collection from the pilot study, including surveys with supervisors and clients, and automated client data from the mobile job aid. These findings also highlight many issues that program partners will need to consider in terms of the potential scale-up and sustainability of the family planning mobile job aid, including cost, training, support, supervision, and ongoing monitoring and evaluation. These findings can help improve the mobile job aid by building a tool that is responsive to CHW input, and ultimately leading to improved family planning service delivery at the community-level.

Chapter 5. Conclusion

The goal of this dissertation was to critically examine an innovative technology-based approach to increasing access to health care at the community-level. Findings from the systematic review demonstrate the impacts of mHealth technology on CHW programs across health issues and geographic locations, and direct future evaluation efforts for community-based mHealth approaches. Findings from the case study of the pilot family planning mobile job aid provide an opportunity to assess the potential to introduce mHealth into family planning service delivery at the community-level, exploring program development, implementation and evaluation with a specific lens toward the experiences of the CHWs themselves.

The first dissertation paper explored the impact of mobile health technology on CHW programs, through a systematic review of the literature in health, medical, social science, and engineering databases, using PRISMA guidelines. A total of 25 unique full-text research articles on CHW and their use of mobile technology for the delivery of health services were identified. Results demonstrate that CHWs have used mobile tools to advance a broad range of health aims throughout the globe, particularly maternal and child health, HIV/AIDS, and sexual and reproductive health. Most commonly, CHWs use mobile technology to collect field-based health data, receive alerts and reminders, facilitate health education sessions, and conduct person-to-person communication. Programmatic efforts to strengthen health service delivery focus on improving adherence to standards and guidelines, community education and training, and programmatic leadership and management practices. Those studies that evaluated program outcomes provided some evidence that mobile tools help CHWs to improve the quality of care provided, efficiency of services, and capacity for program monitoring.

The second dissertation paper examined the development and implementation of a family planning mobile job aid for CHWs in Tanzania, aiming to inform future program and policy decisions. Development began in June 2011. The mobile job aid was designed to facilitate evidence-based counseling, screening and service provision, as well as improve data collection and program management. Once the initial programming was completed in July 2012, six CHWs were selected to test the mobile job aid. Usability testing was conducted via a focus group and field observations to identify areas for improvement; design changes were made subsequently. Focus group data yielded suggestions to improve job aid usability, language, and client referral and follow-up. Field observation data revealed positive changes made in response to the job aid, such as providing follow-up with clients on method selection and referrals, and identified barriers to effective service delivery, including maintaining access to sufficient contraceptive supplies. In January 2013, 50 CHWs and their supervisors participated in a job aid training and were administered a brief baseline survey to assess participant characteristics. The baseline surveys revealed that CHWs in the pilot study were primarily age 40 or older, female and married. Most obtained a secondary school education and had significant CHW experience. They also reported considerable

comfort with and knowledge about family planning, and high levels of access to and use of mobile phones.

The third dissertation paper examined the acceptability, feasibility and impact of the family planning mobile job aid designed for CHWs in Tanzania, from their perspective. After six months in the field, all community health workers participating in the pilot study were contacted for a follow-up interview; 20 community health workers who had used the mobile job aid participated. Findings suggest that CHWs play an important role in expanding access to information and counseling, contraceptive methods and referrals for women in their communities. CHWs see many personal and professional benefits to their work, however they also face many challenges. Overall, CHWs had a positive reaction to the mobile job aid, preferring it over the paper-based job aid and unanimously requesting to continue its use. CHWs found that the mobile job aid simplified their work and increased their efficiency, particularly for data collection and reporting. However, CHWs faced many challenges, including technical problems, cost, and concerns over safety and theft. CHWs showed evidence for feasibility by consistently demonstrating appropriate use of the mobile job aid, as per their training. Most CHWs needed support while working in the field, and the mobile job aid itself simultaneously created opportunities to access real-time support, both through supervisors and colleagues. CHWs also identified many suggestions to improve the mobile job aid. Finally, findings indicate that the mobile job aid impacts participants' self- and community-perception, service provision and interactions with clients.

Taken together, this dissertation highlights several directions for future research in the mHealth field. While there is a growing body of evidence for the use of mHealth tools to improve effectiveness of CHWs in low resources settings, there remains a need for more rigorous measurement of improvements in performance and outcomes, and cost effectiveness analyses. More specific to family planning, further evaluation of mHealth tools should consider how CHWs with little experience with family planning or mobile phones can be supported, as the profile of the CHWs developed from the baseline survey of participants suggests that they can support a successful pilot. Additionally, with regards to the family planning mobile job aid explored in this dissertation, future research should combine the qualitative findings from CHW interviews with other quantitative methods of primary and secondary data collection from the pilot study, including surveys with supervisors and clients, automated client data from the mobile job aid, and data on cost effectiveness.

In addition, this dissertation suggests several implications for public health practice. Evidence suggests mHealth technology presents promising opportunities to improve the range and quality of services provided by CHWs. mHealth technologies show great potential to enhance CHWs' opportunity to participate in design, implementation and evaluation processes, yet this is more the exception than the rule. Thus future mHealth efforts should galvanize on the opportunity to encourage participatory processes that engage CHWs. Specific to family planning, in developing and implementing the mobile job aid in Tanzania, maintaining access to sufficient contraceptive supplies was a key challenge identified by CHWs. Resolving this issue will invariably require significant

national resources and support, but is ultimately key to successfully expanding access to family planning, particularly for women in rural or underserved areas. And despite the potential positive impact of the mobile job aid, further integration of CHWs into the national health care system will be critical to advance community-based access to family planning information and services across Tanzania. Further, in their interviews, CHWs indicated that mobile job aid use increased their compliance with family planning standards and guidelines. This creates an opportunity to support CHWs in providing more effective family planning methods such as injectable contraceptives, a practice not currently allowed in Tanzania, despite support from the WHO. Ultimately, this dissertation provides data that can improve the design, implementation, monitoring and evaluation of mHealth projects targeted for CHWs, and can inform program and policy decisions to implement mHealth technologies in future family planning efforts, in Tanzania and beyond.

References

Abbott L, Luke N. (2011) Local Hierarchies and Distributor (Non) Compliance: A Case Study of Community-Based Distribution in Rural North India. Health Care for Women International 32: 225-242.

Aradhya K. (2009) Task shifting is expanding the roles of family planning providers: Allowing lower-level providers to take on some of the responsibilities of higher-level providers could improve services. Africa Health: 36-39.

Babalola S, Sakolsky N, Vondrasek C, Mounlom D, Brown J, at al. (2001) The impact of a community mobilization project on health-related knowledge and practices in Cameroon. Journal of Community Health. 26(6): 459-77.

Berman P, Pallas S, Smith AL, Curry L, Bradley EH. (2011) Improving the Delivery of Health Services: A Guide to Choosing Strategies. HNP Discussion Paper, The World Bank. Available: http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Resources/281627-1095698140167/ImprovingDeliveryofHealthServicesFINAL.pdf. Accessed 2 July 2012.

Bernabe-Ortiz A, Curioso WH, Gonzales MA, Evangelista W, Castagnetto JM, et al. (2008) Handheld computers for self-administered sensitive data collection: a comparative study in Peru. BMC Medical Informatics and Decision Making 8:11.

Bhattacharyya K, Winch P, LeBan K, Tien M. (2001) Community Health Worker Incentives and Disincentives: How They Affect Motivation, Retention, and Sustainability. Available: http://pdf.usaid.gov/pdf_docs/PNACQ722.pdf. Accessed 27 March, 2012.

Bhutta ZA, Lassi ZS, Pariyo G, Huicho L. (2010) Global Experience of Community Health Workers for Delivery of Health Related Millennium Development Goals: A Systematic Review, Country Case Studies, and Recommendations for Integration into National Health Systems. WHO. Available: http://www.who.int/workforcealliance/knowledge/publications/alliance/Global_CHW_web.pdf. Accessed 29 November 2011.

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.

Burket M. (2006) Improving Reproductive Health through Community-Based Services: 25 Years of Pathfinder International Experience. Pathfinder International. Available: http://www.pathfind.org/site/DocServer/Pathfinder_CBS.pdf?docID=7441. Accessed 22 March 2013.

Chang LW, Kagaayi J, Arem H, Nakigozi G, Ssempijja V, et al. (2011) Impact of a mHealth Intervention for Peer Health Workers on AIDS Care in Rural Uganda: A Mixed Methods Evaluation of a Cluster-Randomized Trial. AIDS and Behavior 15(8): 1776-1784.

Chen L, Evans T, Anand S, Boufford JI, Brown H, et al. (2004) Human resources for health: overcoming the crisis. Lancet 364(9449): 1984-90.

Chenge J; Rutenburg N, Janowitz B; Thompson A. (1998) Factors affecting the outputs and costs of community-based distribution of family planning services in Tanzania. Available: http://pdf.usaid.gov/pdf_docs/PNACD472.pdf. Accessed 27 March, 2012.

Chetley A. (2006) Improving Health, Connecting People: The Role of ICTs in the Health Sector of Developing Countries. InfoDev. Available: http://www.infodev.org/en/Publication.84.html. Accessed 15 April, 2013.

Chib A, Lwin MO, Ang J, Lin H, Santoso F. (2008) Midwives and mobiles: using ICTs to improve healthcare in Aceh Besar, Indonesia. Asian Journal of Communication 18(4): 348-364.

Conway, ME. (1968) How do Committees Invent? Datamation 14(5): 28-31.

Curioso WH, Karras BT, Campos PE, Buendia C, Holmes KK, et al. (2005) Design and implementation of Cell-PREVEN: a real-time surveillance system for adverse events using cell phones in Peru. American Medical Informatics Association Annual Symposium Proceedings 176-80.

DeRenzi B, Findlater L, Payne J, Birnbaum B, Mangilima J, et al. (2012) Improving Community Health Worker Performance Through Automated SMS. Proceedings of the Fifth International Conference on Information and Communication Technologies and Development. Association for Computing Machinery 25-34.

Florez-Arango JF, Iyengar MS, Dunn K, Zhang J. (2011) Performance factors of mobile rich media job aids for community health workers. Journal of the American Medical Informatics Association 18(2): 131-7.

Foreit J, Raifman S. (2011) Increasing access to Family Planning and Reproductive Health services through task-sharing between Community Health Workers and community mid- level professionals in large-scale public-sector programs. Available: http://www.popcouncil.org/pdfs/2011RH_CHWLitRev.pdf. Accessed 15 April, 2013.

Hoke TH, Wheeler SB, Lynd K, Green MS, Razafindravony BH, Rasamihajamanana E, Blumenthal PD. (2011) Community-based provision of injectable contraceptives in Madagascar: 'task shifting' to expand access to injectable contraceptives. Health Policy and Planning 27(1): 52-9.

Hongoro C, McPake B. (2004) How to bridge the gap in human resources for health. Lancet 364(9443): 1451-6.

Islam MA, Wakai S, Ishikawa N, Chowdhury A, Vaughan JP. (2002) Cost-effectiveness of community health workers in tuberculosis control in Bangladesh. Bulletin of the World Health Organization 80(6): 445-50.

Janowitz B, Chege J, Thompson A, Rutenberg N, Homan R. (2000) Community-Based Distribution in Tanzania: Costs and Impacts of Alternative Strategies To Improve Worker Performance. International Family Planning Perspectives 26(4): 158-160.

Jones COH, Wasunna B, Sudoi R, Githinji S, Snow RW, et al. (2012) "Even if You Know Everything You Can Forget": Health Worker Perceptions of Mobile Phone Text-Messaging to Improve Malaria Case-Management in Kenya. PLoS One. 7(6): e38636.

Leach-Lemens C. (2009) Using mobile phones in HIV care and prevention. HIV & AIDS Treatment in Practice 137: 2-7.

Lehmann U, Sanders D. (2007) Community health workers: What do we know about them? World Health Organization, Evidence and Information for Policy, Department of Human Resources for Health. Available: http://www.who.int/healthsystems/round9_7.pdf. Accessed 29 November 2011.

Lee S, Chib A, Kim JN. (2011) Midwives' cell phone use and health knowledge in rural communities. Journal of Health Communication 16(9): 1006-23.

Lemay NV, Sullivan T, Jumbe B, Perry CP. (2011) Reaching remote health workers in Malawi: baseline assessment of a pilot mHealth intervention. Journal of Health Communication 17(1): 105-17.

Mahmud N, Rodriguez J, Nesbit J. (2010) A text message-based intervention to bridge the healthcare communication gap in the rural developing world. Technology and Health Care 18(2): 137-44.

Mangilma J et al. (2010) CommCare: A Phone-based Tool for Home Based Care in Tanzania. 2nd International Conference on Mobiles for Development, Kampala.

Mavranezouli I. (2008) The cost-effectiveness of long-acting reversible contraceptive methods in the UK: analysis based on a decision-analytic model developed for a National Institute for Health and Clinical Excellence (NICE) clinical practice guidelines. Human Reproduction. 23(6): 1338–1345.

Ministry of Health and Social Welfare, Government of Tanzania. (2010) National Family Planning Costed Implementation Program 2010 – 2015. Dar es Salaam, Tanzania: Ministry of Health and Social Welfare.

Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group. (2009) Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097.

Narasimhan V, Brown H, Pablos-Mendez A, Adams O, Dussault G, et al. (2004) Responding to the global human resources crisis. Lancet 363(9419): 1469-72.

National Bureau of Statistics Tanzania and ICF Macro. (2011) Tanzania Demographic and Health Survey 2010. Dar es Salaam, Tanzania: NBS and ICF Macro.

Ngabo F, Nguimfack J, Nwaigwe F, Mugeni C, Muhoza D, et al. (2012) Designing and Implementing an Innovative SMS-based alert system (RapidSMS-MCH) to monitor pregnancy and reduce maternal and child deaths in Rwanda. Pan African Medical Journal 13:31.

Potts, M. (1997) Community-based distribution of contraceptives. International Planned Parenthood Foundation Medical Bulletin 31: 2-3.

Prata N, Vahidnia F, Potts M, Dries-Daffner. (2005) Revisiting community-based distribution programs: are they still needed? Contraception 72(6): 402-7.

Price N, Walder R. (2010) Community-based distribution: Service Sustainability Strategies in Sexual and Reproductive Health Programming. Available: http://www.jsieurope.org/docs/community-based_new.pdf. Accessed 29 November 2011.

Rotheram-Borus M-J, Richter L, van Rooyen H, van Heerden A, Tomlinson M, et al. (2011) Project Masihambisane: a cluster randomised controlled trial with peer mentors to improve outcomes for pregnant mothers living with HIV. Trials 12:2.

Singh S, Darroch JE. (2012) Adding It Up: Costs and Benefits of Contraceptive Services—Estimates for 2012. Guttmacher Institute and United Nations Population Fund (UNFPA). Available: http://www.guttmacher.org/pubs/AIU-2012-estimates.pdf. Accessed 1 November, 2013.

Stanback J, Mbonye AK, Bekiita M. (2007) Contraceptive injections by community health workers in Uganda: a nonrandomized community trial. Bulletin of the World Health Organization 85(10): 768-73.

Stanback J, Spieler J, Shah I, Finger WR. (2010) Community-based health workers can safely and effectively administer injectable contraceptives: conclusions from a technical consultation. Contraception 81(3): 181-4.

Svoronos T, Mjungu D, Dhadialla P, Luk R, Zue C. (2010) CommCare: Automated Quality Improvement To Strengthen Community-Based Health The Need for Quality Improvement for CHWs. Available: http://d-tree.org/wp-

content/uploads/2010/05/Svoronos-Medinfo-CommCare-safe-pregnancy1.pdf. Accessed August 12, 2012.

Tomlinson M, Solomon W, Singh Y, Doherty T, Chopra M, et al. (2009) The use of mobile phones as a data collection tool: a report from a household survey in South Africa. BMC Medical Informatics and Decision Making 9:51.

Tumlinson K, Hubacher D, Wesson J, Lasway C. (2010) Measuring the Usefulness of Family Planning Job Aids following distribution at Training Workshops. Journal of Biosocial Science 42: 695-698.

United Nations Development Program. (2005) Promoting ICT for Human Development in Asia: Realizing the Millennium Development Goals. Available: http://asiapacific-hdr.aprc.undp.org/sites/default/files/files/Promoting%20ICT%20for%20Human%20Development%20in%20Asia_Full%20Report.pdf. Accessed December 3, 2013.

Wandersman A, Duffy J, Flaspohler P, Noonan R, Lubell K, et al. (2008) Bridging the Gap Between Prevention Research and Practice: The Interactive Systems Framework for Dissemination and Implementation. American Journal of Community Psychology 41: 171-181.

Wesson J, Olawo A, Bukusi V, Solomon M, Pierre-Louis B, et al. (2008) Reaching providers is not enough to increase IUD use: A factorial experiment of 'academic detailing' in Kenya. Journal of Biosocial Sciences 40: 69-82.

World Health Organization. (2006) World Health Report. Available: www.who.int/whr/2006/whr06_en.pdf. Accessed 29 November 2011.

World Health Organization. (2008) Framework and standards for country health information systems. Available at: http://www.who.int/healthmetrics/documents/hmn_framework200803.pdf. Accessed 20 October 2012.

World Health Organization. (2010) Taking stock: Task shifting to tackle health worker shortages. Available: http://www.who.int/healthsystems/task_shifting_booklet.pdf. Accessed 29 November 2011.

Zurovac D, Sudoi RK, Akhwale WS, Ndiritu M, Hamer DH, et al. (2011) The effect of mobile phone text-message reminders on Kenyan health workers' adherence to malaria treatment guidelines: a cluster randomised trial. Lancet 378(9793): 795-803.

Appendices

Appendix I: Summary Tables from Systematic Review

First Author	Pub Year	Article Title	mHealth Tool	mHealth Platform or Application	Region	Health issue addressed by CHW	Purpose of technology	Non-experimental	Quasi-experimental	Experimental	Qual	Quant	Standards & Guidelines	Organizational Design	Education & Training	Proc Improvmt, Tech Dvmt	Incentives	Organizational Culture	Leadership & Management	Quality	Efficiency	Utilization	Access	Learning	Sustainability
Andreatta	2011	Using cell phones to collect postpartum hemorrhage outcome data in rural Ghana.	Basic mobile phones	Global System for Mobile Communication (GSM)	Africa	MCH	Health Data Collection	x				x			x	x				x					
Bernabe-Ortiz	2008	Handheld computers for self-administered sensitive data collection: A comparative study in Peru	Personalized Digital Assistant (PDA)	PDA PREVEN	Central/ South America	Sexual & reproductive health	Health Data Collection		x			x				x				x					
Birnbaum	2012	Automated quality control for mobile data collection	Basic mobile phones	CommCare	NA	NA	Data Quality Control		x			x				x									
Chang	2011	Impact of a mHealth intervention for peer health workers on AIDS care in rural Uganda: a mixed methods evaluation of a cluster-randomized trial	Basic mobile phones	Short Message Service (SMS)	Africa	HIV/AIDS	Information on Demand - Health Data Collection - Person-to-Person Communication			x	x	x	x			x		x	x						x
Chib	2010	The Aceh Besar midwives with mobile phones project: Design and evaluation perspectives using the information and communication technologies for healthcare development model	Mobile phones equipped with GRPS technology	Short Message Service (SMS)	Asia	MCH, Sexual & reproductive health	Health Data Collection - Person-to-Person Communication		x		x	x	x			x		x	x	x	x		x	x	
Chib	2008	Midwives and mobiles: using ICTs to improve healthcare in Aceh Besar, Indonesia	Mobile phones equipped with GRPS technology	Short Message Service (SMS)	Asia	MCH, Sexual & reproductive health	Health Data Collection - Person-to-Person Communication		x		x		x			x		x	x	x	x		x	x	
Curioso	2005	Design and Implementation of Cell-PREVEN: A Real-Time Surveillance System for Adverse Events Using Cell Phones in Peru	Basic mobile phones	Cell PREVEN	South America	Sexual & reproductive health, HIV/AIDS	Alerts & Reminders -- Information on Demand -- Health Data Collection -- Electronic Health Record	x				x				x				x					x
DeRenzi	2012	Improving community health worker performance through automated SMS	Basic mobile phones	CommCare	Africa	MCH and general health	Alerts & Reminders			x		x				x					x	x			x
DeRenzi	2012	Improving community health worker performance through automated SMS	Basic mobile phones	CommCare	Africa	MCH and general health	Alerts & Reminders			x		x				x		x			x	x			x
DeRenzi	2012	Improving community health worker performance through automated SMS	Basic mobile phones	CommCare	Africa	MCH and general health	Alerts & Reminders			x		x				x		x			x	x			x
DeRenzi	2012	Improving community health worker performance through automated SMS	Basic mobile phones	CommCare	Africa	MCH and general health	Alerts & Reminders	x				x				x		x			x	x			x
Diero	2006	A computer-based medical record system and personal digital assistants to assess and follow patients with respiratory tract infections visiting a rural Kenyan health centre	Personalized Digital Assistant (PDA)	Mosoriot Medical Record System	Africa	Accute respiratory infections	Health Data Collection - Decision Support	x				x	x			x				x	x				
Dwolatzky	2006	Linking the global positioning system (GPS) to a personal digital assistant (PDA) to support tuberculosis control in South Africa: a pilot study	Personalized Digital Assistant (PDA)	Short Message Service (SMS)	Africa	HIV/AIDS, TB	Mapping		x			x				x					x				
Florez-Arango	2011	Performance factors of mobile rich media job aids for community health workers	Video-capable mobile phones	Windows Mobile Guideview	Central/ South America	Childhood illness, trauma, non-trauma	Decision Support			x		x	x			x				x					x
Gisore	2012	Community based weighing of newborns and use of mobile phones by village elders in rural settings in Kenya: a decentralised approach to health care provision	Mobile phone & weighing scale	Short Message Service (SMS)	Africa	MCH	Health Data Collection		x			x	x	x	x	x				x					
Hoffman	2010	Mobile Direct Observation Treatment for tuberculosis patients: a technical feasibility pilot using mobile phones in Nairobi, Kenya.	Video-capable mobile phones	Short Message Service (SMS), Video	Africa	TB	Health Data Collection - Direct Observation	x			x	x	x			x				x				x	

Author	Year	Title	Phone type	Software/Service	Region	Health area	Application type
Jones	2012	''Even if You Know Everything You Can Forget'': Health Worker Perceptions of Mobile Phone Text-Messaging to Improve Malaria Case-Management in Kenya	Basic mobile phones	Short Message Service (SMS)	Africa	Malaria	Alerts & Reminders
Lee	2011	Midwives' cell phone use and health knowledge in rural communities	Mobile phones equipped with GRPS technology	Short Message Service (SMS)	Asia	MCH, Sexual & reproductive health	Health Data Collection - Person-to-Person Communication
LeMay	2012	Reaching Remote Health Workers in Malawi: Baseline Assessment of a Pilot mHealth Intervention	Basic mobile phones	FrontlineSMS	Africa	Sexual & reproductive health, HIV/AIDS	Information on Demand
Mahmud	2010	A text message-based intervention to bridge the healthcare communication gap in the rural developing world	Basic mobile phones	FrontlineSMS Medic	Africa	HIV/AIDS, TB	Alerts & Reminders - Information on Demand - Health Data Collection - Decision Support - Pharmacy Management
Mhila	2009	Using Mobile Applications for Community-based Social Support for Chronic Patients	Basic mobile phones	CommCare	Africa	HIV/AIDS	Health Data Collection - Electronic Medical Record
Rajput	2012	Evaluation of an Android-based mHealth system for population surveillance in developing countries	Android mobile phone	Open Data Kit	Africa	HIV/AIDS	Health Data Collection
Ramachandran	2010	Mobilizing health workers in rural India	Video-capable mobile phones	Short Message Service (SMS), Video	Asia	MCH	Multimedia Content
Ramachandran	2010	Research and Reality: Using Mobile Messages to Promote Maternal Health in Rural India	Video-capable mobile phones	Short Message Service (SMS), Video	Asia	MCH	Multimedia Content
Rotheram-Borus	2011	Project Masihambisane: a cluster randomised controlled trial with peer mentors to improve outcomes for pregnant mothers living with HIV	Basic mobile phones	Mobile Researcher	Africa	HIV/AIDS	Alerts & Reminders - Health Data Collection
Svoronos	2010	CommCare: Automated Quality Improvement To Strengthen Community-Based Health The Need for Quality Improvement for CHWs	Basic mobile phones	CommCare	Africa	MCH	Alerts & Reminders - Decision Support - Electronic Medical Record
Tomlinson	2009	The use of mobile phones as a data collection tool: a report from a household survey in South Africa	Basic mobile phones	Mobile Researcher	Africa	NA	Health Data Collection
Zurovac	2011	The effect of mobile phone text-message reminders on Kenyan health workers' adherence to malaria treatment guidelines: a cluster randomised trial	Basic mobile phones	Short Message Service (SMS)	Africa	Malaria	Alerts & Reminders

Appendix II: CHW Baseline Survey Data

Overall n=50 participants

Demographics

Category	Subcategory	Result (n)	Result (%)
Age	<30	1	2%
	30-39	12	24%
	40-49	23	46%
	50-59	13	26%
	60+	1	2%
Gender	Male	9	18%
	Female	41	82%
Marital Status	Never Married	5	10%
	Married	28	56%
	Widowed	14	28%
	Other (Separated, Divorced)	3	6%
Education	Primary School	0	0%
	Secondary School (O-Level)	29	58%
	Secondary (A-Level)	17	34%
	Vocational Training	2	4%
	University	2	4%
	Other	0	0%
#Years CHW	<2	0	0%
	2-5	27	54%
	6-10	21	42%
	>10	2	4%

Source(s) of Health Information

Category	Subcategory	Result (n)
Source(s) of Health Information	Radio	25
	Health Organizations	22
	Television	20
	Friends/Family	19
	Newspaper/Magazine	18
	Community Meeting	11
	People at Work	11
	Dispensary	6
	Health Facility	6
	Advertisement	4
	Internet	3
	Mobile Phone	2

Family Planning

Category	Subcategory	Result (n)	Result (%)
FP Training	Yes	49	98%
	No	1	2%
#Years FP Provider	<2	4	8%
	2-5	43	86%
	6-10	3	6%
	>10	0	0%
Comfort talking about FP	Very Comfortable	21	42%
	Comfortable	28	56%
	Uncomfortable	1	2%
	Very Uncomfortable	0	0%
FP Knowledge	A lot	21	42%
	Some	25	50%
	A little	4	8%
	Not very much	0	0%
	Nothing	0	0%

Mobile Phone Use

Category	Subcategory	Result (n)	Result (%)
Personal Mobile Phone	Yes	50	100%
	No	0	0%
Family Mobile Phone	Yes	47	94%
	No	3	6%
Other Mobile Phone Access	Yes	31	62%
	No	19	38%
#Years Mobile Phone Use	<2	0	0%
	2-5	16	32%
	6-10	25	50%
	>10	9	18%
Phone Ready to Use	Always	39	78%
	Most of the time	9	18%
	Sometimes	2	4%
	Never	0	0%
Mobile Phone Use for Job	Yes	36	72%
	No	14	28%

Appendix III: Information and Communication Technology for Health Framework