



MHEALTH AND MNCH: STATE OF THE EVIDENCE

Trends, Gaps, Stakeholder Needs, and Opportunities
For Future Research on the Use of Mobile Technology
to Improve Maternal, Newborn, and Child Health

WILLIAM C. PHILBRICK

MHEALTH ALLIANCE, UN FOUNDATION

January 2013





TABLE OF CONTENTS

ACKNOWLEDGMENTS	4
LIST OF ACRONYMS	5
EXECUTIVE SUMMARY	6
INTRODUCTION	9
BACKGROUND	11
METHODOLOGY	12
LITERATURE REVIEW	15
1. Summary	15
2. Literature and Systematic Reviews Previously Published	15
3. Supplemental Articles Search	19
LANDSCAPE SCAN	23
KEY INFORMANT INTERVIEWS	23
1. Sources of Evidence	23
2. How Key Informants Use Evidence	24
3. Themes Reported by Key Informants	24
DISCUSSION OF GAPS AND RESEARCH OPPORTUNITIES	29
1. Types of MNCH Interventions	29
2. Rigor in Study Design	33
3. Measurement Indicators	34
4. Crosscutting Approaches	34
CONCLUSION	39
APPENDIX A: Landscape Scan—Illustrative Studies	41
APPENDIX B: List of Key Informants	44
APPENDIX C: mHealth Ecosystem Stakeholders	45
ENDNOTES	46

ACKNOWLEDGMENTS

First, I would like to thank the mHealth Alliance for its support in the preparation of this report. I owe a debt of gratitude particularly to Patty Mechael, Executive Director of the mHealth Alliance, whose commitment to promoting quality research on the use of mobile technologies to improve health has been inspirational. I would like to also acknowledge Carolyn Gulas, intern with the mHealth Alliance, for her contribution to this report, and Madhura Bhat, former Deputy Director of the mHealth Alliance, for her role in providing such a supportive working environment. Thanks also go to Yvette Efevbera, Francis Gonzales, and Margeaux Akazawa for their editing and thoughtful comments in reviewing the report.

I would also like to express my gratitude to the mHealth Alliance's Evidence Working Group, especially Chaitali Sinha from the International Development Research Centre, Martin Were from the Regenstrief Institute and Indiana University School of Medicine, and Gladys Faba from the Instituto Nacional de Salud Publica, for the amount of time they spent reviewing the drafts of this report and their insightful comments and suggestions. It was a delight to work with individuals who are not only experts in the field of research and information and communications technology, but who are also committed to understanding how mHealth has the potential to reduce health inequities and improve health systems.

In addition, I would like to express my appreciation to Caricia Catalani from the University of California-

Berkeley School of Public Health and InSTEDD, Alain Labrique from the Johns Hopkins Bloomberg School of Health, Garrett Mehl from the World Health Organization, and Marc Mitchell from the Harvard University School of Public Health and D-Tree International, for their constructive feedback and encouraging words.

I would like to thank each and every key informant I interviewed for this report including: Heather Cole-Lewis from Yale University; Helga Fogstad of the Government of Norway; Craig Friderichs from GSMA; Richard Gakuba of the Government of Rwanda; Annette Ghee from World Vision; Judy Gold from Marie Stopes International; Christopher Grey from Pfizer; Anu Gupta and Alice Fabiano from Johnson & Johnson; Nadi Kaonga from Columbia University and the Earth Institute; Barbara Mittleman, Wendy Nilsen, and William Riley from the National Institutes of Health; Mwendwa Mwenesi of the Government of Tanzania; Camielle Noordam from UNICEF; Laura Raney of FHI 360; Sandhya Rao from USAID; Dianne Sullivan from Vodafone; Rachel Vreeman from AMPATH-Kenya and Indiana University School of Medicine; and Fredrik Winsnes from NetHope. The time and unique perspectives they provided me have been invaluable.

Lastly, I would like to express my appreciation to my friend, colleague and former boss, Madhu Deshmukh of CARE International, for being a mentor and instilling values that have helped me to understand the role that underlying social, gender, and economic dynamics play in health.



LIST OF ACRONYMS

Acronym	Description	LMIC	Description	PEPFAR	Description
ARVs	Anti-retrovirals	LMIC	Lower and Middle Income Countries	PEPFAR	President's Emergency Plan for AIDS Relief
BSE	Breast Self-Examination	M&E	Monitoring and Evaluation	PHI	Public Health Institute
CHW	Community Health Worker	MAMA	Mobile Alliance for Maternal Action	PMTCT	Prevention of Mother-to-Child Transmission of HIV
CITPH	Center for Innovation and Technology in Public Health	MDGs	Millennium Development Goals	RCT	Randomized Control Trial
DFID	U.K. Department for International Development	MNCH	Maternal, Newborn and Child Health	SMS	Short Messaging Service
EID	Early Infant Diagnosis	NORAD	Norwegian Agency for Development Cooperation	TBA	Traditional Birth Attendant
GSMA	GSM Association	NGO	Non-Governmental Organization	USAID	United States Agency for International Development
HUB	Health UnBound	NIH	National Institutes of Health	WASH	Water, Sanitation, and Hygiene
ICT	Information and Communication Technologies	NTD	Neglected Tropical Disease	WHO	World Health Organization
IMCI	Integrated Management of Childhood Illnesses			WLH	Women living with HIV

EXECUTIVE SUMMARY

Background: Mobile technology, particularly mobile telecommunication technology, is increasingly becoming an important tool in global health programs. Excitement about the potential of “mHealth” centers especially on how mobile technology can be applied in lower and middle income countries where people have traditionally had limited access to health services. mHealth strategies are being used to overcome factors that limit access, such as geographic distance to services, social marginalization, inadequate skilled medical personnel or a lack of financial resources.

As the evidence base supporting mHealth is still relatively nascent, the global health community is just beginning to recognize the potential role that mHealth can play in improving health program results. Some within the development and global health communities are demanding more research evaluating if and how mHealth improves impact in global health programs. Accordingly, generating quality evidence through methodologically rigorous research has emerged as a priority for the broader mHealth community.

Objective: In accordance with its mission and strategy, the mHealth Alliance has commissioned this report to present the findings of a needs assessment and gaps analysis of the current state of the evidence in mHealth, using maternal, newborn, and child health (MNCH) as a use case. The intent for the needs assessment and gaps analysis summarized in this report is to 1) identify gaps in the evidence base and 2) advocate for and encourage others to undertake research to fill these knowledge gaps and build the evidence base for mHealth. The report aims to identify challenges and make recommendations towards enhancing the mHealth for MNCH evidence base. The primary intended audience is the Alliance’s Evidence Working Group and other stakeholders who generate and use evidence in mHealth for MNCH.

Methodology: The methodology for this report was conducted in three parts:

1. Literature Review of existing published articles in the areas of mHealth and (some aspect of) MNCH;

2. Landscape Scan of current ongoing projects or programs evaluating mHealth (research) and some aspect of MNCH; and
3. Key Informant Interviews with individuals representing a convenience sample selected from different types of organizations involved in generating, supporting and/or using evidence relating to some aspect of mHealth and MNCH.

Key findings:

4. The current body of evidence in mHealth and MNCH tends to focus more on maternal health interventions, particularly reminders for antenatal appointments compared to newborn and child health interventions.
5. If the gaps in MNCH coverage, as identified in “Countdown to 2015,” serve to inform evidence priorities for evaluating mHealth and MNCH, the following areas of lowest coverage along the MNCH continuum of care would warrant greater attention: 1) increasing contraception prevalence; 2) intermittent prevention treatment of malaria in pregnant women; 3) PMTCT; 4) children sleeping under insecticide treated net; 5) antibiotics for pneumonia; and 6) malaria treatment.
6. Global health trends and the subjective needs of particular stakeholders dictate the identification of gaps in crosscutting approaches such as: health systems strengthening; scaling up; integration; implementation science; and understanding the role of social determinants in health
7. An emerging trend gleaned from the literature review, landscape scan, and key informant interviews indicates that gaps in terms of rigor, intervention type, measurement indicators and even crosscutting approaches are closing. The frequency of studies using more rigorous methodologies (such as randomized control trials and detailed study protocols) is increasing.
8. Although a number of the key informants expressed a desire for more evidence linking mHealth with health outcomes, the landscape scan revealed that more studies are using health outcome indicators as primary or secondary measurement units.

Recommendations:

Recommendations for addressing the evidence gaps and enhancing the field of mHealth for MNCH include the following:

- Stakeholders who use evidence, particularly those who influence the research agenda, need to advocate, promote, mandate and ultimately fund activities that would close the identified evidence gaps.
- Greater efforts should be made to identify, capture and disseminate evidence, focusing on the numerous studies and projects in mHealth and MNCH that exist but are not reflected in the literature nor widely shared with the global health community.
- The technical and research communities that have been driving the mHealth agenda ought to frame the evidence in language that resonates with the global health community, paying particular attention to the global health trends that have become priorities to major donors.
- Gaps in the evidence around mHealth and MNCH should be viewed as opportunities for future research.





Trends, Gaps, Stakeholder Needs, and Opportunities For Future Research on the Use of Mobile Technology to Improve Maternal, Newborn, and Child Health

INTRODUCTION

The mHealth Alliance commissioned the study summarized in this report to review the state of the evidence on the use of mobile technology in health (also known as “mHealth”) to improve MNCH. The purpose of the study is to identify evidence trends, gaps, stakeholder needs and opportunities for research. This report is written for the Evidence Working Group of the mHealth Alliance and other stakeholders interested in generating and identifying evidence to support using mobile technology in health. Accordingly, this report identifies research gaps and recommends research priorities to be advocated with stakeholders who influence the research agenda around mHealth. The Evidence Working Group is a group of individuals working in the area of research and mHealth who have accepted invitations to work collectively to identify issues and promote the use of quality evidence around mHealth.

The study was conducted in three parts: the first was a literature review of the currently available published studies examining the use of mHealth for MNCH; the second, a landscape scan of ongoing studies and evaluations of the use of mHealth for MNCH; and third, interviews with 26 individual key informants who use evidence and represent various types of stakeholders involved in mHealth and MNCH (e.g., donor governments, researchers, implementers, etc.).

The identification of gaps in evidence includes a certain amount of subjectivity and is dependent upon the perspective of the stakeholder and the standards or criteria that are employed to ascertain the gaps. For purposes of this study, gap categories include: 1) rigor in study designs; 2) type of MNCH intervention;

3) measurement indicators and; 4) crosscutting approaches that are heavily influenced by global health trends.

The review of the currently available literature and the conversations with key informants, particularly those in the research community, indicated that there was a paucity of mHealth for MNCH studies that employed what researchers typically consider standard criteria for rigor and quality study designs including:

- Clear, full and transparent description of the study design, including limitations of the design and a justification for the choice of study design for the particular research questions;
- Randomization;
- Collection of baseline data;
- Comparison groups;
- Sufficient sample size; and
- Underlying theoretical frameworks with an evidence base drawing on past studies.

In contrast to identifying gaps in the rigor of study designs, there are no accepted criteria for identifying gaps in types of MNCH interventions being studied. Identifying gaps of this kind therefore relies more on the subjective perspective of the stakeholder.

The current body of evidence in mHealth and MNCH represented in peer-reviewed and grey literature tends to focus more on interventions aimed to decrease maternal mortality, particularly reminders for antenatal

appointments, and less on interventions aimed to improve newborn and child health. Accordingly, most of the key informants who opined on content gaps in evidence indicated that the one MNCH area in which they did *not* see any evidence gaps was using mobile phones to improve access to antenatal services.

Although there are no generally accepted criteria to gauge gaps in types of MNCH interventions, there is some guidance from those who are tracking progress in achieving MDGs 4 & 5. The multi-disciplinary, multi-institutional collaboration, “Countdown to 2015,” tracks progress in the 75 countries where more than 95% of all maternal and child deaths occur, including the 49 lowest-income countries. If the gaps in MNCH coverage, as identified in “Countdown to 2015,” serve to inform evidence priorities for evaluating mHealth and MNCH, the following areas of lowest coverage along the MNCH continuum of care would warrant greater attention: 1) increasing contraception prevalence 2) intermittent prevention treatment of malaria in pregnant women, 3) PMTCT 4) children sleeping under insecticide treated nets 5) antibiotics for pneumonia; and 6) malaria treatment. Studies evaluating the impact of using mHealth to improve PMTCT results are patently absent in the current literature although there are numerous studies and projects using mHealth for PMTCT that are either ongoing or have been recently completed and are currently being written up for publication.

Key informants and authors of other literature reviews of mHealth and MNCH identified the area of outcome measurements as its own separate gap category. Many of the key informants, particularly those affiliated with governments and NGOs, noted a lack of mHealth studies using health outcomes as either primary or secondary measurement indicators. One of the most pressing needs expressed by the key informants was for evidence showing that mHealth actually contributes to improving the health status of women and children. Most studies appearing in mHealth and MNCH literature used indicators such as feasibility, usability, acceptability, return visits, and appointments (e.g., to antenatal clinics) offering no further evidence of how any of these measurements are linked to improved health.

Global health trends and the subjective needs of particular stakeholders dictate the identification of gaps in

crosscutting approaches. We see trends in global health towards the following: 1) strengthening health systems to provide quality care; 2) scaling up health programs by integrating health interventions into holistic packages to reach more people; 3) sustaining health programs; 4) understanding how to implement evidence-based interventions; and 5) analyzing the underlying social determinants for accessing quality health services. These trends have led stakeholders, particularly governments, to request evidence on how mHealth contributes to:

- Strengthened health and community systems;
- Scale-up and integration of health services;
- Sustainability and financing;
- Implementation science; and
- Reduction of health inequities due to social and economic marginalization.

An emerging trend gleaned from the literature review, landscape scan and key informant interviews indicates that gaps in terms of rigor, intervention type, measurement indicators, and even crosscutting approaches, are closing. The frequency of studies using more rigorous methodologies including randomized control trials and detailed study protocols is increasing. More rigorous study designs are being used to evaluate the use of mHealth along MNCH continuum of care identified under “Countdown to 2015,” including those MNCH interventions for which coverage is lacking, such as PMTCT and a number of areas in newborn and child health.

The landscape scan revealed that more studies are using health outcome indicators as primary or secondary measurement units. These health outcome indicators include maternal mortality and morbidity, child mortality and morbidity, and child nutrition indicators such as weight for height (wasting) and exclusive breastfeeding. Lastly, more researchers are attempting to tackle crosscutting approaches in study designs by examining how to evaluate mHealth from the perspectives of: 1) strengthening systems; 2) scaling up; and 3) reducing inequities by incorporating systems analysis, cost-effectiveness studies and, to a lesser degree, social analysis into study designs.

These trends toward closing the gaps in the evidence, however, are gradually emerging and therefore are not yet standards routinely reflected in studies. If evidence gaps are to close, the stakeholders who use evidence, particularly those who influence the research agenda, ought to advocate, promote, mandate and ultimately fund activities that would close the gaps. There are numerous studies and projects in mHealth and MNCH generating evidence that is not reflected in the literature or in other ways widely shared with the global health community. Greater efforts should be made to identify, capture and disseminate that evidence. Lastly, the technical and research communities that have been primarily driving the mHealth agenda ought to frame the evidence in language that resonates with the global health community, paying particular attention to the global health trends that have become priorities to the major donors.

In accordance with its mission and strategy, the mHealth Alliance has commissioned this report **to present the findings of a needs assessment and gaps analysis of the current state of the evidence in mHealth, using maternal, newborn, and child health as a use case.**¹ The intent for the needs assessment and gaps analysis summarized in this report is to identify gaps in the evidence base, advocate and promote others to undertake research to fill these knowledge gaps and build the evidence base for mHealth. The primary intended audience of this Report is the Alliance's Evidence Working Group² and other stakeholders who generate and use evidence in mHealth for MNCH.

BACKGROUND

Mobile technology, particularly mobile telecommunication technology, is increasingly becoming an important tool in global health programs. Excitement about the potential of what has become known as "mHealth"³ centers especially on how mobile technology can be applied in lower and middle income countries where people have traditionally had limited access to health services. mHealth strategies are being used to overcome factors that limit access, such as geographic distance to services, social marginalization, inadequate skilled medical personnel, or a lack of financial resources.

As the evidence base supporting mHealth is underdeveloped and young, the global health community has yet to recognize the potential role that mHealth can play in improving health program results. Many interventions utilizing mHealth solutions remain in pilot form and opportunities to scale up are limited. Moreover, the fragmented fashion in which many of these initiatives have been designed has contributed to challenges when integrating into existing health systems. A 2011 internal study commissioned by the mHealth Alliance identified the lack of rigorous evidence linking mHealth solutions to improved health and demonstrated cost-effectiveness as a primary barrier to coalescing more wide scale support for mHealth. The multidisciplinary nature of mHealth, involving specialists in various areas from the health and technology fields, has contributed to the splintered nature of the evidence in mHealth and is arguably responsible for the varying levels of rigor found in the evidence base today.

Some within the development and global health communities are demanding more research evaluating if and how mHealth improves results in global health programs.⁴ Accordingly, generating quality evidence through methodologically rigorous research has emerged as a priority for the mHealth community.⁵

The evidence base for supporting mHealth as a component of global health programs has started growing within the last few years as more researchers evaluate mHealth and increasingly use more rigorous research methodologies such as randomization, collecting baseline data and studying comparison groups. The term "rigor" can have multiple meanings, depending upon who is using it. For the purpose of this report, the following factors contribute to a "rigorous" study:

1. *Clear and full* documentation of the study design, including limitations and rationale for the study design;
2. Use of comparison groups, with attention to the components being compared;
3. Collection of baseline information;
4. Use of theory-based design and methodology, drawing on past studies;

5. Sufficient sample size; and
6. Transparency in disclosing all results, including undesired, unexpected and negative outcomes that contradict the original hypothesis for the study.

Ideally, the studies would be published in peer-reviewed journals.

While rigorous study methodologies contribute to the quality of the evidence, the purpose of this report is not to assess quality. Instead, this report aims to identify challenges and make recommendations towards enhancing the mHealth for MNCH evidence base. Gauging “quality” can be a subjective exercise and dependent upon the perspective of the stakeholder who is using the evidence. What might be quality evidence that sufficiently answers the questions of a needs-based clinician may not be quality evidence to a rights-based sociologist interested in underlying social determinants.

Contributing toward and nurturing a more robust and relevant evidence base requires a process of understanding and clearly identifying several things, namely 1) the current state of the evidence and specific gaps in that evidence base 2) the various stakeholders who will use the evidence (and the purpose for which it will be used) and 3) the specific evidence needed by these stakeholders, reflecting trends in global health and the stakeholders’ position in the health system. These evidence needs may refer to types of study designs, the particular area of health intervention being studied (e.g., antenatal care, PMTCT, emergency obstetric services), crosscutting approaches (systems analysis) and desired outcome measurements (e.g., health impact, process measurements). Once the evidence gaps have been identified and the needs of the evidence stakeholders have been clarified, research efforts can be prioritized, focused and promoted.

The findings of this report should not be deemed conclusive or dogma. Like assessing “quality,” identifying “gaps” in evidence is a subjective exercise dependent upon the perspective of the key informant. Accordingly, the intent of this report is to provide an objective overview of the various evidence gaps and needs identified through a review of the available literature and from the perspectives

of different types of stakeholders working across the health ecosystem.

METHODOLOGY

The methodology for this Report was conducted in three parts:

1. Literature Review of existing published articles in the areas of mHealth *and* (some aspect of) MNCH;
2. Landscape Scan of current ongoing projects or programs evaluating mHealth (research) and some aspect of MNCH; and
3. Key Informant Interviews with individuals representing a convenience sample selected from different types of organizations involved in generating, supporting and/or using evidence relating to some aspect of mHealth and MNCH.

Interview responses were informally coded according to theme and issue. Codes were grounded rather than *a priori*.

These three methods were deemed feasible based on the study scope, available resources and accessible capacity. They were intended to counterbalance intrinsic biases and subjectivity by providing sufficient triangulation to identify trends, gaps, stakeholder needs and research opportunities. It should be noted, however, that the stakeholders’ subjectivity is a key and necessary component in identifying evidence gaps.

The findings in this report are a snapshot of the state of the evidence at the point of time this report was written. However, noting the dynamic and evolving nature of using mHealth in MNCH, the observations noted herein are expected to change with the evolving evidence base.

1. Literature Review

First, a detailed and methodical review of existing literature on mHealth for MNCH was conducted to contextualize the existing evidence base. MNCH was selected as a case for three main reasons: first, MNCH is one of the key health

areas in which mHealth is used; second, MNCH has been globally identified as a priority area explicitly through MDGs 4 and 5, and implicitly through MDG 6; third, several key initiatives of the mHealth Alliance have prioritized MNCH, including the Mobile Alliance for Maternal Health Action,⁶ and the NORAD-supported Innovation Working Group catalytic grant program, providing financial support to on-the-ground initiatives using mobile technology to improve women and children's health in line with the goals of *Every Woman Every Child*.⁷

The scope of the search for MNCH was intentionally broad. "Maternal health" included, but was not limited to:

- Sexual and reproductive health
- Family planning
- Antenatal, perinatal, intrapartum and postnatal care
- Delivery (midwifery)
- Maternal depression (psychological issues)
- Maternal mortality, related to:
 - Hemorrhage
 - Hypertensive disorder
 - HIV
 - Sepsis/Infections
 - Abortion
 - Obstructed labor
 - Anemia
 - Ectopic pregnancy
 - PMTCT

"Newborn and child health" included all health conditions relating to neonates, newborns and children age five and under. Adolescents were excluded unless they were part of an analysis of a health condition linked to a health event or situation occurring at the age of five or under.

Search terms included one or a combination of the following terms: "mHealth," "mobile phones," "mobile technology," "eHealth," "cell phones," "text messaging," "maternal," "obstetric," "child health," "children," "newborn," "pediatric," "women," "gender," "neonate," "neonatal," "breastfeeding," "sexual health," "reproductive," "family

planning." Searches were limited to articles and programs published or occurring from 2009 to June 2012 based upon the assumption that the select literature reviews captured relevant research and studies published prior to 2009.

Literature and programs that examined the health consequences of the use of mobile phones by mothers on their children (which were extensive) and using phones to control childhood obesity were excluded. Articles with exclusive references to eHealth, internet and non-mobile forms of ICT were also excluded, as were articles that discussed mHealth without an explicit focus on some form of MNCH. Literature and programs pertaining to general health conditions such as HIV, malaria, tuberculosis and diabetes were excluded, unless they explicitly targeted women and/or children age five and under.

Because of financial restrictions, full versions of published articles requiring payment were not accessed. In such cases, information was retrieved from the article's abstract.

The literature review of published articles for this report included:

- Reviewing already published literature reviews and systematic reviews of mHealth and any aspect of MNCH;
- Reviewing publication databases for academic articles and grey literature addressing mHealth and any aspect of MNCH (databases and websites searched included: Google Scholar, Mendeley; Cochrane Collaboration, Campbell Collaboration, 3IE, GSMA, PubMed and the World Health Organization Bulletin); and
- Reviewing articles in knowledge management sites including: the mHealth Alliance's "HUB," K4Health, MobileActive.org and the Royal Tropical Institute's "mHealth in Low Resource Settings" knowledge portal.

A total of 1760 articles and documents were identified using the various search iterations, of which the preponderance was either duplicative or fell within one of the exclusion criteria.

While acknowledging the careful methodology employed during this literature review process, it is important to note that the research was not conducted in accordance with Cochrane or Campbell process guidelines for systematic reviews and was not designed to follow the methods typically used in literature reviews published by academic journals.

2. Landscape Scan

The landscape scan of current ongoing projects was conducted to fully contextualize the existing field of mHealth for MNCH. This included a review of the following:

- NIH Clinical Studies database;
- NIH Project Reporter database;
- Various articles and inventories of projects and programs maintained by organizations, websites and listservs, including the mHealth Alliance HUB, Johns Hopkins Global mHealth Initiative, K4Health.org, MobileActive.org, GSMA, ict4chw and Mobihealth.org;
- 2012 Report and Inventory of all mHealth and eHealth projects around the world conducted for the Alliance by the CITPH at the PHI; and
- Unpublished reports, inventories and descriptions provided by the key informants interviewed

3. Key Informant Interviews

Telephone interviews were conducted during the period of April 2–May 10, 2012 with 26 individuals representing a convenience sample of stakeholders; each of these stakeholders make use of evidence and are involved in some aspect of both mHealth and MNCH. The objective of the interviews was to inform the gaps analysis, as well as to understand who the users of evidence are and what the users are looking for in terms of evidence (e.g., types of studies, indicators, health intervention areas, etc.). These individuals represented organizations that included:

- NGOs/Implementers
- Researchers/Academic

- Governments (donors and LMIC)
- Private sector
- Academic/research institutions
- Multinational organizations.

While there may be a number of other types of stakeholder (e.g., foundations), due to time and capacity issues, a **non-random convenience sample** was used in identifying key informants. However, an assumption underlying the study was that this particular convenience sample would not respond differently than a random sample from the same population. For a comprehensive perspective of mHealth stakeholders, see Appendix “C” — mHealth Ecosystem Stakeholders.

Key informants fell into one or more of the following categories, noting that some informants were both implementers and researchers (which explains why the total is over 26 in the table below).

CATEGORY	
NGOs/implementers	9
Researchers	11
Government	7
Donor	5
African	2
Private sector	5
Networks/associations	3
Multinational organizations	2

Additionally, all key informants had some experience in the area of both MNCH **and** mHealth, 17 key informants were female (65%) while 9 were male (35%), and 14 key informants were U.S.-based (54%).

Key informants were interviewed via phone or through Skype, with the exception of one who could only be reached via email. Respondents were asked open-ended questions, contextualized for the individual depending upon his or her organizational affiliation. Leading questions

were purposefully avoided. These questions included (but were not necessarily limited to): What sources of information do you find the most credible for building your personal knowledge base (in the area of mHealth and MNCH)?

- What sorts of evidence do you use and what do you use the evidence for?
- In your opinion, from the perspective of your role in “X” organization, in what topic areas do you believe there is an adequate evidence base (in mHealth and MNCH)?
- From your perspective in “X” organization, what are the primary gaps in evidence and research efforts (in mHealth and MNCH) that should be prioritized for future research and evaluation efforts?

LITERATURE REVIEW

1. Summary

Although peer-reviewed journals and other literature are increasingly addressing the general topic of mHealth,⁸ the literature review of the current evidence revealed a limited number of articles evaluating mHealth in MNCH contexts. While this emerging body of evidence is still nascent, more research using rigorous study methodologies to evaluate using mHealth across the MNCH and reproductive health continuum of care is appearing in both academic and grey literature.⁹

The use of mHealth to improve results in MNCH programs focuses on appointment reminders to increase access to and demand for antenatal and other maternal health clinic services, SMS messaging to improve health-seeking behaviors, and mobile phone applications for improving data collection (accuracy, reliability and completeness). There have been few published studies that report on the correlation of mHealth with health outcomes (e.g., morbidity, mortality and weight for height).

The literature review revealed a limited number of published studies evaluating mHealth as applied to MNCH. Of those studies that were published, few used rigorous research methodologies such as randomization and comparison cohorts. However, just within the last year,

there appears to be an uptake in the number of studies evaluating mHealth applied to MNCH and a greater effort to use more rigorous research methodologies in studies.

The literature review findings can be broken down into the following parts:

1. Review of literature and systematic reviews previously published
2. Review of the results of a supplemental articles search, including both peer-reviewed and non-peer reviewed articles

2. Literature and Systematic Reviews Previously Published

The literature search revealed:

- 2 literature reviews, both published in 2011, which explicitly examined the published evidence for mHealth and some aspect of MNCH.¹⁰
- 1 systematic review conducted by Great Lakes University Kisumu and funded by the WHO, pending publication in 2012, which examined the effectiveness of mobile phone technology in improving MNCH in LMICs.
- 1 unpublished student paper that included a literature review of studies on mHealth and MNCH published in 2002, 2009, 2010 and 2011.^{11,*}

2.1 TAMRAT AND KACHNOWSKI LITERATURE REVIEW

Tigest Tamrat and Stan Kachnowski conducted a literature review (hereinafter, “Tamrat and Kachnowski”) published in 2011 and providing a schematic overview of the outcomes, barriers and strategies for integrating mHealth, with a focus on improving prenatal and neonatal outcomes.¹² Their search found 34 articles on the use and limitations of mHealth for prenatal and neonatal healthcare access and delivery (from conception to 28 days following birth) along the stages of the continuum of care for MNCH as defined by WHO.¹³

* The findings of this paper mirrored the findings of the two literature reviews and supplemental articles search and therefore will not be specifically discussed

Of the 34 articles that met their search criteria, Tamrat and Kachnowski identified that 26 studies used a **qualitative** design, 4 studies used a **quantitative** design, and 4 studies used a **mixed qualitative and quantitative** design.¹⁴

Tamrat and Kachnowski noted the rising use of mHealth for MCH but concluded that few studies have focused exclusively on using mHealth to improve prenatal and neonatal services.¹⁵ Tamrat and Kachnowski identified key health areas for study regarding the use of mHealth in neonatal and prenatal health, which included:

- Emergency medical responses
- Point-of-care-support
- Health promotion
- Data collection and management
- Economics

Tamrat and Kachnowski made the following conclusions based upon their interpretation of the evidence presented in the literature:

1. mHealth tools can help minimize time barriers and facilitate urgent care during obstetric referrals -

based on interventions that (i) trained traditional birth attendants to use protocols to recognize pregnancy complications and connected them with walkie talkies to health centers for emergency transport;¹⁶ (ii) observed the correlation between family ownership of telephones with seeking emergency services during pregnancy-related complications;¹⁷ (iii) furnishing traditional birth attendants and outreach workers trained to recognize obstetric complications with mobile phones to make appropriate emergency referrals; and¹⁸ (iv) used 24-hour obstetric mobile phone-based help lines to mitigate the delays associated with obstetric deliveries.

2. Health systems can use mHealth to ameliorate human capacity issues -

based on interventions that (i) equipped midwives with mobile phones and phone credit to consult with specialists while providing obstetric support in remote locations;¹⁹

and (ii) equipped community-based health workers to contact supervisors for consultation and timely referrals of emergency cases.²⁰

3. mHealth can support information for health promotion primarily through short-message service (SMS) to expecting mothers -

based on interventions that (i) used SMS to disseminate information pertaining to antenatal appointments and immunizations;²¹ (ii) linked pregnant women with health services and skilled attendants for obstetric care;²² (iii) improved emotional health of pregnant women who received SMS messages during the prenatal period;²³ and (iv) sent health education messages to pregnant women coinciding with the progression of pregnancy.²⁴

4. mHealth improves data collection and management -

based on interventions that (i) linked health promotion SMS programs to central health systems that contained records of pregnant women and their weekly progression;^{25, 26, 27} (ii) provided outreach workers in India with handheld computers to collect and feed data on immunization records, prenatal care schedules and demographic information into a centralized health record system accessible by rural health providers;^{28, 29} and (iii) provided frontline health workers with handheld devices to monitor and disseminate pregnancy, nutrition and immunization information to the nearest rural health centers.³⁰

5. While there are a number of articles being published on the economics and financial implications of mHealth, there are few published studies that demonstrate the cost-effectiveness or value added economic benefits of integrating mHealth solutions.³¹

According to Tamrat and Kachnowski, the strength of the study findings presented in this literature review is undermined by a number of factors, reflecting a lack of rigorous study methodologies, including:

- Logistical issues which may have compromised the study;
- Failure to disclose the research methodology in detail;
- Not being published in peer-review journals;



**...THERE IS A SLOWLY EMERGING EVIDENCE
BASE USING MORE RIGOROUS METHODOLOGIES
INCLUDING RANDOMIZATION, BASELINE DATA,
COMPARISON COHORTS (CONTROLS) AND
CLEARLY DOCUMENTED STUDY DESIGNS.**

- Failure to report on comparison groups or provide quantitative details on changes observed;
- Confounding factors which may have (negatively) influenced the results; and
- Lack of both an evaluation and conclusions based on qualitative evidence from programs “at similar locations”.

Additional study shortcomings identified by Tamrat and Kachnowski included the following:

- While some articles appeared to use rigorous study methodology, as determined by mixed quantitative and qualitative methodology, others were reports of nascent projects that had “not produced conclusive evidence on obtaining their objectives”.³²
- While more rigorous study methodologies using quantitative analysis appeared to be used to demonstrate increased antenatal appointments and vaccinations, and improving emotional health, other data published were either preliminary or more of a descriptive overview.³³
- While a number of the studies demonstrated improvement in tasks relating to administrative functions (such as data management), increased access to health services and increased antenatal appointments and vaccinations, most of the studies did not translate such improvements into changes in health outcomes.³⁴
- While articles are being published that describe financial obstacles to introducing mHealth, including financial implications for various stakeholders, there were no articles in the literature base that presented conclusions from cost-efficiency studies.³⁵

2.2 NOORDAM LITERATURE REVIEW

Another literature review conducted by a team led by Camielle Noordam (hereinafter, “Noordam”), focused exclusively on maternal health service outcomes using mobile phones. Noordam described various scientific and grey literature accounts of projects and concluded that there is “a need for robust evidence on evidence and impacts,” noting that there were few projects existing in the field yielding published evidence.³⁶ Noordam found

that most of the articles addressed the three delays connected with maternal mortality.³⁷

Noordam described several early projects in Mali, Uganda, Malawi, Sierra Leone and Ghana that used changes in maternal deaths as an outcome indicator for interventions that used radio systems (before the wider use of mobile phones) to improve communications to reduce delays in getting pregnant women to a facility.³⁸

According to Noordam, the more recent projects that actually used what we call “mobile phones” targeted improving the capacity of health care workers by connecting them to skilled medical personnel.³⁸ Also included in Noordam’s article were references to:

- A 2010 *Lancet* article reporting the preliminary results of a project in Rwanda measuring outcomes in terms of access to maternal health services and changes in mortality rates. The project used text messaging and a data exchange to coordinate communications among health workers, health centers and hospitals.⁴⁰
- An article describing a pilot project in Tanzania using forms and protocols meant to support pregnant women before, during and after delivery. The article presented outcomes in terms of completed referrals and subjective perceptions of community health workers gleaned from “anecdotal evidence and focus groups” with regards to issues such as duration of household visits and consistency of follow-ups.⁴⁰¹
- Other articles describing on-going studies including a study following 2500 women and the use of text messages containing health information and appointment reminders.⁴¹² Outcome indicators included impact on quality of services, health seeking behavior and maternal morbidity and mortality.

Noordam identified a number of gaps in the literature pertaining to research in mHealth for maternal health. These gaps included:

- Lack of evidence-based studies focusing on the efficacy and effectiveness of interventions;

- Lack of studies focusing on interventions other than pilot interventions;
- Lack of baseline data;
- Lack of a control group; and
- Lack of clear outcome indicators.⁴²³

Key gaps in content areas in the literature identified by Noordam included:

- Evidence for scaling-up;
- Analyses of the benefit of mHealth in ensuring timely delivery of medical equipment;
- Research on the use of mHealth to provide health education and improve access to reproductive health services; and
- Evidence on the use of mHealth beyond life-threatening situations, looking at other risk factors that would warrant accessing antenatal facilities, such as fistula, incontinence and infertility.⁴³⁴

Contrary to Tamrat and Kachnowski, Noordam's review did not indicate the number of articles meeting the search criteria nor did Noordam characterize or quantify research methodologies and study design. Additionally, the two studies differed as Tamrat and Kachnowski conducted an analysis of the strength of evidence in order to make conclusions regarding the use of mHealth, whereas Noordam focused more upon describing the projects and studies found in the literature search.

2.3 WHO-SUPPORTED GREAT LAKES UNIVERSITY KISUMU SYSTEMATIC REVIEW: PRELIMINARY FINDINGS

The preliminary report of the unpublished WHO-supported Great Lakes University Kisumu systematic review (hereinafter, "the Kisumu review"), which looks at the effectiveness of using mobile phone-based interventions to accelerate the health MDGs in LMICs, reported three studies in the area of MNCH that met the search criteria. Preliminary results of the Kisumu review did not include an analysis or conclusion regarding the evidence. Instead,

the Kisumu review presented descriptions of relevant published studies. These studies included:

- A study in Ghana evaluating the ability of TBAs to use text messaging to correctly follow a protocol in reporting data for all births. All attendants followed the reporting protocol correctly, although with uncertain data integrity.⁴⁴⁵
- A study evaluating the effectiveness of two media (text messages and pamphlets) in imparting health education to mothers of preschool children. Text messaging was deemed more effective than pamphlets in improving knowledge, attitude and practices of mothers.⁴⁵⁶
- A study in which monthly SMS were sent to remind mothers to carry out BSE. That study reported both on the obstacles in following through with BSE (e.g., forgetfulness, too busy, anxiety). It also reported that after the first two months of sending the reminder there was a significant increase (30.2% by the sixth month, $p < 0.05$) in the practice of BSE.⁴⁶⁷

The Kisumu review did not include the citations to the studies described. With the exception of the Ghana study, the Kisumu review did not state where the studies were located except that they were conducted in LMICs.

3. Supplemental Articles Search

Insofar as the literature and systematic reviews described above covered the period through 2010, a supplemental search of databases was conducted for literature published during the period from 2009 through 2012. Of approximately 1,760 articles and documents screened, 38 met the search criteria and were analyzed.

Of these 38 articles, several key characteristics were identified (noting that some articles carry more than one characteristic). These include the following:

- 6 articles reported on a study that was designed as a **randomized control trial**;
- 10 articles reported on a study where there were **no comparison groups**;
- 2 articles reported on studies that used a **case control** study design;

- 11 articles were exclusively **descriptive** in nature (not reporting on a specific study) or research methodology was not described;
- 9 articles reported studies that used exclusively **interviews, focus group discussions or surveys** (two of which included randomization);
- 3 articles presented **study protocols**; and
- 1 article was a **systematic review**.^{478, †}

The results of the supplemental articles search confirmed the conclusions presented in the literature reviews concerning the paucity of studies using rigorous methodologies to evaluate mHealth in the context of MNCH, and the scarcity of studies using health outcomes as measurement indicators. However, there is a slowly emerging evidence base using more rigorous methodologies including randomization, baseline data, comparison cohorts (controls) and clearly documented study designs.

Similar to mHealth literature more broadly, the mHealth for MNCH article search revealed an emphasis on studies evaluating the technology itself in terms of usability, feasibility and acceptability. While there appears to be a gradual emerging evidence base evaluating mHealth using health outcome measurements, most studies mirror the trend in HIV work, where attendance and accessing health services (e.g., antenatal visits, vaccination appointments) are used as proxy measure for health outcomes.

Some of the key findings and MNCH intervention areas reported in the supplemental articles search included the following:

- The majority of the articles identified addressed the use of mHealth to **facilitate accessing antenatal or postnatal care services**.^{49, 490, 501, 512, 523, 534} Few published studies addressing the use of mHealth to impact pediatric health were identified.

† This systematic review actually did not meet the search criteria insofar as mHealth was not a focus of its analysis. However, it is mentioned here because the systematic review was conducted by leading global maternal health experts, addressed key areas of maternal health and, made an explicit recommendation to further examine the use of cell phones in maternal health programs.

- A significant number of articles analyzed the use of mHealth for **data collection and management** of information such as birth registration, maternal and neonatal death registration, tracking maternal care, registration of pregnancies, nutrition surveillance and postpartum hemorrhage data within the community (e.g., by midwives, village health workers, village elders, etc.).^{545, 556, 567, 578, 59, 58}
- *Project Masihambisane*, a published protocol from South Africa, is important as part of the evidence base because it is a cluster randomized control trial evaluating a comprehensive integrated PMTCT program.⁵⁹ Although not exclusively focused on evaluating the use of cell phones in data collection and management, the intervention involves using cell phones (rapid SMS and existing cellular networks) for collecting routine information, completing questionnaires and remaining in contact with participants over time. The intervention involves working with peer mentors to **improve quality of life outcomes and mental health of pregnant women** living with HIV through antenatal and postnatal small group sessions and a clinic-based strategy to improve their health behaviors over time. Pregnant WLH (N = 1200) were randomly assigned by clinic (N = 8 clinics) to an intervention program, called Masihambisane (n = 4 clinics, n = 600 WLH) or a standard care PMTCT control condition (n = 4 clinics; n = 600 WLH). The study is ongoing and using a number of physical and mental health outcome indicators related to the overall intervention using peer mentors. The article made a preliminary conclusion that data collection with cellular phones are “innovative and effective” in low-resource settings.⁶⁰
- The majority of the articles identified, which reported on studies, presented study findings in terms of **usability, feasibility and acceptance as outcome measurements**.^{61, 62, 63, 64, 65, 66} However, there may be a nascent trend for an increased number of published articles or protocols reporting on the impact of mHealth using **health outcome measurements**. Such measurements include mortality,⁶⁷ vaccination coverage (although one is an ongoing study),⁶⁸ pregnancy

outcomes,⁶⁹ maternal and infant outcomes,⁷⁰ anxiety levels⁷¹ and even implicit reference to physical and mental well-being.^{72, †}

- Two articles examined how mHealth may be utilized to reach **marginalized or particularly vulnerable populations** including displaced border populations⁷³ and “vulnerable” prenatal and post-natal mothers.⁷⁴ Several articles addressed **social determinants** and constructs that serve as obstacles in using mHealth, though they were not research studies.^{75, 76, 77, 78}
- At least three articles reported on findings connected with using mHealth to **implement protocols in (1) data reporting⁷⁹ and (2) treatment and/or clinical services**. These studies included (i) a randomized control trial in Kenya for pediatric malaria treatment with the primary outcome being correct pediatric treatment management;⁸⁰ and (ii) a qualitative study nested within a larger quantitative study in Tanzania around the IMCI, examining user perception using personal digital assistants and provider adherence to IMCI protocols.⁸¹ While the data reporting and pediatric malaria studies indicated using mobile devices to improve protocol adherence, the last study reported “widespread non-adherence” to the IMCI protocols, despite positive perceptions of using the devices.⁸²
- One study published, but not in a peer-reviewed academic publication, reported on a case study using **mFinance to reimburse sexual and reproductive health vouchers in Madagascar**.⁸³ This is a descriptive case study looking at the implementation challenges in an *ongoing project* using mFinance to reimburse vouchers for sexual and reproductive health services. The data used in this case study is drawn from Marie Stopes International’s online database that stores all voucher reimbursement claims, as well as all SMS data received and sent. The data was collected for a period of six months, starting from the implementation of the voucher project in February 2011 until the end of July 2011. Semi-structured interviews with several of the implementers’ team members and two social franchisees on the implementation process were used to construct and identify the programmatic lessons and recommendations.
- One article, published in the WHO Bulletin, reported on the preliminary results of a UNICEF-supported study of an intervention called *Project Mwana* in Zambia using mHealth (via a printer connected to a phone) to expedite the delivery of EID HIV test results.⁸⁴ Baseline data from a 19-month retrospective period was compared with a system over a 7 ½ month period that delivered the test results automatically and directly from the processing laboratory to the health facility of sample origin via SMS. Mean turnaround time for result notification to a health facility fell from 44.2 days pre-implementation to 26.7 days post-implementation. The reduction in turnaround time was statistically significant in 90% of the facilities (9 of 10). The mean time to notification of a caregiver also fell significantly, from 66.8 days pre-implementation to 35.0 days post-implementation. The study is ongoing in both Zambia and Malawi, but preliminary results from Zambia indicated that the texting of the results of infant HIV tests significantly shortened the times between sample collection and results notification to the relevant health facilities and caregivers. While the hope is that the shortened turnaround time for the delivery of HIV results expedited HIV-positive infants initiating ARV treatment to prevent morbidity and mortality, there was no indication in the preliminary report that actual health outcome data from the expedited delivery of test results were being collected and evaluated.

† Health outcome indicators for mHealth studies will be further outlined in the following “Landscape Scan” section.



LANDSCAPE SCAN

The landscape scan confirmed the existence of a trend to conduct more rigorous studies focusing on mHealth and MNCH compared to the body of evidence currently available. The mHealth Alliance contracted the CITPH at the PHI to identify and collect information on all eHealth and mHealth projects working in MNCH globally. At the request of the Alliance, PHI focused on 13 LMICs and conducted the study during the period between May 17, 2011 and January 31, 2012.

The PHI study identified 230 projects in health areas. In total, 70 completed and ongoing projects focused specifically on MNCH in the 13 countries.⁸⁵ Of the 70, 36 were in Africa, 27 in Asia, 7 in Latin America and 18 in other regions.⁸⁶ The PHI study indicated that the “mHealth applications in the MNCH field are in the formative stage and preliminary evidence of their effectiveness and impact on health impacts is emerging.”⁸⁹

A search of the NIH’s ClinicalTrials.gov website produced 106 studies using mobile phones, but only 4 met the search criteria for this report.

Noting that taking a complete inventory of ongoing relevant studies is impractical for purposes of this report, a notable number of **illustrative** studies were nonetheless identified that are currently ongoing that could bolster the evidence base in mHealth and MNCH. (See *Appendix A: Landscape Scan—Illustrative Studies*).

A review of those illustrative studies and other studies discovered in the landscape scan revealed some clear trends in the shaping of the evidence around mHealth and MNCH. The most obvious trend is an increase in studies using more rigorous study designs; there are a number of randomized control trials underway or recently completed. There are also several studies being conducted that use comparison groups, the collection of baseline data and/or larger sample sizes, provide full descriptions of research protocols, and provide justifications for the selected study design. Notably, there are a discernible number of studies underway that are or will be using health outcomes as primary measurement indicators. The landscape scan did not yield any studies that clearly indicated the use of a theoretical framework.

The mHealth studies identified in the landscape scan ranged across the maternal health continuum of care and the coverage gaps identified under “Countdown to 2015,” including PMTCT and EID, as well as in numerous areas of newborn and child health including vaccinations, promoting breastfeeding and improved infant and young child nutrition, implementing IMCI protocols, pediatric malaria treatment, pediatric antiretroviral adherence, family planning and other areas of sexual and reproductive health. Crosscutting areas being studied include scaling-up programs, cost-effectiveness, community health worker performance, supply chains and financing of MNCH interventions.

KEY INFORMANT INTERVIEWS

1. Sources of Evidence

Stakeholders access different types and sources of evidence. The source of evidence often depends upon the nature of the stakeholder (and the purpose for which evidence is used). Researchers and academics tended to access and rely directly upon studies in peer-reviewed academic journals more than their non-researcher counterparts. Other than the researchers, few key informants indicated that they regularly access peer-reviewed publications for evidence underlying the use of mHealth in MNCH. These non-researcher key informants indicated that they rely more on a variety of evidence sources including:

- Program evaluations;
- Conference presentations;
- Conversations with colleagues;
- Websites such as mobileactive.org;
- Evidence summaries and information released by inter-agency task forces such as the Maternal Health Task Force, the Interagency Task Force for the Reduction of Maternal Mortality and the Inter-Agency Task Team for the Prevention of Mother-to-Child Transmission; and

- Technical guidelines and standards developed by organizations or government bodies such as the WHO and PEPFAR.

Though many key informants did not routinely access peer-reviewed articles, the interviews revealed that this form of evidence is still important. In particular, evidence underlying the guidelines, standards and technical briefs are all rooted in the evidence contributed by peer-reviewed studies.

2. How Key Informants Use Evidence

In addition to informing their own knowledge base, key informants' needs generally depended upon the type of organization with which they were affiliated:

- Key informants affiliated with **governments** used evidence to decide what sorts of projects to support with funding and to inform fellow policymakers, particularly colleagues working in global health and with budgets. Some viewed the evidence as informing the process for setting standards in global health. Two of the government key informants indicated that they depended upon researchers to inform them about gaps in research to be supported with funding.
- Key informants who were affiliated with **research** organizations or were researchers with another type of organization used evidence to (i) inform their own studies, either for comparison cases in terms of methodology, design and outcome measurements or (ii) to guide them in selecting areas for their own research. Some would use the evidence to advocate for governments to fund certain types of interventions or research initiatives.
- Key informants affiliated with the **private sector** used evidence to make a business case to colleagues, inform marketing efforts, identify potential marketing trends and, in some cases, make decisions about funding support.
- Key informants who were **implementers** or affiliated with **NGOs** value evidence as more of a guide for **how** to deliver services, rather than **what** sort of services to deliver. The types of services to deliver are guided by international and national standards and donors' priorities. Some implementers, particularly large NGOs,

use evidence to advocate for increased funding or to promote innovations and issues such as addressing the social determinants of health.

- Key informants affiliated with **multinational organizations** used evidence to inform standards of practice and make recommendations to governments. They emphasized the need to disseminate the evidence to the wider global community including health, technology and governments. The goal of dissemination was also a concern of key informants representing networks/associations and one from the government/donor perspective.

(See Appendix B: List of Key Informants Interviewed).

3. Themes Raised by Key informants

A. STUDY DESIGN AND RCTs

Generally, while the majority key informants (58%) acknowledged the value of RCTs to the evidence base for mHealth (and MNCH), a significant number of the key informants (26%) opined that in the field of mHealth (in MNCH contexts and otherwise) other types of studies could be just as valuable and, in many situations, more valuable than RCTs. The field of mHealth warrants different types of study designs depending upon the research question and the hypothesis being tested.

There was near universal consensus that there should be more studies using more rigorous research methodology (compared to descriptive studies), including using comparison groups (paying attention to the components being compared), collecting baseline information, and fully and transparently describing research methodology, limitations and negative results.

Those key informants who tended to place more emphasis on the use and value of RCTs tended to fall into the **researcher** category. Those who were more open to other methodologies and placed equal value on qualitative studies were affiliated with **implementing organizations** and **governments**.

Below are some of the specific comments made regarding RCTs and study methodology:

“People generally tend not to value different types of methodologies; most see a hierarchy of methodologies. RCTs are not always the best. (For example) RCTs are not good for understanding complex behavior patterns.” (researcher)

“Technology is outpacing the research paradigm.” By the time we complete (and publish) an RCT study, because of advances in technology, that study will be irrelevant. (2 implementers, both researchers). Most studies are required (by donors) to show results in a short window of time dictated by the length of the project. It often is impractical “to gather useful evidence at a pace that even remotely corresponds with how technology moves.”⁸⁸ In response, one other key informant adamantly stated that while technology may have advanced, the underlying premises that the research evaluates remain steadfast.

To be valuable research, the questions (being studied) must be clearly articulated. That is not always being done. (1 government key informant, 1 researcher)

We need more evidence isolating the role mHealth plays in order to determine attribution. (2 government key informants, 1 researcher)

“Mixed methods studies are the most critical: what works and the process supporting it.” (government key informant).

“We need to invest in solid formative research to understand the target for an mHealth strategy.” (researcher)

B. HEALTH OUTCOME INDICATORS

Nearly half of the key informants (42%) identified the need to evaluate mHealth (in MNCH and other health contexts) in terms of **health outcomes**, using measurements such as morbidity, mortality and nutritional indicators. Every key informant affiliated with a government mentioned the need for the evidence to demonstrate that mHealth actually makes a difference in program outcomes, particularly in health. On the contrary, one key informant affiliated with an implementer/NGO indicated that implementers do not

necessarily need health outcome information, and that indicators such as exclusive breastfeeding rates, treatment adherence and vaccination coverage were sufficient proxies for changes in health status.

One key informant (implementer/NGO) commented that gathering health outcome information takes time to observe and is most often not practical in light of the project duration. However, there are certain health outcome indicators that can be observed within a relatively short time frame such as the child health indicator for wasting (weight for height), which is indicative of acute malnutrition (but more expensive to measure) and underweight (chronic malnutrition), a more cost effective measurement to take but not always the best indicator of growth because it is most sensitive to change.

Many of the studies focus on how mHealth might improve the performance of community health workers (CHWs), which is important to know, particularly for a Theory of Change. However, several key informants commented that studies ought to address how changes in CHW performance translate into changes in the health status of the population.

C. COST-EFFECTIVENESS

The interviews also revealed that 39% of key informants raised the need for robust evidence demonstrating the cost-effectiveness of employing mHealth solutions for MNCH. They stressed that understanding how mHealth contributes to efficiencies is particularly important in LMIC contexts because of weak health systems with low human resource capacities. Interviews revealed that the recent global financial problems have led to increased donor demands for greater accountability in the budget apportionments for foreign aid in health. In response, advocates of foreign aid for health face increased pressure to produce evidence on value for money spent. One key informant shared that if researchers are not able to demonstrate that mHealth actually improves impact, they should be able to demonstrate that mHealth can achieve equal impact as compared to current standards. In this case, the scale-up of mHealth solutions needs to be justified by demonstrating effectiveness and efficiencies in both financial and opportunity costs.

D. SCALING UP PILOTS AND GENERALIZABILITY OF FINDINGS

Approximately 31% of the key informants, including all key informants affiliated with a government, acknowledged a lack of evidence that demonstrates how mHealth interventions can be scaled-up and achieve impact at scale. These key informants noted that most mHealth studies are conducted as pilots and worried that the results are not generalizable to other contexts. One government key informant proposed supplementing and replicating studies in different contexts and settings. Another key informant noted that certain biases accompany pilots, particularly around acceptability; the informant questioned whether the use of mobile phones would be equally accepted among a general CHW population as compared to a small pilot group of CHWs who might have been “cherry-picked” for the pilot and are predisposed to using mobile phones.

Most government key informants expressed interest in more **program evaluations**, studying what works on the ground for MNCH compared to the small pilot studies. One such key informant recommended establishing principles on how to contextualize and focus on targeting to sub-groups such as women with HIV and specific marginalized populations. Another key informant recommended establishing criteria for scalability.

E. SYSTEMS ANALYSIS

Related to the issue of generalizability of findings and taking activities to scale, key informants identified the need to apply ‘systems analysis’ in developing and analyzing the evidence base in MNCH. While key informants were informed that the interview focused on MNCH as a use case, 20% of them, particularly government donors and researchers, emphasized the need to do systems research to tie in the evidence for mHealth in MNCH and other areas, such as HIV and TB, and apply that knowledge to how it impacts the health system. Those who supported tying mHealth for MNCH research to systems analysis expressed concern on the risks of creating numerous parallel health systems when research efforts focus on use cases like MNCH without integrating systems analysis. While recognizing that the increasing number of guidelines for integrating health services such as PMTCT and nutrition partly ameliorates these risks, those key informants who advocated for

systems analysis encouraged a more deliberate effort to use a systems lens. As one key informant shared:

“In the first generation [of mHealth research], the research will naturally be in silos. We will gradually see a convergence of solutions that simultaneously address multiple issues.” (Multinational organization key informant)

Another key informant, when responding to using project level findings to inform higher level system said:

“We need (research) projects to think upstream and think systematically” (i.e. how to take all the small things being discovered at the project level and determine how they inform and feed into the higher level system). (Government key informant)

F. SHARING AND DISSEMINATION OF EVIDENCE

A number of key informants were very vehement about saying there was much evidence that has been or is currently being generated. There are numerous projects with research components that have demonstrated results that could add to the evidence base in mHealth and MNCH. These findings are neither shared nor disseminated to the wider global health communities. Key informants cited several reasons for this including the reticence of health publications to publish academic studies focusing on mHealth. Some major themes emerging from key informants included the following:

- A few of the NGO/implementer key informants expressed that they believed that a significant portion of the mHealth community tends to be insular, sharing their experiences only with each other. There is a perception that many within the mHealth community are either unable or unwilling to reach out to the broader global health community.
- There is a need for more forums that unite implementers to share project results with each other, emphasizing promoting and sharing operational and implementation research. (government key informant).
- There are many rich examples of knowledge, but they are not being gathered, synthesized or used. Nor is this knowledge being captured and curated in a

quality manner through a knowledge management vehicle with a gatekeeper to monitor quality. (government key informant).

- We need to know what does not work in pilots and understand why they did not work. As one researcher shared, “much of the bad stuff is being hidden.” (researcher)
- Several of the key informants from different categories believed that researchers ought to better translate research findings and evidence into a language that resonates with global health specialists, governments and policymakers.
- One key informant who is both an implementer and a researcher indicated that relying on published peer-reviewed literature to establish an evidence base is not practical because it can take up to five years to publish, three years to do the research and two years to write and publish.

G. USING THEORETICAL FRAMEWORKS AND THEORIES OF CHANGE

A number of the researchers, implementers and government key informants remarked that the quality of the evidence and its usefulness could be improved by tying the evidence back to a theoretical model, stressing that the best evidence refers back to theoretical models. For example, behavioral change theories should serve to inform mHealth activities aimed at CHWs to change their work patterns or at mothers to adopt behaviors that improve their health and well-being.

According to several of the implementers, researchers and government key informants, there also needs to be a clear theory of change. This would be similar to a results framework or logic model that demonstrates the role that mHealth plays to achieve desired results. The theory of change should then guide the development of the research questions and outcome indicators.

H. UNDERSTANDING SOCIAL AND CULTURAL DETERMINANTS

Understanding how social and cultural dynamics affect using mHealth in MNCH and other health areas has been missing in much of the research, according to 20% of the

key informants representing researchers, implementers and governments. As one researcher remarked:

“We need to go further than sending messages to influence behaviors; we need to understand cultural and societal influences to change the behaviors [using sound behavioral change theory] and use that understanding to frame the content and delivery of those messages.”

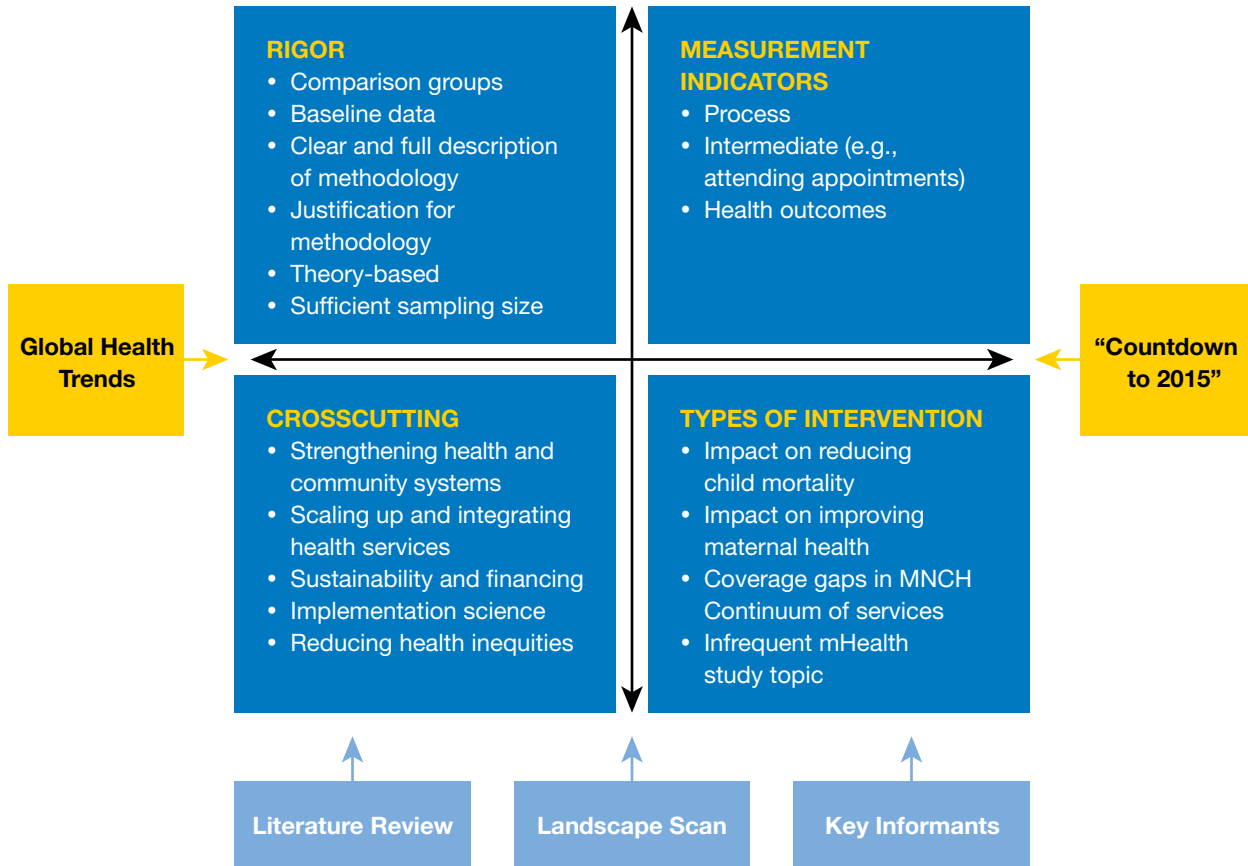
Multiple researchers noted the failure to apply a gender analysis lens to mHealth research, particularly in studies evaluating interventions with mothers. While mHealth is being used to increase access to health services for pregnant women, most mHealth for MNCH research projects are not incorporating a gender framework. This is a key oversight because a gender framework can help researchers understand at a deeper level how gender power dynamics permeate all aspects of life regarding accessing health care in many LMICs. Understanding how mobile phones affect and are affected by gender dynamics, including how women make decisions regarding whether or not to access health services, is critical to effectively leveraging mobile phone services to increase demand for health services.

Issues of reducing inequities and health disparities were noted by several of the key informants. One of the great promises of mHealth is its potential to reach people who traditionally have not had access to health services, not only because of geographic isolation and poverty but also because of social and cultural marginalization based upon prejudices and stigma. The mHealth field has not yet scratched the surface in generating evidence on how mHealth can be used to reduce inequities and health disparities in these populations.



“WE NEED (RESEARCH) PROJECTS TO THINK UPSTREAM AND THINK SYSTEMATICALLY”
(GOVERNMENT KEY INFORMANT)

Figure 1: Evidence gaps in mHealth for MNCH framework



DISCUSSION OF GAPS AND RESEARCH OPPORTUNITIES

During the preparation of this report, it became apparent that evidence gaps fall into four categories: 1) "rigor" in study designs 2) type of MNCH intervention being studied 3) measurement indicators and 4) crosscutting approaches that are determined by global health trends. Identifying gaps involves a certain level of subjectivity and depends upon the perspective of the person being asked.

Although the term "gaps" holds a negative connotation, areas identified as gaps in this report should be seen as future opportunities for implementers, funders and

researchers, particularly given the nascence of the mHealth field and the evolving evidence base in this area.

The following framework was developed as a tool to identify the evidence gaps in mHealth and MNCH for purposes of this report.

1. Types of MNCH Interventions

1.1 AREAS OF MHEALTH AND MNCH FOR WHICH THERE IS A MORE ESTABLISHED EVIDENCE BASE: DO WE CHALLENGE THOSE FINDINGS?

The identification of gaps should begin with identifying those areas in mHealth and MNCH which have been researched to a certain degree and for which the research has generated consistent findings. The preponderance

of the literature in mHealth and MNCH has focused on: usability, feasibility and acceptance of mHealth; the use of mHealth in the area of data collection and management⁸⁹ (not limited to MNCH); the use of mHealth for appointment reminders (e.g., antenatal visits); and the use of mHealth to improve access to emergency obstetric care by reducing the so-called “Three Delays” in accessing skilled delivery care. Those studies focusing on the Three Delays primarily focused on the first two delays namely: 1) the delay in deciding to seek appropriate medical help for an obstetric emergency and 2) the delay in reaching skilled birth attendants.⁹⁰

As mentioned previously in this report, the PHI study concluded that research in mHealth and MNCH has generated **preliminary** (emphasis added) evidence supporting the contention that mHealth contributed to:

- Improved compliance with scheduled follow-up appointments;
- Improved service utilization;
- High levels of trust;
- User satisfaction with services; and
- Improved rates of delivery in the presence of skilled birth attendants.⁹¹

There have also been findings in a few studies that participants “receive a strong psychological benefit” from the use of mobile phones.⁹²

A few key informants agreed with the conclusions of the PHI study and additionally noted a substantial evidence base supporting the role of mHealth in improving data collection and management.

Yet, several sources disagree that there is sufficient evidence to make generalizable statements regarding the role of mHealth. While there may be preliminary evidence of outcomes attributable to mHealth, many of those studies were conducted using pilot programs, the findings of which are not necessarily generalizable to different contexts.

For example, there are a number of people working

in the mHealth and MNCH fields who believe that the evidence, although promising, is still insufficient to make any conclusive generalizable statements about user acceptability. One key informant worried that the findings of user acceptability (using CHWs) generated from pilot interventions are not generalizable to scaled-up interventions that involve a greater number and range of users in terms of ages and experience. There is a risk that a larger pool of community health workers selected from a larger segment of society would not be as predisposed to using mobile phones in their work.

1.2 WHICH MNCH INTERVENTION AREAS ALONG THE MNCH CONTINUUM OF CARE AND WITHIN MDGS 4 & 5 SHOULD BE PRIORITIZED IN THE MHEALTH RESEARCH AGENDA?

Because of the nascent nature of the evidence base for mHealth in the area of MNCH, studies of all interventions along the MNCH “Continuum of Care”, with the goal of improving maternal newborn and child health are certainly warranted. (See Figure 2).

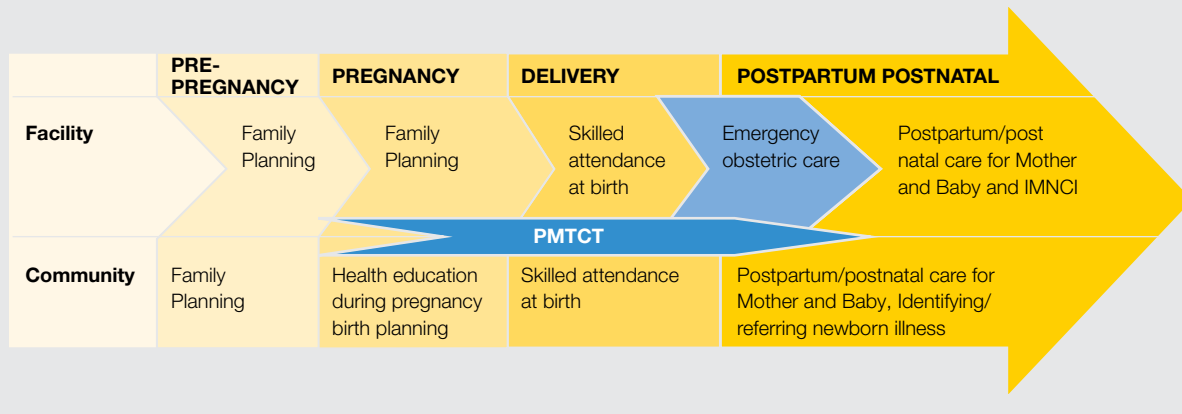
Most key informants interviewed were reticent about prioritizing specific MNCH interventions for research with the exception of PMTCT.

A few of the key informants suggested that the ideal focus areas for research would be the MNCH areas prioritized by donors and the global health community. These interventions would be in those areas which the global health community has identified as “gaps” and/or those areas that are responsible for the greatest proportion of maternal, neonate and child mortality.

A significant proportion of the global health community has prioritized achieving the health related MDGs by 2015, specifically MDGs 4 and 5, which refer to reducing child mortality and improving maternal health.[§] Global health experts who are tracking progress toward achieving MDG 4 and 5 as part of “Countdown to 2015” have identified the interventions along the MNCH continuum that contribute the most to MDGs 4 and 5. They have also identified obstacles to implementing those interventions.⁹³ Much of the momentum behind mHealth emanates from its potential to improve health interventions that are not being effectively implemented. Those health interventions

§ Goal 6 refers to combatting HIV/AIDS, malaria and other diseases.

Figure 2. Maternal-Newborn Continuum of Care



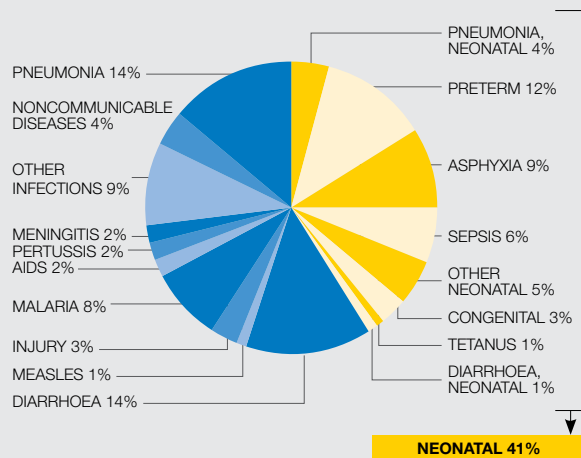
Credit: UNICEF

are identified as coverage gaps in “Countdown to 2015”.

Using “Countdown to 2015” as a standard to identify the most important interventions that contribute to MNCH and where there are gaps in coverage of those interventions, an argument can be made that the following MNCH gaps areas be prioritized for mHealth research and evaluation:

- Prevention-of-mother-to child transmission of HIV (PMTCT);
- Intermittent preventive treatment of malaria for pregnant women;
- Increasing contraceptive prevalence;
- Increasing postnatal follow-up visits for mothers;
- Intervention improving the nutritional status of children, particularly early initiation of breastfeeding and exclusive breastfeeding;
- Children sleeping under mosquito nets;
- Antibiotics for childhood pneumonia;
- Pediatric malaria treatment; and
- Pediatric diarrheal treatment.⁹⁴

Figure 3. Global Causes of Death Among Children Ages 0–59 Months, 2008

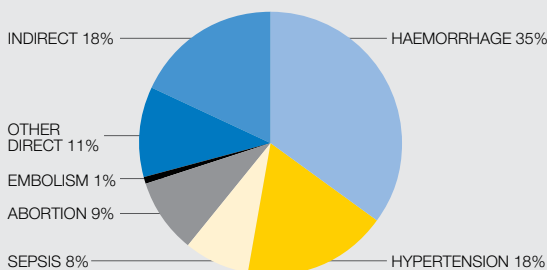


More than 40% of child deaths occur during the neonatal period

Note: Undernutrition contributes to one-third of child deaths.

Source: Countdown to 2015, 2000–2010 Decade Report

Figure 4. Global Estimates of the Causes of Maternal Deaths, 1997–2007

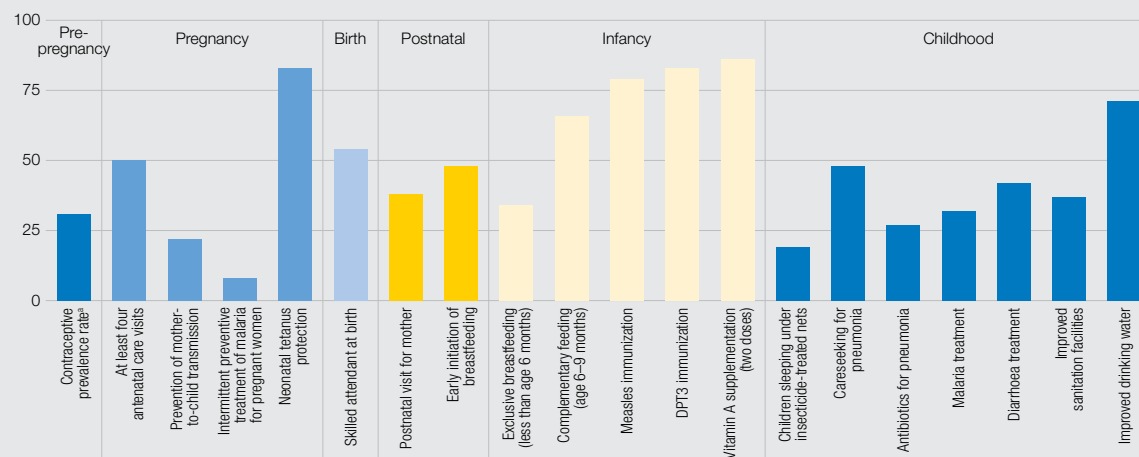


New estimates show that haemorrhage and hypertension account for more than half of maternal deaths

While the literature review and landscape scan indicated studies looking at the role of mHealth in a number of these MNCH intervention areas, PMTCT coverage stands out as one of the most significant gaps. Insofar as PMTCT is a priority health area not only under the MDGs but also under PEPFAR and the Global Fund, researchers who recently completed a systematic review of the literature addressing mHealth used for HIV interventions were surprised to discover that there were no completed studies published in any peer-reviewed journals focusing on how mHealth can improve results in PMTCT programs.⁹⁵ There was one study on how mHealth can improve treatment adherence looking at HIV+ patients that included PMTCT patients, but that study did not include an analysis of the impact upon those women based on their status as pregnant women.⁹⁶

Source: Countdown to 2015, 2000–2010 Decade Report

Figure 5. Median national coverage of interventions across the continuum of care for 20 Countdown interventions and approaches in Countdown countries, most recent year since 2000 (%)



Coverage of interventions varies across the continuum of care

a. Target coverage value is not 100%.

Source: Prevention of mother-to-child transmission of HIV/AIDS, UNICEF, Joint United Nations Programme on HIV/AIDS (UNAIDS) and WHO; immunization rates, WHO and UNICEF; postnatal visit for mother, Saving Newborn Lives analysis of Demographic and Health Surveys; improved water and sanitation, WHO and UNICEF Joint Monitoring Programme 2010; all other indicators, UNICEF Global Databases, November 2009, based on Demographic and Health Surveys, Multiple Indicator Cluster Surveys and other national surveys.

1.3 OTHER PROMISING AREAS FOR STUDY IN THE AREA OF MHEALTH AND MNCH

There is an increasing and robust body of evidence describing the strong correlation between **maternal depression** and its impact on both maternal health and early childhood health outcomes, particularly in developing countries.⁹⁷ There is also an increasing body of evidence indicating a correlation between the use of mobile phones and feelings of well-being or a sense of community.^{98, 99, 100} This correlation arguably justifies continuing research that evaluates how the use of mobile phones may contribute to improving the mental health of mothers, affording them a greater sense of community particularly in stressful environments with extreme poverty, HIV and other diseases.

2. Rigor in Study Design

Assessing methodological rigor in study design can be a subjective exercise, although the research community generally employs certain standards. “Quality” of evidence generally pertains to the rigor of the methodology employed, referring to the scientific process encompassing all aspects of study design. These aspects included the match between the methods and questions; selection of subjects; measurement of outcomes; and protection against systematic bias, nonsystematic bias, and inferential error (Boaz & Ashby, 2003; Lohr, 2004; Shavelson & Towne, 2002).

From the perspective of the research community, rigor criteria for published studies would include: having a baseline; posing appropriate questions; selection of the appropriate research methodology for the question being investigated and justifying that methodology; having a clear theory of change; sufficient size and description of comparison groups; controlling for biases and confounding, being peer reviewed; and no apparent conflicts of interests among the investigators.

The Tamrat and Kachnowski and Noordam literature reviews described earlier opined that the evidence base for using mHealth in the sphere of MNCH lacked quality for several reasons. Many of the studies:

- Did not have intervention and control groups for comparison;
- Did not have baselines;

- Were conducted as part of a pilot intervention (rather than a scalable program);
- Used small samplings for analysis;
- Did not sufficiently control for other biases and/or confounding;
- Did not adequately attribute changes observed (to mHealth); and
- Were primarily descriptive in nature.

Using properly conducted cluster RCTs, which are often considered the gold standard in research, is generally thought to provide the highest quality data in the mHealth evidence base in MNCH. However, as a number of the key informants pointed out during the key informant interviews, RCTs are not always necessary or even appropriate depending upon the research question being studied.

The supplemental articles search revealed the majority of the available published articles on mHealth and MNCH were descriptive in nature or simply reported the results of surveys or interviews with participants. Less than one-third of the articles reported on studies using experimental design, and often those studies were conducted with pilots and small sample sizes. Only one published study had a clearly articulated theoretical framework.

Several researchers recently conducted a still unpublished survey of mHealth project managers to assess the evaluation rigor of mHealth projects across different health areas.¹⁰¹ The purpose of the survey was to “better understand from the mHealth project managers their intentions and practices regarding monitoring, evaluation and impact assessment.”¹⁰² The study looked at 69 mHealth projects from 29 countries. Of the mHealth projects, 69% addressed MNCH.¹⁰⁵ The investigators used an 8-point scale to assess the evaluation rigor of each project, with 6-8 points indicating strong rigor. Top scores were given to projects with comparison groups, randomization, adequate sample size and other quality markers. Using the 8-point scale, preliminary results showed that less than one-fourth (22.6%) reported strong evaluation rigor.¹⁰⁴ Of all health-related mHealth projects that focused on evaluation, 60% reported using non-experimental designs, 19% reported using a

quasi-experimental design, and 21% reported using an experimental design.¹⁰⁵ The most common study design was cross-sectional. Less common study designs were case-control and step-wedge.¹⁰⁶ Less than half the studies examined (47%) included a comparison group; 43% used randomization and 37% calculated sample size for power.¹⁰⁷ The unpublished report summarized its findings by stating:

“A common feature of many mHealth projects is a general failure to address critical evaluation questions with rigor.”¹⁰⁸

3. Measurement Indicators

The selection of primary outcome indicators is one of the key factors influencing study quality in the view of a substantial portion of the global health community. The literature review of current published studies in the field of mHealth and MNCH revealed a slowly emerging body of research in mHealth using MNCH **outcomes** as measurement indicators. Yet, overall there is still a paucity of peer reviewed published mHealth studies in the MNCH area that used health outcomes as primary measurement indicators. A significant number of studies in the published literature instead used proxy or intermediate results as indicators for clinical and health outcomes such as access to antenatal clinics and access to skilled birth attendants. In the area of child health, the literature search revealed no published studies that went beyond using the act of returning for vaccinations appointments as the primary outcome measurement. There were no peer-reviewed published studies using, for example, reduction of morbidity or child nutrition indicators such as weight for height as outcome measurements.

A few key informants suggested tracking antenatal appointments and immunization visits are appropriate indicators for inferring better health outcomes.

The landscape scan revealed an increasing number of current mHealth studies (and protocols) in the MNCH which are measuring the impact of mHealth in terms of **clinical and health outcomes**.

A few of the key informant interviews confirmed the perception that if mHealth in MNCH is going to attract significant funding, donors are expecting the research to increasingly show how mHealth contributes to clinical outcomes and health impact.¹⁰⁹ While the concept of measuring the impact of mHealth in terms of MNCH clinical and health outcomes is an ideal goal, one of the key informants duly noted that **measuring clinical and health outcomes often takes significantly longer** (and requires significantly more resources) than using proxy measures such as measuring return visits to a health facility. With the field of mHealth rapidly evolving in a way that technologies and approaches become obsolete rather quickly, the practicality of conducting studies that require longer amounts of time to gauge health impacts must be weighed against pressures to demonstrate results quickly and the limitations of available funding to support longer-term studies.

The absence of rigorous studies using **cost-efficiency indicators** as primary outcome measurements was just as glaring, particularly from the viewpoint of government key informants. A few of the key informants speculated that mHealth is not necessarily going to generate evidence of substantial differences in outcomes and impacts when compared to standards of care that do not involve mHealth. There is a likelihood that in many instances, research will show that mHealth contributes to comparable outcomes and impact as current standards of care that do not use mHealth. In these cases, in order to make the case to the donors and implementers justifying using mHealth solutions, it is important to demonstrate the cost-efficiencies afforded by mHealth, in terms of both financial and opportunity costs.

4. Crosscutting Approaches

Global health trends and the subjective needs of particular stakeholders dictate the identification of gaps in crosscutting approaches. Global health trends exist toward strengthening health systems to provide quality care, integrating health interventions into holistic packages to reach more people, achieving sustainability, understanding **how** to implement evidenced-based interventions, and analyzing the underlying social determinants for accessing quality health services.

The trends have led to stakeholders, particularly governments, looking for evidence on how mHealth contributes to five key areas:

1. Strengthening health and community systems;
2. Scaling up and integrating health services;
3. Sustainability and financing;
4. Implementation science; and
5. Reducing health inequities due to social and economic marginalization.

4.1 FRAMING MHEALTH AND MNCH RESEARCH IN TERMS OF HEALTH AND COMMUNITY SYSTEMS STRENGTHENING

Priority areas that are receiving a lot of attention in the world of global health (all areas, not just MNCH) are **health system strengthening**^{110, 111, 112} and **community system strengthening**.¹¹³ Related to systems analysis (and cost-efficiency studies) is the use of Michael Porter's value chain analysis in understanding how to add value to health systems.^{114, 115}

There are few recent published studies or known ongoing research that evaluate mHealth for MNCH from the perspective of contributing to health and community systems strengthening.^{116, 117} Global health experts including major international donors like the WHO, U.S. Government, the Global Fund and DFID have been pondering how the programs and interventions they support with funding contribute to health systems and community systems strengthening.¹¹⁸ The WHO framework for health systems strengthening lays out six building blocks including:

- Service delivery
- Health workforce
- Information systems
- Medical products, vaccines, and technologies

- Financing
- Leadership and governance¹¹⁹

The Global Fund's core components of community systems include:

- **Enabling environments and advocacy**—including community engagement and advocacy for improving the policy, legal and governance environments, and affecting the social determinants of health.
- **Community networks, linkages, partnerships and coordination**—enabling effective activities, service delivery and advocacy, maximizing resources and impacts, and coordinated, collaborative working relationships.
- **Resources and capacity building**—including *human resources* with appropriate personal, technical and organizational capacities, *financing* (including operational and core funding) and *material resources* (infrastructure, information, and essential medical and other commodities and technologies).
- **Community activities and service delivery**—accessible to all who need them, evidence-informed and based on community assessment of resources and needs.
- **Organizational and leadership strengthening**—including management, accountability and leadership for organizations and community systems.
- **Monitoring, evaluation and planning**—including M&E systems, situation assessment, evidence building and research, learning, planning and knowledge management.

In scanning WHO's 6 building blocks and the Global Fund's Community Systems core components, it is easy to see how mHealth can contribute to each building block and core component, whether it is in the area of MNCH or in any other health area.

For example, there have been a number of studies that demonstrate how mHealth improves CHW performance (which is linked to both WHO's health workforce building block for health systems strengthening and the Global Fund's resource and capacity building core component of community systems).¹²⁰

Many global health specialists would prioritize research and evidence of mHealth in the context of MNCH interventions, if framed in terms of how mHealth in MNCH interventions contribute to both health systems strengthening and community systems strengthening or adding value to a health system. In particular, major global health funders like WHO, the Global Fund and the U.S. Government, all whom have prioritized systems strengthening as a pathway to improved global health, have an interest in evidence supporting how mHealth contributes to health and community systems.

4.2 INTEGRATING HEALTH SERVICES

As integration of MNCH interventions becomes a strategy for scaling-up health services, guidelines for integration are being issued in a number of interventions and applications. Key examples include the Integrated Management of Childhood Illnesses (IMCI),¹²¹ the PEPFAR Technical Guidance for Integrating PMTCT Interventions with MNCH Services,¹²² and the Essential Package for Young Vulnerable Children and their Caregivers Affected by HIV and AIDS.¹²³ Organizations such as Dimagi and D-Tree International have been spearheading the use of mobile applications like CommCare as decision support tools to aid CHWs with facilitating integrated health interventions using phone-based protocols.¹²⁴ While results have been mixed,¹²⁵ the use of mobile phones as decision support tools using protocols to implement integrated health services, particularly in the area of MNCH, warrants further research.

4.3 SUSTAINABILITY AND FINANCING

Innovative means of financing for health interventions contribute to the sustainability of health programs. International donors, such as the U.S. government, are increasingly expecting that the interventions they support have developed plans for **sustainability**. A key component of sustainability plans is the identification of **financing mechanisms** that are not dependent upon donor funds. There is a growing interest in payment and

microfinance mechanisms, such as mFinance and mPesa, which employ mobile phone technology. In the area of maternal health, interventions such as the Marie Stopes/ Strengthening Health Outcomes through Private Sector (SHOPS) program use mobile phones for reimbursing and remitting vouchers and conditional cash transfers as payment for health services related to MNCH.^{126, 127} Despite the proliferation of mobile technology in the mobile payment and mFinance arenas, no substantive evidence appeared in either the published literature or the landscape scan explicitly linking and evaluating mFinance and mobile payments with mHealth outcomes. The exception was the Marie Stopes/SHOPS evaluation. That evaluation, however, was not published in a peer-reviewed journal. **The potential of linking mFinance with mHealth, particularly in the donor priority areas of performance (or results-based) financing and conditional cash transfers**, warrants research and evaluation in terms of how (or if) the linkage of the two mobile technology areas contribute to the sustainability of programs.

4.4 IMPLEMENTATION SCIENCE

Global health stakeholders such as PEPFAR are increasingly interested in evidence using scientific methodologies to study **how** to implement and operationalize health guidelines, protocols and research findings, a field known as "implementation science."¹²⁸ Implementation science or research has been defined as "the scientific study of methods to promote the systematic uptake of clinical research findings and other evidence-based practices into routine practice, and hence to improve the quality (effectiveness, reliability, safety, appropriateness, equity, efficiency) of health care."¹²⁹

Researchers are beginning to use implementation science to evaluate how mHealth can be used to improve the quality of health services. Topics studied within the implementation science framework include using mHealth to increase the skill levels of health workers using clinical practice guidelines or protocols.^{130, 131} Framing research analyzing the role that mHealth may play in improving MNCH as "implementation science" may be a strategy for presenting mHealth evidence in a language that would resonate with the global health community, particularly those stakeholders who need evidence of not only **what** to do but also **how** to do it.

4.5 REDUCING HEALTH INEQUITIES

Addressing the **social determinants** of health and how social marginalization leads to health inequities has become a priority topic in the global health community.¹³² The literature review revealed an emerging evidence base on how mHealth may be utilized as a tool for working with marginalized or particularly vulnerable populations. Some of the grey literature addressed the social determinants and constructs that serve as obstacles to using mHealth. In the field of MNCH and mHealth, gender power dynamics that contribute to inequities are being addressed by the mHealth Alliance and by initiatives such as GSMA's mWomen Program.¹³³

Despite the global consensus around the role that social determinants play in contributing to health inequities and the emerging attention in the literature to how mHealth can influence social determinants, the evidence base for using mHealth to reduce health inequities is still nascent. In light of the recognized role that social and economic marginalization play in accessing health services, the lack of a strong evidence base analyzing how mHealth might impact health inequities should be considered a gap warranting further research.




CONCLUSION

The evidence base for using mHealth to improve MNCH interventions in terms of health impact and cost-effectiveness is still nascent. Research using pilot studies, process or proxy indicators for health, and less methodologically rigorous study designs are natural precursors for more rigorous studies using health and cost-effectiveness outcome indicators and more labor, time and cost-intensive research designs such as RCTs. All research, so long as there is transparent disclosure of limitations and results, adds to the evidence base. A number of research advocates propose that common metrics and quality standards regarding what is good research be developed to assist the larger community in understanding and using evidence. Efforts should be made to encourage sharing of results through an easily accessible knowledge management platform with quality controls to filter out information that does not meet quality standards. Research and evidence of the role that mHealth plays in other health fields such as HIV, behavioral change, WASH, and NTDs are valuable, should be evaluated and, if appropriate, integrated into the

field of MNCH, particularly as the global health community prioritizes more integration and health systems strengthening.

Gaps in the evidence around mHealth and MNCH should be viewed as **opportunities** for future research. Because of the nascent nature of mHealth use in the field of MNCH, all types of MNCH interventions present important areas to be studied. From a practical standpoint, those areas along the MNCH continuum that receive less service coverage, particularly pediatric health, warrant examination of how mHealth could increase their coverage and improve impact.

Lastly, as the global community acknowledges the inherent inequities in health that exist throughout the world, mHealth presents a promising opportunity for increasing access to health services, particularly for hard-to-reach populations isolated not only by geography but also by marginalization due to gender, social, health and economic status.



**GAPS IN THE
EVIDENCE AROUND
MHEALTH AND MNCH
SHOULD BE VIEWED AS
OPPORTUNITIES FOR
FUTURE RESEARCH.**

APPENDIX A

Landscape Scan— Illustrative Studies

Improving Uptake of Early Infant Diagnosis of HIV for the Prevention of Mother-to-child Transmission of HIV

- (SMS4PMTCT) (underway in Kenya); as of June 29, 2012, enrolled 239 women out of a target of 388).^{134, 135} The investigators are conducting a randomized controlled trial (RCT) to examine the effect of text messages sent to women enrolled in PMTCT programs on adherence to postpartum clinic visits and uptake of early infant diagnosis by DNA polymerase chain reaction (PCR). This study seeks to test the hypotheses that (a) text messages sent to women enrolled in PMTCT will improve their attendance at the postnatal clinic within the first 6-8 weeks after childbirth; and (b) text messages sent to women enrolled in PMTCT programs will increase uptake of DNA PCR HIV testing at 6-8 weeks among infants exposed to HIV. If proven superior to standard care, the proposed intervention can be easily scaled-up and integrated into existing healthcare systems in resource-limited settings. Primary outcome measures include: (i) proportion of women who attend postnatal clinic within 6-8 weeks postpartum (ii) proportion of infants tested for HIV by DNA PCR. Secondary outcome measures include: (i) infant adherence to antiretroviral prophylaxis; (ii) time to post-natal clinic return; (iii) maternal adherence to antiretroviral prophylaxis. The study includes sub-groups analyses: a) women on HAART vs. women not on HAART; b) women who knew status before pregnancy vs. women who learned status during pregnancy; c) women who share phones vs. women who own their own phones and; d) women in urban areas vs. women in rural areas.¹³⁶ Findings from this study will provide randomized trial evidence to inform HIV prevention program planners and implementers. In addition, the study is conducting an exploratory analysis of the correlation between using SMS and impact on infant HIV status and infant feeding choices.¹³⁷ This study will also provide further information on the feasibility of using mobile phone-based technology for public health

interventions in resource-limited settings. (NIH supported project: University of Washington, University of California, San Francisco, Kenya Medical Research Institute).

- *Project Mwana* (Zambia and Malawi)—The intervention, supported by UNICEF, Boston University and the Clinton HIV/AIDS Initiative (CHAI) uses mHealth (via a printer connected to a phone) to expedite the delivery of early infant diagnosis results (dry blood spot tests for HIV).¹³⁸ (See above under “Supplemental Articles Search”).

Pediatric Antiretroviral Therapy Adherence in Uganda.

This observational study is assessing a wireless adherence monitoring device and mobile phone-based adherence data collection among caregivers of children under the age of ten years in Mbarara, Uganda. It involves both quantitative and qualitative measures of the feasibility and acceptability of these measures, as well as circumstances of adherence lapses and other individual and cultural factors affecting adherence. The qualitative data will be used to explore models of adherence behavior, which will likely include the child-caregiver dynamic, the child’s mental and physical health, and social support mechanism. Primary outcome measures include: (i) distribution of adherence based on wireless adherence monitoring devices and interactive voice response (IVR) or short message service (SMS) self-reported by caregivers of HIV-infected children under ten years old in Mbarara, Uganda. Secondary outcome measures include: (i) feasibility and acceptability of wireless adherence measures and; (ii) model of adherence behavior.¹³⁹

Mobile Phones and Exclusive Breastfeeding (at least two (2) studies)

- Sponsored by the Lata Medical Research Foundation, Nagpur, the non-randomized case control efficacy and effectiveness study evaluated an intervention that is using cell phones for lactation counseling to address malnutrition in pregnancy and other disorders of breast and lactation associated with childbirth.¹⁴⁰ The objectives of the interventions are to improve exclusive breastfeeding, antenatal visits and the timely introduction

of solid foods (complementary feeding). The primary outcome measure is changes in the percentage of women exclusively breastfeeding (breast milk and no other foods or milk based liquids) their infants at 24 weeks. The secondary outcome measure is growth through 6 months of age—weight, length and head circumference gains between birth and each immunization visit (at 6, 10 and 14 weeks), at 24 weeks and at 26 weeks for growth velocity.

- Sponsored by the University of Toronto, this behavioral support intervention trial will investigate the potential to increase exclusive breastfeeding rates in an urban Kenyan community through peer mother support delivered either by cell phone or through group meetings. It will follow a cohort of more than 800 women attending antenatal care at a large public hospital, and compare indicators of breastfeeding and infant and maternal health between groups receiving one or other type of peer mother support. Study design included randomization, parallel assignments and double blinding.^{138b}

Prevention of Mother-to-Child Transmission (of HIV)

In addition to the EID studies (*SMS4PMTCT* in Kenya and *Project Mwana* in Zambia), there are several ongoing studies examining how mobile phones contribute to improved uptake of services and follow-up.

- A study in Kenya sponsored by the University of Manitoba has the overall goal of assessing if mobile phones and SMS text messages can be used to help improve prevention of maternal to child transmission (PMTCT) of HIV services by strengthening health systems.¹⁴²⁴ The study is randomized and will include an intervention group and a control group. The primary outcome measure is increased nevirapine uptake in labor in pregnant HIV positive women from 60% to 70%. Secondary outcome measures include: i) HIV positive rates in infants born to mothers in the study; ii) number of antenatal care visits; iii) earlier identification and treatment of HIV positive infants and; iv) acceptability of SMS messages for PMTCT related care.

- Cell-Life, partnering with the Empilweni PMTCT clinic in Johannesburg, has completed a randomized, controlled trial to assess whether SMS can be used to remind HIV+ mothers to keep appointments and bring their infants for HIV testing and, if needed, treatment. The objective of the intervention was to reduce loss of follow-up of mothers delivering (and their infants) at Rahima Moosa hospital in Johannesburg. Preliminary results indicated that of the 323 mothers in the intervention (total 738 in the study), more than 90% who received the messages returned with their infants for testing, 78% who did not received texts brought their infants back for testing.¹³⁸⁵ In addition, the exit interviews have revealed that the participants in the intervention receive a “strong psychological benefit” from participating.¹⁴³⁶ The final results are currently being written up. Surprisingly, the final results of the trial did not indicate any statistically significant differences between the cohort and control groups.¹⁴⁴⁷ One possible explanation being considered for the difference between the mid-term and final results is that a strike of health workers midway into the trials may have confounded results.¹⁴⁶⁸
- *Project Masihambisane—(See Supplemental Articles Search, page 20).*
- The Elizabeth Glaser Pediatric AIDS Foundation (EGPAF) is conducting a comprehensive study in Kenya that is using a **cluster randomized control trial** design with 36 health facilities randomized to two arms (intervention and control) among 910 HIV-infected pregnant women to determine the effect of mobile phone technology on PMTCT completion from antenatal to six weeks postpartum. The study will examine the **acceptability, effectiveness, and costing** of implementing a PMTCT-focused mHealth strategy among HIV-infected pregnant women, health workers, and male partners. The tested intervention will engage women, health workers, and male partners in a multi-directional mobile communication network for PMTCT. Low-literacy SMS text messages and structured calls to reinforce key PMTCT messages, including provision of automated and manual reminders to encourage

adherence to medical regimens, antenatal care use, skilled birth attendance, safe infant feeding, early identification of HIV in infants, and family planning will be introduced.¹⁴⁷⁹

Maternal Mortality in India: Bihar Project (India Family Health Initiative)

The \$30 million comprehensive maternal mortality project in Bihar India supported by the Bill and Melinda Gates Foundation uses mHealth as an integral part of the program. The program is conducting an RCT testing the hypothesis that frontline workers (FLWs) using ICT (mobile phone) enabled tools will have greater coverage and higher quality and timely interactions at multiple points in the family care continuum compared with FLWs using paper-based tools. Outcome measures include: i) Birth Preparedness Plan: % of mothers who have a transportation plan for normal delivery as well as for emergency; ii) Receipt of IFA tablet: % of mothers who received at least 90 IFA tablets during their last pregnancy; iii) Essential Newborn Care: % of newborn infants breastfed within one hour of delivery; iv) % of deliveries where clean cord practice was followed; v) initiation and age appropriate frequency of complementary feeding; vi) % of children (older than 6 months) receiving any cereal based complementary food; vii) % of children receiving age appropriate frequency of complementary feeding between 6-11 months of their age; viii) Family Planning: Adoption of modern method of contraception: % adopting a modern post-partum family planning method within 6 months of delivery; ix) Immunization: % children receiving DPT3 by 6 months.¹⁴⁸⁵⁰

Using CommCare to Implement Supervisory Management Techniques on ASHAs in India

Dimagi is planning a randomized control trial assessing the use of CommCare as a supervisory tool to improve community health workers (ASHAs) who work with pregnant women. The purpose of the study will be to compare performance outcomes (of the ASHAs) in terms of tracking pregnant women and births, % of enrolled women who attend all their antenatal visits and, the % of reported births receiving a visit (from an ASHA) within 48 hours, and clients' overall knowledge and practices related to

pregnancy and newborn care. Because of the high associated survey costs, health outcome indicators such as maternal and neonatal morbidity and mortality will not be measured.

Txt4Baby (United States)

A major randomized control trial that reportedly include health outcome indicators. The intervention uses a free health text messaging service to help more pregnant women and new mothers get information about caring for their health and the health of their babies. Although conducted in the United States, according to several key informants, the results might have implications for health programs in LMIC.

MAMA (Mobile Alliance for Maternal Action)

Testing accessibility, acceptability and effectiveness of *Aponjon* mobile phone based health information messages for behavior change for improved health care practices in Bangladesh. This proposed matched case-control research design will test its effectiveness in improving knowledge, attitude, healthy behavior practice and utilization of care for maternal and neonatal and child health. It will most likely include one health outcome indicator (e.g., child nutrition).

Using a mHealth Tool by Health Extension Workers in Ethiopia in carrying out maternal and child care responsibilities

Supported by the World Bank, the randomized control study is rigorously testing (in a pilot) the impact of using the mHealth tool on the *health outcomes* with rural mothers and children, with the **intention of scale up and collecting evidence for scale-up**. The intervention addresses low level of complete antenatal care, unsafe deliveries, improving vaccination coverage and facilitating emergency referrals.

Johns Hopkins University (JHU)

JHU, which has 49 ongoing mHealth studies/interventions in numerous health areas, is conducting studies in MNCH on: 1) using SMS reminders to improve immunization of children (along with cash transfers); 2) increasing communication between district hospitals and village CHWs in Malawi to report emergencies and supply needs. This

mHealth intervention aims to provide CHWs with health information and encourage them to use the health information; 3) testing in integrated mobile phone based data system (mCare) in Bangladesh that links women and newborns to improve target delivery of care to high risk mothers and newborns, as well as enhancing the survival of pre-term neonates and growth restricted infants in resource poor settings.¹⁴⁹⁵¹

Mobile Technology for Community

Health (MoTeCH) Initiative¹⁵⁰²

MoTeCH is a program (rather than a pilot) to determine how to use mobile phones to increase the quantity and quality of prenatal and neonatal care in rural Ghana, with the goal of improving health outcomes for mothers and their newborns. MoTeCH is comprised of two interrelated services. The "Mobile Midwife" application enables pregnant women and their families to receive SMS or pre-recorded voice messages on personal mobile phones that provide time-specific information about their pregnancy each week in their own language (99% have chosen voice). The messages continue through the first year of life for the newborn and reinforce well-child care practices and vaccination schedules. There is also a "Nurse Application" that enables Community Health Nurses to electronically record care given to patients and identify women and newborns in their area that are due for care. The two components are linked so that if a patient has missed treatment that is part of the defined care schedule, the Mobile Midwife service sends a message to remind the patient to go to the clinic for that particular service and the nurse is also informed that the patient is due for treatment. The MoTeCH initiative is supported by the Bill & Melinda Gates Foundation, and collaborating with Grameen Foundation, Columbia University's Mailman School of Public Health and the Ghana Health Service.

Mobile for Reproductive Health¹⁵¹³

In Kenya, PROGRESS has launched and is evaluating Mobile for Reproductive Health or m4RH, a new family planning information service delivered via text message. A similar evaluation will begin in Tanzania soon. PROGRESS is a five-year project funded by the U.S. Agency for International Development and implemented by Family

Health International to improve family planning services among underserved populations. The goal of this project is to obtain evidence for whether mobile technology is an effective and acceptable means of providing family planning information. The m4RH project is designed to answer the following questions: (1) who can be reached with the m4RH family planning program? (2) What type of family planning information can successfully be delivered using the mobile platform? (3) What impact does the m4RH program have? (4) Is the program cost-effective and sustainable? (5) How feasible is it to evaluate this mobile phone program through the use of electronic data collection and monitoring? There are no indications that the research will be measuring health outcomes.

mMoney for Women with Fistula¹⁵²⁴

This project uses a combination of mobile banking, public information, and free treatment in order to give women access to fistula repair. Women can call a free hotline, and if money is needed for transport to a fistula unit this is transferred via M-PESA. The project commenced in 2010, and although research is planned, there is no information on the study design, methodology and primary outcome indicators.

mFinance to Reimburse Sexual and Reproductive Health Vouchers in Madagascar

(See above under Literature Review Findings). Ongoing research is being conducted and was presented at the 2012 GSMA-mHealth Alliance Mobile Health Summit in Cape Town in May-June 2012.

OASIS II Research Project: Evaluating MVG-Net

The OASIS II Research Project in the Millennium Villages Project (MVP) is a study aiming to systematically assess the impact of the Millennium Villages Global Network (MVG-Net) and its components, including OpenMRS, ChildCount+ and other electronic service delivery systems in four* of the MVP sites, although implementation of MVG-Net is taking place across all MVP sites. The study applies a mixed methods approach. Key informant interviews comprise the qualitative component. The quantitative component focuses on tracking inputs and outputs as well as aggregated data generated through MVG-Net. Key areas that may be explored

include the use of data, performance monitoring, human resources planning and budgeting, supply chain management, efficiency in service delivery, and quality of care on health interventions related to MDGs 4, 5, and 6--such as pregnancy-related care; newborn health; diagnosis and treatment of children under 5; malaria, TB, and HIV/AIDS; respectively. Health-related indicators include: number of ante-natal care visits; immunization coverage; numbers of positive malaria tests; utilization of family planning techniques; exclusive breastfeeding, underweight children, and wasting (acute malnutrition), etc.¹⁵³⁵

*The four MVP OASIS II Research Project Sites are: Bonsaaso, Ghana; Mbola, Tanzania; Mayange, Rwanda and Ruhira, Uganda.

M-Afya Project¹⁵⁴⁶

A research project of Afya Research Africa, the M-Afya project is about a public-private partnership program to promote quality, timely utilization, and monitoring of focused ante-natal care and skilled delivery services through a network between health facilities and solar-powered community health kiosks (M-Afya kiosks) connected through mobile telephony. The kiosks are targeted at expectant mothers and are intended to facilitate the monitoring of clinical parameters that are important indicators of the progress and complications of pregnancy and delivery. Through mobile phone short messaging, the system incorporates a feedback system, and an educational and information advocacy service. The program also has a money saving scheme for expectant mothers, savings which are intended to earn interest as an incentive for attending all antenatal care sessions and for deliveries done in health care facilities. This special money saving scheme for expectant mothers forms the basis of a business model that will help sustain the initiative beyond the initial funding. The successful implementation of this program is anchored on the improved mobile phone access by the Kenyan population. This program will first be initiated in the rural area of Thika district, an administrative region in Kenya, for an initial period of 2 years. Information about the study methodology, design and outcome indicators are unavailable.

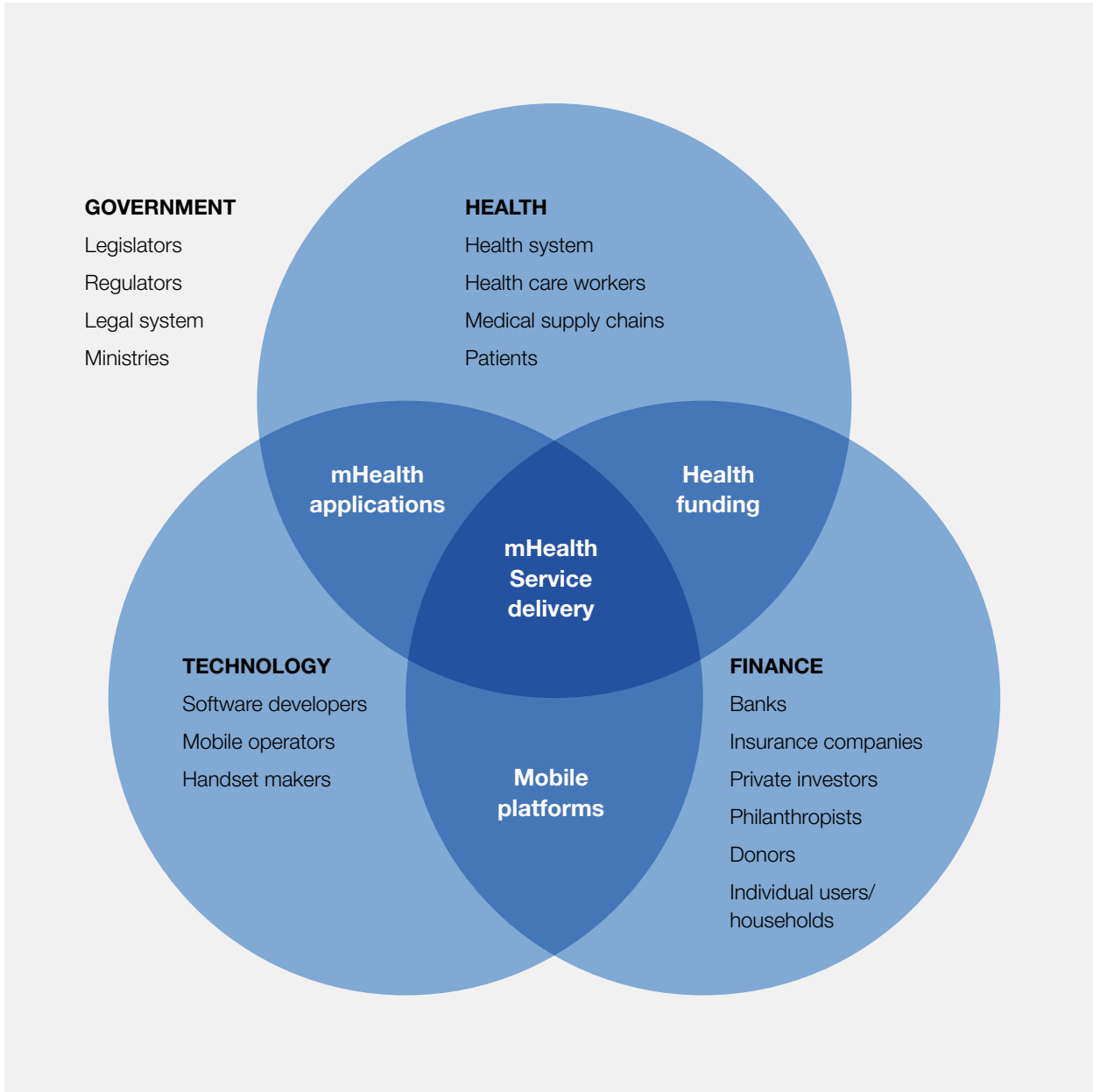
APPENDIX B

List of Key Informants Interviewed

NAME	ORGANIZATION	LOCATION
Martin Were	Regenstrief Institute	Indianapolis/Kenya
Chaitali Sinha	IDRC	Ottawa
Garrett Mehl	WHO	Geneva
Sandhya Rao	USAID	Washington, DC
Alain Labrique	Johns Hopkins School of Public Health	Baltimore
Heather Cole-Lewis	Yale University, Columbia University	Hartford, CT, New York
Marc Mitchell	D-tree International, Harvard School of Public Health	Boston
Annette Ghee	World Vision	Seattle, Washington
Caricia Catalani	University of California, Berkeley, InSTEDD	Palo Alto, CA
Judy Gold (by email)	Marie Stopes International	London
Richard Gakuba	Government of Rwanda	Kigali, Rwanda
Craig Friderichs	GSMA	Cape Town, South Africa
Mwendwa Mwenesi	Government of Tanzania	Dar es Salaam, Tanzania
Camielle Noordam	UNICEF	New York
William Riley	National Institutes of Health	Bethesda, Maryland
Wendy Nilsen	National Institutes of Health	Bethesda, Maryland
Rachel Vreeman	AMPATH-Kenya, Indiana University School of Medicine	Indianapolis, Kenya
Anu Gupta	Johnson & Johnson	New Jersey
Laura Raney	FHI 360, mHealth Working Group	Washington, D.C.
Dianne Sullivan	Vodafone	London
Christopher Grey	Pfizer	New York
Helga Fogstad	Government of Norway	Oslo
Alice Fabiano	Johnson & Johnson	New Jersey
Barbara Mittleman	National Institutes of Health	Bethesda, Maryland
Fredrik Winsnes	NetHope	Seattle, Washington
Nadi Kaonga	Columbia University, Earth Institute	New York

APPENDIX C

mHealth Ecosystem Stakeholders



Source: Dalberg research and analysis

ENDNOTES

1. MNCH was selected as a “use case” for the Needs Assessment and Gaps Analysis primarily because of its prioritization in global health programming. Millennium Development Goals 4 and 5 directly reference maternal and child health and there are a number of major global health initiatives and campaigns targeting maternal and child health such as “*Every Woman Every Child*,” “Global Plan towards the Elimination of New HIV Infections in Children by 2015 and Keeping their Mothers Alive” and “Every Child Deserves a Fifth Birthday.” In addition, Millennium Development Goal 6 (combating HIV, malaria and other Diseases) encompasses maternal and child health.
2. The evidence work of the Alliance is primarily performed through its Evidence Working Group, composed of technical and health specialists working in mHealth around the world, with an interest and expertise in research and evidence generation.
3. For purposes of a survey on mHealth published in 2011, the Global Observatory for eHealth at the World Health Organization defined “mHealth” as “medical and public health practice supported by mobile devices such as mobile phones, patient monitoring devices, personal digital assistants (PDAs) and other wireless devices. *mHealth—New Horizons for Health through Mobile Technologies, Global Observatory for eHealth—Second Global Survey on eHealth*, World Health Organization, 2011.
4. The International Development Coordinating Group (IDCG) has identified “mHealth” as one of the priority issues amenable to a Campbell systematic review and recognizes it as an important topic in the broad field of international development. See http://www.campbellcollaboration.org/ID_Resources/Priority_Topics_in_International_Development.php, (accessed May 3, 2012).
5. See, e.g., A.T. Kearney, *Improving the Evidence for Mobile Health* (GSMA 2012).
6. See <http://healthunbound.org/mama>.
7. See www.mhealthalliance.org/news/press-releases/21-norway-commits-99-million-to-maternal-and-newborn-health.
8. See, e.g., (2012) *Journal of Health Communication: International Perspectives*, 17:sup1 (May).
9. The “Continuum of Care” for reproductive, maternal, newborn and child health (RMNCH) includes integrated service delivery for mothers and children from pre-pregnancy to delivery, the immediate postnatal period, and childhood. Such care is provided by families and communities, through outpatient services, clinics and other health facilities. See www.who.int/pmnch/about/continuum_of_care/en/index.html (accesses June 23, 2012).
10. Noordam, A. C., Kuepper, B. M., Stekelenburg, J. and Milen, A. (2011), “Improvement of maternal health services through the use of mobile phones.” *Tropical Medicine & International Health*, 16: 622–626. doi: 10.1111/j.1365---3156.2011.02747.x; (hereinafter, “Noordam”) Tamrat, T. and Kachnowski, S. (2011). “Special Delivery: An Analysis of mHealth in Maternal and Newborn Health Programs and Their Outcomes Around the World.” *Maternal Child Health Journal*. (hereinafter, “Tamrat and Kachnowski”).
11. Victoria, V. (2011). *mHealth: Saving Lives with Mobile Technology, Mobilizing healthcare to the Most Underserved and Remote Populations*. (unpublished academic paper). George Mason University. Arlington, Virginia.
12. Tamrat and Kachnowski.
13. Id.
14. Id.
15. Id.
16. Id.
17. Id.
18. Id.
19. Id.
20. Id.
21. Kaewkungwal, J., Singhasivanon, P., Khamsiriwatchara, A., Sawang, S., Meankaew, P., & Wechsart, A. (2010). Application of smart phone in “better border healthcare program”: A module for mother and child care. *Medical Informatics and Decision Making*, 10(69), 1–12.
22. Lund S and Hemed M (2010) *Wired mothers: use of mobile phones to improve maternal and neonatal health in Zanzibar*. [Internet]. Copenhagen: University of Copenhagen [cited 2010 Dec 10]. Available from: www.oresund.org/logistics/content/download/74534/429853/file/Ida%20Marie%20Boas_Wired%20Mothers.pdf.
23. Jareethum, R., Titapant, V., Tienthai, C., Vibonchart, S., Chuenwattana, P., & Chatchainoppakhun, J. (2008). Satisfaction of healthy pregnant women receiving short message service via mobile phone for prenatal support: A randomized controlled trial. *Journal Medical Association Thai*, 91(4), 458–463.
24. Mechael, P., & Dodowa Health Research Center. (2009). *MoTech: mHealth ethnography report*. New York: Grameen Foundation.
25. Lund, S. and Hemed M (2010), *Wired Mothers: Use of Mobile Phones to Improve Maternal and Neonatal Health in Zanzibar*. [Internet]. Copenhagen: University of Copenhagen. Available from: <http://mhealthinfo.org/project/wired-mothers>.
26. Kaewkungwal, J., Singhasivanon, P., Khamsiriwatchara, A., Sawang, S., Meankaew, P., & Wechsart, A., (2010). Application of Smart Phone in ‘Better Border Healthcare Program’: A Module for Mother and Child Care. *Medical Informatics and Decision Making* 10(69), 1–12.
27. Jareethum, R., Titapant, V., Thenthai, C., Vibonchart, S., Chuenwattana, P., & Chatchainoppakhun, J. (2008). Satisfaction of Healthy Pregnant Women Receiving Short Message Service Via Mobile Phone for Prenatal Support: A Randomized Controlled Trial. *Journal Medical Association Thai* 91(4), 458–463.

28. Mechael, P., & Dodowa Health Research Center. (2009). *MoTech: mHealth Ethnography Report*. New York: Grameen Foundation.
29. Chib., A. Lwin. M. O., 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), 248–364.
30. Rao, S. (2009). Achieving the Millennium development goals: Role of ICTs innovation in India. *Telematics and Informatics*, 26(2), 127–143.
31. Tamrat and Kachnowski.
32. Id.
33. Id.
34. Id.
35. See, e.g., Cole-Ceesay, R., Cherian, M., Sonko, A., Shivute, N., Cham, M., & Davis, M. (2010). Strengthening the emergency healthcare system for mothers and children in the Gambia. *Reproductive Health Journal*, 7(21), 1–10; Chib, A., Lwin, M. O., 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), 248–364; Musoke M (2002). Maternal health care in rural Uganda: leveraging traditional and modern knowledge systems. *Indigenous Knowledge Notes* 1–4.
36. Noordam.
37. The “Three Delays” model proposes that pregnancy-related mortality is overwhelmingly due to delays in: (1) deciding to seek appropriate medical help for an obstetric emergency; (2) reaching an appropriate obstetric facility; and (3) receiving adequate care when a facility is reached.
See e.g., Barnes-Josiah, D, C Myntti, and A Augustin. 1998, The “Three Delays” as a Framework for Examining Maternal Mortality in Haiti, *Social science medicine*. www.ncbi.nlm.nih.gov/pubmed/9579750.
38. See, e.g., Samai O & Sengeh P (1997) Facilitating emergency obstetric care through transportation and communication, Bo, Sierra Leone. *International Journal of Gynecology & Obstetrics* 59, S157–S164; Musoke MGN (2002) Maternal Health Care in Rural Uganda: Leveraging Traditional and Modern Knowledge Systems. IK Notes No.40, World Bank, Washington DC; Matthews MK & Walley RL (2005) Working with midwives to improve maternal health in rural Ghana. *Canadian Journal of Midwifery Research and Practice* 3, 24–33; Lungu K & Ratsma YEC (2007) Does the upgrading of the radio communications network in health facilities reduce the delay in the referral of obstetric emergencies in Southern Malawi? *Malawi Medical Journal* 19, 1–8; Fournier P, Dumont A, Tourigny C, Dunkley G & Drame’ S (2009) Improved access to comprehensive emergency obstetric care and its effect on institutional maternal mortality in rural Mali. *Bulletin of the World Health Organization* 87, 30–38.
39. See, e.g., Chib A (2010) The Aceh Besar midwives with mobile phones project: Design and evaluation perspective using the information and communication technologies for healthcare development model. *Journal of Computer-Mediated Communication* 15, 500–525; 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, 348–364.
40. Holmes D (2010) Rwanda: an injection of hope. *Lancet* 376, 945–946.
41. Svoronos T, Mjunga D, Dhadialla P et al. (2010) CommCare: Automated Quality Improvement To Strengthen Community-Based Health. Available at: <http://d-tree.org/wp-content/uploads/2010/05/Svoronos-Medinfo-CommCare-safepregnancy1.pdf>.
42. Lund S (2009) Mobile Phones can Save Lives. Profile / Global Health, University of Copenhagen, Copenhagen, 18–19. Available at: www.e-pages.dk/ku/307/18. Lund S (2010a) Wired Mothers—Use of Mobile Phones to Improve Maternal and Neonatal Health in Zanzibar’. *Enreca Health*. Available at: <http://www.enrecahealth.dk/archive/wiredmothers>.
43. Noordam.
44. Id.
45. Mutwiwa, S., Lunze, K., Olum, C., Kasseje, D. (2012). *Progress Report on the Systematic Review: The Effectiveness of Using Mobile Phone-Based Interventions to Accelerate the Three Health MDGs in Low and Middle Income Countries*. (Unpublished Report).
46. Id.
47. Id.
48. Lee, Anne C C, Joy E Lawn, Simon Cousens, Vishwajeet Kumar, David Osrin, Zulfiqar A Bhutta, Steven N Wall, Allyala K Nandakumar, Uzma Syed, and Gary L Darmstadt. 2009. Linking families and facilities for care at birth: What works to avert intrapartum-related deaths? *International journal of gynaecology and obstetrics the official organ of the International Federation of Gynaecology and Obstetrics* 107 Suppl 1, no. Suppl. 1: S65–S85, S86–S88. <http://discovery.ucl.ac.uk/152506>.
49. Kaewkungwal, J., Singhasivanon, P., Khamsiriwatchara, A., Sawang, S., Meankaew, P., & Wechsart, A. (2010). Application of smart phone in “Better Border Healthcare Program”: A module for mother and child care. *BMC Medical Informatics and Decision Making*, 10(1), 69. BioMed Central. Retrieved from <http://www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2989931&tool=pmcentrez&rendertype=abstract>.
50. Cole-Ceesay, R., Cherian, M., Sonko, A., Shivute, N., Cham, M., Davis, M., Fatty, F., et al. (2010). Strengthening the emergency healthcare system for mothers and children in The Gambia. *Reproductive Health*, 7(1), 21. BioMed Central. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2931483&tool=pmcentrez&rendertype=abstract.

51. Otto, K Kate (March 1, 2012) Do m-Health Tools Really Work? Testing The Impact of Mobile Technology on Maternal and Child Health Care data sheet (World Bank) retrieved from: www.mobileactive.org/case-studies/do-m-health-tools-really-work-testing-impact-mobile-technology-maternal-and-child-health.
52. Thomas, J., Rankin, Y., Tuta, M, & Mibuari, E., Proceeding from CHI EA '11 Annual Conference Extended Abstracts on Human Factors in Computing Systems.
53. Donát, J. (2009). Czech model for decrease of maternal mortality in Uganda. *Casopis Lékáru Ceskych*, 148(7), 338–341. Retrieved from www.ncbi.nlm.nih.gov/pubmed/19642302.
54. Ramachandran, D., Canny, J., Das, P. D., & Cutrell, E. (2010). Mobile-izing health workers in rural India. *Proceedings of the 28th international conference on Human factors in computing systems CHI 10*, 1889. ACM Press. Retrieved from <http://portal.acm.org/citation.cfm?doid=1753326.1753610>.
55. Valez, O. (2011) *Design and Usability Testing of an mHealth Application for Midwives in Rural Ghana* (Unpublished doctoral dissertation). Columbia University, New York.
56. Ngoma, C., Chawani, M.S. & Herstad, J. (2011) in E-INFRASTRUCTURES AND E-SERVICES FOR DEVELOPING COUNTRIES.
Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, 2011, Volume 64, Part 3, 79–92, DOI: 10.1007/978-3-642-23828-4_8.
57. Danell, I.; Grahamll, W.J.; Boermal T. (2011) *Maternal Death Surveillance and Response*, Bull World Health Organ vol.89 no.11 Geneva Nov. 2011 <http://dx.doi.org/10.1590/S0042-96862011001100003>.
58. Blaschke, S., Bokenkamp, K. Cosmaciuc, R., Denby, M. Hailu, B. & Short, R. (2009). Using Mobile Phones to Improve Child Nutrition Surveillance in Malawi. UNICEF. New York.
59. Gisore, P. Shipala, E., Otieno, K., Rono, B., Marete, I., Tenge, C. Mabeya, M., Bucher, S., Moore, J., Liechty, E. & Esamai, F. (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*. BMC Pregnancy and Childbirth 2012, 12:15 doi:10.1186/1471-2393-12-1.
60. Andreatta, P., Debpuur, D., Danquah, A., & Perosky, J. (2011). Using cell phones to collect postpartum hemorrhage outcome data in rural Ghana. *International journal of gynaecology and obstetrics the official organ of the International Federation of Gynaecology and Obstetrics*, 113(2), 148–151. International Federation of Gynecology and Obstetrics. Retrieved from www.ncbi.nlm.nih.gov/pubmed/21420086.
61. Rotheram-Borus, M.-J., Richter, L., Van Rooyen, H., Van Heerden, A., Tomlinson, M., Stein, A., Rochat, T., et al. (2011). Project Masihambisane: a cluster randomised controlled trial with peer mentors to improve outcomes for pregnant mothers living with HIV. *Trials*, 12(1), 2. BioMed Central. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3022743&tool=pmcentrez&rendertype=abstract.
62. Id.
63. Otto, K Kate (March 1, 2012) Do m-Health Tools Really Work? Testing The Impact of Mobile Technology on Maternal and Child Health Care data sheet (World Bank) retrieved from: www.mobileactive.org/case-studies/do-m-health-tools-really-work-testing-impact-mobile-technology-maternal-and-child-health.
64. Ibembe, J.D.B. (2011). *Mobile Phone Use and Reproductive Health Care in Nakuru Provincial Hospital, Kenya*. (Unpublished thesis) Örebro University, Örebro, Sweden.
65. Valez, O. (2011) *Design and Usability Testing of an mHealth Application for Midwives in Rural Ghana* (Unpublished doctoral dissertation). Columbia University, New York.
66. Ramachandran, D., Canny, J., Das, P. D., & Cutrell, E. (2010). Mobile-izing health workers in rural India. *Proceedings of the 28th international conference on Human factors in computing systems CHI 10*, 1889. ACM Press. Retrieved from <http://portal.acm.org/citation.cfm?doid=1753326.1753610>.
67. *Improving Client Retention in the PMTCT Cascade through Active Client Follow-Up (ACFU)* (2011). <http://maternalhealthtaskforce.org/discuss/wpblog/2012/01/19/mothers2mothers-report-improving-client-retention-in-the-pmtct-cascade-through-active-client-follow-up-acfu/>.
68. Walker, L. O., Im, E.-O. and Vaughan, M. W. (2012), Communication Technologies and Maternal Interest in Health-Promotion Information about Postpartum Weight and Parenting Practices. *Journal of Obstetric, Gynecologic, & Neonatal Nursing*, 41: 201–215. doi: 10.1111/j.1552-6909.2011.01333.x.
69. Cole-Ceesay, R., Cherian, M., Sonko, A., Shivute, N., Cham, M., & Davis, M. (2010). Strengthening the emergency healthcare system for mothers and children in the Gambia. *Reproductive Health Journal*, 7(21), 1–10.
70. Otto, K Kate (March 1, 2012) Do m-Health Tools Really Work? Testing The Impact of Mobile Technology on Maternal and Child Health Care data sheet (World Bank) retrieved from: www.mobileactive.org/case-studies/do-m-health-tools-really-work-testing-impact-mobile-technology-maternal-and-child-health. Kaewkungwal, J., Singhasivanon, P., Khamsiriwathchara, A., Sawang, S., Meankaew, P., & Wechsart, A. (2010). Application of smart phone in “better border healthcare program”: A module for mother and child care. *Medical Informatics and Decision Making*, 10(69), 1–12.
71. Jareethum, R., Titapant, V., Chantra, T., Sommai, V., Chuenwattana, P., & Jirawan, C. (2008). Satisfaction of healthy pregnant women receiving short message service via mobile phone for prenatal support: A randomized controlled trial. *Journal of the Medical Association of Thailand Chotmaihet thangphaet*. Retrieved from www.ncbi.nlm.nih.gov/pubmed/18556852.
72. Lavender, T., Richens, Y., Sj, M., & Rmd, S. (2011). Telephone support for women during pregnancy and the first six weeks postpartum (Protocol). *Midwifery*, (10).
73. Jareethum, R., Titapant, V., Chantra, T., Sommai, V., Chuenwattana, P., & Jirawan, C. (2008). Satisfaction of

- healthy pregnant women receiving short message service via mobile phone for prenatal support: A randomized controlled trial. *Journal of the Medical Association of Thailand Chotmai het thangphaet*. Retrieved from www.ncbi.nlm.nih.gov/pubmed/18556852.
74. Monteiro, S. M., Jancey, J., Howat, P., Burns, S., Jones, C., Dhaliwal, S. S., McManus, A., et al. (2011). The protocol of a randomized controlled trial for playgroup mothers: Reminder on Food, Relaxation, Exercise, and Support for Health (REFRESH) Program. *BMC Public Health*, 11, 648. BioMed Central. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3166931&tool=pmcentrez&rendertype=abstract.
 75. Kaewkungwal, J., Singhasivanon, P., Khamsiriwatchara, A., Sawang, S., Meankaew, P., & Wechsart, A. (2010). Application of smart phone in "Better Border Healthcare Program": A module for mother and child care. *BMC Medical Informatics and Decision Making*, 10(1), 69. BioMed Central. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2989931&tool=pmcentrez&rendertype=abstract.
 76. Tezcan, B., Von Rege, I., Henkson, H., & Oteng-Ntim, E. (2011). Unified communication to reach vulnerable mothers. *Journal of obstetrics and gynaecology the journal of the Institute of Obstetrics and Gynaecology*, 31(2), 122–124.
 77. Ramachandran, D., Canny, J., Das, P. D., & Cutrell, E. (2010). Mobile-izing health workers in rural India. *Proceedings of the 28th international conference on Human factors in computing systems CHI 10*, 1889. ACM Press. Retrieved from <http://portal.acm.org/citation.cfm?doid=1753326.1753610>.
 78. Chib, A. (2010). The Aceh Besar midwives with mobile phones project: Design and evaluation perspectives using the information and communication technologies for healthcare development model. *Journal of Computer-Mediated Communication*, 15: 500–525. doi: 10.1111/j.1083-6101.2010.01515.x.
 79. Thomas, J., Rankin, Y., Tuta, M., & Mibuari, E., Proceeding from CHI EA '11 Annual Conference Extended Abstracts on Human Factors in Computing Systems.
 80. Flynn-Dapaah, K., RASHID, A. Gender digital equality in ICT interventions in health: Evidence from IDRC supported projects in developing countries. *The Journal of Community Informatics*, North America, 5, may. 2010. Available at: www.ci-journal.net/index.php/ciej/article/view/526/512. Date accessed: 24 Apr. 2012.
 81. Andreatta, P., Debpur, D., Danquah, A., & Perosky, J. (2011). Using cell phones to collect postpartum hemorrhage outcome data in rural Ghana. *International journal of gynaecology and obstetrics the official organ of the International Federation of Gynaecology and Obstetrics*, 113(2), 148–151. International Federation of Gynecology and Obstetrics. Retrieved from www.ncbi.nlm.nih.gov/pubmed/21420086.
 82. Zurovac, D., Sudoi, R. K., Akhwale, W. S., Ndiritu, M., Hamer, D. H., Rowe, A. K., & Snow, R. W. (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. Elsevier Ltd. Retrieved from www.ncbi.nlm.nih.gov/pubmed/21820166.
 83. Mitchell, M., Getchell M, Nkaka M, Msellemu D, Van Esch J, Hedt-Gauthier B. (2012). Perceived improvement in integrated management of childhood illness implementation through use of mobile technology: Qualitative evidence from a pilot study in Tanzania. *Journal of Health Communication: International Perspectives*, 17, 118–127. doi: 10.1080/10810730.2011.649105.
 84. Mitchell et al.
 85. Marie Stopes International. (2011). N. Corby (ed). *Using Mobile Finance to Reimburse Sexual and Reproductive Health Vouchers in Madagascar*. Retrieved from: www.eldis.org/go/display&type=Document&id=59374?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+eldis-ict+%28Eldis+ICT+for+Development%29.
 86. Seidenberg, P., Nicholson, S., Schaefer, M., Semrau, K., Bweupe, M., Masese, N., Bonawitz, R., Chitembo, L., Goggin C., & Theaa, D., (2012). Early infant diagnosis of HIV infection in Zambia through Mobile Phone Texting of Blood Test Results, *Bull World Health Organ* 2012;90:348–356 | doi:10.2471/BLT.11.100032.
 87. Leveraging Mobile Technologies to Promote Maternal and Newborn Health: The Current Landscape and Opportunities for Advancement in Low Resource Settings. (mHealth Alliance 2012). (hereinafter, "PHI").
 88. Id.
 89. Id.
 90. Email correspondence from Judy Gold. Marie Stopes International. May 17, 2012.
 91. Blascke, D., Bokenkamp, K., Cosmaciuc, R., Denby, M., Hailu B., Short, R. (2009). Using Mobile Phones to Improve Child Nutrition Surveillance in Malawi: UNICEF Malawi and UNICEF Innovations. Retrieved from: mobileactive.org/files/file_uploads/unicef_Malawi_CNS.pdf.
 92. Noordam.
 93. PHI.
 94. Id.
 95. *Countdown to 2015: Taking Stock of Maternal, Newborn and Child Survival, 2000–2010 Decade Report*. (2010).
 96. Id.
 97. Email correspondence from Caricia Catalani, April 2, 2012.
 98. Lester, R. T., Ritvo, P., Mills, E. J., Kariri, A., Karanja, S., Chung, M. H., Jack, W., et al. (2010). Effects of a mobile phone short message service on antiretroviral treatment adherence in Kenya (WelTel Kenya1): a randomised trial. *Lancet*, 376(9755), 1838–1845. Elsevier Ltd. Retrieved from www.ncbi.nlm.nih.gov/pubmed/21071074.
 99. Surkan, P. J., Kennedy, C. E., Hurley, K. M., & Black, M. M. (2011). Maternal depression and early childhood growth in developing countries: systematic review and meta-analysis. *Bulletin of the World Health Organization*,

- 89(8), 608–615E. World Health Organization. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3150769&tool=pmcentrez&rendertype=abstract.
100. Rotheram-Borus, M.-J., Richter, L., Van Rooyen, H., Van Heerden, A., Tomlinson, M., Stein, A., Rochat, T., et al. (2011). Project Masihambisane: a cluster randomised controlled trial with peer mentors to improve outcomes for pregnant mothers living with HIV. *Trials*, 12(1), 2. BioMed Central. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=3022743&tool=pmcentrez&rendertype=abstract.
101. Mechael, P. (2005). Case Study From Egypt: Mobile phones for mother and child care. *i4d The first monthly magazine on ICT4D*, 2006(April 10), 3–5. I4D: Information for Development. Retrieved from www.i4donline.net/May05/casestudyegypt_full.asp.
102. Igarashi, T., *Social networks formed through mobile phone text-message and their effects on psychological well-being: Focusing on social capital approached from micro-, dyad-, and meso-levels*. (Unpublished dissertation). Retrieved from: tasukuigarashi.com/PDF/article/dissertation_summary.pdf.
103. *Unmet Needs: Improving mHealth Evaluation Rigor to Build the Evidence Base* (2012). (unpublished report).
104. Id.
105. Id.
106. Id.
107. Id.
108. Id.
109. Id.
110. Id.
111. Gulas, C.A., Mehl, G., Labrique, A. (2012) *INFORM: Implementation and Evaluation Framework for mHealth, a framework for expanding the mHealth evidence base and providing implementation and evaluation guidance for mHealth projects worldwide*. (unpublished article).
112. Sundewall, J., Swanson, R. C., Betigeri, A., Sanders, D., Collins, T. E., Shakarishvili, G., & Brugha, R. (2011). Health-systems strengthening: current and future activities. *Lancet*, 377(9773), 1222–1223. Elsevier Ltd. Retrieved from <http://linkinghub.elsevier.com/retrieve/pii/S0140673610606794>.
113. Marchal, B., Cavalli, A., & Kegels, G. (2009). Global health actors claim to support health system strengthening: is this reality or rhetoric? (D. Thierens, Ed.) *PLoS Medicine*, 6(4), e1000059. Public Library of Science. Retrieved from www.pubmedcentral.nih.gov/articlerender.fcgi?artid=2667637&tool=pmcentrez&rendertype=abstract.
114. Global Action for Health System Strengthening. (2009). Task Force on Global Action for Health System Strengthening. Retrieved from: www.jcie.org.
115. Community Systems Strengthening Framework. (2011). Global Fund. www.theglobalfund.org/en/civilsociety/reports.
116. See, e.g., Anjali, S., "Pathways and Chains: Strategy and Process Mapping for Healthcare Delivery," Global Health at MIT (blog), Feb. 23, 2011. Retrieved from: <http://globalhealth.mit.edu/home/value-chain/>.
117. Gamble, J. E., Savage, G. T., & Icenogle, M. L. (2004). Value-chain analysis of a rural health program: toward understanding the cost benefit of telemedicine applications. *Hospital Topics*, 82(1), 10–17. Retrieved from www.ncbi.nlm.nih.gov/pubmed/15490956.
118. Treatman, D., Lesh, N. (2012). Strengthening Community Health Systems with Localized Multimedia. Retrieved from: www.asc.upenn.edu.
119. B. DeRenzi, G. Borriello, J. Jackson, V.S. Kumar, T.S. Parikh, P. Virk, and N. Lesh, "Mobile Phone Tools for Field-Based Health care Workers in Low-Income Countries," *Mount Sinai Journal of Medicine: A Journal of Translational and Personalized Medicine*, vol. 78, May, 2011, pp. 406–418.
120. See, e.g., www.healthsystems2020.org; www.theglobalfund.org/en/performance/effectiveness/hss; www.dfid.gov.uk/What-we-do/Key-Issues/Health/Strengthening-health-systems.
121. World Health Organization. (2010). *Monitoring the building blocks of health systems: a handbook of indicators and their measurement strategies*. Retrieved from: www.who.int/healthinfo/systems/monitoring/en/index.html.
122. See, e.g., DeRenzi, B., Birnbaum, B., Findlater, L., Mangilima, J., Payne, J., Parikh, T., Borriello, G., et al. (2012). Improving Community Health Worker Performance Through Automated SMS. *Context*, 25. ACM Press. Retrieved from <http://dl.acm.org/citation.cfm?doi=2160673.2160677>.
123. Handbook IMCI Integrated Management Childhood Illnesses. (2005). WHO/UNICEF. Retrieved from: www.who.int/maternal_child_adolescent/documents/9241546441/en/index.html.
124. Integrating Prevention of Mother-to-Child Transmission of HIV Interventions with Maternal, Newborn, and Child Health Services Technical Brief. (2011). AIDSTAR-One. USAID. Retrieved from: www.aidstar-one.com/focus_areas/pmtct/resources/technical_briefs/integrating_pmtct_mnch_services.
125. The Essential Package: Holistically Addressing the Needs of Young Vulnerable Children and Their Caregivers Affected by HIV and AIDS. (2012). Retrieved from: www.ovcsupport.net/s/library.php?id=1154.
126. 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. *Health San Francisco*. International Medical Informatics Association. Retrieved from <http://icohere-presentations.com/presentations/SHOPS2010/tSvoronos/player.html>.
127. Mitchell, M., Getchell M, Nkaka M, Msellemu D, Van Esch J, Hedt-Gauthier B. (2012). Perceived improvement in integrated management of childhood illness implementation through use of mobile technology: Qualitative evidence from a pilot study in Tanzania. *Journal of Health Communication: International Perspectives*, 17, 118–127. doi: 10.1080/10810730.2011.649105.
128. Marie Stopes International. (2011). N. Corby (ed). *Using Mobile Finance to Reimburse Sexual and Reproductive*

- Health Vouchers in Madagascar*. Retrieved from: www.eldis.org/go/display&type=Document&id=59374?utm_source=feedburner&utm_medium=feed&utm_campaign=Feed%3A+eldis-ict+%28Eldis+ICT+for+Development%29.
129. Mobile Technology for Monitoring Vouchers. (2012). RHVouchers.org. Retrieved from www.rhvouchers.org/media/2012/mobile-technology-for-monitoring-vouchers.
 130. Padian, N. S., Holmes, C. B., McCoy, S. I., Lyerla, R., Bouey, P. D., & Goosby, E. P. (2010). Implementation Science for PEPFAR. *Journal of Acquired Immune Deficiency Syndromes*. Retrieved from www.ncbi.nlm.nih.gov/pubmed/21242234.
 131. See, e.g., Eccles, M. P., Armstrong, D., Baker, R., Cleary, K., Davies, H., Davies, S., Glasziou, P., et al. (2009). An implementation research agenda. *Implementation science IS*, 4(18), 18. BioMed Central. Retrieved from <http://dx.doi.org/10.1186/1748-5908-4-18>.
 132. te Boveldt N, Engels Y, Besse K, Vissers K, Vernooij-Dassen M. (2011) Rationale, design, and implementation protocol of the Dutch clinical practice guideline pain in patients with cancer: a cluster randomised controlled trial with Short Message Service (SMS) and Interactive Voice Response (IVR). *Implement Sci*. 6:126.
 133. Baker, U., Tomson, G., Some, M., Kouyate, B., Williams, J., Mpembeni, R., Massawe, S., et al. (2012). "How to know what you need to do": a cross-country comparison of maternal health guidelines in Burkina Faso, Ghana and Tanzania. *Implementation Science*, 7(1), 31. Retrieved from www.implementationscience.com/content/7/1/31.
 134. See, e.g., www.who.int/social_determinants/en; www.cdc.gov/socialdeterminants; www.acdi-cida.gc.ca/acdi-cida/ACDI-CIDA.nsf/eng/FRA-61882334-GJT; www.regjeringen.no/en/dep/hod/Whats-new/News/2011/new-norwegian-public-health-act--institutt.html?id=660492; Marmot, M. (2005). Social determinants of health inequalities. *Lancet*, 365(9464), 1099–1104. Elsevier. Retrieved from <http://discovery.ucl.ac.uk/676>.
 135. www.mwomen.org.
 136. U.S. National Institute of Health. (2012). ClinicalTrials.gov. Retrieved from: <http://clinicaltrials.gov/ct2/show/NCT01433185?term=%22mobile+phones%22&rank=60>.
 137. Skype Conversation with Dr. Thomas Odeny, Fogarty International Research Fellow, Kisumu, Kenya, June 29, 2012.
 138. Id.
 139. Id.
 140. Seidenberg, P., Nicholson, S., Schaefer, M., Semrau, K., Bweupe, M., Masese, N., Bonawitz, R., Chitembo, L., Goggin C., & Theaa, D., (2012). Early infant diagnosis of HIV infection in Zambia through Mobile Phone Texting of Blood Test Results, *Bull World Health Organ* 2012;90:348–356 | doi:10.2471/BLT.11.100032.
 141. U.S. National Institute of Health. (2012). ClinicalTrials.gov. Retrieved from: <http://clinicaltrials.gov/ct2/show/NCT01140633?term=%22mobile+phones%22&rank=56>.
 142. U.S. National Institute of Health. (2012). ClinicalTrials.gov. Retrieved from: <http://clinicaltrials.gov/ct2/show/NCT01383070?term=%22cellular+phones%22+breastfeeding&rank=1>.
 143. U.S. National Institute of Health. (2012). ClinicalTrials.gov. Retrieved from: <http://clinicaltrials.gov/ct2/show/NCT01385410?term=%22cellular+phones%22+breastfeeding&rank=2>.
 144. U.S. National Institute of Health. (2012). ClinicalTrials.gov. Retrieved from: <http://clinicaltrials.gov/ct2/show/NCT01157442?term=PMTCT&rank=4>.
 145. deTolly, K., Technau, K., Benjamin, P., Cell-Life Research Poster, "Helping HIV+ Mothers Protect their Babies: Improving Follow-up and HIV Testing Rates of Exposed Infants through SMS."
 146. Id.
 147. Skype conversation with Katherine de Tolly, Cell-Life, Cape Town, South Africa, June 29, 2012.
 148. Id.
 149. Personal Communication Attachments, Adaku Eliogu. May 23, 2012.
 150. Personal Communication. Shamik Trehan. April 10, 2012.
 151. Johns Hopkins University. (2102). Global mHealth Initiative. (2012) Retrieved from: sites.google.com/site/jhumhealth/project-overviews.
 152. Grameen Foundation. (2011). *Mobile Technology for Community Health in Ghana*. Retrieved from: www.grameenfoundation.org/what-we-do/technology/mobile-health.
 153. FHI 360. (2012). *The m4RH Information Service in Kenya and Tanzania*. Retrieved from: www.fhi360.org/en/Research/Projects/Progress/GTL/mobile_tech.htm.
 154. Bangser, M. Engender Health. 2011, Making Mobile Phones Work for Women with Fistula: The M-PESA Experience in Kenya and Tanzania. EngenderHealth Briefing, Retrieved from: www.fistulacare.org/pages/pdf/technical-briefs/mobile_phone_brief_updated4.5.2011.pdf.
 155. Email Correspondence from Nadi Kaonga, June 25, 2012, summarizing the research protocol for the OASIS II Research Project evaluating MVG-Net.
 156. Afya Research Africa. (2012). *The m-Afya Project*. Retrieved from: <http://afyaresearch.org/research/mafya>.



The mHealth Alliance champions the use of mobile technologies to improve health throughout the world. Working with diverse partners to integrate mHealth into multiple sectors, the Alliance serves as a convener for the mHealth community. The mHealth Alliance also hosts Health Unbound (HUB), a global online community for resource sharing and collaborative solution generation. For more information, visit mHealthAlliance.org.