UNIVERSITY OF RWANDA

Evaluating the Impact of RapidSMS: Final Report

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List of Acronyms

ANC: Antenatal Care
CHW: Community Health Worker
DHU: District Health Unit
EDPRS: Economic Development and Poverty Reduction Strategy
FGD: Focus Group Discussion
HC: Health Center
HMIS: Health Management Information System
IDI: In-depth Interview
ITS: Interrupted Time Series Analysis
KII: Key Informant Interview
KOICA: Korea International Cooperation Agency
MDG: Millennium Development Goals
MoH: Ministry of Health
PBF: Performance-based Financing
PNC: Postnatal Care
RBC: Rwanda Biomedical Center
SDG: Sustainable Development Goals

Executive Summary

With the adoption of the Millennium Development Goals (MDGs) in 2000, especially MDGS 4 and 5, the world has witnessed an accelerated reduction in both under-five and maternal mortality. In 2014, Rwanda was among 10 low and middle income (one of only two countries in the sub-Saharan region) with a high maternal and child mortality burden that in 2012 were on track to achieve MDGs 4 and 5a. This success has resulted from the use of several programs to improve maternal and child health in the country.

One of the strategies that Rwanda employed over this time period was the use of an mHealth system called RapidSMS. The platform was implemented to facilitate communication between Community Health Workers (CHWs) and the broader health system, including the ambulance system, health facilities, and the central government. As part of this program, CHWs were equipped with mobile phones that enabled them to collect and use real-time data on key maternal, neonatal, and child health indicators. This was collected during the first 1000 days of life: from the start of pregnancy until 2 years of age.

The RapidSMS system was first piloted in Musanze District starting in 2009, then scaled-up nationwide starting in 2013. A pilot study found an increase in the proportion of births taking place in a health facility in the district.[1] After completing this pilot, in addition to scaling up the RapidSMS program nationwide, UNICEF provided additional support in 10 Districts, including CHW training and quarterly supervision meetings, the provision of essential equipment to health facilities, and community nutrition initiatives.

Through a stakeholder engagement session and qualitative interviews, we considered three mechanisms through which RapidSMS could have influenced maternal and child health. The first was the RED Alert notification system that could have led to a decreased response time and earlier intervention in emergency situations. Second, through improved tracking of pregnancies, newborns, and children, we hypothesized that RapidSMS could have impacted processes of care including the number of ANC visits, and the proportion of deliveries that took place in health care facilities. Similarly, better tracking of newborns through the first 1,000 days of life could have resulted in increased PNC visit rates and follow-up visit rates, allowing the earlier identification of issues that might have led to infant mortality and child mortality. Finally, the improved data on maternal and child health services could have led to more informed decision-making by policymakers.

This study used longitudinal quantitative data and comprehensive qualitative interviews to evaluate the impact of the RapidSMS program on a number of key indicators and outcomes. Our mixed methods approach assessed the relevance, effectiveness, impact, efficiency, equity, and sustainability of the RapidSMS program. Our quantitative analysis used program data from RapidSMS, along with administrative health data from Rwanda's Health Management Information System (HMIS) between January 2012 and June 2016. We used Interrupted Time Series Analysis (ITS), one of the strongest quasi-experimental research designs, to study longitudinal changes in several outcomes of interest. Our qualitative study leveraged key informant interviews from stakeholders and program recipients along with focus groups of CHWs, mothers, and fathers, in 4 Districts (Ngororero, Nyanza, Gasabo, and Ngoma). All interviews and focus groups were conducted using a semi-structured interview guide, were transcribed, and were coded using ATLAS.TI software. Finally, we also reviewed all available program manuals and documents made available to us.

In terms of program use, we found that over the course of the study period, CHWs sent more than 9.3 million text messages, most commonly for community-based nutrition and child health visits. In terms of completeness, it appears that RapidSMS is only capturing a portion of births: compared to

HMIS and Census estimates, only about 56% of births were recorded using RapidSMS. This varied substantially by district, with UNICEF supported districts showing much higher rates. The overall rate of message use was similar in UNICEF supported Districts and other districts. The use of RED Alert emergency messages was low, which may have been driven in part by the fact that CHWs reported ambulances not responding more often than they came.

Our quantitative analysis found little impact of the start of RapidSMS use in health centers on most antenatal care outcomes, including registrations, 1st trimester visits, and the number of mothers completing 4 standard visits. In contrast, we did find an impact on facility delivery rates, with UNICEF supported districts showing an 18% increase at one year over what would have been expected based on existing trends. However, we found no evidence of such a change in non-supported districts. Similarly, we found increases in postnatal care registration, visit numbers, malnutrition screening, and immunizations delivered in UNICEF supported districts; for example, a 100% increase at 1 year in total postnatal care visits. However, we found either smaller on non-existent changes in these same indicators in non-supported districts. Unfortunately, unanticipated data quality issues precluded our ability to rigorously assess the impact of the program on maternal or neonatal mortality.

Our interviews showed broad support for the RapidSMS program, and a widespread belief that the program is improving maternal and child health care and outcomes. Participants shared the program objectives are well-aligned with District, national, and international targets, and that it has reached most of the intended beneficiaries. Most respondents felt the financial and human resources dedicated to the program were sufficient to ensure its effective operation. However, program sustainability was a concern given the ongoing dependence on funding from developing partners.

Taken as a whole, our analysis suggests that RapidSMS has made contributions to particular areas of maternal and child health. This was largely limited, however, to Districts that also received additional support from UNICEF. We also found room for improvement in several aspects of program focus and operation. In terms of suggested improvements to the system, both our qualitative and quantitative analyses led to several recommendations, including the following:

1. Refocus and target specific areas for health care improvement, whether this is a focus on increasing a particular type of care or facility delivery rates.
2. Develop a long-term sustainability plan for both funding and management of the program.
3. Consider expanding the use of other UNICEF support programs in non-supported Districts, as the impact of RapidSMS is muted in other Districts.
4. Improve data validation in the system, particularly for biometric measures.
5. Study the possibility of directly messaging beneficiaries to increase program impact and reduce CHW workload.
6. Ensure that CHWs have access to functional phone equipment, and the ability to charge it.
7. Refine the Red Alert system to facilitate it's use by CHWs.
8. Improve training programs, particularly for new CHWs and in non-supported districts.
9. Take measures to increase the motivation of CHWs, who find the system increases their workload. This could take the form of training, or financial remuneration.
10. Ensure CHWs have access to the necessary equipment to perform biometric measurements.
11. Provide access and training to health providers on using RapidSMS data.

Introduction and Program Description

Globally, by 2015, both infant mortality and maternal mortality had dropped dramatically; infant mortality dropped from 86 to 32 deaths per 1,000 live births between 2005 and 2014/15 and maternal mortality declined from 750 per 100,000 live births to 210 over the same time period.[2] With the adoption of the Millennium Development Goals (MDGs) in 2000, especially MDGS 4 and 5, the world has witnessed an accelerated reduction in both under-five and maternal mortality; in sub-Saharan Africa, the annual rate of reduction of under-five mortality was over five times faster during 2005–2013 than it was during 1990–1995.

In 2014, Rwanda was among 10 low and middle income—and one of only two countries in the sub-Saharan region—with a high maternal and child mortality burden that in 2012 were on track to achieve MDGs 4 and 5a. It is important to note that by 2014, Rwanda had already achieved MDG 4.[3,4] Although this rate of improvement is notable, the Rwandan government aims at decreasing these rates to reach their Economic Development and Poverty Reduction Strategy (EDPRS) 2, the Vision 2020 goals, as well as Sustainable Development Goals (SDG), in particular SDG 10.[5]

Rwanda's success has likely stemmed from a number of innovative initiatives that have been implemented, including task shifting , the provision of health insurance, the use of performance-based finance (PBF) to health care providers and community health workers (CHWs), and the initiation and use of innovative health information systems for rapid and reliable decision-making.[4] According to the academic literature, when equipped with mobile devices, CHWs can become capable collectors of complete, high quality, and timely data from the field. More specifically, prior studies have suggested that compared to paper-based data collection, data collected by CHWs using mHealth tools had fewer errors and less missing data.[6] Further, these mobile tools can enable real-time quality review and analysis for decision-making, as well as rapid response to cited health issues.

With the increasing penetration of mobile phones, there has been a rising interest in so-called mHealth programs to improve maternal and child health. As more than 95% of the global population have access to mobile technology (46% in Africa), mHealth has considerable potential in settings with limited infrastructure and human resources.[7,8] These initiatives have aimed to use mobile technology to promote behavior change, collect data, improve financial communication, manage logistics, and improve service delivery. These programs have become widespread, and more than half of the mHealth projects implemented to date in Africa to date have been in the area of maternal, newborn, and child health.[9] For example, promising results from a randomized control trial found that an mHealth intervention improved the percentage of pregnant women who attended four ANC visits and improved skilled birth attendance in urban areas.[10,11]

Among these initiatives, one of the strategies that Rwanda has employed in the effort to reduce maternal and child death is the use of mHealth system called RapidSMS.[1] RapidSMS is a free and open source platform for mobile system built in Python and Django, which was customized for application to maternal and child health in Rwanda. The platform was implemented to facilitate communication between CHWs and the ambulance system, health facilities staff, and the central government. These health workers, the lowest level of service delivery at the community level, offer preventive and basic curative services at village level. They are intended to be the first point of contact with the health system for the population and to create a liaison between community health services and health facilities. Each village has an elected CHW who is charged with maternal and child health.

As part of RapidSMS, CHWs in Rwanda were equipped with mobile phones to enable them to collect and use real-time data on key maternal, neonatal and child health indicators. This is collected during

the first 1000 days of life (pregnancy until birth, and newborn until 2 years), and includes a broad range of areas: antenatal care, delivery, post-natal care, growth monitoring, as well as death indicators such as maternal and neonatal and child mortality. The real-time indicators are recorded using RapidSMS. The system then generates automatic reminders for clinical appointments, delivery, and post-natal care visits, with the intent of increasing attendance at antenatal care and postnatal care visits. Additional intended outcomes include the provision of a quick link to emergency obstetric care through so-called Red Alerts, and the creation of a database of clinical records on maternal care delivery.[1] The RapidSMS system was first piloted in Musanze District starting in 2009, then scaled-up nationwide starting in 2013. At present, the system is actively available and used across all Districts in the country.

Despite being in place for several years, no rigorous and comprehensive evaluation has been conducted in Rwanda to assess its impact on access to and use of health care services and health outcomes. A pilot study found an increase in the proportion of births taking place in a health facility in one district.[1] More broadly, a recent systematic review has also questioned the methodological quality of much of the existing research on mHealth programs.[12,13] As a result, there is little real-world knowledge on the impact of mHealth programs both within Africa and internationally. Therefore, we used longitudinal data and comprehensive qualitative interviews to evaluate the impact of the RapidSMS program on a number of key indicators and outcomes.

The role of UNICEF and the Government of Korea

In their role as developing partners, both UNICEF and the Government of Korea through the Korea International Cooperation Agency (KOICA) provided assistance for the RapidSMS program. While the Rwanda Ministry of Health provided the overall strategic direction and budget allocations, UNICEF and KOICA were involved in providing funding, technical support, maintenance assistance, and capacity development for the RapidSMS system.[14]

It is important to note that the funding for the nationwide scale-up of RapidSMS was included in a larger proposal aimed at improving maternal and child health outcomes in Rwanda funded by KOICA. This further assistance was directed at 10 selected districts shown in Figure 1: The UNICEF-supported districts included Musanze, Nyaruguru, Bugesera, Kamonyi, Ngororero, Nyabihu, Nyamagabe, Nyanza, Rubavu, and Rwamagana.

Figure 1. Map of UNICEF supported Districts

This additional support included the following items:

1. Community-based initiatives to improve maternal and newborn care: staff were deployed in each of the 10 districts to facilitate the implementation and use of RapidSMS. This included refresher training of CHWs in home-based care, quarterly supervision and management to follow maternal and newborn care, and health center visits. The quarterly supervision meetings involved reviewing performance, determining what needed to be improved, and planning for the coming quarter. Finally, this part of the support included community outreach through CHWs, the inter-faith forum, and community radio stations to increase the understanding of and participation in maternal and child health services.

2. Institutional capacity building: this included the provision of essential equipment for treating newborns to health facilities and health centers. This included CPAP machines and seringue pumps for the District Hospitals, and radiant warmers, bed nets, ambu bag masks, and suction devices for all District Hospitals and all health centers. Further, it included quarterly supervision and monitoring meetings with health workers to increase performance, emphasizing the use of RapidSMS to plan for deliveries, training of health works to build skills for newborn services, and the provision of a technical assistance consultant in maternal and newborn health. Solar chargers were also provided in a selection of districts.

While these services are beyond the scope of this evaluation, it is important to place RapidSMS in a context where these initiatives were being undertaken contemporaneously in some Districts.

Purpose of this Evaluation

This evaluation was commissioned by UNICEF and the Ministry of Health to assess the progress and impact of the RapidSMS system in Rwanda over the first three years after it had been nationally scaled-up.

Theory of Change

As a program intended to improve the quality of care for pregnant mothers and children, we have grounded our analysis in an appropriate Theory of Change.[15] In this approach, the pathway from programs to long-term impacts is explicitly traced out, including the specific statement of hypotheses and assumptions that are made in program linkages. The pathway includes (1) the resources that were used by the RapidSMS program, (2) the activities undertaken as part of the program, (3) the outputs produced by these activities, (4) the short- and medium-term outcomes resulting from these activities, and (5) the long-term impacts envisioned for the program on maternal, infant, and child morbidity and mortality.

As shown in Figure 2, we conceptualized three major pathways through which the outputs of the RapidSMS program could have resulted in the intended program impacts. The first is the RED Alert notification system that could have led to a decreased response time and earlier intervention in emergency situations. Second, through improved tracking of pregnancies, newborns, and children, we hypothesized that RapidSMS could have impacted processes of care including the number of ANC visits, the proportion of deliveries that took place in health care facilities, and other child health outcomes. Similarly, better tracking of newborns through the first 1,000 days of life could have resulted in increased PNC visit rates and follow-up visit rates, allowing the earlier identification of issues that might have led to infant mortality and child mortality. Finally, the improved data on maternal and child health services could have led to better decision-making by policymakers.

Inputs

RapidSMS Platform

Existing Data Resources

Mobile Phones, IT, and code cards
Indicators: CHW perceptions of adequacy and availability

Financial Resources
Indicators: Perceptions of adequacy

HR Resources
Indicators: Perceptions of adequacy

Ministry Policy and Support
Indicators: Perceptions of adequacy

Activities

IT System Development
Indicators: Perceptions of function and completeness

RapidSMS Trainings
Indicators: CHW and in-charge perceptions of adequacy

Supervision and M&E
Indicators: CHW and in-charge perceptions of adequacy

Public Engagement
Indicators: Community perceptions of adequacy

Planning & Coordination
Indicators: Perceptions of adequacy

Outputs

Operational RapidSMS System
Indicators: Stakeholder perceptions of uptime and reliability, downtime measures

CHW Knowledge, Attitudes and Skills
Indicators: Stakeholder perceptions of adequacy

CHWs Use the System
Indicators: Understanding of system, Number and Frequency of SMS Messages

Outcomes

CHWs Use Red Alert System
Indicator: Number of Emergency Service Calls

CHWs Track Pregnancies
Indicator: Proportion of pregnancies registered

CHWs Track Newborns
Indicator: Number of Newborn messages

CHWs Track Children
Indicator: Number of Newborn messages

Improved Data on MCH
Indicator: Perceptions of data utility

EMS Responds to Red Alerts
Indicators: Proportion of Alerts with En Route Responses

Reminders lead to client behavior change
Indicators: Qualitative perceptions

Reminders lead to client behavior change
Indicators: Qualitative perceptions

Reminders lead to client behavior change
Indicators: Qualitative perceptions

Data Influences Policy Decisions
Indicators: Perceptions of policy influence

Emergency Services Respond Faster
Indicators: RAR messages, Emerg. Admissions

Clients Increase ANC Visits
Indicators: Number of ANC visits, Proportion with 4

Clients Increase Facility Deliveries
Indicators: Proportion of facility birth rates

Clients Increase PNC Visits
Indicators: Number of PNC visits, Proportion with 3

Clients have more Follow-up Contacts
Indicators: Visits, Immunization rates, nutrition consults

Ministry Makes Better Policy Decisions
Indicators: Perceptions of policy change

Faster response has better outcomes

Appropriate care for pregnancy, delivery, and postnatal period is increased

Appropriate health care for children is increased

Impacts

Reduced Maternal Mortality and Morbidity
Indicators: maternal mortality rate, maternal admissions

Reduced Newborn Mortality and Morbidity
Indicators: newborn mortality rate, diarrhea with severe dehydration, severe malnutrition

Reduced Child Mortality and Morbidity
Indicators: child mortality rate, diarrhea with severe dehydration, severe pneumonia, severe malnutrition, severe malaria

Figure 2. Theory of Change for the RapidSMS Program in Rwanda

Objectives and Research Questions

Using comprehensive databases and both quantitative and qualitative research techniques, we conducted an integrated set of analyses to respond to the main objectives of this evaluation, which were developed using the OECD DAC Criteria for Evaluating Development Assistance.[16] Drawing from our Theory of Change, our policy analysis focused on the following questions under 6 categories:

Program Relevance

1. How well did the program align with national priorities and strategies?
2. To what extent has RapidSMS contributed to the national and local policy directions for maternal, newborn, and child health?
3. How well was RapidSMS accepted by individual communities? Did it fit with community priorities?

Program Effectiveness

4. How was the RapidSMS system used, how frequently, and for what purposes?
5. Has the project contributed to the improvement in the maternal, newborn, and child continuum of care?
6. What was the impact of the RapidSMS program on health care utilization, including ANC and PNC visits, ambulance transfers, hospital admissions, and the facility birth rate?
7. Did RapidSMS impact CHW's knowledge, skills, and practices regarding essential maternal and newborn care?
8. Did RapidSMS increase the motivation of community health workers?
9. Do beneficiaries report having been reached by RapidSMS? Did they feel the program was beneficial to them?

Program Impact

10. What was the impact of the RapidSMS program on key maternal and child health outcomes, including morbidity and mortality?

Program Efficiency & Coordination

11. Were the available resources (financial, human and other) efficiently used to achieve the program objectives?
12. Were the overall program coordination mechanisms functional and effective? How could they be improved?

Program Sustainability

13. To what extent will RapidSMS be sustainable over the long term? What factors will be involved in ensuring this sustainability?

Equity Considerations

14. To what extent did the program consider a human rights-based approach and equity in its approach, including focusing on comparatively deprived areas and areas with poorer maternal and child health outcomes?

Evaluation Design

Overview

Our study used a mixed methods approach to provide key information on the RapidSMS program. Our quantitative analysis used a rigorous quasi-experimental approach using program data from the

RapidSMS database, and administrative data from the Rwandan Health Management Information System (HMIS). Our qualitative study leveraged key informant interviews from stakeholders and program recipients along with focus groups of CHWs, mothers, and fathers.

Quantitative Methodology

Analysis of HMIS data

Our quantitative analysis specifically focused on Objectives 1, 2, and 3: program impact, program relevance, and program effectiveness. We used two databases: the RapidSMS database of all messages sent during the life of the program, and the Rwanda HMIS, which contains facility-level indicators across a broad range of maternal and child health outcomes. Data in the HMIS system are collected monthly within each health center in Rwanda by an identified individual responsible for their reporting. From the RapidSMS database, we used data on messages sent by CHWs from the inception of the program until present, from March 2010 until June 2016. As the HMIS system was upgraded and the reporting forms changed in 2012, we used data from that date forward to ensure consistency, from January 2012 until June 2016.

We derived descriptive information on uptake and use of the RapidSMS system from the database of SMS messages sent by Community Health Workers. Our impact analysis used Interrupted Time Series Analysis (ITS), one of the strongest quasi-experimental research designs, to study longitudinal changes in several outcomes of interest from the HMIS database. This method has the distinct advantages of being methodologically rigorous and easily interpretable by non-technical audiences, while also controlling for pre-existing secular trends in the outcome.[17] The HMIS database was used to assess outcomes as it provided consistent data on key indicators from both before and after the implementation of RapidSMS.

As the scale-up of RapidSMS occurred unevenly across the country, we determined the date on which the CHWs affiliated with each health facility started using the system. We considered a health facility to have started using RapidSMS in the first month after January 2013 during which their affiliated CHWs sent 50 or more SMS messages. Based on this index month, we extracted data from HMIS for 14 months preceding the starting date of the intervention in each health facility. This length of time was chosen to maximize the number of facilities contributing data, as many started in March 2013 (14 months following the launch of the upgraded HMIS database in January 2012). We followed data from each health facility for 24 months following this date. The 20 health facilities that did not cross the 50 message threshold before July 2014 were excluded from our analysis, as we did not have had 24 months of post-intervention data available.

Our ITS analysis thus used study time, which allowed each facility to be standardized to the others based on their individual start date. As shown in Figure 3, our models included both a level change—an immediate and sustained increase or decrease in a measure—and a trend change—a change in the trajectory of the outcome over the post-intervention period. These changes were calculated relative to a counterfactual derived from a linear extension of the pre-intervention level and trend. In this figure, month 1 represents the specific month in which each health facility started using RapidSMS.
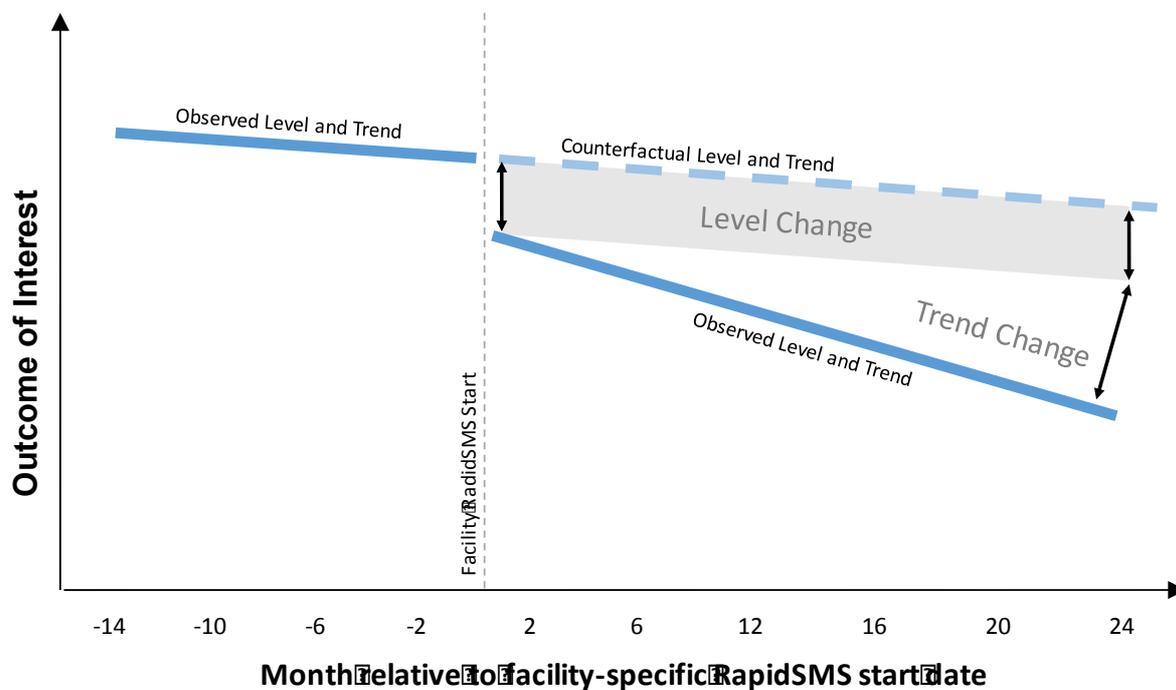
Figure 3. Diagrammatic presentation of the Interrupted Time Series study design

Our models took the following general form to model each outcome measure in month *t*:

$$outcome_t = \beta_0 + \beta_1 \cdot time_t + \beta_2 \cdot RapidSMS_t + \beta_3 \cdot RapidSMS_t \cdot post_t + \varepsilon_t$$

Where *time* represents the month in study time at time *t* (i.e. 1, 2, 3…), *RapidSMS* is an indicator for whether the health facility had implemented RapidSMS at time *t*, and *post* represents whether the program was in place in month *t* (i.e. month *t* it was after that health facility implemented the program). The two parameters of interest are β_2, which indicates any immediate change in the *level* of the outcome in the RapidSMS group relative to the control group, and β_3, which indicates any change in the *trend* of the outcome relative to the control group following initiation of the RapidSMS program.

We ran all of our models on data that was stratified between the 10 UNICEF-supported districts and the other 20 districts within Rwanda.[*] For each individual indicator, our analysis included only facilities that reported complete data over their entire 38-month window for each outcome of interest. As the monthly observations may have been correlated over time, we assessed autocorrelation and used appropriate adjustments in a generalized least squares model, and assessed autocorrelations at various lags using the Ljung-Box X^2 statistic.[17] Based on this assessment, we ran all models using a generalized least squares model with a first-order autoregressive structure.[17] In cases where results were statistically significant, we used standard methods to calculate percentage changes in the outcomes to aid in interpretation.[18]

Outcome Measures
Our analysis focused on several indicators derived from both the RapidSMS database and the HMIS database. These included both process measures and outcomes measures.

Process measures we derived from the RapidSMS database included the following:

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[*] The distinction between supported and non-supported districts is discussed above.

1. The number of pregnant women who had a message sent, and the average number.
2. The number of CHWs that sent a message, and the average number.
3. The number of text messages sent and their type.
4. The number of ambulance transfers requested, and the follow-up responses.
5. To measure uptake of the RapidSMS system, we estimated the proportion of births that were registered in the system in each District. To perform this calculation, we will use the use information on the number of births in health facilities from the HMIS system. It is worth noting that this only includes births in a health facility, which is approximately 91% of births in Rwanda.[2] Thus, to scale this estimate to represent all births (including those not in a health facility), we used the estimate of facility births for each district from the 2014/15 DHS.[2]

Our health services and health status outcome measures included the following monthly metrics derived from the health center data in the HMIS system:
1. Antenatal Care (ANC): new registrations, first visits in 1st trimester, complete sequence of 4 standard antenatal care visits, high risk pregnancy detections, HIV screening, tetanus vaccinations, anemia testing, malnutrition screening, iron testing
2. Deliveries: number of facility deliveries, infant referrals to higher level of care
3. Postnatal Care (PNC): new registrations, total visits, malnutrition screening
4. Neonatal death: all-cause mortality
5. Childhood routine care: Receipt of immunizations

For each indicator, we calculated population-adjusted rates by summing the estimated catchment population for each included health center and calculating the rate per 1,000 population. This served to make our estimates comparable between the UNICEF-supported and non-supported areas, given that the former comprised 1/3 of all districts, and also allowed us to account for the opening of new health centers during the study period. While we had originally intended to include other indicators, we were precluded from doing so due to a lack of data over the time period which resulted in unusable estimates. These indicators included maternal mortality and admission rates for certain childhood morbidities (such as measles and severe malaria).

Qualitative Methodology
Our qualitative component focused on key informant interviews (KIIs) with a range of program stakeholders, including the Ministry of Health, Rwanda Biomedical Center, development partners (DPs), National Professional Societies, Academics, selected District Health Unit Directors, and selected health facility authorities. We also conducted in-depth interviews (IDIs) with service providers, including selected maternity/Antenatal care department leadership staff, Cell Coordinators of CHWs and In-charge/Supervisors of Community Health Workers from selected health facilities and districts. Finally, we conducted Focus group discussions (FGDs) with beneficiaries of CHWs health services, both mothers and fathers, and CHWs living in selected areas.

Study Locations
We conducted our qualitative interviews both nationally and in four selected districts that implemented the RapidSMS program and their four corresponding district hospitals. We intentionally selected two districts that were UNICEF-supported, Ngororero and Nyanza, and two that were not supported, Gasabo and Ngoma. Within each district, we selected one specific health center in order to recruit IDIs and FGDs participants.

Sampling procedures
In each District, we used purposive selection of facilities to obtain diverse experiences with implementation and use of the RapidSMS system. The selection criteria we considered while

sampling and selecting facilities to be visited included their performance in maternal and child health, location (urban versus rural), starting time of the RapidSMS program (early versus late), and the geographical accessibility of clients to Health Facilities.

Recruitment of study participants

Interviews

Participants in KIIs and IDIs were contacted directly by members of the research team and invited to participate. Those who agreed were given an appointment for an interview, which was semi-structured in nature. Selection criteria included the following:

- Being aged 21 or higher
- Willingness to sign a consent form after being provided with study information

We aimed to conduct the following interviews:

- 8 KIIs with informants from the MoH, RBC, and Developing Partners
- 2 KIIs with informants from National Professional Societies/councils
- 2 KIIs with informants from academia
- 4 KIIs with informants from district authorities (District Health Unit Directors of each selected district)
- 4 KIIs informants from Health Facility Authorities of selected facilities
- 4 IDIs with service providers including the in-charge of maternity departments of selected facilities
- 4 IDIs with Cell Coordinators of CHWs
- 4 IDIs with the In-charge/Supervisor of Community Health at Health center level

Focus Groups

Participants in the FGDs were recruited through the In-charge of CHWs at each health center. This included both CHWs and beneficiaries (women and men) who had been provided with their services during a pregnancy or partner's pregnancy. After identification, verbal invitations were sent to them through CHWs specifying the venue and time of the FGD.

The following selection criteria were considered for CHWs FGD participants:

- Being aged 21 or higher
- Living/working in the selected HC catchment area for at least 12 months prior to the study
- Accepting to sign a consent form after being provided with study information

And the following selection criteria were used for beneficiaries including mothers and men:

- Being aged 21 years or higher
- Living in the selected HC catchment area for at least 12 months prior to the study
- Accepting to sign a consent form after being provided with study information
- Having used CHW services in the 3 months prior to the FGD

Overall, the research team conducted 10 FGDs, including:

- 4 FGDs with a target of 12 female beneficiaries each (one per District)
- 2 FGDS with a target of 12 male beneficiaries each (two selected Districts)
- 4 FGDs with community health workers (one per District)

Data collection procedures

Our research team developed semi-structured interview guides, including one for each category of FGD, IDI and KII. These guides are attached to this report as Appendix 1: Data Collection Tools. During each interview, the topic guide was followed. If consent to record was given, research team

members made a recording of each interview and FGD. In addition, a field worker made notes regarding the responses and non-verbal behavior during the interview and FGDs, along with notes about the setting and atmosphere of the interview and FGD. Interviews were conducted in either Kinyarwanda or English, depending on the preference of the interviewee(s). All digital recordings were transferred to a central computer system for the expansion of field notes and/or transcribing.

Data management and analysis

After each interview or FGD, the note taker transcribed verbatim all interview content. To ensure the quality of the resulting data, two interview transcripts and two focus group discussion transcripts were randomly selected and quality-checked by the qualitative lead (AM). Comments were shared with note takers and supervision was conducted to ensure all field notes and transcripts were of high quality.

Our analysis of the data proceeded in four steps. First, the we reviewed our field notes in order to be familiar with their contents; this was paired with the data collection activities in which major themes were identified. Second, an initial set of codes were created from interview and FGD transcripts, which were further enriched with detail throughout the coding process. Third, the research team then proceeded to code all transcripts and field notes using ATLAS.TI software, a qualitative analysis package. Finally, after coding was completed, we produced output on specific themes/codes and this was used to guide the authoring of our results following the objectives of the evaluation. When the original interview was conducted in Kinyarwanda, it was translated to English by the investigators for inclusion in this report.

Stakeholder Participation

Stakeholder participation was ensured in two ways through this project. First, we assembled a project steering committee that included representation from the Ministry of Health, Rwanda Biomedical Center, and the University of Rwanda. This committee had several meetings during the course of the project to review progress and preliminary results. It was also charged with signing off on the final methodology presented in the study team's Inception Report. Second, we engaged a number of invited participants at a Stakeholder's Workshop held at the Nobleza Hotel in Kigali on May 18, 2016. At this meeting participants were asked for specific input on the proposed theory of change for the project, as well as specific outcomes that the research team should consider investigating. The workshop included 14 participants, including several from outside of Kigali based in District health services.

Ethical Considerations

Informed Consent

We obtained written consent from all interview and focus group participants. The consent form used is attached as Appendix 2: Informed Consent Documents.

Participant Confidentiality

The research team ensured that secondary data were properly de-identified and retained in password protected computers of the lead investigators. For all qualitative data, the research team used a series of measures to ensure participant confidentiality. First, we kept the names of all key informants who participated in the study confidential, and did not link participants with their specific comments in this report. Second, we maintained no identifiers that could connect any data collected from focus group participants to any particular participant. Finally, we will retain one set of the audio recordings, which will be deleted or otherwise destroyed by February 28, 2019.

Research Ethics Board Review

Our research protocol was submitted and approved the University of Rwanda College of Medicine and Health Sciences Institutional Ethics Review board.

Evaluation Results: Quantitative Analysis

RapidSMS Use

Overall Use

Over the course of our entire study period, there were 9,350,079 unique SMS messages sent by Community Health Workers. As expected, the vast majority of these messages were sent after the program was scaled-up nationally in early 2013, as shown in Figure 4. The messages were sent by 45,587 unique CHWs, for an average of 205 messages per user (median 166, inter-quartile range 110 to 253). Messages were sent regarding 2,509,743 different mothers, for an average of 3.7 messages per patient.
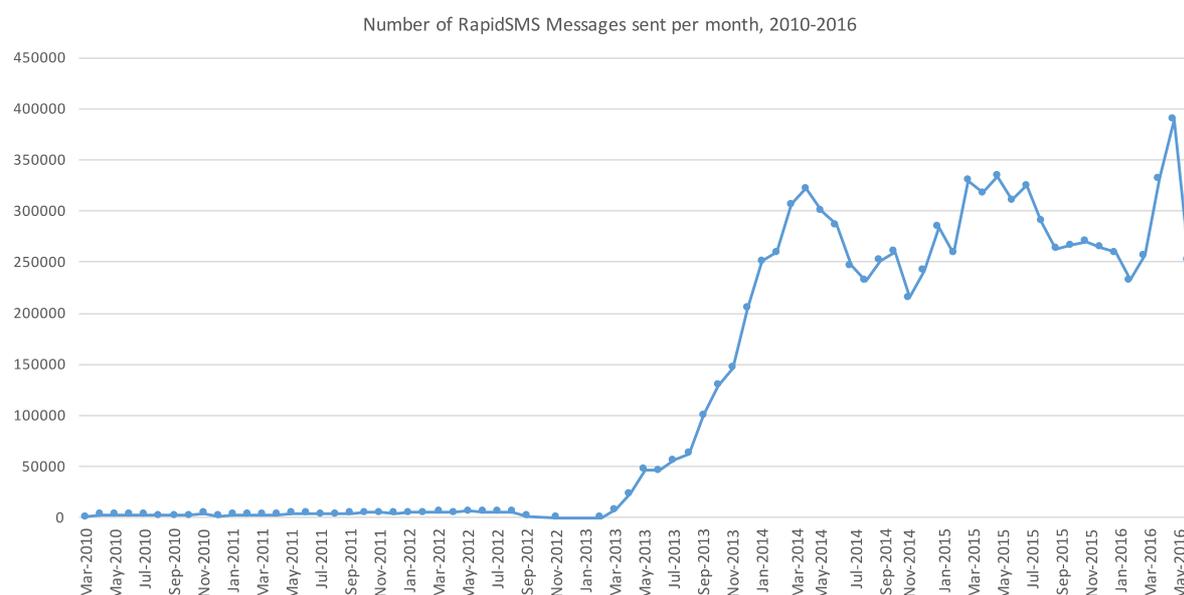
Figure 4. Number of RapidSMS Messages sent each month by Community Health Workers in Rwanda

Table 1 shows the different types of RapidSMS messages sent by CHWs, the number of unique messages that received one or more of each type of message, and the number of patients having each message as their first message in the system. Overall, nearly half of the messages were with respect to Community Based Nutrition, with the next most popular categories being Child Health and Community Case Management. The high level of Community Based Nutrition messages is not surprising, as these messages are intended to follow the regular monthly check-up of newborns performed by CHWs in each village. Despite the fact that RapidSMS was originally implemented to track pregnancy and birth, messages for Pregnancy, ANC visits, and Births constituted just 15% of the total messages sent. Similarly, despite Red Alerts being a major focus of RapidSMS, these messages were sent fewer than 9,000 times. This appears to be very low use, particularly given that between an estimated 5% and 15% of pregnancies will experience potentially fatal complications.

In most instances, mothers received between 1 and 2 instances of each type of message. The notable exceptions to this rule was child health and community based nutrition visits, where the number per patient exceeded 2 and 3, respectively. In terms of the initial message for each patient in the system, pregnancy constituted 16.3% of initial messages, compared to 5.7% of messages overall. Community based nutrition remained high on this outcome as well, with 47% of patients having their first message as such a visit.

	Total Messages		Unique patients		1st Message	
Type	**Number**	**%**	**Number**	**# Per Mother**	**Number**	**%**

Pregnancy	533,781	5.7	497,449	1.07	408,206	16.3
ANC	376,501	4.0	261,685	1.44	82,335	3.3
Birth	525,465	5.6	492,789	1.07	144,672	5.8
Death	20,211	0.2	19,570	1.03	6,513	0.3
PNC	465,849	5.0	234,263	1.99	19,116	0.8
Newborn Care	558,466	6.0	268,207	2.08	33,124	1.3
Case Management Response	419,509	4.5	224,426	1.87	39,047	1.6
Child Health	1,031,374	11.0	432,182	2.39	125,268	5.0
Community Based Nutrition	4,394,727	47.0	1,391,002	3.16	1,189,110	47.4
Community Case Management	774,649	8.3	463,213	1.67	345,177	13.8
Red Alert	8,950	0.1	8,064	1.11	1,263	0.1
Red Alert Result	4,618	0.1	4,209	1.10	143	0.0
Refusal	37,506	0.4	32,843	1.14	31,386	1.3
Risk	7,189	0.1	5,405	1.33	1,585	0.1
Risk Result	5,033	0.1	3,125	1.61	546	0.0
Departure	186,249	2.0	134,501	1.38	82,252	3.3
Total	9,350,077				2,509,743	

Table 1. Types of RapidSMS messages sent by Community Health Workers, including the total number, number of unique patients, and the number of each type which was the first message for each patient.

To further investigate the outcomes of RED Alert messages, we examined the characteristics of the RED Alert Result messages sent by CHWs in the two weeks following a RED Alert. Of the RED Alert messages sent, there were 3,624 with a corresponding response message within 14 days. Within these messages, the key results for emergency services are shown in Table 2. As shown in the table, CHWs reported that ambulances arrived 12.1% of the time; 9.0% on time and 3.1% late. If considered against the total number of RED Alerts sent, CHWs reported that ambulances arrived only 4.8% of the time (438 times of 8,950 messages). CHWs reported no ambulance response in 20.7% of RED Alert response messages, and most often patients were directly referred to a health facility (55.4% of the time). Finally, RED Alert Response messages did not contain a code for the outcome in 11.8% of cases.

Intervention	Number	Percentage
Ambulance on time[†]	326	9.0%
Ambulance late	112	3.1%
No Ambulance Response	751	20.7%
Patient Directly Referred	2,007	55.4%
No Intervention Reported	427	11.8%
Total	3,623	

Table 2. RED Alert Results sent by CHWs within fourteen days following an initial RED Alert message

We also specifically investigated the use of Red Alert messages over time, shown below in Figure 5. The chart shows that the monthly use of Red Alerts was quite low for the majority of the early months of RapidSMS availability. Rates of use in UNICEF supported areas jumped substantially in March 2015, while rates in non-supported regions grew slowly and were generally below 200

[†] Note that "on time" constitutes an ambulance arrival within 2 hours

messages per month. This increase followed a decision at a December 2014 program coordination meeting to try and increase the use of RED Alert messages. Both types of Districts appeared to show similar underlying seasonal variation.

Number of Red Alert RapidSMS messages sent per month in Rwanda, by UNICEF support status
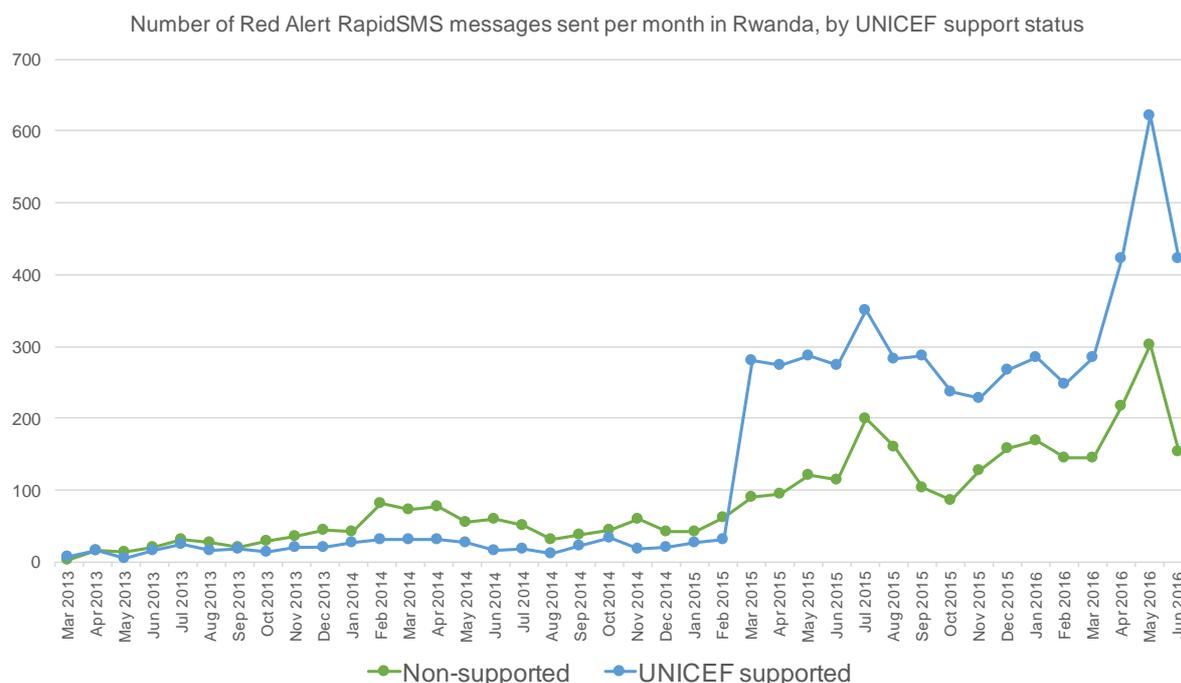
Figure 5. Number of RapidSMS Red Alert messages sent per month, by District-level UNICEF support status

One measure of the quality and representativeness of the RapidSMS data is how well it mirrors national estimates for key outcomes. As shown in Table 3, the recording of birth locations in RapidSMS appeared to closely mirror the findings of the DHS survey. Facility births—those in a health center or hospital—constituted 90.4% of all recorded births, which is very comparable to the 91% estimate from the 2014/15 DHS survey.[2]

Location of Birth	Count	Percentage
Health Center	364,155	69.5%
Hospital	109,665	20.9%
Home	41,700	8.0%
En Route	8,335	1.6%
Total	523,855	

Table 3. Location of birth in RapidSMS Messages

Recording of Births

To assess the overall use of the RapidSMS system, we compared the recording of births in the system in 2015 to both the HMIS data on facility deliveries and projections from the most recent Census conducted in 2012. In 2015, there were 192,264 recorded births in the RapidSMS system. In comparison, there were 311,376 births in a health facility recorded in the HMIS system. If this figure is scaled using the DHS estimate of 91% of births occurring in a health facility, it suggests there were 342,171 births in 2015. Similarly, Census projections estimated 343,077 total births in 2015 (range 322,674 to 349,714).[19] This suggests that overall, the RapidSMS system is recording just over half of the births that occurred in Rwanda that year: 56.0% based on Census estimates and 56.2% of births based on HMIS estimates.

To estimate differences in the reporting of births by district, we scaled the estimates from the HMIS system by the individual percentage of facility births reported in the 2014/15 DHS.[2] As shown in Figure 6, the estimated percentage of reporting ranged from a high of 87% in Nyaruguru to a low of 13% in Nyarugenge. Notably, the bottom 3 districts in terms of reporting were all from the Kigali City District. The chart also shows that those districts supported by UNICEF had much higher rates of reporting of births than others: 71.5% overall versus 51.2% in other Districts (55.9% if Kigali Districts are excluded).

Estimated Percentage of Births recorded by RapidSMS by District (2015)
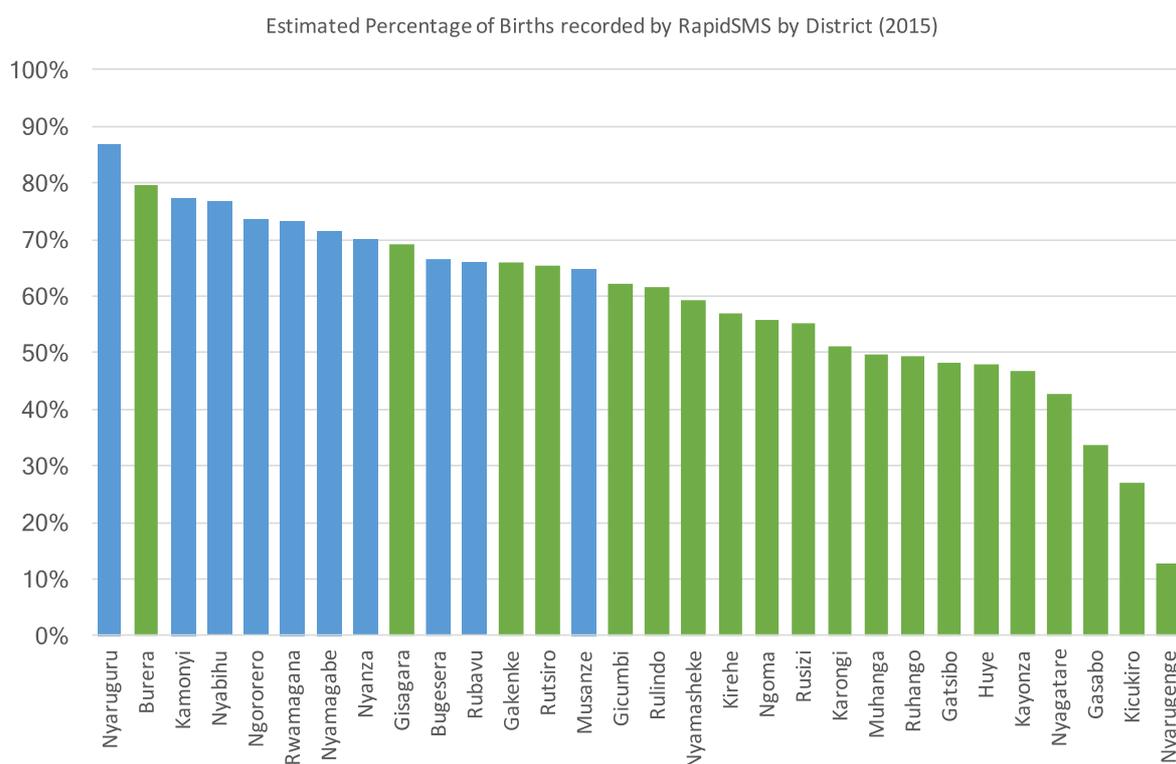
Figure 6. Estimated percentage of births reported in RapidSMS in 2015. Blue districts are those supported by UNICEF, while green districts were not.

Data Quality

While analyzing the RapidSMS data, we noted several inconsistencies in the data. For example, messages that contained codes regarding the status of an ambulance (arrived on time, arrived late, no response) were made under several different types of messages. While 1,477 of the codes were tied to the seemingly appropriate code of "Red Alert Response", 1,116 were of type "PNC" and 1,048 were "Newborn Care". This was also the case for responses that required numeric inputs. For example, the recorded numbers for middle upper arm circumference included numerous figures that were implausibly small and / or large.

Outcomes Analysis

Start Date for Health Facilities

As stated above in the Methods section, we used a rule of 50 messages in one month to denote the start date for each individual health facility. As shown in Figure 7, this resulted in a range of start dates across facilities, most of which started using RapidSMS in 2013. In order to have 24 months of follow-up data available for analysis, we included the 461 health facilities that started using RapidSMS prior to June 2014.

Number of Facilities starting RapidSMS Use, by month
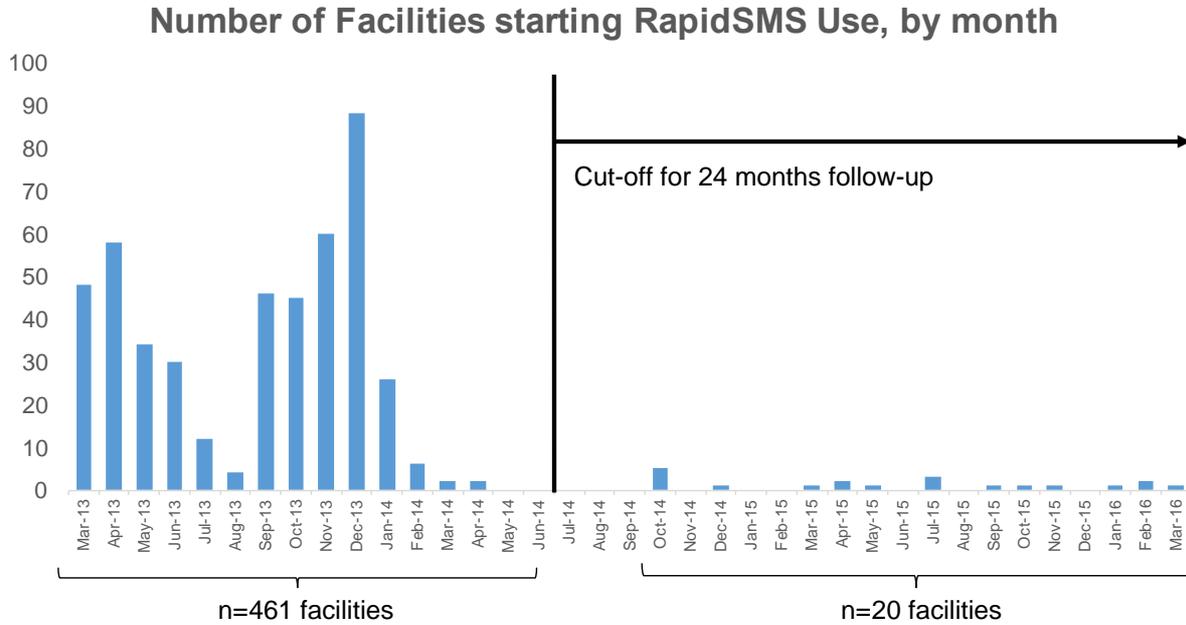
Figure 7. Start date of health facilities based on the 50 message rule

Number of Messages per capita

The number of RapidSMS messages sent per 1,000 catchment residents is shown below in Figure 8. As shown in the Figure, the number of messages per capita was reasonably similar between UNICEF supported and non-supported areas. After a steep increase in messages over the first six months, use plateaued at around 25 messages per 1,000 inhabitants per month. After the 18-month time point, use in UNICEF supported areas increased relative to other districts.
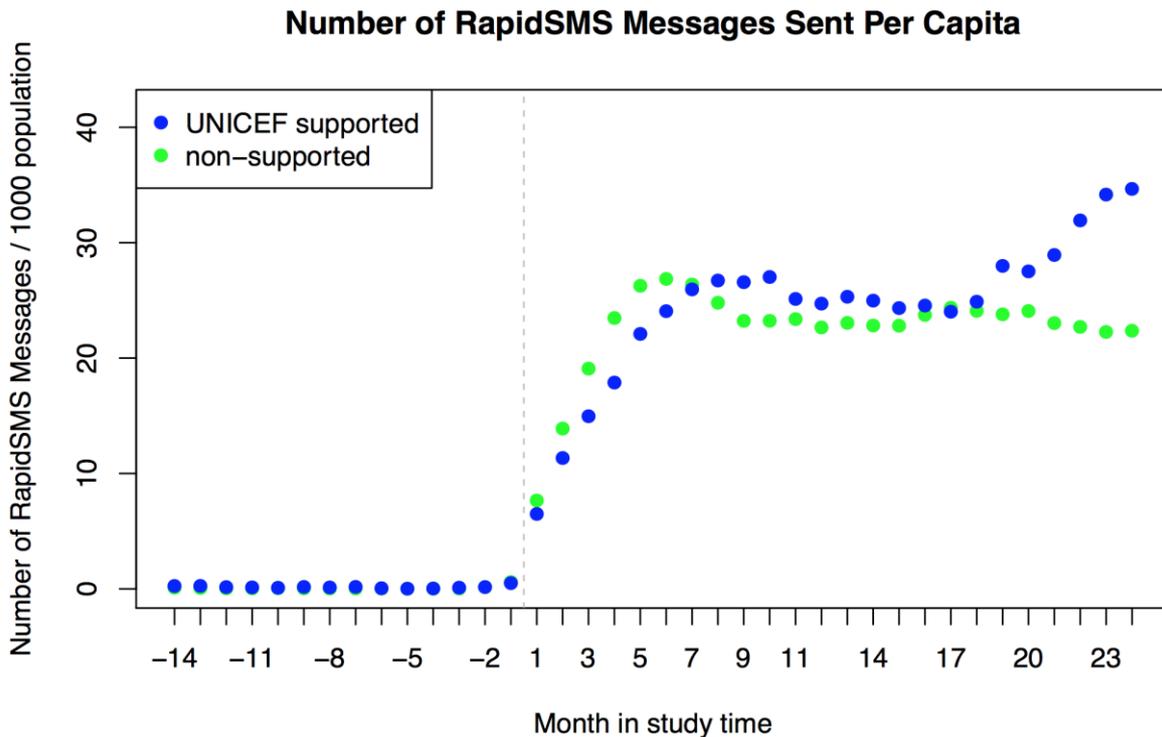
Figure 8. Average number of RapidSMS messages per 1,000 catchment population in both UNICEF supported and non-supported health centers

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Antenatal Care Outcomes

Our first category of outcomes studied using HMIS data and interrupted time series analysis were those that reference antenatal care (ANC) services.

ANC Registrations

The number of new ANC registrations per month at health centers before and after the start of RapidSMS in UNICEF supported Districts is shown in Figure 9. As shown in the Figure, we found that the start of the RapidSMS program and UNICEF support led to no change in the level of new ANC registrations (estimate 0.032, 95% CI: -0.127 to 0.192, p=0.69). While there was a slight increase in trend visible in the data, this change was not statistically significant (estimate 0.014, 95% CI: -0.004 to 0.031, p=0.14). In contrast, our analysis of non-supported districts, shown in Figure 10, found a slight increase in the level of 0.123 registrations per 1,000 catchment population (95% CI: 0.014 to 0.232, p=0.03). However, this increase was quickly offset by a decrease in the trend of 0.021 registrations per 1,000 catchment population per month (95% CI: -0.034 to -0.008, p=0.004).

UNICEF-supported Districts
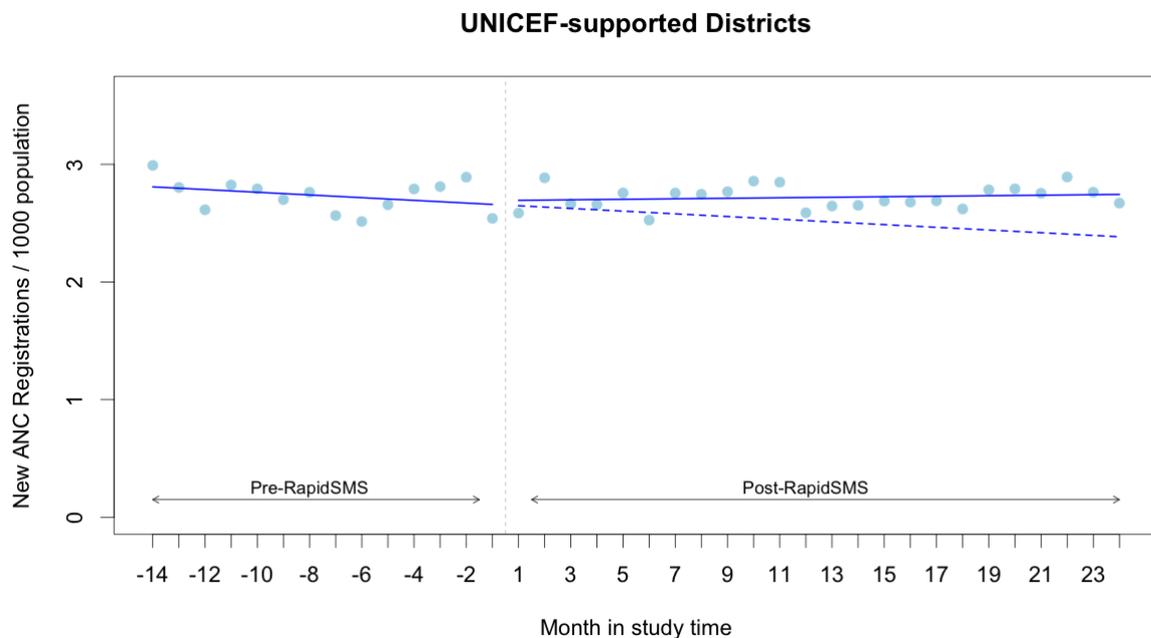
Figure 9. ITS analysis of new ANC registrations per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
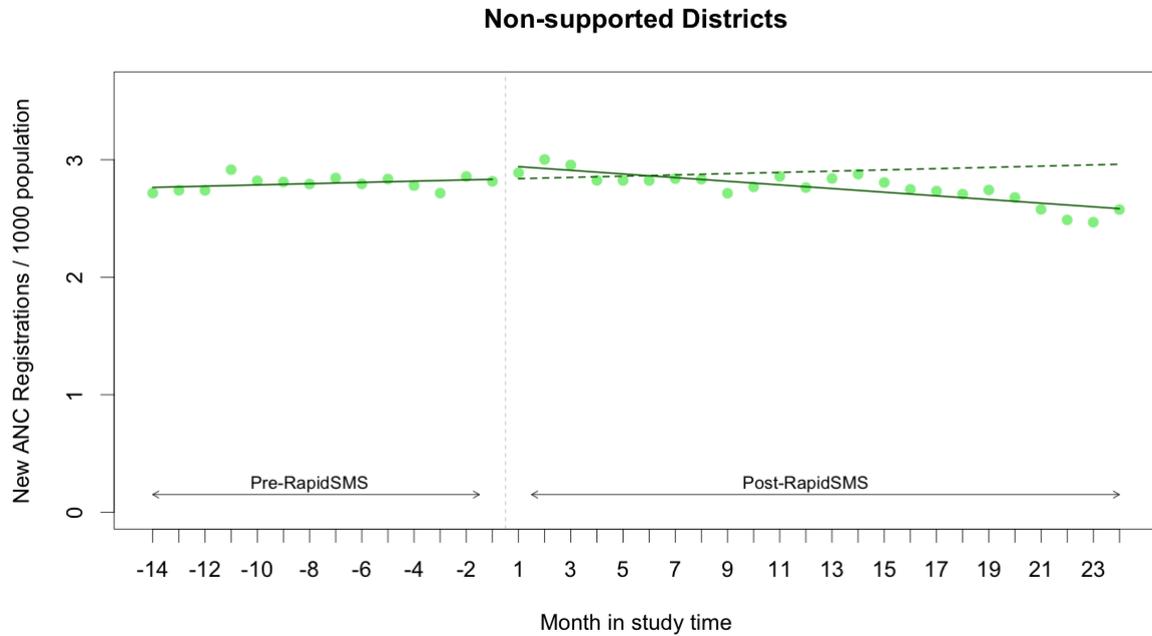
Figure 10. ITS analysis of new ANC registrations per 1,000 catchment population in non-supported Districts

First Trimester ANC Visits

The number of new 1ˢᵗ trimester ANC visits in health centers are shown below in Figure 11 and Figure 12. As shown in the first Figure, there were no statistically significant changes in either the level or trend in ANC visits in UNICEF supported districts (p=0.36 and p=0.46, respectively). Similar to ANC registrations, we found a small level increase in new ANC first trimester visits in non-supported districts (estimate=0.080, 95% CI: 0.021 to 0.138, p=0.012), but this was again offset by a negative change in trend, which in this case was not statistically significant (p=0.13).

UNICEF-supported Districts
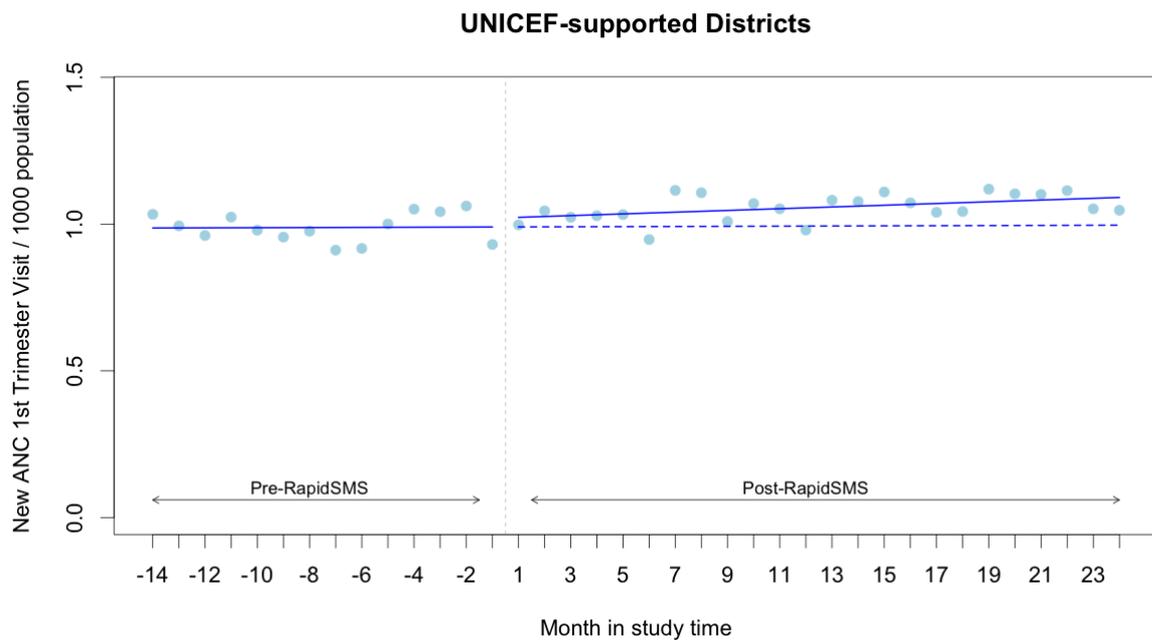
Figure 11. ITS analysis of new First Trimester ANC visits per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
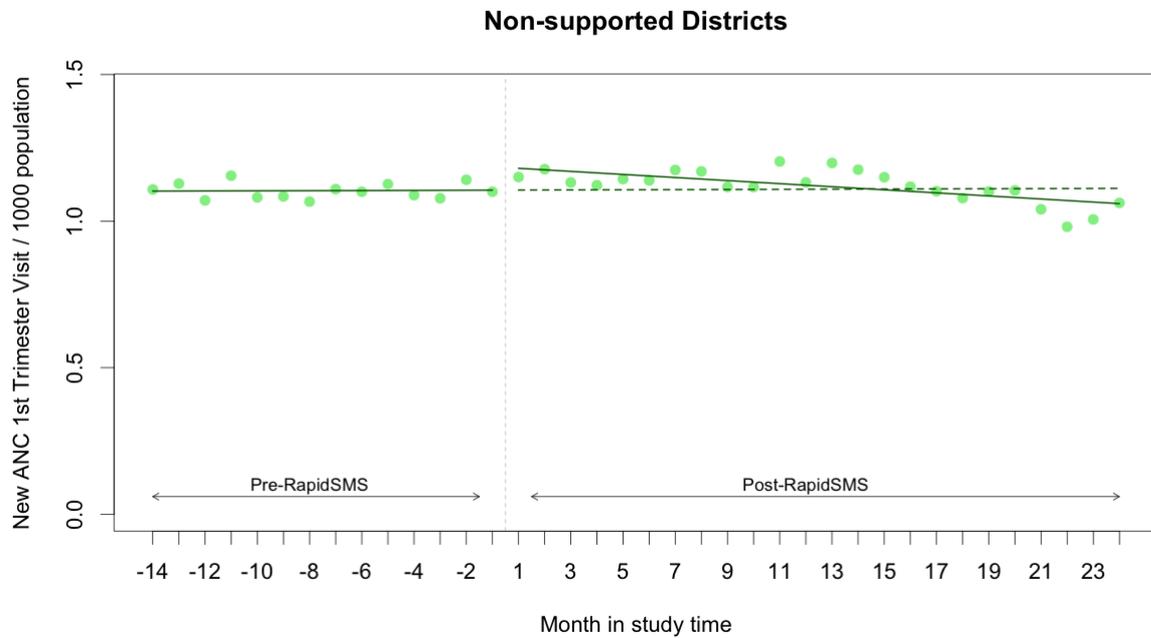
Figure 12. ITS analysis of new First Trimester ANC visits per 1,000 catchment population in non-supported Districts

Number of Women with 4 Standard ANC Visits

This outcome examines the number of women per 1,000 catchment population who complete the recommended standard regimen of 4 ANC visits during their pregnancy. As shown in the Figures, we found no changes in either the level or trend of the receipt of 4 standard visits in either UNICEF supported or non-supported districts (p= 0.51 and 0.70 for UNICEF supported and 0.38 and 0.50 for non-supported districts, respectively).

UNICEF-supported Districts
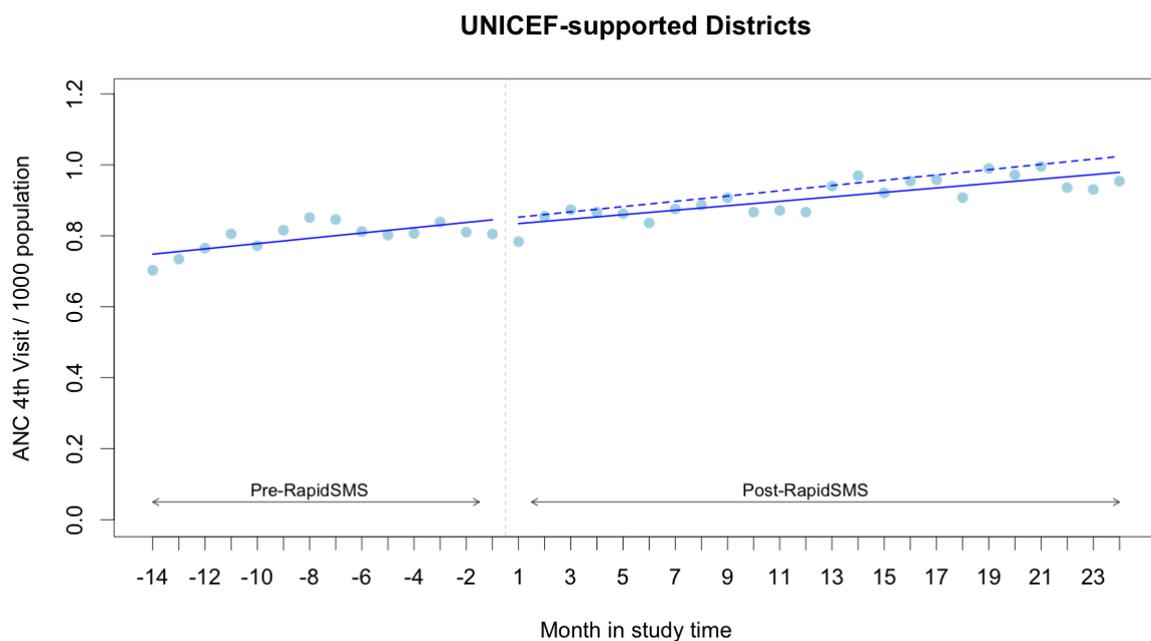
Figure 13. ITS analysis of receipt of four standard ANC visits per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
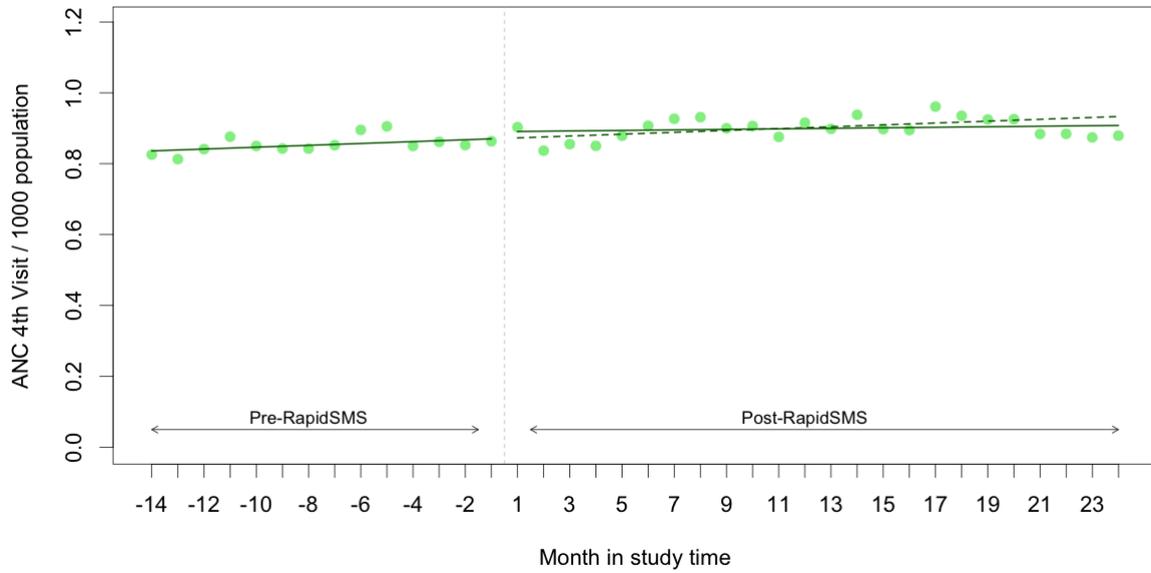
Figure 14. ITS analysis of receipt of four standard ANC visits per 1,000 catchment population in non-supported Districts

ANC High Risk Detections

The rates of ANC visits leading to the detection of high-risk pregnancies are shown below in Figure 15 and Figure 16. As shown in the first Figure, the start of RapidSMS was associated with an increased trend in the detection of high risk pregnancies (estimate=0.006 cases / 1,000 population / month, 95% CI: 0.001 to 0.011, p=0.03). There was no statistically significant change in the level (p=0.27). While the Figure shows a modest increase in level and trend for non-supported districts, neither of these changes were found to be statistically significant (p=0.23 and 0.59, respectively).

UNICEF-supported Districts
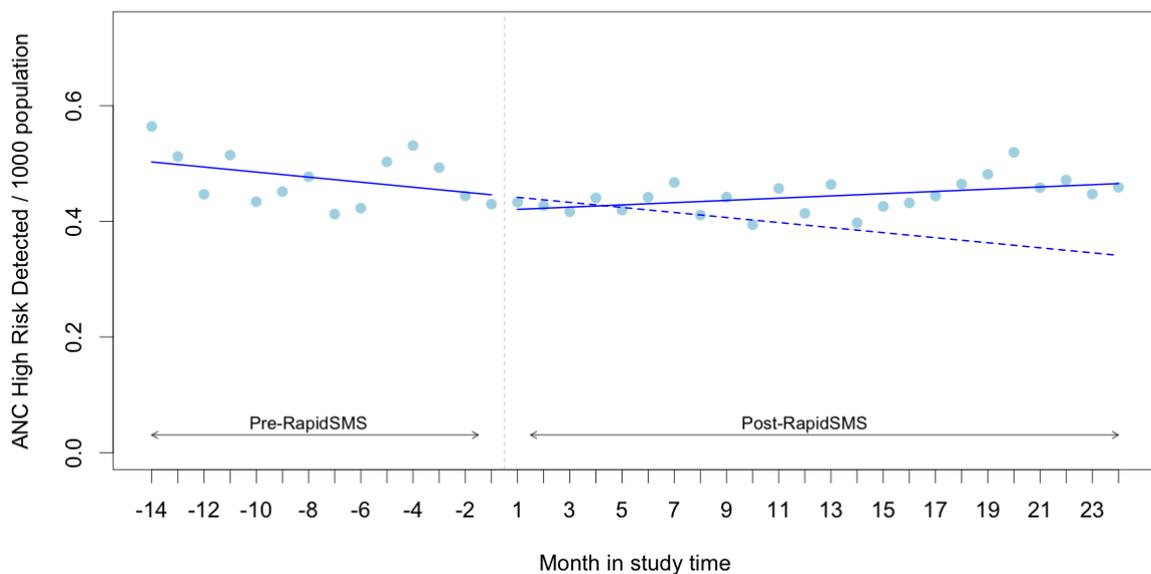
Figure 15. ITS analysis of ANC detections of high risk pregnancies per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
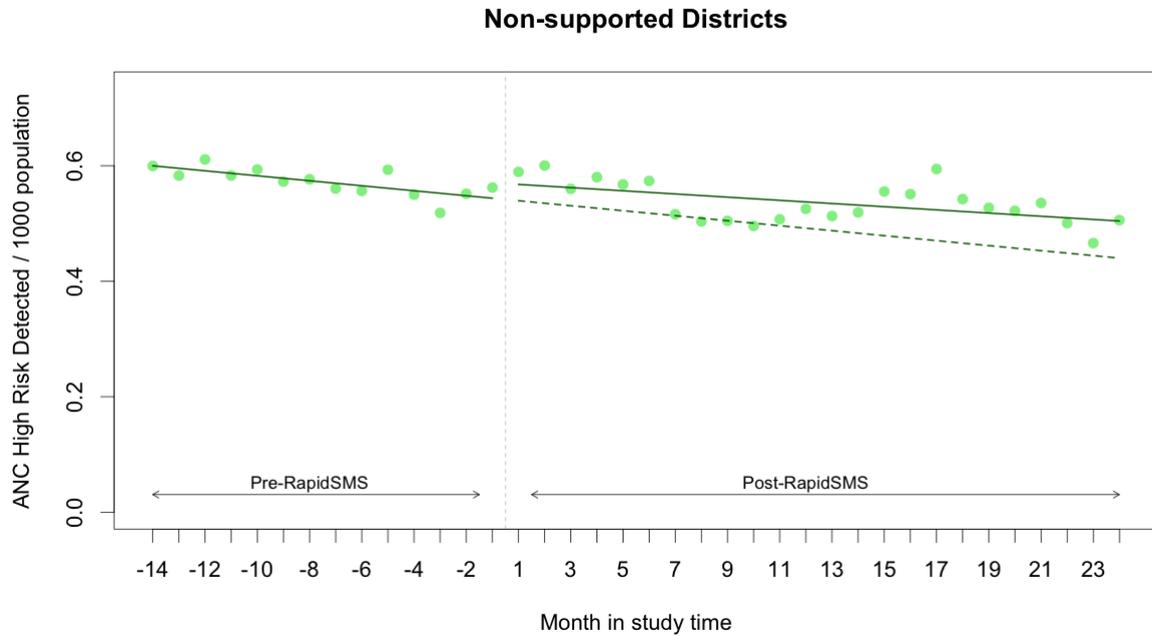
Figure 16. ITS analysis of ANC detections of high risk pregnancies per 1,000 catchment population in non-supported Districts

ANC HIV Screening

The rates of ANC HIV tests conducted per 1,000 catchment population are shown below in Figure 17 and Figure 18. Notably, the scale of the rates is very similar to the number of ANC registrations shown above, suggesting ANC HIV testing is widely conducted. As shown in the first Figure, there was no significant change in either the level and the trend in UNICEF supported Districts (p=0.31 and 0.31, respectively). We did not find a change in the level in non-supported districts, but did observe a decline in the trend following the start of RapidSMS in these health centers (estimate=-0.026, 95%CI: -0.039 to -0.013, p<0.001).

UNICEF-supported Districts
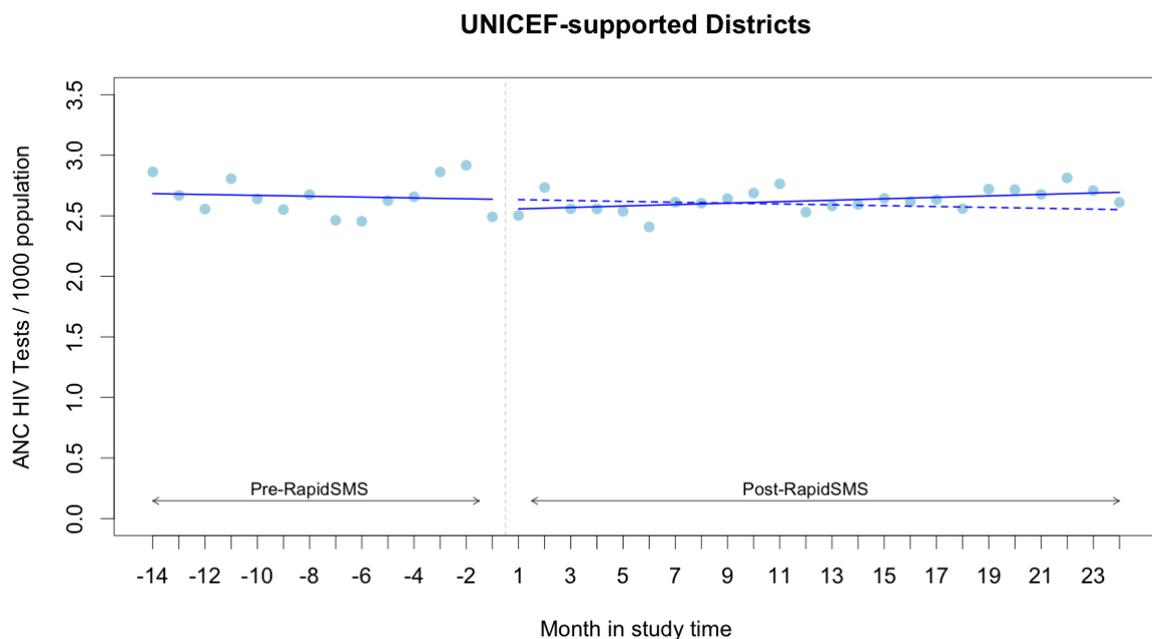
Figure 17. ITS analysis of ANC HIV tests conducted per 1,000 catchment population in UNICEF supported Districts

30

Non-supported Districts
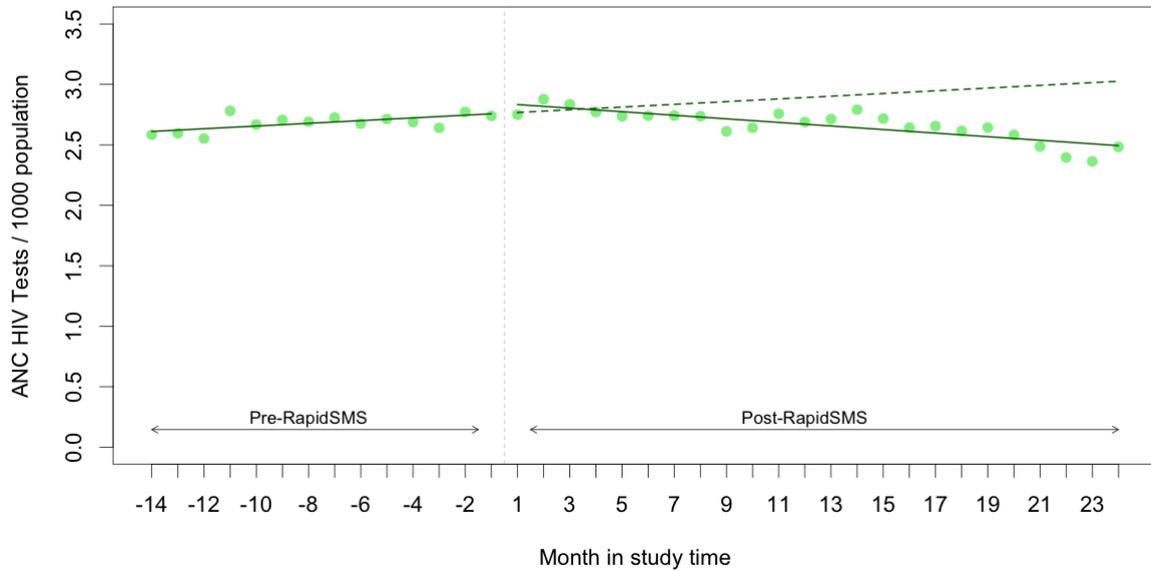
Figure 18. ITS analysis of ANC HIV tests conducted per 1,000 catchment population in non-supported Districts

ANC Anemia Testing

The rates of ANC testing for anemia are shown below in Figure 19 and Figure 20. Our ITS analysis showed an increase in level in UNICEF supported districts of 0.147 tests per 1,000 catchment population (95% CI: 0.023 to 0.270, p=0.03), but no change in trend (p=0.98). In contrast, we found no change in the level in non-supported Districts, but a substantial decrease in trend (estimate=-0.028, 95% CI: -0.037 to -0.019, p<0.001).

UNICEF-supported Districts
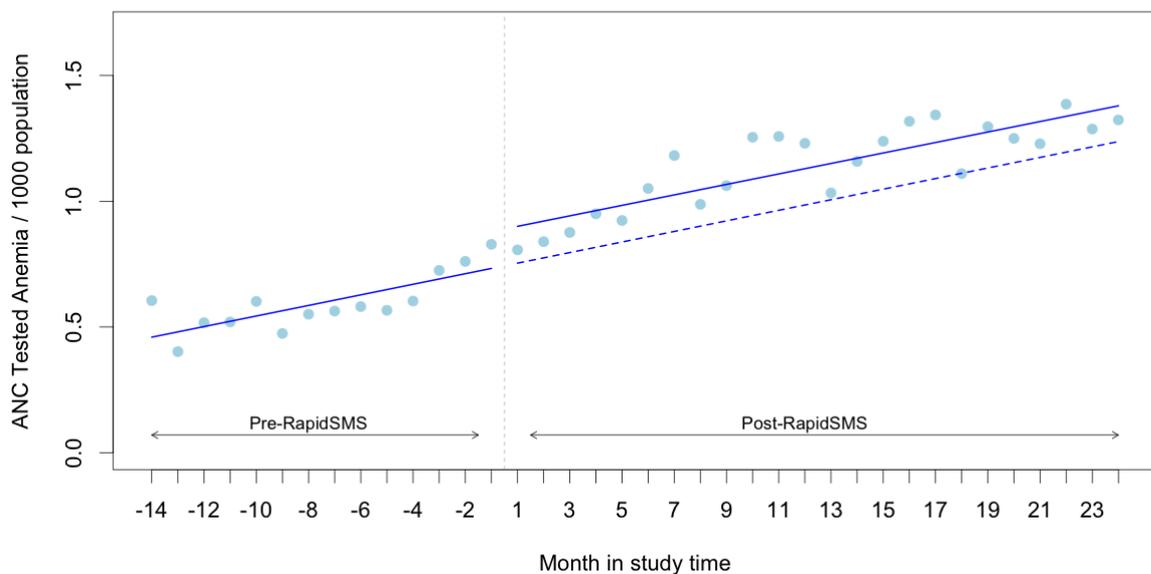
Figure 19. ITS analysis of ANC Anemia tests conducted per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
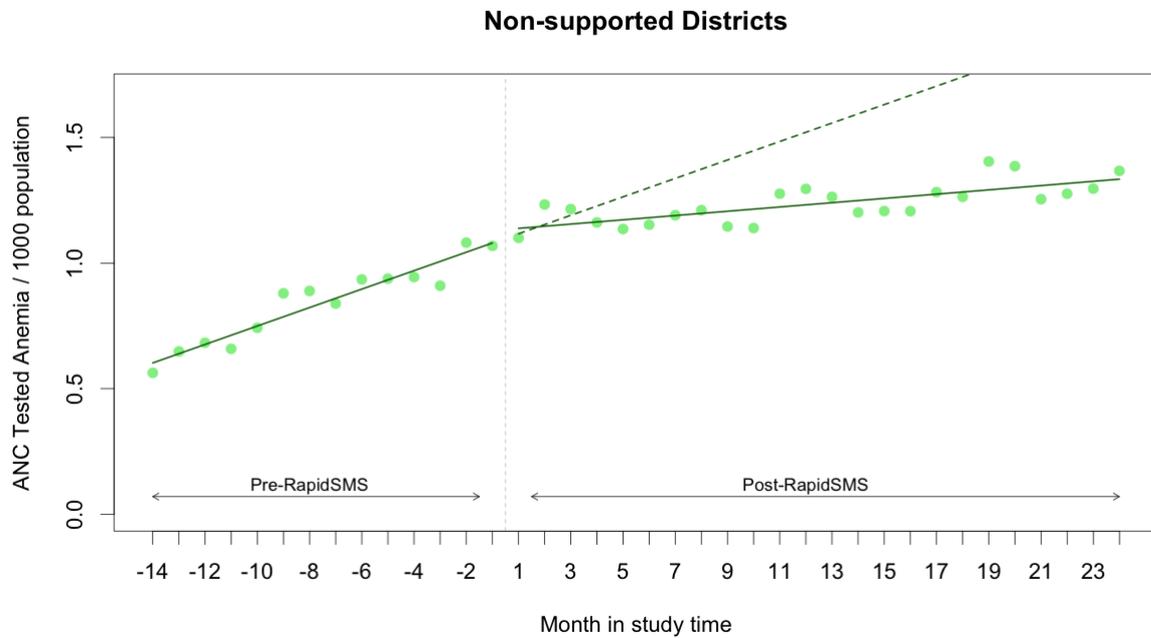
Figure 20. ITS analysis of ANC Anemia tests conducted per 1,000 catchment population in non-supported Districts

ANC Malnutrition Screening

We found no increases in the rates of ANC malnutrition screening, as shown below in Figure 21 and Figure 22. Both charts exhibit a drop in trend following the start of the RapidSMS program, but only the estimate for non-supported regions was statistically significant (estimate=-0.021, 95%CI: -0.037 to -0.004, p=0.02).

UNICEF-supported Districts
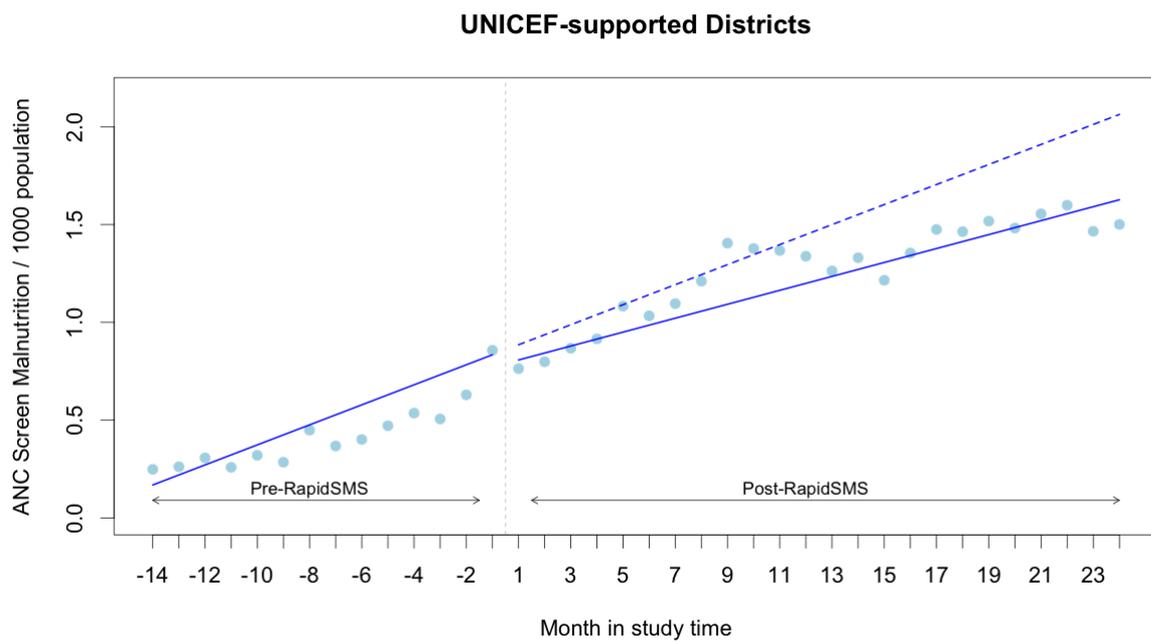
Figure 21. ITS analysis of malnutrition screening per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
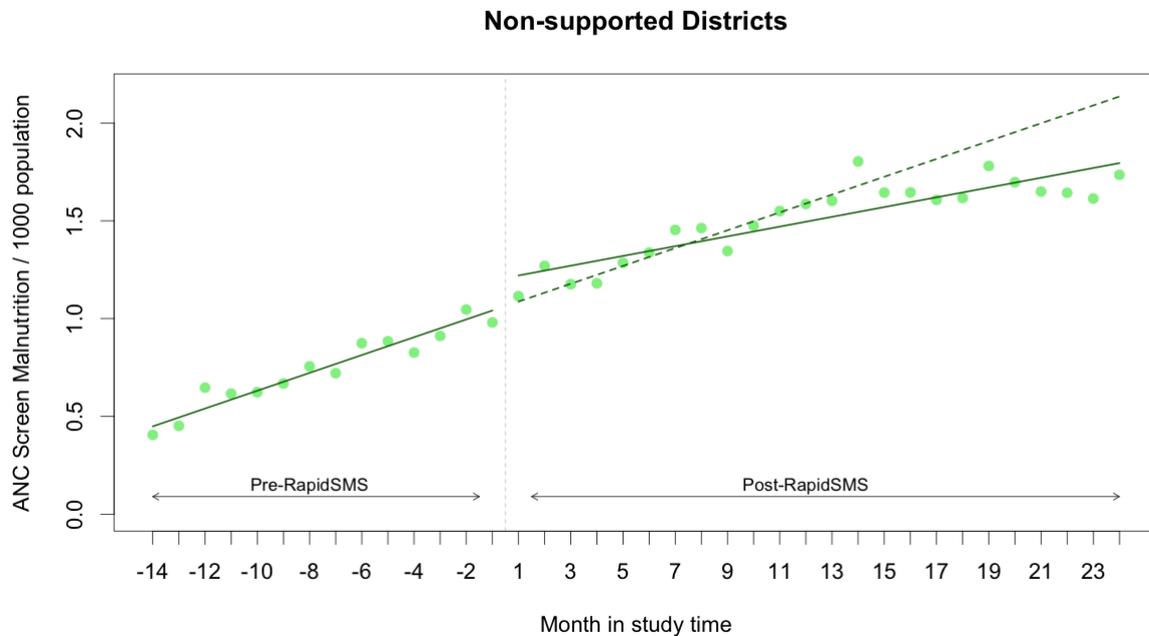
Figure 22. ITS analysis of malnutrition screening per 1,000 catchment population in UNICEF supported Districts

Delivery Outcomes

Our analysis of delivery-related outcomes included two indicators: the rate of facility deliveries and the rate of infant referrals to a higher level of care.

Facility Delivery Rates

The rate of delivery in health facilities per 1,000 catchment population are shown below in Figure 23 and Figure 24. Notably, both UNICEF districts and non-supported Districts demonstrated a declining trend in the rates of facility deliveries prior to the start of RapidSMS. As shown in the first Figure, the start of RapidSMS did not change the level in UNICEF supported Districts, but it did halt this pre-existing trend (trend change estimate=0.015, 95%CI: 0.007 to 0.023, p<0.001). This represents a 17.6% relative increase over the number of facility deliveries that would have been expected 1 year after the start of RapidSMS. In contrast, there was no change in either the level or trend of facility delivery rates in non-supported districts (p=0.69 and 0.70, respectively).

UNICEF-supported Districts
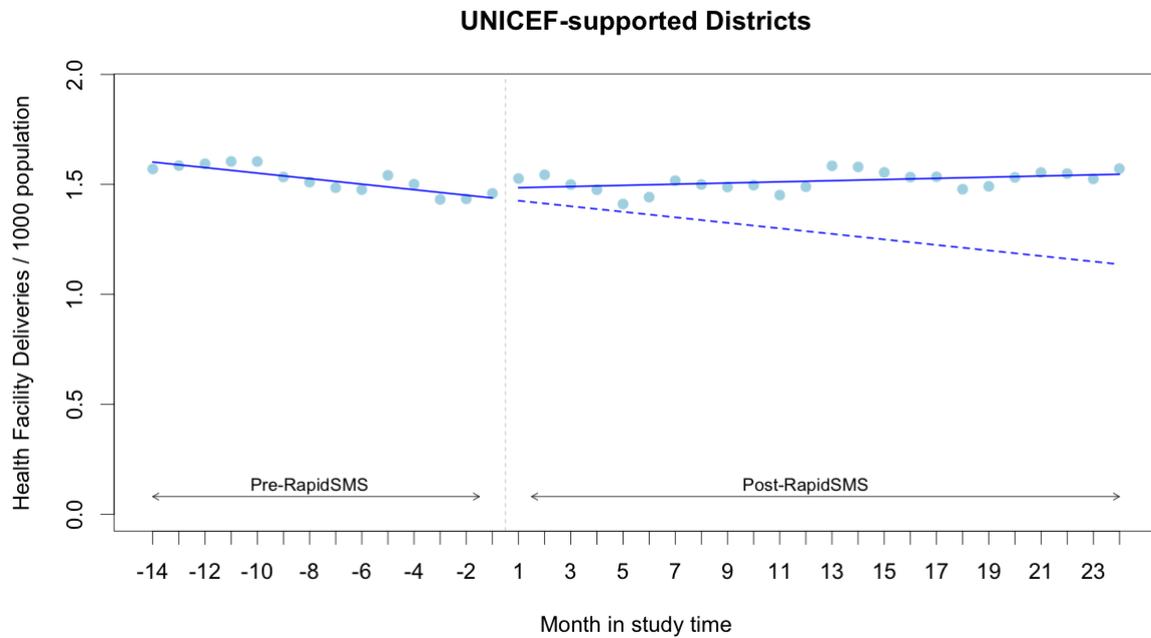
Figure 23. ITS analysis of facility deliveries per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
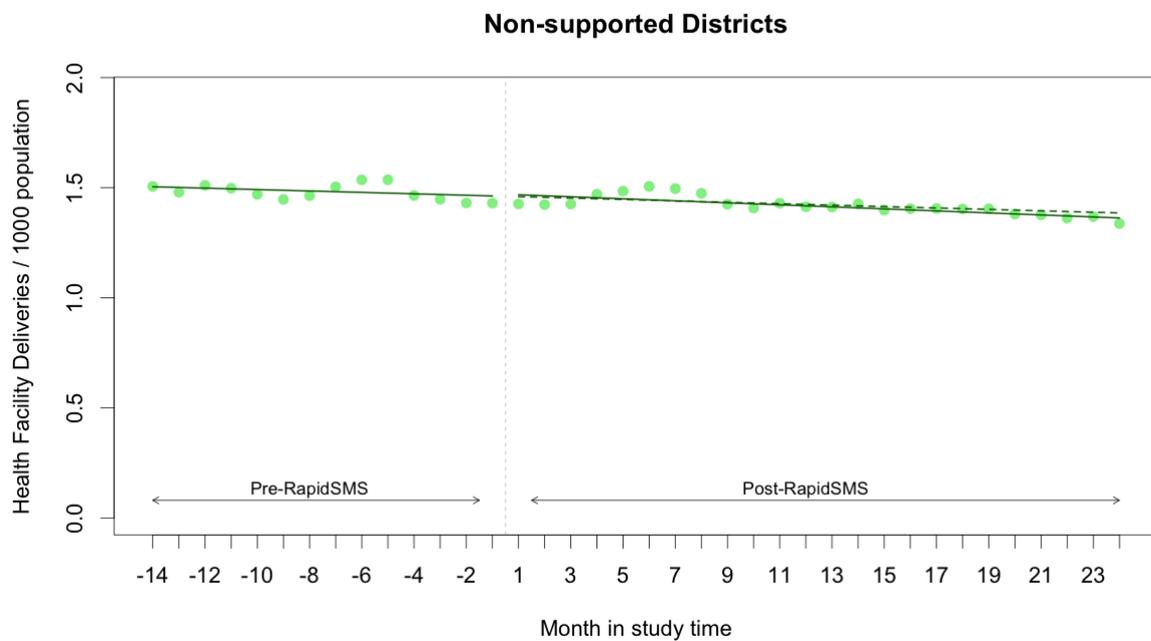
Figure 24. ITS analysis of facility deliveries per 1,000 catchment population in non-supported Districts

Infant Referrals to Higher Levels of Care

As shown in Figure 25 and Figure 26, the trend in rates of infant referrals to higher levels of care increased in both UNICEF supported and non-supported Districts. However, the rate in UNICEF districts was not statistically significant (estimate=0.003, 95%CI: -0.001 to 0.006, p=0.11), while the trend change in non-supported Districts was statistically significant (estimate=0.003, 95%CI: 0.000 to 0.005, p=0.04).

UNICEF-supported Districts
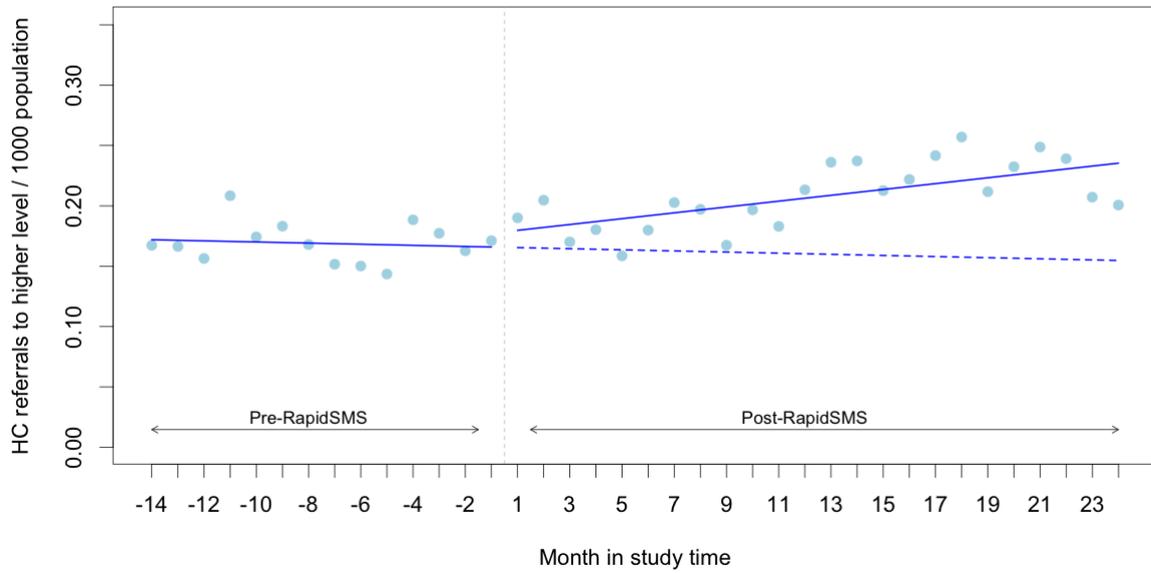
Figure 25. ITS analysis of health facility infant referrals to higher levels of care per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
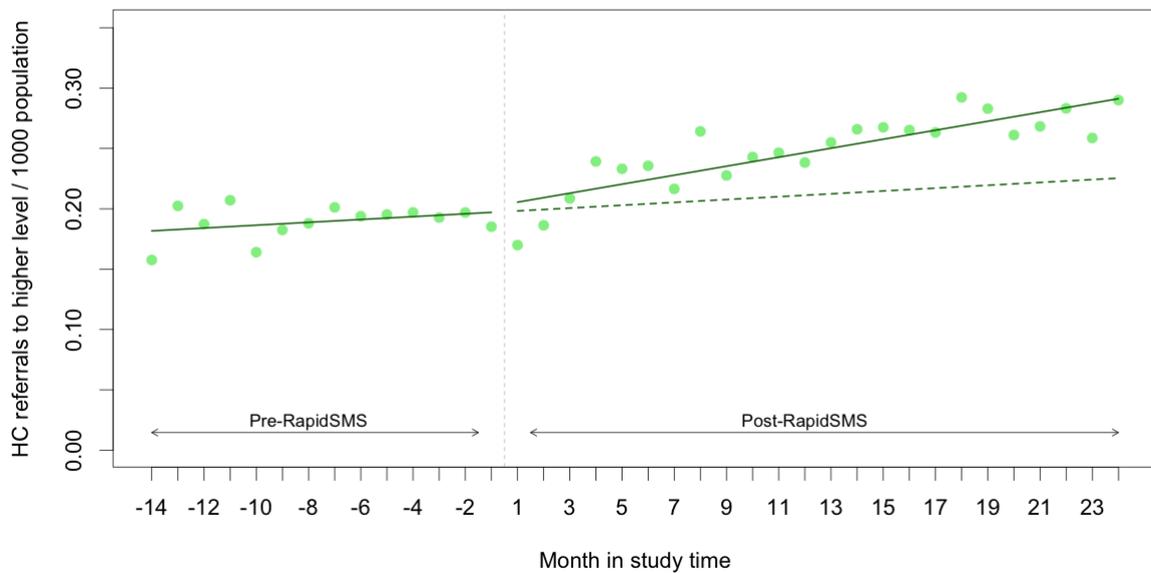
Figure 26. ITS analysis of health facility infant referrals to higher levels of care per 1,000 catchment population in non-supported Districts

Post-Birth Outcomes

Our analysis included several outcomes regarding post-natal care services (PNC), neonatal death rates, and the receipts of childhood services including immunizations.

Postnatal Care Registrations

The rate of new registrations for PNC services are shown below in Figure 27 and Figure 28. It is worth noting that these figures are based on data from fewer health centers than the above outcomes: due to missing data, our sample for PNC visits was limited to 88 health centers: 20 UNICEF supported and 68 non-supported. As shown in the first Figure, we found an immediate increase in the rate of new registrations in UNICEF supported districts of 0.048 new registrations / 1000 catchment population (95% CI: 0.010 to 0.085, p = 0.02). While the estimated change in trend was negative, it was not statistically different from zero and did not cancel out this level increase over 24 months. Similarly, we found a level increase of 0.030 new registrations / 1000 catchment population in non-supported districts (95% CI: 0.011 to 0.048, p=0.003). The estimated trend was also negative, and also statistically non-significant, for this group, but did return the estimated trend back to the expected level after 16 months.

UNICEF-supported Districts
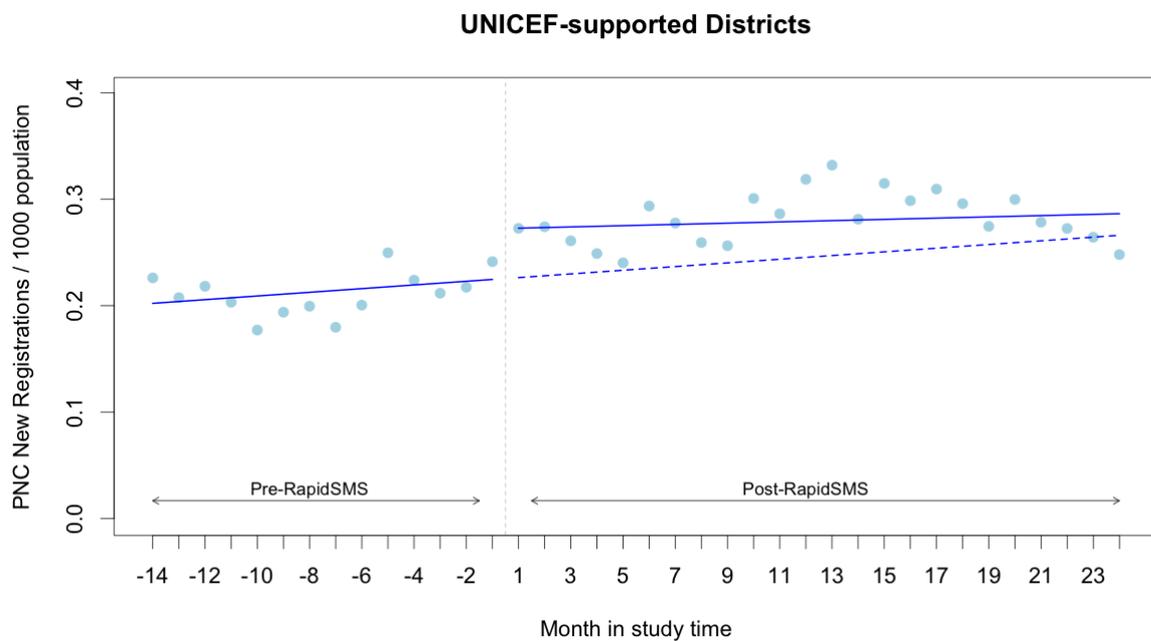
Figure 27. ITS analysis of new PNC registrations per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
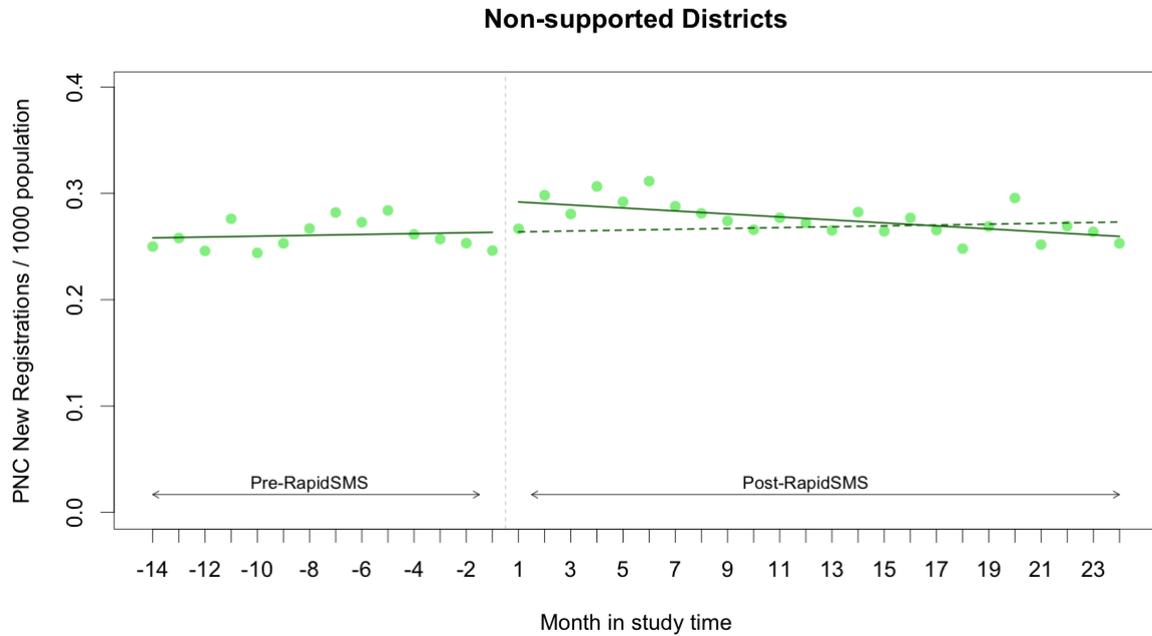
Figure 28. ITS analysis of new PNC registrations per 1,000 catchment population in non-supported Districts

PNC Visits

Due to missing data issues in many health centers, we chose to analyze the rate number of all PNC visit types together (including 0-3 day visits, 4-9 days, and 10-42 days). As shown in Figure 29 and Figure 30, we found a dramatic difference in the impact between UNICEF supported and non-supported Districts. We found that the start of the RapidSMS program was associated with a 0.11 visits / 1,000 catchment increase in the level of PNC visits (95% CI: 0.033 to 0.179, p=0.007). We also found an increase in the trend, but this change was not statistically significant (p=0.11). Together, our estimates suggest that PNC visits increased 100% at 1 year over what would have been expected based on existing trends. In contrast to this, we found no change in the level in total PNC visits / 1000 catchment population in non-supported Districts (p=0.13), but did find a significant decline in the trend of -0.005 PNC visits / 1000 catchment population / month (95% CI: -0.009 to -0.002, p=0.007). This equated to a 10% reduction the total PNC visit rate versus what would have been expected based on existing trends.

UNICEF-supported Districts
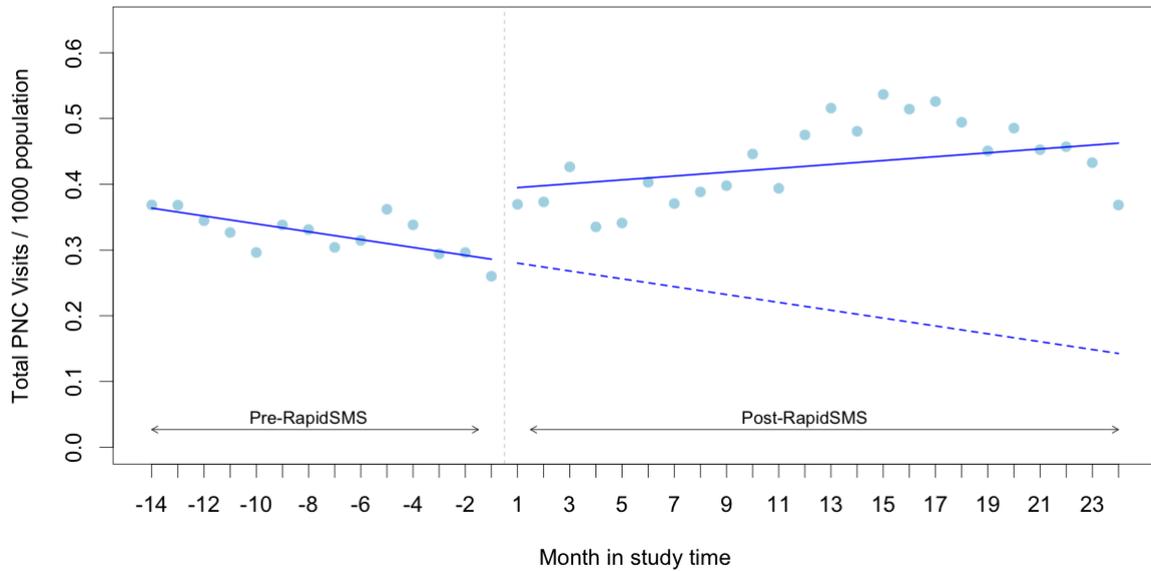
Figure 29. ITS analysis of total PNC visits per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
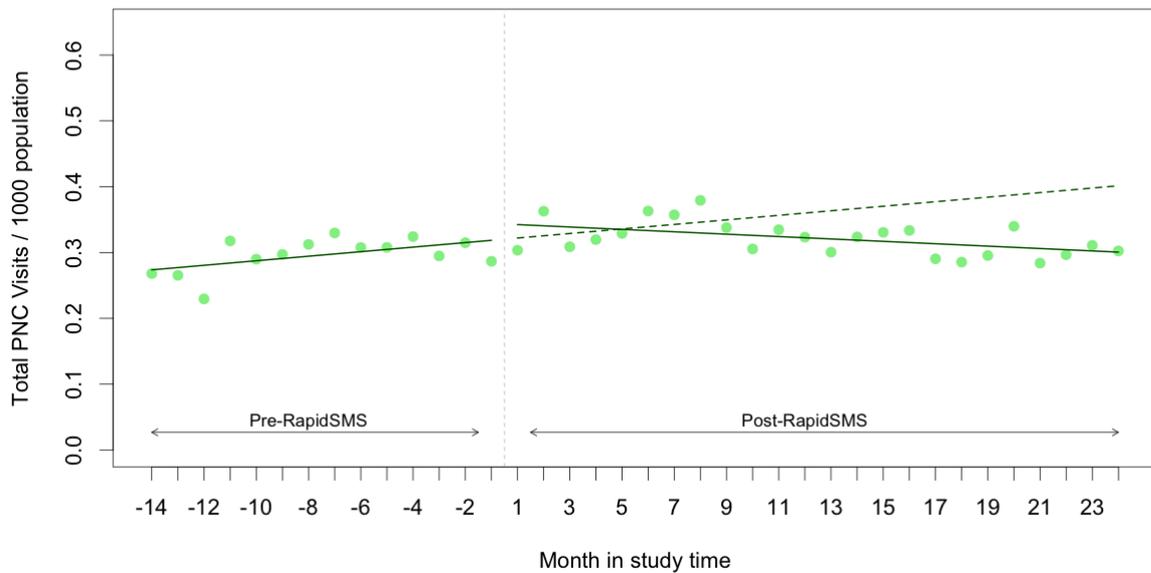
Figure 30. ITS analysis of total PNC visits per 1,000 catchment population in non-supported Districts

PNC Malnutrition Screening

Similar to the results for total PNC visits, we also found a stark difference in the impact of the start of the RapidSMS program on PNC malnutrition screening rates. As shown in Figure 31, rates of PNC malnutrition screening showed no change in level in UNICEF supported districts (p=0.47), but did demonstrate a large shift in trend of 0.180 screenings / 1000 catchment / month after the RapidSMS program started (95% CI: 0.121 to 0.240, p < 0.001). In contrast, our analysis of non-supported districts, shown in Figure 32, found no change in either the level or trend of screenings (0.29 and 0.54).

UNICEF-supported Districts
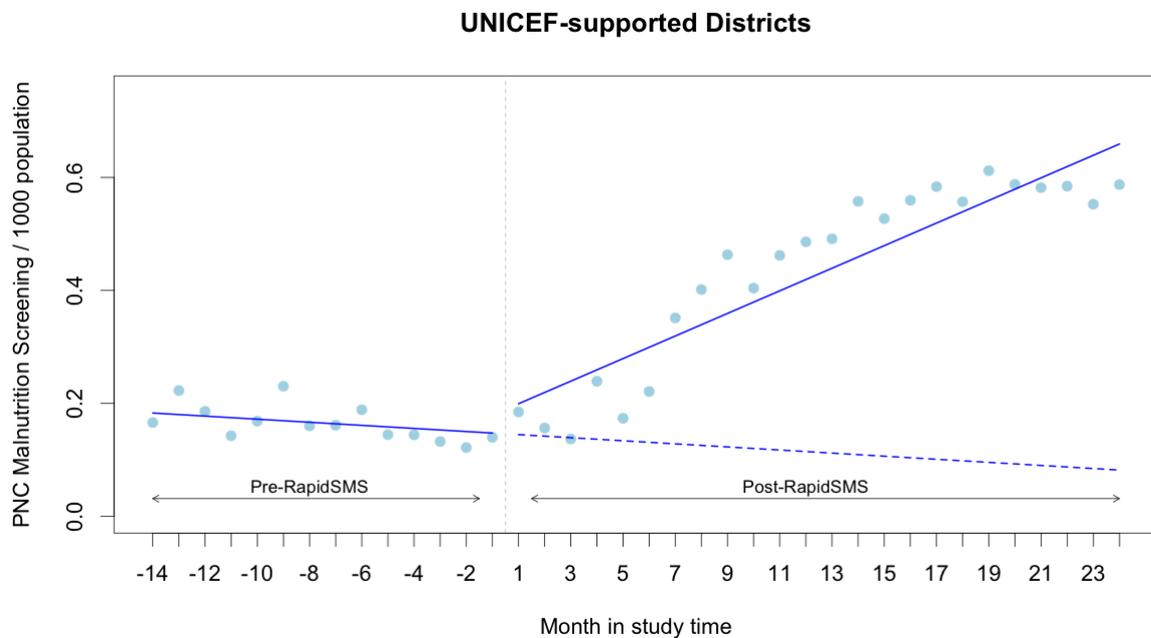
Figure 31. ITS analysis of total PNC malnutrition screenings per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
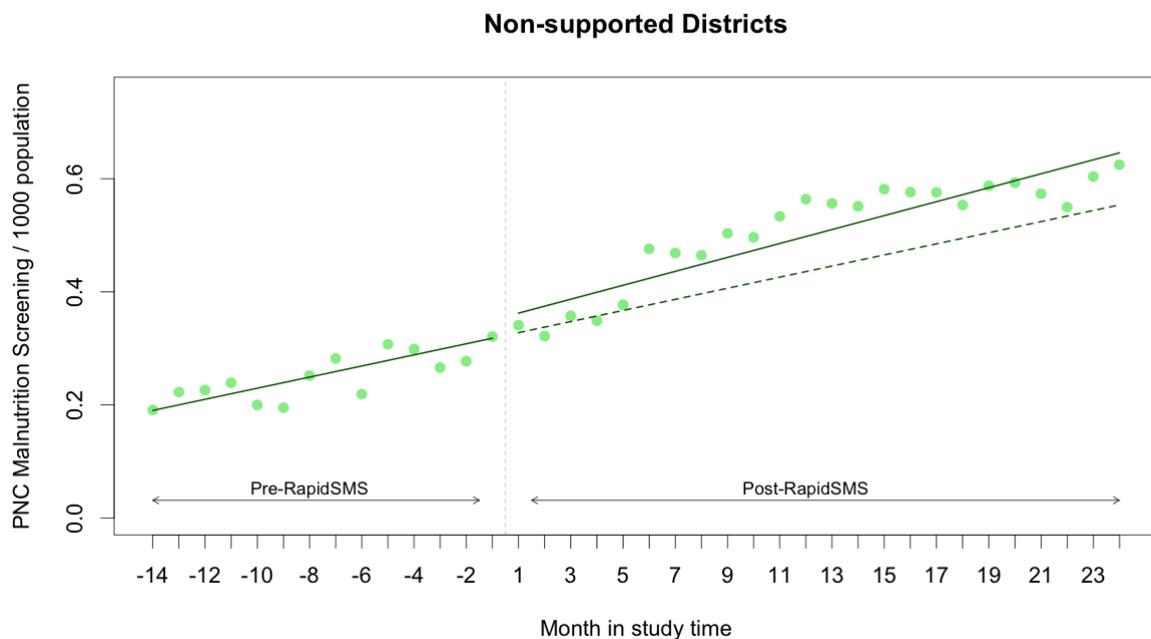
Figure 32. ITS analysis of total PNC malnutrition screenings per 1,000 catchment population in non-supported Districts

Deaths at Birth

The rate of infant deaths at birth per 1000 catchment population are shown in Figure 33 and Figure 34. As shown in both figures, the recorded rate of infant deaths in health centers was quite low and highly variable over the study period. While the estimates for infant deaths at birth in UNICEF supported districts showed an increase in both level and trend, neither of these results were statistically significant (p=0.28 and 0.54, respectively). We did observe a level decrease in deaths in non-supported districts of -0.0013 per 1000 catchment population (95% CI: -0.0021 to -0.0005, p=0.002), but no significant change in trend (p=0.29).

UNICEF-supported Districts
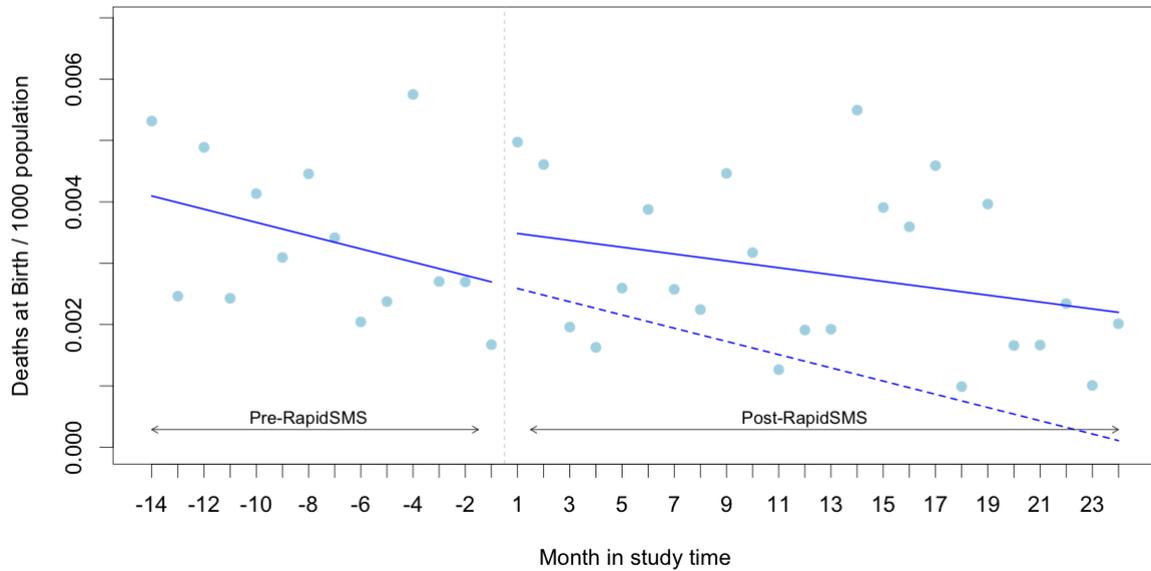
Figure 33. ITS analysis of infant deaths at birth per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
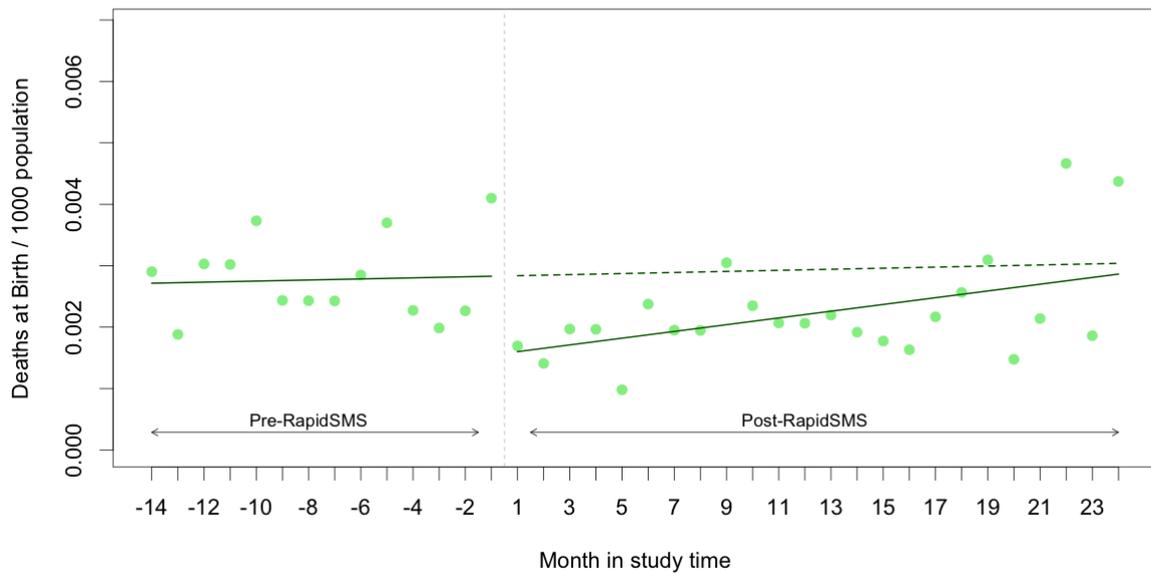
Figure 34. ITS analysis of infant deaths at birth per 1,000 catchment population in non-supported Districts

Child Vaccinations

We included 4 types of routine childhood vaccination in our analysis: BCT, DPT, Polio, and Pneumococcal. While Rwanda also has immunization programs for Measles and Rotavirus, these programs were modified or introduced during the course of our study period and thus did not have consistent data available over time in HMIS. As the patterns of our results are consistent across the different times for vaccination (e.g. the 2nd and 3rd immunization for Polio), below we just present results for the first vaccination event.

The rate of BCG vaccination per 1000 catchment population is shown below in Figure 35 and Figure 36. The Figures show a stark difference in the change in vaccination at the launch of the RapidSMS program. While there was no change in the level of BCG vaccinations in UNICEF supported areas, there was a change in trend of 0.037 (95% CI: 0.025 to 0.049, p < 0.001). This equates to a 26% increase in vaccination rates at 1 year versus what would have been expected based on existing trends. Conversely, we found no change in either the level or trend of vaccination rates in non-supported districts (p=0.52 and 0.30, respectively).
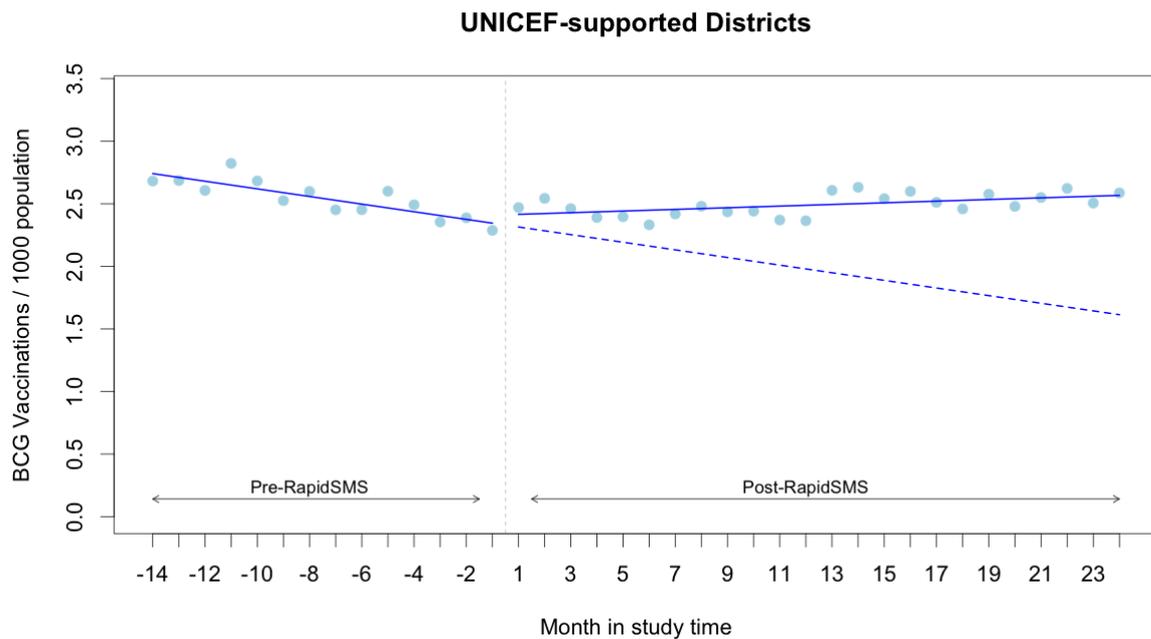
Figure 35. ITS analysis of BCG vaccinations delivered per 1,000 catchment population in UNICEF supported Districts
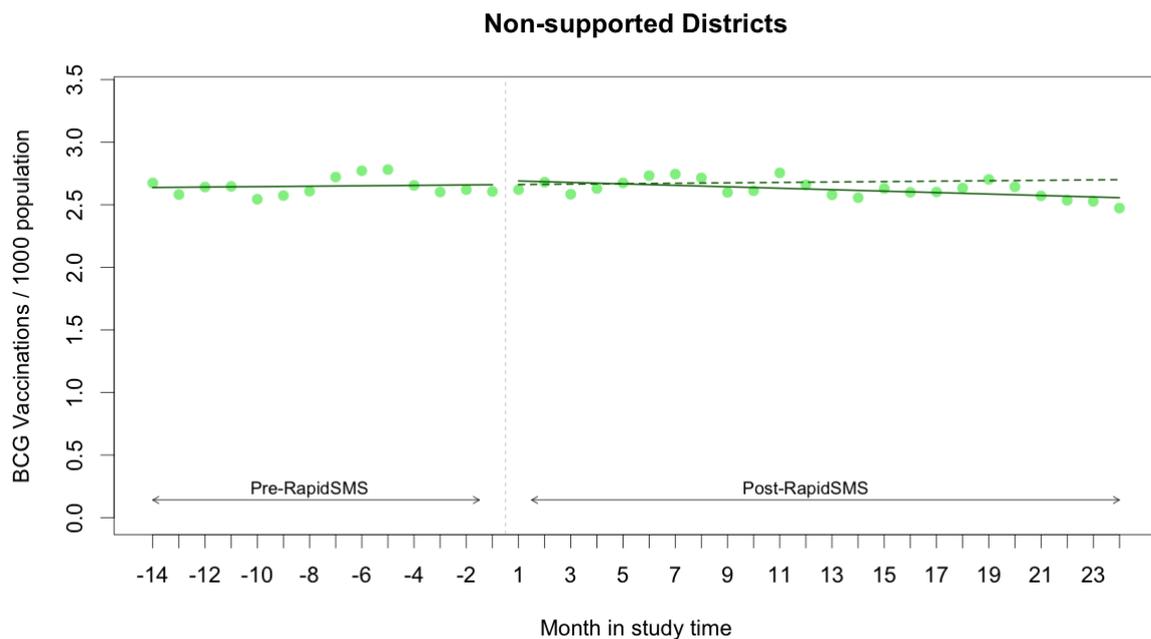
Figure 36. ITS analysis of BCG vaccinations delivered per 1,000 catchment population in non-supported Districts

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Our results for first DPT vaccinations per 1000 catchment population were very similar. As with BCG, we found no change in the level and a significant increase in the trend of DPT vaccinations in UNICEF supported regions (estimate = 0.024, 95% CI: 0.010 to 0.038, p=0.002). We also found no change in either the level or trend of non-supported Districts (p=0.93 and 0.38, respectively).

UNICEF-supported Districts
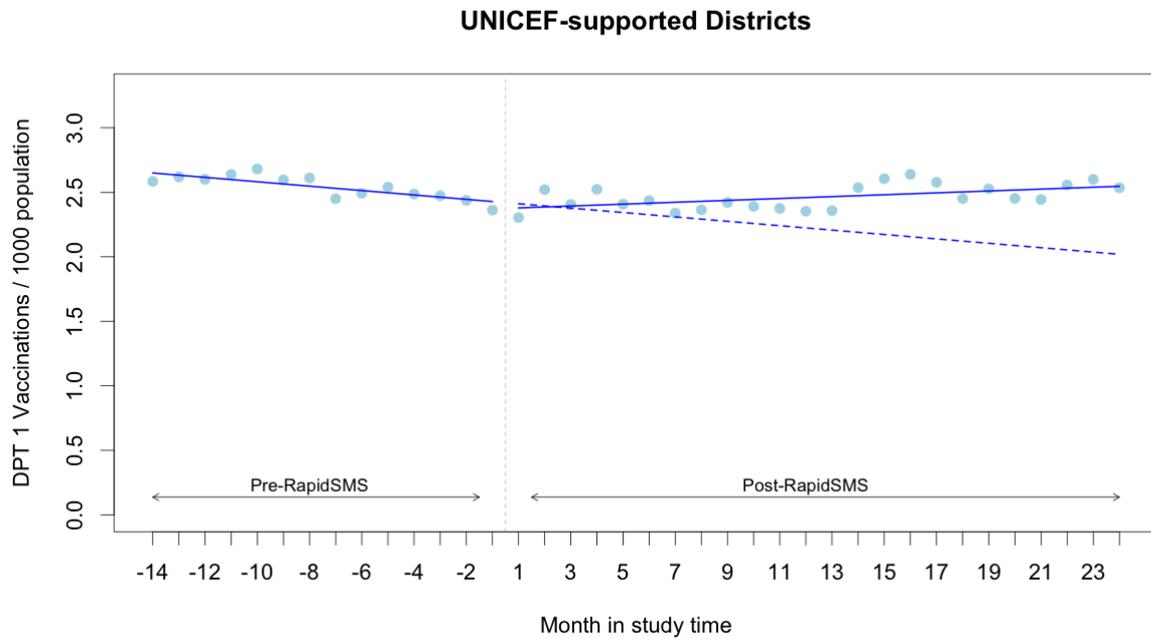
Figure 37. ITS analysis of first DPT vaccinations delivered per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
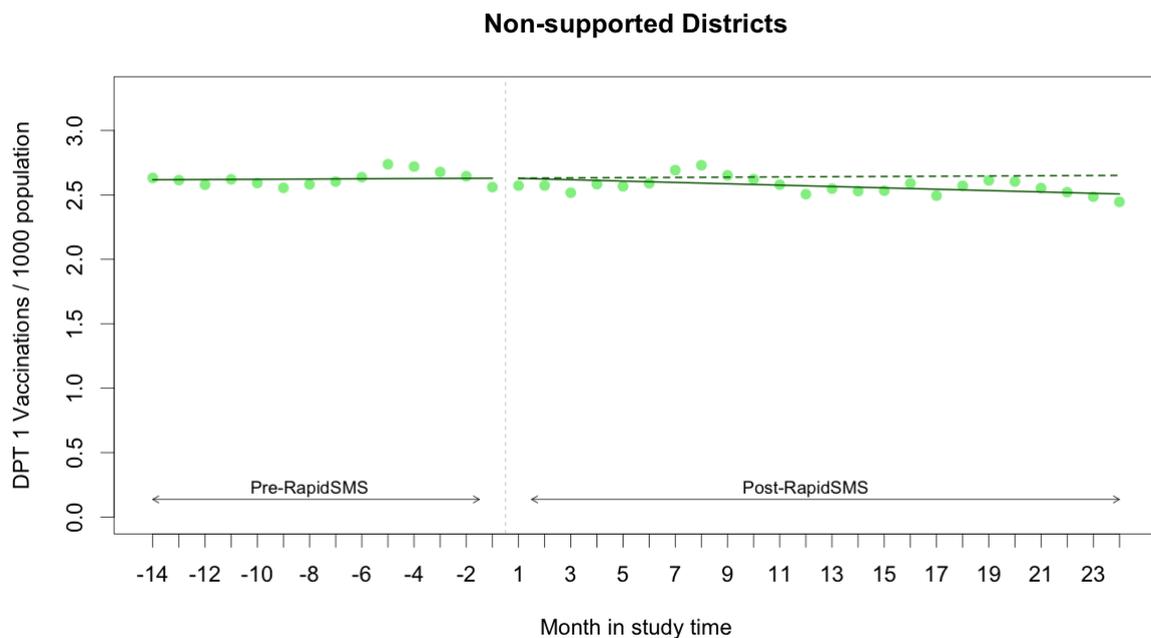
Figure 38. ITS analysis of first DPT vaccinations delivered per 1,000 catchment population in non-supported Districts

Finally, we also found similar results for the receipt of first polio and pneumococcal vaccinations, as shown in Figure 39, Figure 40. We similarly found increases in the trend in UNICEF Districts, and no changes in non-supported Districts (results not shown).

UNICEF-supported Districts
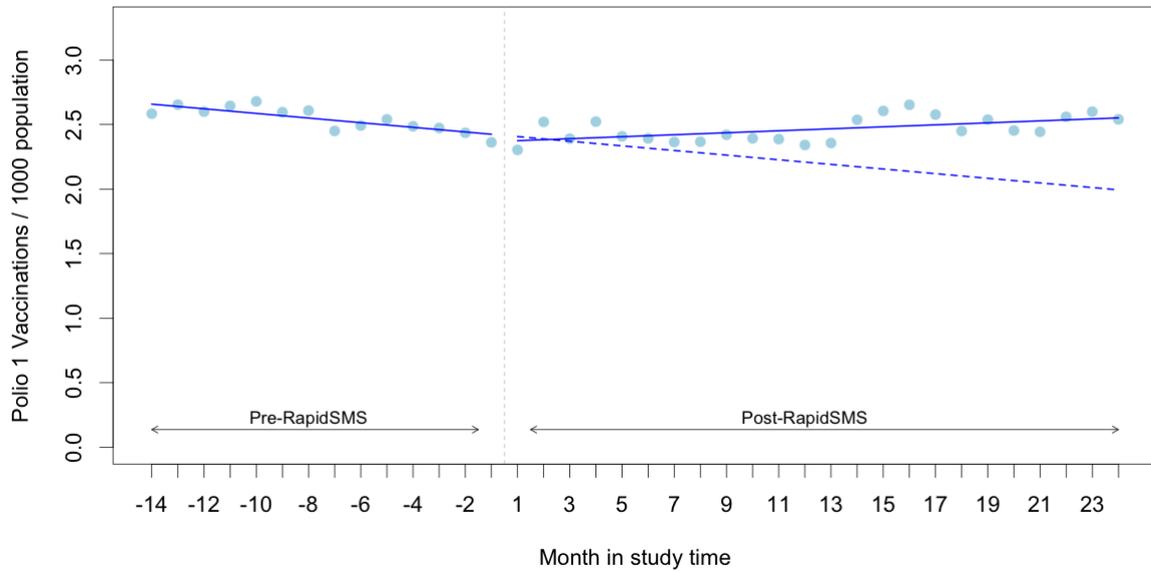
Figure 39. ITS analysis of first polio vaccinations delivered per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
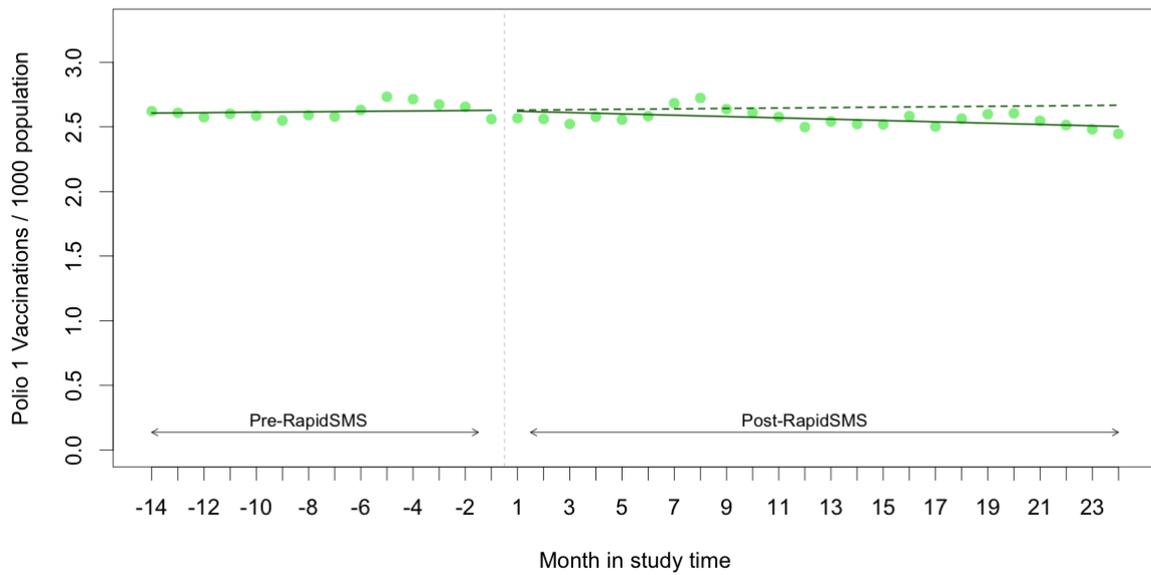
Figure 40. ITS analysis of first polio vaccinations delivered per 1,000 catchment population in non-supported Districts

UNICEF-supported Districts
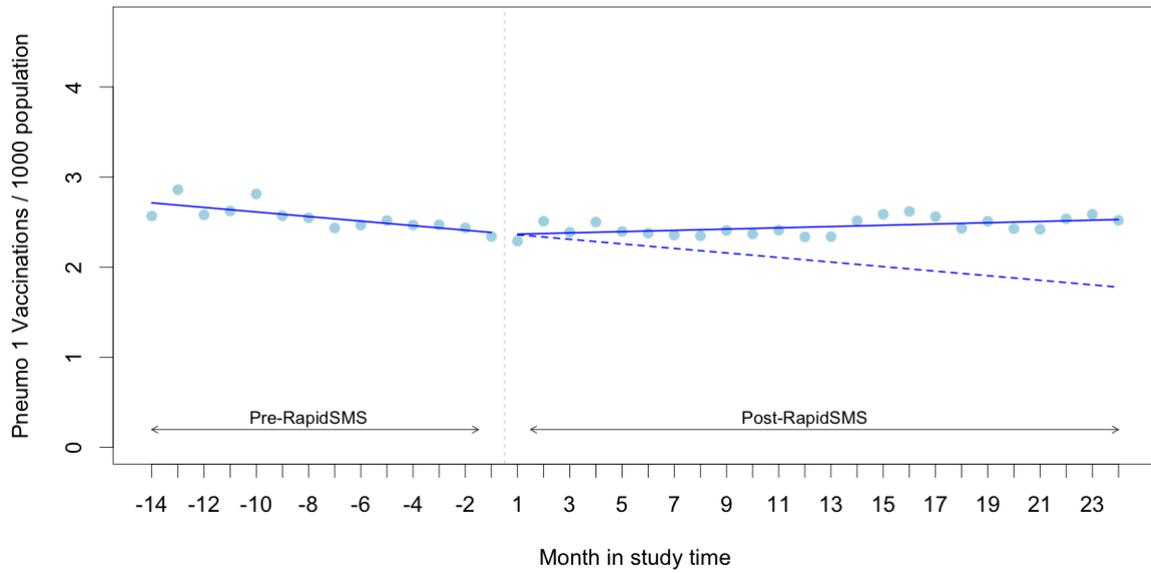
Figure 41. ITS analysis of first pneumococcal vaccinations delivered per 1,000 catchment population in UNICEF supported Districts

Non-supported Districts
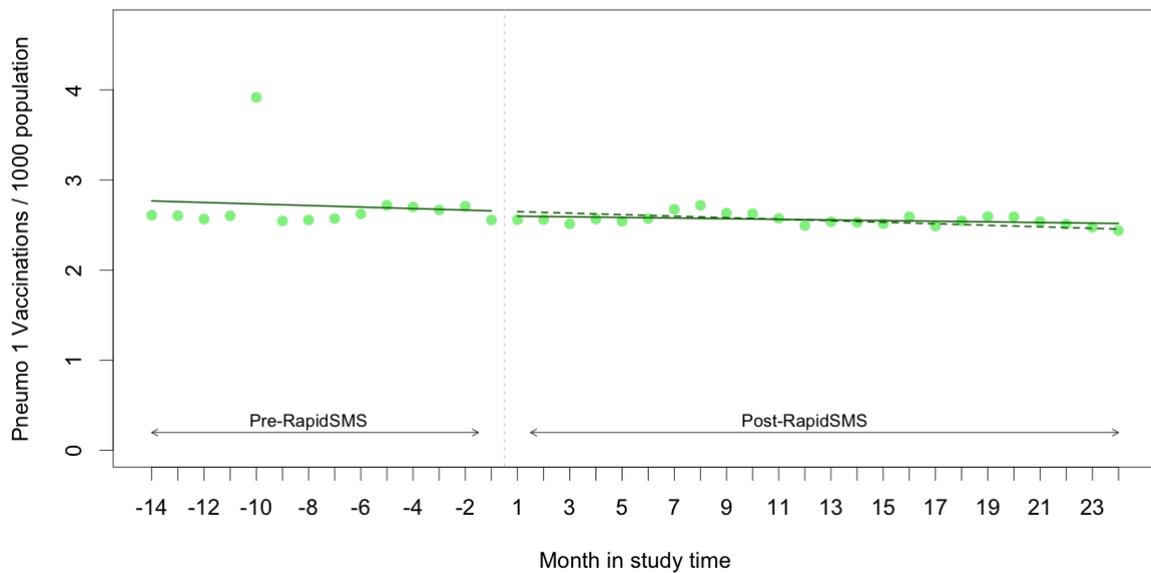
Figure 42. ITS analysis of first pneumococcal vaccinations delivered per 1,000 catchment population in non-supported Districts

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Evaluation Results: Qualitative Analysis

Interviews and Focus Groups Conducted

Of our targeted 32 key informant interviews, we were able to successfully conduct 28. The missing participants resulted from the refusal to participate on the part of two DHOs, a response from one targeted participant who refused based on her belief that she had relevant no information to share about RapidSMS, and a lack of response from one participant from a development partner who was thus not available for an interview. The full list of interviews conducted is shown below in Table 4. While we had expected to record all interviews and focus group discussions, one interview participant refused and thus notes were used in this instance. All 10 planned Focus Group Discussions were conducted, the details of which are outlined below in Table 5.

IDI/KII #	Gender	Position	Category
KII 1	M	DG of Clinical and Public Health Services	Ministry of Health
KII 2	M	eHealth Specialist	Ministry of Health
KII 3	F	Community Health Regulation Officer	Ministry of Health
KII 4	F	Director of Community Health Unit	Rwanda Biomedical Center
KII 5	F	Head of Midwifery Department	Academic
KII 6	M	Monitoring and Evaluation Officer	DHU
KII 7	M	Supervisor of Community Health Workers (Hospital-based)	Health Facility Authorities
KII 8	M	Supervisor of Community Health Workers (Hospital-based)	Health Facility Authorities
KII 9	M	Director of Health Information System	Rwanda Biomedical Center
KII 10	F	Maternal and Child Health Specialist	Ministry of Health
KII 11	M	Chairperson	Professional bodies
KII 12	M	Health Specialist	DP
KII 13	M	Head of Health Informatics Department	Academic
KII 14	M	Director of Health	DHU
KII 15	F	Supervisor of Community Health Workers (Hospital-based)	Health Facility Authorities
KII 16	M	Supervisor of Community Health Workers (Hospital-based)	Health Facility Authorities
IDI 1	M	In-Charge of Maternity department	Provider
IDI 2	F	In-Charge of Community Health	CHWs supervisor at HC level
IDI 3	F	CHW	Cell Coordinator
IDI 4	M	CHW	Cell Coordinator
IDI 5	M	In-Charge of Maternity department	Provider
IDI 6	F	In-Charge of Community Health	CHWs supervisor at HC level
IDI 7	F	In-Charge of Maternity department	Provider
IDI 8	F	In-Charge of Community Health	CHWs supervisor at HC level
IDI 9	M	CHW	Cell Coordinator
IDI 10	F	CHW	Cell Coordinator
IDI 11	F	In-Charge of Maternity department	Provider
IDI 12	F	In-Charge of Community Health	CHWs supervisor at HC level

Table 4. In-Depth Interview and Key Informant Interviews conducted

FGD #	# of Participants	Sex	Type of Participants	UNICEF supported
FGD 1	12	12 F	CHW	No
FGD 2	12	12 F	Mothers	No
FGD 3	10	8 F and 2 M	CHW	Yes
FGD 4	10	10 M	Fathers	Yes
FGD 5	10	10 F	Mothers	Yes
FGD 6	9	9 F	Mothers	No
FGD 7	7	7 M	Fathers	No
FGD 8	7	7 F	CHW	No
FGD 9	8	8 F	Mothers	Yes
FGD 10	8	7 F 1 M	CHW	Yes

Table 5. Details of the focus group discussion participants

Organization of Qualitative Results

In the below sections, we highlight relevant themes and representative quotes that emerged from all of the interviews and focus groups. We have grouped these into the broad areas of the research questions.

Problems intended to be addressed by RapidSMS

Universally, Central Level respondents (MoH, RBC) indicated that RapidSMS was created in an attempt to reduce maternal and child mortality. There were two mechanisms through which respondents felt this would happen. First, it was hoped that the system would help to track emergency maternal and child health threats in the community and allow an emergency decision to be taken as fast as possible. Second, participants felt that the system would help to increase the utilization of formal health care services, which in turn would reduce maternal and newborn mortality rates. A somewhat secondary goal was the collection of better data on maternal and child health.

> *"Briefly we started RapidSMS because we had the problem of maternal mortality rate and we come up with a solution, a digital solution to help us to reduce that … That was the primary objective but it was also to track the pregnant women, it was also to increase the numbers of assisted delivery, because in RapidSMS we do have a reminder once you are registered they are reminding you when you should come back for the second ANC visit, third and fourth and probably ."*
> - *Central level Participant*
>
> *"I think it was implemented with the aim to quickly dispatch any information regarding Maternal and Child Health. Yeah, I think it was done for this purpose, so that any emergency would be communicated either to the health center or at hospital level and for gathering necessary information on maternal and Child Health on the indicators recorded in Rapid SMS system"*
> - *Central level participant*

Similar to the Central level respondents, all District level participants including those from District Hospitals and administrative District Health Units felt that the objective of implementing the RapidSMS system was the prevention of maternal and early childhood deaths. This group also felt

that RapidSMS was intended as a tool for monitoring maternal and child health at the community level.

> *"The system was put in place to reduce the maternal and child deaths, which at that time was an issue. … It was intended to help us monitor the mother and child's health from pregnancy until she reached the Health facility for delivery and birth."*
> - **CHWs supervisor at DH level in a UNICEF supported District**
>
> *"The objective of RapidSMS when it was initiated was primarily to reduce maternal and child mortality. That was the main objective."*
> - **CHWs supervisor at DH level in a District not supported by UNICEF**
>
> *"The intent was mostly to reduce deaths. It was a tool to simplify the monitoring of maternal and child health with an aim to reducing maternal death during delivery, perinatal mortality, and early childhood death."*
> - **DHU participant from a UNICEF supported District**
>
> *"The indisputable objective of RapidSMS was the monitoring of child health during the first 1000 days of life. These days include the pregnancy period, so the system was intended to prevent all pregnant related complications and home deliveries…"*
> - **DHU participant from a District not supported by UNICEF**

The Impact of RapidSMS

There was near-universal agreement from participants in all categories that RapidSMS contributed to reducing maternal and child mortality rates in Rwanda. Further, there was consistent sentiment that the system generally contributed to improvements in the quality of services provided both in the community and in health facilities. The one caveat expressed by several participants at the central and district level was that RapidSMS was not the only program during this time that would have contributed positively to maternal and child health improvements.

> *"I can see we dropped maternal mortality we reached MDG, about maternal reducing maternal mortality we reached MDG… and the impact is very positive for me and may be statistically you can't report what is related to RapidSMS only because there were so many interventions in the area. But generally it is contributing so much toward the reduction of maternal and newborn and child mortality."*
> - **Central level participant**
>
> *"RapidSMS has helped a lot to prevent maternal, child and neonatal death. Through the collaboration between the health facility and CHWs and the information shared with RapidSMS, once the mother is reminded and attends the needed service on time, providers are motivated to do their best to keep the newborn and the mother alive".*
> - **CHW from a district not supported by UNICEF**
>
> *"What I can say, it was generally improved. Before 2012, maternal and child mortality was high, but nowadays, it is reduced".*
> - **Male parent from a UNICEF supported district**

The Relevance of RapidSMS

Alignment with National Priorities and Strategies

In terms of the alignment of the RapidSMS program with national priorities and strategies, Central Level interviewees were of the belief that RapidSMS is well aligned and has contributed to achieving both national and international health-related targets. Similarly, both District-level authorities as well as Health center and community level providers mentioned that RapidSMS has helped them to reach targets included in their performance contracts. There was less consistency in views regarding how much the data produced by RapidSMS has contributed to generating future policy directions.

> *"…international MDG goals four and five were fully in RapidSMS because they are about reducing maternal mortality and child mortality… coming back to EDPRS and increasing the wellbeing of Rwandans, you can't get the well-being of Rwanda when people are dying especially those vulnerable ones which are the pregnant women and new born up to five years old. RapidSMS was addressing it … It was among the top priorities for the government of Rwanda, even IDRPRS, HSSP2 and 3. RapidSMS fitting with all Government of Rwanda plans, even their international commitments."*
> *- Central level participant*
>
> *"Among our District performance targets, one is rates of assisted delivery. When a mother delivers at a health facility it shows that we are able to take care of our community. It is a pride of our villages, our health center, and our whole country."*
> *- CHW from a district not supported by UNICEF*
>
> *"RapidSMS includes a nutrition component, four standard ANC visits, [reminders to] prevent home deliveries and we have all these elements in our performance targets and District priorities…"*
> *- District Health Unit member*

Acceptance of RapidSMS by the community

Generally, participants at the district level along with beneficiaries felt that RapidSMS was well accepted by most CHWs and community members. It was also mentioned that CHWs like the system because it increased the quality of their collaboration with community members. Members of the community also indicated they valued the speed with which messages could be sent in comparison with the time a formal appointment at the health center would consume. Though this was the general perception, we also heard that there is a small proportion of community members who have a negative view of the system.

> *"They accept it! Now you will find women who take the initiative to look for a CHW to share the information that she is pregnant. Some also ask the CHW if the information about the fact that she is pregnant was sent through RapidSMS! After delivery, some also remind the CHW to send a message about the event. But this is not yet 100% of women."*
> *- CHW supervisor at HC level in a District not supported by UNICEF*
>
> *"CHWs are very pleased to use the system! They are happy to see how they are assisting women and women are asking them to send both common and alert messages for their emergency cases."*
> *- CHW supervisor at HC level in a UNICEF supported District*
>
> *"We are motivated to use the system. However, some community members have a poor mindset regarding RapidSMS thinking that we are selling their information and getting paid for the information we send. As a result, sometimes they hide*

> *the needed information."*
> *- CHW from a District not supported by UNICEF*
>
> *"CHWs are highly accepting of the system. They consider it an innovation that increases awareness about them and their value in the communities in which they are working."*
> *- CHW supervisor in urban area*
>
> *"RapidSMS is useful for us in the community. When a CHW finds a health problem, a message is sent. That process is faster than traveling to reach the Health center and waiting to share it face to face. We consider this a very helpful system."*
> *- Father from a UNICEF supported District*

The Effectiveness of RapidSMS

The majority of participants pointed out that RapidSMS has reached the intended beneficiaries. However, there was some concern about specific subgroups who are difficult to obtain information from. There was a general perception that the program contributed to improvements in the maternal, newborn, and child health continuum of care and increased access and utilization of the maternal and newborn services. More specifically, there were noted improvements in the knowledge, skills, and practices of CHWs on essential maternal and newborn care that resulted from RapidSMS. However, none of participants noted an improvement in Health center providers' knowledge or skills that prompted by RapidSMS.

> *"If you have a sign of danger reported, then there is a reaction. If you know what is going on and you need to intervene, you can send an ambulance to pick up these ladies. If you don't have this means of communication [RapidSMS] then you can't react. So this is something we can say is very tangible."*
> *- Central level participant*
>
> *"CHWs are becoming great health care providers! Currently they have high-level knowledge and skills to provide health care. Many of those who started with RapidSMS can provide health care services upon which a health facility provider could add nothing. They can treat children and follow a pregnant woman and refer them or send an alert message at the right time."*
> *- Health care provider from a UNICEF supported district*
>
> *"...more women are delivering at health facilities and risks of perinatal and postnatal complications have been reduced. They are always followed up by CHWs who visit them at home when they are pregnant, and who perform postnatal visits. And this is done with reminders from RapidSMS sent to CHWs. We can follow this by entering in the RapidSMS system!"*
> *- Supervisor of CHWs at UNICEF supported District Hospital level*

All beneficiaries including women and men from the different focus group sites confirmed that RapidSMS helped them to utilize health facility services. Rural area CHWs pointed out that poor women, those living with mental problems, and those with a "poor mindset" are hard to reach and report on using RapidSMS. Often this is the result of being unable to share that they are pregnant for reasons of stigma. On the other end of the spectrum, CHWs from urban settings said that the hardest women to report on were those that are wealthy.

> *"What I will mention is that when you give the information to the CHW that you attended ANC, she reports that using RapidSMS. I experienced this: I told her the truth and gave her the right information about my probable date of birth. One evening she came to see me stating that she received a reminder that I was about to deliver and that I should go to the Health facility. We left the village and reached the Health center at the right time."*
> *- Mother from a District not supported by UNICEF*
>
> *"...Pregnant women who live with mental disability are hard to reach and report through RapidSMS. They are not able to reveal that they are pregnant."*
> *- CHW from a rural District not supported by UNICEF*
>
> *"poor women and single ones are also a challenge because they hide that they are pregnant."*
> *- CHW from a rural District not supported by UNICEF*
>
> *"...we have two villages that have been assigned CHWs who are supposed to help the community. But, for example, how can a CHW report a birth for a woman who delivers in France? The CHW who is in charge of children health obviously cannot see those children!"*
> *- CHW from an Urban District not supported by UNICEF*

The Efficiency of RapidSMS

Universally, participants who responded to questions about the efficiency of RapidSMS felt that the allocated resources have been used efficiently to achieve the project objectives. Surprisingly, some central level participants were not knowledgeable about the financial resources allocated to RapidSMS, which limited their ability to comment on this point. In contrast, participants shared widely divergent opinions regarding the adequacy of the resources allocated to RapidSMS. Similarly, there were differing opinions on how to improve the efficiency of the program in order to better meet its objectives. These divergent opinions could be found both within the same level of respondents, and between different levels of participants.

> *"...at this time now we need to sit with UNICEF to understand costing, because the big amount of costing is supported by UNICEF..."*
> *- Central level participant*
>
> *"The human resources deployed for this system matched our expectations. Maybe we have had a problem on the side of finance where we critically needed a lot of money to support implementation. Also, because RapidSMS is a reporting system it needs to be hosted. We needed the costing of hosting, we needed the cost of reporting materials. So, on the side of money, this is where we have had problems. But in terms of human resources, I think there has not been any challenge."*
> *- Central level participant*
>
> *"The financial resources allocated to RapidSMS are adequate. Requesting more would be exaggerating the true need. The proof of this is that the system did not stop functioning due to insufficient financial resources."*
> *- CHW supervisor at HC level in a UNICEF supported District*
>
> *"the money that was so-called allocated for RapidSMS was for the entire health program: training on maternal and newborn health care, procuring new*

> *equipment for newborns... But, if you talk of the money which was used for managing the system, it is very little... For the whole year, we have not been given more than 60,000 USD!"*
> **- Participant from a DP**
>
> *"The human resources are not enough. The program should add maternity service providers who have direct access to RapidSMS to support the existing health center staff."*
> **- Provider from a District not supported by UNICEF**

The Sustainability of RapidSMS

The majority of participants at all levels expressed their hope that RapidSMS proves to be a sustainable system. Several factors were noted by participants that can help to sustain the program, namely the motivation of CHWs, the high level of technology use in Rwanda, and the political commitment the program has had thus far. The most substantial threat to the sustainability of that system that was noted was the current reliance on Developing Partner funds. Most of central level participants said that the Government will need to fund the continued maintenance and improvements to the system before these partners withdraw their funds to ensure its sustainability.

> *"I have no doubt UNICEF will do whatever it can to mobilize resources. But this requires Government involvement and commitment, and overall support. As long as the Government makes it a priority, UNICEF will always try to mobilize support for the initiative."*
> **- Participant from a DP**
>
> *"...all this is part of the dialogues about sustainability of health sector in general. How can we gradually get out of budget financing by partners? As you know, this is not about the Ministry of Health. If you see the strategic document of the government, if you read vision 2020, if you see EDPRS..."*
> **- Central level participant**
>
> *"CHWs are motivated to use RapidSMS. This shows that it is certain that they will continue to use it in the future at a more satisfactory level."*
> **- CHW supervisor at DH level in a District not supported by UNICEF**

At all levels, participants felt that the ownership of the system is an issue. At the District level, it was stated that the involvement of local authorities is needed to ensure the ownership of the system at this level. At present, there was a feeling that district and health facility authorities are not adequately involved in planning and management. At the Central Level, some interviewees felt that the system remains the property of partners.

> *"They is still doubt about the budget, the running costs. So, we can only assume that as soon as there is an impact of RapidSMS, the Government will take ownership of it and find money to continue supporting the system."*
> **- Central level participant**
>
> *"It is important to involve all stakeholders in the system planning, evaluation, and usage. For example, regarding system usage, RapidSMS data could be used by medical doctors for planning high risk pregnancy cases. It could also be used by district hospitals to supervise health centers and community health worker*

> *performance on maternal and child health."*
> **- Participant from Health professional association**
>
> *"Local authorities do not own the system because they are not involved in decision making."*
> **- CHW supervisor at HC level in a UNICEF supported District**
>
> *"Because the system was developed with the support of UNICEF, and continues to get financial support, UNICEF is still driving some aspects of the system. … ownership means that we should have a 100% ownership; both in terms of development, and in terms of maintenance."*
> **- Central level participant**
>
> *"As we are training people who will be working in maternal and child health services, we should make them familiar with the RapidSMS system. It would help to have information on that. Then they can know that the system exists and not be surprised to learn about it once they are in service."*
> **- Academic participant**

Universally, all participants mentioned that challenges with electricity are a constant issue which hinders the use of RapidSMS. This mainly impacts the ability of CHWs to engage in timely reporting in remote areas. Virtually all district participants felt this issue has to be addressed in order to improve the future performance of the system. Another major issue noted by participants is the regular turnover of volunteer CHWs. While participants felt that controlling this was beyond the scope of RapidSMS, it does result in the need for more frequent training of new reporters.

> *"Many CHWs do not have electricity at their homes. It is not easy for them to charge their phones in order to send RapidSMS reports at the right time. It is a big challenge. This affects the timeliness of our reporting."*
> **- Cell coordinator from a District not supported by UNICEF**
>
> *If CHWs were assisted in finding a way to charge their phones, the reporting rate through RapidSMS would increase.''*
> **- CHW supervisor at HC level in a UNICEF supported District**
>
> *"CHWs regularly leave their job. New ones are elected and their training is hard to perform and takes a long time."*
> **- CHW supervisor at HC level in a UNICEF supported District**

The Coordination of RapidSMS

The management of the system was given good reviews by some participants, and poor reviews by others. At the central level in particular, there were two different views about the way the system is managed and coordinated. Some participants shared that the system is well coordinated and managed, while others noted significant challenges that need to be addressed. At the District level, while hospitals have been charged with managing the system, DHU members expressed their wish to be more involved in the coordination and management of the system.

> *"I see a big issue with the change which took community health activities to RBC. It left a small department at the ministry, and it is scattered as you know. There is community health in clinical services, there is the community health cooperative*

> *in planning, and there is now the community health group in RBC. So it is a very big challenge to coordinate all of this. … it is not easy to manage any institution which is not within your responsibility and you can find that even meetings are not involving some people and you miss some meetings which are very important."*
> *- Central level participant*
>
> *"Briefly the Ministry is coordinating, setting the priorities, planning the system upgrade, coordinating through technical groups, approving the request forms from different divisions and then RBC implements work on daily basis and ensures technical responses, analysis, feedback and so on."*
> *- Central level participant*
>
> *"At the District level, the system management and coordination is based at District hospital. Administration at the District Office is informed about what is going on, but is not involved."*
> *- DHU level in a District not supported by UNICEF*

The Equity Focus of RapidSMS

According to the majority of respondents, RapidSMS started with Musanze District because the District had high needs and this choice was supported by UNICEF. Beyond Musanze, we heard mixed messages about the selection criteria for the other districts that were to receive UNICEF support, with some claiming need was accounted for, and others not. In particular, some participants from the central level were not sure about whether equity was considered when RapidSMS was started, or when decisions on UNICEF support were made. This was opposed by the opinion of a DP participant, who claimed that it was based on human rights-based and equity considerations.

> *"let's move on how we have started with Musanze. One, because the situation of Musanze whom home delivery was very high, newborn child mortality was very high. It was like a test, it was a model to see if it can help to improve."*
> *- DP participant*
>
> *"There was no formula. What we did, we just compiled the list of all districts. We started there … Some of them were not picked based on some factors or criteria".*
> *- Central level participant*
>
> *"I don't have the details about the selection, but I do remember that the first district was Musanze and UNICEF was very involved in the initiation of RapidSMS there. According to the mapping, Musanze was one of the districts supported by UNICEF, especially in child health."*
> *- Central level participant*

Perceived areas where RapidSMS is not currently having the intended impact

The majority of participants mentioned that there is no area where RapidSMS is not currently having the intended impact. This was a widely held view among different levels and types of respondents.

> *"RapidSMS is impacting everywhere it was intended to do so. Apart from the insufficiency of materials, it is functioning well."*
> *- CHW supervisor at DH level in a UNICEF supported District*

Some participants did feel that although RapidSMS is targeting issues of malnutrition, they did not feel it would impact this area as greatly. Notably, there was confusion about the malnutrition indicators reported by both CHWs and their supervisors.

> "Using the Nutrition module, CHWs enter anthropometric information of the child and the system would classify a child as "yellow" or "red" but this has not started yet. Same as for vaccination."
> - **CHWs supervisor at DH level in a UNICEF supported District**
>
> "CHW take measurements of the child …Okay! They have the tools, they take the measurements, then they classify children as "red" or "yellow". But the indicators used confuse them. They mix them up: some use MUAC, others weight for age, weight for height, … there is a need to have a look on how to train them better or maybe there is a need to recruit more qualified personnel. There is a need for improvement."
> - **DHU participant from a UNICEF supported District**
>
> "In real time, [RapidSMS] has not been used so much for malnutrition data, because, as I told you, malnutrition data are massive and the system was not strong enough to manage and display the data as it does for other components. But, I have no doubt, if correctly and effectively used, it can contribute. So, my advice is that we should actually invest in using RapidSMS data to effectively track follow up and ensure targeted support where it is much needed".
> - **DP participant**

Despite the opinion of a majority of participants that RapidSMS was having an impact, there were some participants who felt the impact of RapidSMS on ANC and assisted delivery was likely to be minor. These respondents felt this resulted from mothers who did not follow the reminders, and those who are not attending antenatal care entirely.

> "Mothers who deliver at home are those who are not reported. When some mothers are informed that it is time to deliver they dismiss the CHW and would later deliver at home. We have discussed at least two specific women who were informed that they have to go to the health facility, but dismissed the CHW stating that it is not yet time, we will be going there later"
> - **DHU member from a District not supported by UNICEF**
>
> "There are mothers who are not attending antenatal care until they come for delivery. You wonder in that kind of case how that mother has not been located or identified until the time of delivery."
> - **Academician participant**

Perceptions about RapidSMS training

CHWs appreciated the initial training they received when the system was about to start. It was well prepared and enough to allow them to start the RapidSMS reporting process. Several noted that they appreciated refresher trainings to keep their skills up to date.

> "I think we were only trained once, but we were well trained. …however, sometimes you need to be trained more than once to be good at something—we are old and do sometimes forget! We had later a sensitization, and that is how we were able to starting sending RapidSMS."
> - **Cell Coordinator from a District supported by UNICEF**

> *"last year, they (CHW) were trained on a quarterly basis on how to use RapidSMS. We were supported by UNICEF. They were trained last quarter for a few days."*
> - **CHW supervisor at DH level in a UNICEF supported District**

On this same theme, CHWs in Districts not supported by UNICEF expressed that crucial refresher trainings were not available to them. This leaves them responsible for training and assisting new CHWs when they start.

> *"I would approach the new CHW and train him/her on how to use RapidSMS. I train them because I know how to use the system. With time, they will be able to use RapidSMS smoothly."*
> - **Cell Coordinator from a District not supported by UNICEF**
>
> *"We were trained only once. The challenge we have is that we work with colleagues who were never trained".*
> - **CHW from a District not supported by UNICEF**

Issues with the RED Alert system

In our interviews and focus groups, we found significant issues with the RED Alert system that may have played a role in lowering its use. For example, in regular use CHWs identified that often ambulances either took a long time to come, or did not at all. They also identified a concern that if they called an ambulance for mothers that did not have public insurance coverage (Mutuelle in Rwanda), the CHW would be responsible for the ambulance charge.

> *"There are times when it [the ambulance] does not come on time, even when we call for an urgent matter."*
> - **CHW from a District not supported by UNICEF**
>
> *"You can only call it [the ambulance] for someone who has mutuelle. If a CHW calls the ambulance for someone who is not insured by mutuelle, they will have to pay 18,000 FRW. This happened to me; one woman didn't have mutuelle, so we didn't call the ambulance. [Unfortunately] the women did not make it."*
> - **CHW from a District not supported by UNICEF**

CHWs also expressed frustration at the amount of time it took to use the RED Alert system. Many noted how cumbersome it was to have to look for a code card and enter so many numbers in an emergency situation. Instead, many were resorting to using the free minutes they are provided to call the health center directly, as this was a faster way to notify the ambulance services.

> *"The CHW already has a phone, and has credit for calling [the health center]. It is free and it is easy! After she calls the health center, the health center will call us [the district hospital]. The easiest way for them to communicate an emergency is by calling on their mobile phone."*
> - **CHW Supervisor at DH Level**

Suggested improvements to the system

In every interview, we asked participants what changes they thought should be made to improve the RapidSMS system. This resulted in many improvements being suggested.

Increase Motivation of CHWs

The first group of suggestions had to do with the education, training, and motivation of CHWs, particularly the amount of time CHWs have to dedicate to the system and the impact this might be having on turnover rates. We also heard that training needs to be undertaken to instruct CHWs on new message types.

> *"CHWs need more motivation [for RapidSMS]. Their motivation is dropping with time. I think this lack of motivation may increase their turnover rate."*
> **- CHWs supervisor at DH level in a UNICEF supported District**
>
> *"We know that we are volunteers and RapidSMS necessitates a lot of community-based work. It seems like there should be a financial motivation for all of this work, but we do not receive it. We received it once, but now we do not. If we were paid for our time, we would be more motivated to work as CHWs because there would be compensation to help support our families."*
> **- CHW from a District not supported by UNICEF**
>
> *"Yes, we were trained and able to use the system. But if there is any new component in the system we should be trained about it. They should tell us what to respond if we receive a new kind of message and how to interpret it. Additionally, as CHWs we keep changing; due to this fact after one or two years there should be a training similar to the initial one to serve as a refresher training for experienced CHWs and initial one for new CHWs".*
> **- CHW from urban area**
>
> *"What I would suggest is replacing CHWs with people who have a higher level of education; for example, those who at least have ended the 'O level' in secondary school. It is easier to train such people because they are familiar with phone manipulation, which would make the reporting process would be easier.''*
> **- DHU member from a District not supported by UNICEF**

Improve technical aspects of phone service

We heard several comments from CHWs and their supervisors regarding difficulties with using the provided phones and mobile services. For example, several expressed frustrations at the current SIM card swapping process for new CHWs, and others shared difficulties with the phones which were provided as part of the program.

> *"It would be better if MTN performed the CHW sim card swap at the standard price, rather than pretending that it is a special sim card."*
> **- CHW supervisor at HC level in a UNICEF supported District**
>
> *"In addition, the phones given to CHWs are old. Now they are buying phones using their own money. Providing them with new phones would provide them with a type of motivation."*
> **- CHW supervisor at HC level in a UNICEF supported District**

Give providers access to RapidSMS data

Several health care providers and DHU staff mentioned that it would be better if they had direct access to RapidSMS data. They said that this would help them to plan and make timely decisions about their daily duties.

> *"We don't have access to the information in RapidSMS. The data manager and the CHW supervisor are the only ones who have access to this information. For example, we would like to be able to check whether all the women who delivered at our health center were registered in RapidSMS, because we have their name in our registers."*
> - **Provider from a District not supported by UNICEF**
>
> *"I wish that staff working at the district would have access to RapidSMS data. For example, the director of health unit, M&E officer, and the CHW supervisor at the district hospital. They are all very busy, so may not have enough time to consult with a data manager every time they want to use data for decision making."*
> - **DHU member from a District not supported by UNICEF**

Build capacity for analyzing RapidSMS data

Also with respect to data, respondents related that there is a limited capacity for properly using and analyzing the data from RapidSMS. This was blamed on a lack of capacity in analysis skills among the people who are supposed to analyze the RapidSMS data.

> *"What needs to be improved is the use of the data we are collecting. Health facility staff and everyone who has access to RapidSMS should be trained on data analysis so that they can benefit from the system and know what type of information is provided by the system."*
> - **CHW supervisor at DH from a District not supported by UNICEF**

Provide direct messages to beneficiaries

Several respondents suggested that the system be modified to directly message with beneficiaries. For example, if woman were linked directly to the system, this would allow her to directly receive reminder messages. Another possibility that was mentioned was that women might also use the system to request an appoint at her health facility if needed.

> *"I wonder whether pregnant women should provide their phone number, since they are the beneficiaries. Then both she and the CHW would receive the RapidSMS messages. This could include messages such as "your child is now xx month old, so has to come to the health facility for something", or "Your child should now be eating this type of food". This system would help remind parents; we are very busy and we sometimes forget all our responsibilities to our children".*
> - **Father from an urban area**
>
> *"Through RapidSMS, I think it should be possible for someone in a village to exchange information with their community health worker or other health professionals on their child's health in direct way. I suspect this step would take some time to be implemented, but we should start planning it. Secondly, patients might be able to use it to request an appointment at the health center. This would help someone living a long distance from the health center, as they could use RapidSMS to ensure they have an appointment. Health care providers could also then use it to see the order of consultations for the day. This would reduce the time patients spend queuing for an appointment."*
> - **Central level participant**

Provide National forums for sharing best practices

Some respondents from district health units proposed regular stakeholder and end user meetings to discuss RapidSMS use. They said that such meeting would help districts and CHWs to learn from each other, improve the way in which they use RapidSMS, and improve the reporting rates.

> *"The Ministry of Health should convene a health sector-wide meeting every six months or yearly to celebrate the best performing district and shame the worst performing ones. These types of meetings are very effective in pushing underperforming districts to improve. There would be time allocated for the best performing districts to share what factors lie behind their success. Right now, a method to learn from each other does not exist."*
> - **DHU member from a UNICEF supported District**
>
> *"something else which would be helpful would dedicate some funds to hosting quarterly meeting with CHWs to share what is happening in their respective villages, what challenges they are facing, to discuss performance, to identify weaknesses, and to propose solutions."*
> - **DHU member from a District not supported by UNICEF**

Ensure CHWs have equipment for reporting

Particularly in non-supported districts, we heard reports from some CHWs that they lacked the necessary equipment to report particular outcomes requested in RapidSMS. For example, they reported not having tools to measure middle upper arm circumference, temperature, height, and weight.

> *"Equipment are not yet available… We need the right equipment to take measures from pregnant women and children. For example, we need instruments to measure the height and weight of pregnant women because those measures were not taken at the health facility…. We also need thermometers to measure temperature."*
> - **CHW from a District not supported by UNICEF**

Implement measures to improve reporting rates

Several respondents mentioned their concern that the reporting rate in RapidSMS is low, particularly those in urban areas. Differences were noted between data that is derived from the HMIS system and RapidSMS system. This was noted as being problematic, as RapidSMS has individual data whereas HMIS does not. Therefore, if complete it could be more valuable for planning and quality assessment purposes.

> *"…one of the problems we are currently facing is that in the city the reporting rate and usage of RapidSMS is not good."*
> - **Central level participant**
>
> *"At the district level we regularly use HMIS data, which often gives us different statistics from RapidSMS. … Right now we mostly consider the data from the Ministry. But we have individual-level data in RapidSMS! There is a need to harmonize the information."*
> - **DHU member from a UNICEF supported District**
>
> *"If reporting rates go down, this could mean that a woman with a health problem in our community did not receive services from the health facility. It*

Key Limitations

As with any evaluation, there were several limitations in our analysis that merit discussion. First, we suspect that we have over-counted the number of unique mothers in our analysis. We suspect this is due to errors in the National ID numbers reported on each message, which we have no way of differentiating from one another. With respect to our quantitative analysis, we were limited in our selection of indicators to those that were available in the HMIS system. This meant that we were unable to analyze some indicators where missing data were a problem, such as the provision of Vitamin A, referrals from CHWs, indications such as severe diarrhea, and maternal mortality information. It also limited us to analyzing data from the actual facility, as comparable data on events in the community—most importantly the number of home births—was not available. It also meant that some data that are not collected in HMIS could not be assessed, such as attendance at the 2nd or 3rd ANC visit (as opposed to just all 4). Finally, while the HMIS system appears to be producing reasonable consistent data estimates over time, there still may be some unknown issues with some indicators as they have not been validated against a gold standard such as biological measures or clinical records to our knowledge. Where at all possible, we attempted to mitigate these limitations by analyzing process indicators that would be reasonably expected to influence the ultimate outcome of interest. For example, while consistent data on nutrition status and stunting were not available, we were able to analyze malnutrition screening rates.

Similarly, given our timeframe for analysis we would of course only have been able to detect changes that would have accrued during the 24-month period following the scale-up of the RapidSMS system in each health center. This would particularly be an issue for outcomes which might accrue benefits over a longer time period, such as malnutrition screening, where we did see a positive effect on rates. As the benefits to child health may take several months or years to develop, this of course would not show up in our data. Also, given the change in 2012 to the HMIS system, we were not able to include a longer pre-intervention period than 14 months. For some analyses this may have impacted our ability to detect changes, particularly those with less stable data points over time.

For our qualitative analysis, we were quite successful in securing interviews with the desired individuals from the Central Level and Districts. While our use of the CHW in-charge to arrange focus groups of CHWs and beneficiaries meant we were able to recruit participants from these groups, it remains unknown if they applied particular selection criteria to the individuals. For example, they may have chosen more effective or engaged CHWs to participate. We attempted to mitigate the potential influence of such factors by conducting multiple focus groups in diverse districts. Finally, we were unable to secure an interview with one of the key DPs, meaning that perspective was not incorporated into our interpretation.

Case Studies of Good Practices

In the course of our qualitative interviews, we made note of unique or noteworthy ways in which the RapidSMS system was being used or things that enabled its use. Below we present the details on three of the best examples we encountered.

Case Study 1: Using RapidSMS Numbers for Facility Care Planning

In several instances, study participants expressed that RapidSMS data was helpful for health system planning purposes. For example, at Kibungo Hospital, staff have been using the data collected through RapidSMS in order plan surgeries. For example, staff at the hospital have used the system to collect information on patients with cleft lip and/or cleft palette, so when a program such as Operation Smile comes to Rwanda, they already have their cases identified and know their numbers.

> *"…through RapidSMS I know when there is a newborn with this congenital abnormality and what health center they use. When this happens, we can initiate contact with the hospital and physicians who perform the repair procedures for such children. We can immediately refer those babies to the hospital and have them treated as soon as would be possible. I get this information and can act without even leaving my office. The RapidSMS system provides us with additional information to help improve maternal and child health".*
> **- CHW Supervisor from Kibungo Hospital**

Similarly, in Ngoma district, staff use RapidSMS to collect data on the number of scheduled births. They use this to plan, such as ensuring they have enough birth kits on hand for all of the expected deliveries.

> *"Based on the RapidSMS messages, we know that, for example, two women are expected to deliver in this health center during a specific week. As we know the number of pregnant women who will deliver at that time, we can plan accordingly. We can prepare essential materials in advance for assisted delivery because we have been informed by RapidSMS."*
> **- Supervisor of CHW at Zaza HC**

In Rubaya Health Center in Ngororero, the sharing of RapidSMS data is integrated into their weekly meetings:

> *"At our Monday staff meetings, we share information from the RapidSMS system with departments that can use it. For example, we give department-related information to the in-charge of maternity care. The same is done for immunization services, and so on…"*
> **- Supervisor of CHWs at Rubaya HC**

While we heard many examples such as these, they were far from universally applied across the country. Sharing best practices for these types of activities might help enhance the use and impact of the RapidSMS system.

Case Study 2: Disseminating RapidSMS Data for District Policy-making

Beyond just health care, health unit staff in Ngororero have been sharing RapidSMS data with district authorities to encourage changes to other social determinants of maternal and child health.

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For example, in the case of nutrition, RapidSMS data is being used to involve local leaders in matters related to health that were traditionally reserved for healthcare professionals. Using this data, local leaders are being pushed to study their sector, in the hope that they may take other measures to curb malnutrition.

> *"When we meet the sector's executive secretaries, we will tell them: 'This is your data. They were produced by software called HMIS and RapidSMS, and it shows how your sector is performing. It has become a tool that we can use to make them [local leaders] understand that health is not just the business of physicians! We have seen instances where local leaders have been embarrassed by poor outcomes. People will as 'What is happening? Malnutrition is very high! … are your people taking proper care of their children?'"*
> - **Director of Health Unit, Ngororero district**

If combined with additional efforts to increase data completeness, it might the case in future that RapidSMS data could lead to comparisons between Sectors and Districts that could inform policy interventions, both within and outside of the health sector.

Case Study 3: Providing Key Equipment to Community Health Workers

In UNICEF-supported districts, equipment was provided to CHWs and health centers to ensure that proper measurements could be taken and entered into the RapidSMS system. Particularly in non-supported districts, we heard reports from some CHWs that they lacked the necessary equipment to report particular outcomes requested in RapidSMS. For example, they reported not having tools to measure middle upper arm circumference, temperature, height, and weight.

> *"Equipment are not yet available… We need the right equipment to take measures from pregnant women and children. For example, we need instruments to measure the height and weight of pregnant women because those measures were not taken at the health facility…. We also need thermometers to measure temperature."*
> - **CHW from a District not supported by UNICEF**

CHWs in UNICEF supported districts did not report the same concerns. Thus, it seems that providing this equipment is enabling CHWs to use the RapidSMS system.

General Conclusions

As is clear from the documents we reviewed and the views of interview participants, the intent of the RapidSMS system was to improve health outcomes for mothers and children in Rwanda. Overall, we found the program was relevant to national priorities and well used. Our quantitative results, however, found that RapidSMS only contributed to some changes in the use of particular health care services in supported Districts. Below we return to our original research questions to discuss the evidence on each point.

Program Relevance

> *Question 1: How well did the program align with national priorities and strategies?*

The results of our evaluation was very positive with respect to the relevance of the RapidSMS program. Our interviews made it very clear that the RapidSMS program was responding to and well-aligned with government priorities and strategies, both domestic and international. Further, participants from districts, health facilities, and at the community level all felt that RapidSMS had helped them reach their maternal and child health-related targets.

> *Question 2: To what extent has RapidSMS contributed to the national and local policy directions for maternal, newborn, and child health?*

In terms of policy directions, participants from the central government level mentioned that they used data from RapidSMS for decision making, but did not cite any examples of major policy changes that have resulted from it. Similarly, health facility authorities indicated that they use RapidSMS for decision-making both at the district hospital level and at the health center level. However, it is worth noting that they felt more training in data analysis would aid them in using this purpose.

> *Question 3: How well was RapidSMS accepted by individual communities? Did it fit with community priorities?*

We also found that RapidSMS was generally well accepted by the community, in particular by community health workers. Beneficiaries reported that they felt that the Ministry of Health knew them personally and cared about their work. This aligns with the results of other similar studies: for example, the majority of participants in a Kenyan study stated feeling that "somebody cares" was one benefits of an mHealth initiative to improve HIV treatment adherence.[20]

Program Effectiveness

> *Question 4: How was the RapidSMS system used, how frequently, and for what purposes?*

We found that the RapidSMS system was widely used, with millions of messages sent over the time period we studied. In particular, from January 2014 onward CHWs sent between 200,000 and 400,000 messages every month. The majority of these messages were for community-based nutrition tracking. Notably, one of the least used modules was the so-called red alerts, which remained low nationwide until a small increase in March 2015 in UNICEF supported districts.

Despite this widespread use, both our quantitative and qualitative investigations found shortcomings in the completeness of the datasets. Several interview respondents expressed concerns about data completeness, and some suggested that these issues may be getting worse over time due to decreased motivation among CHWs. This was particularly true in urban areas. Our quantitative numbers suggest that RapidSMS reporting was quite incomplete, as the number of births that were registered was far lower than would have been expected based on both HMIS and Census data.

These issues of reporting rates are probably at least partially the result of technical issues and how the program operates. In our interviews, several issues were raised with how the program operates. For example, CHWs said that the system would send them feedback in English when the report didn't go through, and they would not know what happened. The availability of electricity is still very low in Rwanda, especially in rural areas (7.7%)[21], leading participants to identify power as a persistent challenge for RapidSMS. For example, one community health worker reported that she walks 4 hours to get her phone charged. The process of replacing a SIM card is tedious and long, and the provided mobile phone equipment is ageing. CHWs identified issues with the availability and frequency of training.

> *Question 5: Has the project contributed to the improvement in the maternal, newborn, and child continuum of care?*
>
> *Question 6: What was the impact of the RapidSMS program on health care utilization, including ANC and PNC visits, ambulance transfers, hospital admissions, and the facility birth rate?*

Our quantitative analysis found only limited evidence of an impact of RapidSMS on key maternal and child health care use and health outcomes. Despite the fact that RapidSMS originated to track pregnancies and births, this is where we found the most limited impact of the program. We feel that the lack of impact on ANC visit rates—while unexpected—was likely the result of mothers not being detected and entering the health system during early pregnancy, something which would obviously not change as the result of RapidSMS reminders. The lack of change in the number of women registering for ANC is also not surprising given that the most recent DHS survey concluded that 99% of pregnant women received at least one antenatal care visit.[22] Finally, assuming RapidSMS had no impact on early detection of women in pregnancy, this would also serve to explain why the program had no impact on women completing the full sequence of standard ANC visits. While the reminders may have served to increase the number of women with 2 or 3 of the standard 4 visits, unfortunately these data were not available in the HMIS system.

Our results for the rate of deliveries in a health facility were mixed. The rate of deliveries in health facilities was declining in the period before the initiation of RapidSMS. However, in districts supported by UNICEF, our results showed a significant increase in the trend of facility deliveries (17.6% relative increase at one year). In sharp contrast, we observed no change in either the level or trend in non-supported districts. This lends itself to one or two possible interpretations: first, it might be that the RapidSMS system requires the additional support structures delivered by UNICEF in order to be effective. Alternatively, it might be that RapidSMS was ineffective and the increase in facility deliveries was purely the result of the additional support from UNICEF. The fact the number of RapidSMS message sent per capita was very similar between these two types of Districts over the first 18 months of RapidSMS at the very least indicates that the support provided by UNICEF was key to this change in outcome. Overall, it may also be relevant that health facility delivery rates are quite high in Rwanda: 91% compared to many other African nations with rates closer to 60%.[23] Thus, it may be that further increases in this outcome are very difficult to achieve.

Similarly, we also found an increase in the total number of PNC visits after the start of the RapidSMS program, but again this effect was concentrated in areas with UNICEF support. This area is particularly important, as more than 50% of pregnant women did not receive any postnatal checkup in 2014-15 according to the last DHS.[22] A recent paper on factors associated postnatal utilization in Rwanda concluded that low use of PNC services appears to be a universal problem[24]. Therefore, system-level solutions to address this issue would be welcome. Similar to our conclusions regarding facility delivery rates, it seems that the type of support offered by UNICEF was a necessary condition, but our results cannot differentiate if it alone would have been sufficient to prompt these changes.

The main universal change at the start of RapidSMS was on nutrition screening in health facilities. This is perhaps unsurprising given the large message volume dedicated to nutrition within RapidSMS. As with our other outcomes, however, there was a striking difference between supported and non-supported districts. One potential reason for this is a lack of equipment: CHWs in non-supported districts reported that they don't have tools to take appropriate anthropometric measurements. Whether an increase in screening will ultimately lead to better health outcomes remains unknown, as it would likely take several years to see an effect and it would be hard to directly attribute any changes to RapidSMS given the numerous other initiatives to improve nutrition in Rwanda.

> *Question 7: Did RapidSMS impact CHW's knowledge, skills, and practices regarding essential maternal and newborn care?*

Both CHWs and other respondents reported that CHWs have gained knowledge regarding essential maternal and newborn care as a result of using RapidSMS. For example, respondents reported that CHWs can now directly provide more services in the community. Whether this is a widespread phenomenon is unclear.

> *Question 8: Did RapidSMS increase the motivation of community health workers?*

Universally, participants identified motivation as one of the main challenges RapidSMS is facing. The attrition rate of CHWs is high, and the trend shows no signs of change. Among CHWs, there was a decidedly mixed feeling about the impact of RapidSMS on motivation levels. CHWs feel as though they are helping their community and feel respected as a result of using the system. At the same time, however, they noted that RapidSMS increased their workload and they had less time to cater for their own families as a result.

> *Question 9: Do beneficiaries report having been reached by RapidSMS? Did they feel the program was beneficial to them?*

In our focus groups, both mothers and fathers reported having been reached by RapidSMS, and felt that the program was beneficial for them.

Program Impact

> *Question 10: What was the impact of the RapidSMS program on key maternal and child health outcomes, including morbidity and mortality?*

We found a widespread belief among our interview and focus group participants that RapidSMS was helping to improve maternal and child health. It is worth noting, however, that participants from the

central level were unsure whether any improved outcomes would be attributable to RapidSMS due to the multiplicity of initiatives aimed at improving maternal and child health outcomes.

Unfortunately, data limitations made it difficult to assess the impact of the RapidSMS program on maternal and child health outcomes. Maternal mortality data was unavailable over the entire study period, and child death data was very noisy as it is a comparatively rare event versus our other outcomes. However, the program did not have any adverse effects. Universally, community health workers and beneficiaries believed that the program had a positive impact on maternal and child health outcomes. However, it seems unlikely that RapidSMS has had a major impact on health for two reasons. First, there was only a limited impact on health services utilization such as ANC attendance and facility delivery. Second, there was very limited use of the "Red Alert" function. Thus, we found limited evidence for change in either of the major pathways through which RapidSMS might have been expected to impact maternal or child health outcomes. Following our theory of change, this would suggest the program did not have a major impact on morbidity or mortality.

It is worth noting, however, that RapidSMS may have had an impact on longer-term outcomes that we were unable to measure in our analysis. In particular, the number of messages sent for nutrition visits constituted nearly half of the total message volume, and any benefits from this would likely take some time to accrue. As HMIS data does not include information on the nutritional status of patients, we were not able to assess any changes in these metrics. Further, it is also important to note that we found no evidence of any unintended consequences to maternal or child health in the course of our analysis.

Program Efficiency & Coordination

> *Question 11: Were the available resources (financial, human and other) efficiently used to achieve the program objectives?*
>
> *Question 12: Were the overall program coordination mechanisms functional and effective? How could they be improved?*

Most participants felt that the allocated resources were sufficient and have been used efficiently. However, several noted that the program relies on funds which are not managed within the Ministry of Health. Some recommended that it would improve the coordination of the program and maximize the future sustainability were the financial aspects of the program managed within the Ministry of Health. For the most part, the other aspects of program coordination received very little comment. As a full cost analysis was not part of the original terms of reference for our evaluation (see Appendix 3), we did not compare the cost of RapidSMS to other similar programs or comment on whether the program is worthwhile from a cost perspective.

Program Sustainability

> *Question 13: To what extent will RapidSMS be sustainable over the long term? What factors will be involved in ensuring this sustainability?*

While participants in our interviews and focus groups noted many factors that are helping to sustain the system, several noted the potential loss of developing partner funds as the single largest threat to long-term sustainability of the program. Ensuring a viable long-term commitment to funding appears to be the largest factor involved in ensuring the sustainability of RapidSMS.

Equity Considerations

Question 14: To what extent did the program consider a human rights-based approach and equity in its approach, including focusing on comparatively deprived areas and areas with poorer maternal and child health outcomes?

As RapidSMS aims to increase access to health services and improve outcomes for both mothers and their children, it seems reasonable to believe that a human rights-based approach was considered I the development of RapidSMS.[25] At the same time, we received mixed responses from participants about how decisions were made regarding the scale-up of the program. It seemed clear that Musanze was chosen for the pilot as it was a district in which UNICEF was already present and had the highest neonatal mortality at the time. The remainder of the 9 supported districts appeared to have poorer outcomes, but this was not universally the case. However, the RapidSMS portion of the program was rapidly scaled-up across all 30 districts in the country over the course of 2013 and early 2014, meaning that all areas would have been reached.

Lessons Learned

In terms of broader lessons learned from this evaluation, we note several key point:

1. The most important lessons learned are likely related to our finding that the impact of RapidSMS was concentrated in those Districts for which UNICEF provided additional support. This suggests two key lessons. First, it suggests that mHealth initiatives such as RapidSMS will only function in jurisdictions that have the necessary infrastructure and equipment in place. The key example in this instance was malnutrition screening, where the supported districts received the necessary equipment and saw large increases in their use.

2. Second, our finding of an effect concentrated in supported Districts suggests that simply enacting an mHealth system is not sufficient to assure its use. As the UNICEF support included embedding an individual in each District and conducting regular trainings and meetings, it seems likely that this activity was necessary in order to see the benefits of the program. This was clearly evidenced by the much higher rate of pregnancy registrations and use of RED Alert messages in the supported Districts, for example.

3. We heard from several CHWs and their supervisors that the mobile phones provided at the start of the program have been lost or broken. In terms of long-term planning to support a technology-focused program such as RapidSMS, turnover and replacement of devices should be planned from the outset.

4. The low use of the RED Alert system suggests that any technology platform intended for use during emergencies needs to be simple and fast to use. The fact that CHWs had to use code cards and input long National ID numbers were likely key factors in the very low use of this notification system. In addition, the reported lack of response by emergency services for many RED Alerts likely acted to prevent the use of the system as well.

Recommendations

Based on the above findings, we have developed the following recommendations for the refinement of the RapidSMS program in Rwanda. These recommendations are based on an initial list developed by the research team, which was further refined through formal presentation and discussion with the project Steering Committee. For each recommendation, we have also indicated the primary target group for action, and other target groups that would be involved in implementing each recommendation.

Program Management

1. Focus on specific priority outcomes: most participants in our study could only cite the goals of the RapidSMS program in very broad terms: to reduce maternal and child mortality. This leaves many open pathways for how RapidSMS could impact health. We feel it is likely that RapidSMS could benefit from an attempt to focus on particular behaviors that merit changing, whether that's a big push to further increase ANC / PNC visits, or to fix the issues CHWs are facing with the Red Alert system to make it more widely used. The increase in use of RED Alert messages in early 2015 shows that having focus and intent in trying to change particular process measures can deliver results.
   Primary Target: Ministry of Health (MoH)
   Other Target Groups: Rwanda Biomedical Center (RBC), UNICEF

2. Develop a sustainability plan: when asked about the future of RapidSMS, we heard vague and conflicting messages about the future of the program. If the program is to be sustained, then a long-term plan for funding and management needs to be developed.
   Primary Target: Ministry of Health
   Other Target Groups: Ministry of Finance, Ministry of Local Government, UNICEF, Other Developing Partners (DPs)

3. Consider the use of other UNICEF management support programs: as outlined above, the vast majority of the effects were concentrated in the areas with UNICEF support. While an evaluation of what aspects of this support were most beneficial in these Districts was beyond the scope of this evaluation, given their positive impact their use should be considered for use elsewhere within Rwanda. In particular, the use of staff in each District to review performance and suggest changes based on RapidSMS data is likely a key component of the observed success, achieved through consistent quality improvement through an ongoing feedback loop.
   Primary Target: MoH
   Other Target Groups: UNICEF, RBC, Other DPs

Technical Aspects

4. Improve data validation: as outlined above, we found many issues with incorrectly categorized data types and implausible values for biometric measurements. To rectify this, improved data validation should be implemented on future iterations of the RapidSMS platform. This should include responses in Kinyarwanda to aid in the understanding of all error messages that can be received by CHWs.
   Primary Target: RBC

5. Study direct messaging: several groups of participants highlighted the added value that might come from sending some messages to pregnant women directly. Given the high rate of mobile phone penetration and availability in Rwanda, this possibility should be

investigated. If pursued, this could be rolled out in an experimental fashion to truly understand whether there was an additional benefit.
Primary Target: RBC
Other Target Groups: MoH, UNICEF

6. Ensure that CHWs can access functional phone and charging equipment: CHWs reported that many of the original phones that were distributed as part of the RapidSMS program are no longer working, leaving them having to spend their own funds to purchase a phone. As CHWs are volunteers, this might lead to frustration and lower motivation on their part. More than one participant suggested that providing phones would avert this problem and help motivate CHWs. CHWs in rural areas expressed an almost universal frustration with the current facilities for charging their mobile phones in order to use RapidSMS. The possibility of using other systems that would work outside areas with power—such as solar chargers—should be investigated.
Target groups: MoH
Other Target Groups: RBC, UNICEF, Other DPs

7. Refine the red alert system: despite being a key reason cited for the creation of the RapidSMS system, the use of red alerts is problematic for CHWs. This was evidenced in both the low use we found in our quantitative results, and the feedback we received from CHWs and their supervisors in the qualitative portion. The consequence is that use of the system remained very low throughout most of the study period. Based on our qualitative interviews, we believe that it will likely remain simpler for CHWs to simply call their associated health facility. As a result, we would suggest that in future RED Alerts be changed from a real-time care access function to performing a reporting function for CHWs.
Primary Target: RBC
Other Target Groups: MoH, UNICEF

Program Operation

8. Improve CHW training programs: In every non-supported District studied we heard about the difficulties new CHWs face in learning the RapidSMS system as there are no training programs. Different modalities for providing this training as quickly as possible should be investigated. Further, existing CHWs expressed difficulties with learning about changes to the system, such as new message types. The suggestion was made that more frequent refresher trainings would help to alleviate these issues.
Primary Target: RBC
Other Target Groups: MoH, UNICEF

9. Consider reimbursement for messaging performance: several CHWs expressed frustration with the amount of time it took to use and report using RapidSMS, as it necessitated the need not only to enter data but also more frequent travel to households in the community to communicate reminder messages and collect data. Similarly, several people at both District and higher levels expressed concerns about the incompleteness of RapidSMS data. We frequently heard that reimbursement provided to CHWs based on their messaging performance would be one way in which to alleviate these issues.
Primary Target: MoH
Other Target Groups: RBC, UNICEF, Other DPs

10. Ensure CHWs have the necessary equipment to effectively use RapidSMS: While the RapidSMS system is designed to collect anthropometric measurements, it is vital that CHWs have access to the necessary instruments to do so, such as MUAC measurement tools,

thermometers, and scales.
Primary Target: MoH
Other Target Groups: RBC, UNICEF, other DPs

11. Improve the sharing of RapidSMS data with health providers and district level staff – In several of our interviews, providers at health facilities and staff working at the district level asked for access to the system. However, it was also clear that the capacity for analyzing the data was not present. As a result, we suggest that effort be put into training local data managers to produce standardized and useful data for sharing with these groups on a regular and consistent manner. This would allow access to the system and responsibility for data management to be maintained, but also allow for sharing of best practices and quality improvement nationwide.
Primary Target: RBC

Future Evaluation

12. Lay the groundwork for better future evaluation: while our study design is rigorous and used the best possible methods available, it is still weaker than what could be produced with more systematic involvement of an evaluation team at an earlier time. In future, this should be considered in both the roll-out of new features and major changes in the system. For example, if new features such as direct messaging were rolled out in either a randomized or step-wedge fashion, then it would be far easier to determine the true impacts of these changes. Further, it is likely with improvements in mobile technology and smart phones that the next iteration of mHealth in Rwanda will be very different from RapidSMS. The involvement of evaluation teams prior to the rollout of such changes would allow the creation of better evidence on the impact of the program.
Primary Target: MoH
Other Target Groups: RBC, UNICEF, Evaluation Team

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Appendix 1: Data Collection Tools

Interview Guide

Central Level and Developing Partners

Research Project: Evaluating the impact of RapidSMS

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

Respondent Information

1. Name:
2. Organization:
3. Title (describe his/her role):
   ……
4. Gender:
5. Level of education:
6. Present position:
7. Number of years and Experience at the current position:
8. Previous organization where s/he worked, position, and number of years and roles:

   ……

General topics to be discussed during the interview

I.   Introduction questions

1.   What are your responsibilities related tomaternal and child health?

2.   How were you involved in the development of the RapidSMS system?

3.   How are you currently involved in the coordination or management of the RapidSMS System?

II.   RapidSMS design and implementation

4.   What do you think the major objectives of RapidSMS were when it started?

5.   How were decisions made about where and when to implement RapidSMS?

   Probe 1: How did equity considerations play a role in these decisions?
   Probe 2: What factors were part of the decision to scale-up to a national scale?

6.   What, if any, challenges were faced in implementing the RapidSMS system? How were these challenges overcome?

7.   What challenges is the RapidSMS system facing now?

8. What are your perceptions about the amount of financial and human resources which were allocated to RapidSMS?

    Probe: Inquire about specific human and financial resources for coordination, awareness, training, and supervision.

9. What are your perceptions about the use of these resources which were allocated to RapidSMS?

III.   RapidSMS relevance

10. How was the adoption and continued use of RapidSMS related to national or international development targets, including MDGs, Vision 2020, EDPRS 2, and SDGs?

11. To what extent is RapidSMS data used in planning and decision-making?

12. Can you think of areas where RapidSMS is not currently having an impact where it could be?

    Probe : For each area identified, how would RapidSMS have to change for such an impact to be made?

IV.   Impact of RapidSMS

13. What impact do you believe the RapidSMS system has had on health in Rwanda?

    Probe: What impact do you believe it has had on maternal health?
    Probe: What impact do you believe it has had on Newborn health?
    Probe: What impact do you believe it has had on Child health?

14. How has RapidSMS contributed to the reduction of maternal, newborn, and child mortality?

V.   RapidSMS effectiveness and efficiency

15. What changes in maternal, newborn and child health services were prompted by RapidSMS?

    Probe 1: Any change in the maternal, newborn and child continuum of care?
    Probe 2: Any change in access to and utilization of these services?
    Probe 3: Any change in providers' knowledge, skills and practices?

VI.   RapidSMS coordination and sustainability

16. How is the RapidSMS system coordinated and managed?

17. What are your views regarding how well this coordination and management structure is functioning?

    Probe: What elements of the coordination/management should be kept?

    Probe: What elements could be improved?

18. How is the government including/integrating RapidSMS in the Government policies, legislation, strategies, information systems and budgets?

19. To what extent has RapidSMS helped in managing maternal, newborn and child health more efficiently?

20. What challenges do you think RapidSMS will face in terms of sustainability?

    Probe 1: How these challenges can be mitigated?

21. What do you think the role of your institution could be in ensuring the sustainability of RapidSMS?

Closing

Thank you very much for taking your precious time to discuss the RapidSMSprogram with us.

Is there any information you would like to share with us that did not get covered in this interview?

We may be in touch again in case there is need for clarification or to ask about something that was not discussed but emerged as important during transcription and analysis of the data. Would you be available for such follow-up?

Thank you so much for agreeing to follow-up.

Interview Guide

Academia and National Professional Society personnel

Project Title: Evaluating the Impact of RapidSMS

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

<u>**Respondent Information**</u>

9. Name:
10. Organization:
11. Title (describe his/her role):

    ……
    ……………………………………………………
    ……………………………………………………………………………

12. Gender:
13. Level of education:
14. Present position:
15. Number of years and Experience at the current position:
16. Previous organization where s/he worked, position, and number of years and roles:

    ……

<u>**General topics to be discussed during the interview**</u>

VII. Introduction questions

1. What are your responsibilities related to maternal and child health?

2. To what extent are you familiar with the RapidSMS system?

3. How were you involved in the development of the RapidSMS system?

VIII. RapidSMS design and implementation

4. What problems do you think the RapidSMS system in Rwanda was intended to address?

5. What is your institution's role in the RapidSMS system?

    Probe: Do you participate in the analysis of RapidSMS data?

6. What are your perceptions about the amount of resources that were allocated to the RapidSMS system?

7. What are your perceptions about the use of the resources which were allocated to the RapidSMS?

IX. Impact of RapidSMS

8. What impact do you believe the RapidSMS system has had on health in Rwanda?

   Probe: What impact do you believe it has had on maternal health?
   Probe: Newborn health?
   Probe: Child health?

9. What specific changes to academic curricula or continuing professional development do you think have occurred due to the RapidSMS system?

10. Can you think of areas where RapidSMS is not currently having an impact where it could be?

    Probe 1: For each area identified, how would RapidSMS have to change for such an impact to be made?

X. RapidSMS effectiveness and efficiency

11. What changes in maternal, newborn and child health services were promptedby RapidSMS?

    Probe 1: Any change in the maternal, newborn and child continuum of care?
    Probe 2: Any change in access to and utilization of these services?
    Probe 3: Any change inproviders' knowledge, skills and practices?

12. To what extent has RapidSMS helped in managing maternal, newborn and child health more efficiently?

XI. RapidSMS coordination and sustainability

13. What are the challenges that you foresee RapidSMS facing in terms of sustainability?

14. How can these challenges be mitigated?

15. What do you think the role of your institution could be in ensuring the sustainability of RapidSMS?

Closing

Thank you very much for taking your precious time to discuss this program with us.

Is there any information you would like to share with me that did not get covered in this interview?

I may be in touch again in case there is need for clarification or to ask about something that was not discussed but emerged as important during transcription and analysis of the data. Would you be available for such follow-up?

Thank you so much for agreeing to follow-up.

Interview Guide

District and Health Facility Authorities

Research Project: Evaluating the impact of RapidSMS

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

Respondent Information

17. Name:

18. Organization:

19. Title (describe his/her role):

    ………

20. Gender:

21. Level of education:

22. Present position:

23. Number of years and Experience at the current position:

24. Previous organization where s/he worked, position, and number of years and roles:

    ………

General topics to be discussed during the interview

XII. Introduction questions

1.   What are your responsibilities related to maternal and child health?

2.   How were you involved in the development and implementation of the RapidSMS system?

XIII. RapidSMS design and implementation

3.   What do you think the major objectives of RapidSMS were when it started?

4.   How were decisions made about where and when to implement RapidSMS?

   Probe: How did equity considerations play a role in these decisions?

5.   What, if any, challenges were faced in implementing the RapidSMS system? How were they overcome?

6.   How did you consult and collaborate with local leaders in implementing RapidSMS?

7.   What are your perceptions about the amount of human and financial resources that were allocated to the RapidSMS?

8. What are your perceptions about the use of these resources which were allocated to the RapidSMS?

9. What do you think could be improved in the way that RapidSMS is implemented and used?

   Probe: in terms of capacity building?

10. How can these improvements be performed?

11. Who should be involved in implementing these improvements?

XIV. RapidSMS relevance

12. How well was RapidSMS accepted by your community, including both community health workers and the general population?

    Probe: Did it fit your community priorities?

13. Which group(s) of beneficiaries has/have been reached by RapidSMS? Are there groups that are being missed?

14. To what extent was and is RapidSMS data used in decision-making?

XV. Impact of RapidSMS

15. How do you think RapidSMS impacted maternal, child, and newborn health in your area?

    Probe: Can you share a specific example with me?

16. What are any other changes you think resulted from the implementation of the RapidSMS system?

17. What challenges have you face in using the RapidSMS system?

18. Can you think of areas where RapidSMS is not currently having an impact where it could be?

    Probe 1: For each area identified, how would RapidSMS have to change for such an impact to be made?

XVI. RapidSMS effectiveness and efficiency

19. What changes in planning, providing, and monitoring maternal, newborn, and child health services were shaped by RapidSMS?

    Probe 1: Any change in the maternal, newborn and child continuum of care?
    Probe 2: Any change in access to and utilization of these services?
    Probe 3: Any change inproviders' knowledge, skills and practices on essential maternal and newborn care?

    Probe:what implications do you think this has for the sustainability of the program?

20. To what extent has RapidSMS helped in managing maternal, newborn and child health more efficiently?

XVII. RapidSMS coordination and sustainability

21. What are your views regarding the coordination and management of the RapidSMS system?

     Probe: What elements of the coordination/management could be kept up?

     Probe: What elements could be improved?

22. How do Districts and Health Facilities demonstrate their ownership of the RapidSMS program?

Closing

Thank you very much for taking your precious time to discuss RapidSMS with us

Is there any information you would like to share with us that did not get covered in this interview?

We may be in touch again in case there is need for clarification, amplification, or to ask about something that was not discussed but emerged as important during transcription and analysis of the data. Would you be available for such follow-up?

Thank you so much for agreeing to follow-up.

Interview Guide

Maternity and Community Health Staff

Research Project: Evaluating the Impact of RapidSMS

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

Respondent Information

25. Name:

26. Organization:

27. Title (describe his/her role):

    ………………………………………………………………………………………………………

28. Gender:

29. Level of education:

30. Present position:

31. Number of years and Experience at the current position:

32. Previous organization where s/he worked, position, and number of years and roles:

    ………………………………………………………………………………………………………

XVIII. **General topics to be discussed during the interview**

XIX. Introduction questions

1. What are your responsibilities related to maternal and child Health?

XX. RapidSMS design and implementation

2. What role does the RapidSMS system play in your day-to-day work?

3. What, if any, challenges were faced in implementing the RapidSMS system in your facility? How were they overcome?

XXI. RapidSMS relevance

4. To what extent is RapidSMS data used in decision-making within your facility?

5. Which group(s) of beneficiaries have been reached by RapidSMS? Are there groups that are being missed?

6. How well was RapidSMS accepted by your community, including both your community health workers and the general population?

Probe: Did it fit your community priorities?

XXII. Impact of RapidSMS

7. How do you think RapidSMS impacted maternal, child, and newborn health in your area?

    Probe: Can you share a specific example with me?

8. How do you think RapidSMS has changed the way that mothers and their children interact with the health system?

9. What are any other changes you think have occurred due to the implementation of the RapidSMS system?

10. Can you think of areas where RapidSMS is not currently having an impact where it could be?

    Probe 1: For each area identified, how would RapidSMS have to change for such an impact to be made?

XXIII. RapidSMS effectiveness and efficiency

11. What changes in planning, providing, and monitoring maternal, newborn and child health services were shaped by RapidSMS?

    Probe 1: Any change in the maternal, newborn and child continuum of care?
    Probe 2: Any change in access to and utilization of these services?
    Probe 3: Any change CHWs' knowledge, skills and practices on essential maternal and newborn care at their level?

12. What are your perceptions about the amount of resources which were allocated to RapidSMS?

13. What are your perceptions about the use of resources which were allocated to RapidSMS?

XXIV. RapidSMS coordination and sustainability

14. What are your views regarding the coordination and management of the RapidSMS system?

    Probe: What elements of the coordination/management could be kept up?

    Probe: What elements could be improved?

15. How committed and motivated do you think CHWs are to continue the use of RapidSMS in the future? Why?

    Probe: What could be changed to make them more motivated or committed?

16. What do you think could be improved in the way that RapidSMS is implemented?

17. How can these improvements be performed?

18. Who should be involved in implementing these improvements?

<u>Closing</u>

Thank you very much for taking your precious time to discuss RapidSMS with us

Is there any information you would like to share with me that did not get covered in this interview?

I may be in touch again in case there is need for clarification, amplification, or to ask about something that was not discussed but emerged as important during transcription and analysis of the data. Would you be available for such follow-up?

Thank you so much for agreeing to follow-up.

Interview Guide

Cell Coordinator

Project Title: Evaluating the Impact of RapidSMS Rwanda

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

Respondent Information

33. Name:

34. Organization:

35. Title (describe his/her role):
     …………………………………………………………………………………………………

36. Gender:

37. Level of education:

38. Present position:

39. Number of years and Experience at the current position:

XXV. Introduction Questions

1. As a CHW, what is your role in maternal and child health?

2. How were you and the people you supervise trained about the use of the RapidSMS system?

3. What are your perceptions about the quality of this training? In what ways was this training adequate, and in what ways was it lacking?

4. Do you feel that the refresher trainings are enough to keep you up to date on the RapidSMS system? What about them could be improved?

XXVI. RapidSMS design and implementation

5. What role does RapidSMS play in your daily work?

6. What challenges have you faced using RapidSMS? How have you overcome these challenges?

XXVII. RapidSMS relevance

7. What role has RapidSMS had in achieving your district-level targets?

8. To what extent has RapidSMS data been used in decision-making at the District/sector/cell/village level?

XXVIII. Impact of RapidSMS

9. Which group(s) of beneficiaries has/have been reached by RapidSMS? Are there groups that are being missed?

10. Do you think that RapidSMS is as useful after birth as before? Why?

11. Which beneficiaries do you think are reached by RapidSMS?

12. What impact do you believe the RapidSMS system has had on health in your area?

    Probe: What impact do you believe it has had on maternal health?

    Probe: What impact do you believe it has had on Newborn health?

    Probe: What impact do you believe it has had on Child health?

13. Can you think of areas where RapidSMS is not currently having an impact where it could be?

    Probe 1: For each area identified, how would RapidSMS have to change for such an impact to be made?

XXIX. RapidSMS effectiveness and efficiency

14. What are your perceptions about the amount of resources and materials which are allocated to the RapidSMS system?

15. What are your perceptions about the use of the resources and materials which are allocated to the RapidSMS system?

16. What changes in planning, providing, and monitoring maternal, newborn, and child health services were shaped by RapidSMS?

    Probe 1: Any change in the maternal, newborn and child continuum of care?
    Probe 2: Any change in access to and utilization of these services?
    Probe 3: Any change in providers' knowledge, skills and practices on essential maternal and newborn care?

XXX. RapidSMS coordination and sustainability

17. How has the commitment and motivation of CHWs been fostered to continue theiruse of RapidSMS in the future?

18. What support do you need in order to continue or improve your use of the RapidSMS system?

19. What are the challenges that you foresee RapidSMS facing in terms of sustainability?

20. How can these challenges be mitigated?

Closing

Thank you very much for taking your precious time to discuss the RapidSMS system with us.

Is there any information you would like to share with me that did not get covered in this interview?

We may be in touch again in case there is need for clarification or to ask about something that was not discussed but emerged as important during transcription and analysis of the data. Would you be available for such follow-up?

Once again thank you.

ASM-CHWs FGD Agenda

Project Title: Evaluating the Impact of RapidSMS Rwanda

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

(For FGD moderator and note taker: Remember to complete the attached participant log)

XXXI. Introduction Questions

1. What role does the RapidSMS system play in your day-to-day work?

2. How were you trained about the use of the RapidSMS system?

3. What are your perceptions about the quality of this training? In what ways was this training adequate, and in what ways was it lacking?

4. Do you feel that the refresher trainings are enough to keep you up to date on the RapidSMS system? What about them could be improved?

XXXII. RapidSMS design and implementation

5. What challenges, if any, have you faced in using the RapidSMS system?

6. What methods, if any, have you used to overcome these challenges?

7. What groups in your village are vulnerable for poor pregnancy and early childhood outcomes?

   Probe: What has been done to assist these people? Could something be improved?

   Probe: What challenges do they face in benefiting from RapidSMS?

8. Are there any other groups in your village who are not benefitting from RapidSMS services?

   Probe: Ask about youth, single mothers, religious groups, MNH services, etc.

XXXIII. RapidSMS relevance

9. What role has RapidSMS played in achieving your district-level targets?

XXXIV. Impact of RapidSMS

10. How well do the reminders you receive from RapidSMS work in changing health care use by mothers in your village?

11. How do you think RapidSMS has impacted maternal, child, and newborn health in your village?

Probe: Can you share a specific example with me?

12. Do you think that RapidSMS is as useful after birth as before? Why?

13. How has RapidSMS changed how you provide care? Do you think it has improved your knowledge, skills, and practices as a CHW?

14. What economic impact has RapidSMS had on you and your family?

   Probe: Does this financial impact provide motivation to continue using RapidSMS?

15. Can you think of areas where RapidSMS is not currently having an impact where it could be?

   Probe 1: For each area identified, how would RapidSMS have to change for such an impact to be made?

XXXV. RapidSMS effectiveness and efficiency

16. What role has RapidSMS played, if any, in changing use of the health care system by mothers in your village?

17. What are your perceptions about the amount of resources and materialswhich are allocated to the RapidSMS system?

XXXVI. RapidSMS coordination and sustainability

18. To what extent is the time involved in using the RapidSMS worth the effort?

19. What support do you need in order to continue or improve your use of the RapidSMS system?

Closing

Thank you very much for taking your precious time to discuss the RapidSMS system with us.

Is there any information you would like to share with me that did not get covered in this interview?

Once again thank you.

Mothers FGD Agenda

Project Title: Evaluating the Impact of RapidSMS Rwanda

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

(For FGD moderator and note taker: Remember to fill the participant information sheet)

XXXVII. Introduction Questions

1. In your village, once a woman is pregnant, who is typically the first person she consults for getting care?

2. What isthe role of the ASM-CHW in your village with respect to pregnancy, child birth, and newborns?

3. What challenges do you face in accessing the health care system?

4. What do you know about the RapidSMS system?

   Probe: Describe the RapidSMS system if they do not know of it.

XXXVIII. RapidSMS design and implementation

5. How were you informed about the RapidSMS system?

6. What is the importance of RapidSMS in your community?

XXXIX. Impact of RapidSMS

7. How did RapidSMS change the way that you interacted with the health system?

   Probe: For those who have given birth previously, how did RapidSMS change your experience?

8. What impact do you believe the RapidSMS system has had on your pregnancy and the care you provided for your child?

XL. RapidSMS effectiveness and efficiency

XLI. RapidSMS sustainability

9. What do you think could be changedabout the RapidSMS system to bring more benefit to yourself or your community?

10. How can these improvements be performed?

11. Who should be involved in implementing these improvements?

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Closing

Thank you very much for taking your precious time to share your personal experience with the RapidSMS system with us.

Is there any information you would like to share with me that did not get covered in this interview?

Once again thank you so much.

Fathers FGD Agenda

Project Title: Evaluating the Impact of RapidSMS Rwanda

Principal Investigator: Michael Law, PhD

University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali

(For FGD moderator and note taker: Remember to fill the participant information sheet)

XLII. Introduction Questions

12. In your village, once a woman is pregnant, who is typically the first person she consults for getting care?

13. In your village, once a woman is pregnant who take a decision about who to consult?

14. What is the role of the ASM-CHW in your village with respect to pregnancy, child birth, and newborns?

15. As a father, what is your role in maternal and child health?

16. What challenges do you face in accessing the health care system?

17. What do you know about the RapidSMS system?

   Probe: Describe the RapidSMS system if they do not know of it.

XLIII. RapidSMS design and implementation

18. How were you informed about the RapidSMS system?

19. What is the importance of RapidSMS in your community?

XLIV. Impact of RapidSMS

20. How did RapidSMS change the way that you and your wife interacted with the health system?

   Probe : For those whose wife have given birth previously, how did RapidSMS change your experience?

21. What impact do you believe the RapidSMS system has had on the pregnancy of your wife and the care you or your wife provided for your child?

XLV. RapidSMS sustainability

22. What do you think could be changed about the RapidSMS system to bring more benefit to yourself, your wife, children or your community?

23. How can these improvements be performed?

24. Who should be involved in implementing these improvements?

<u>Closing</u>

Thank you very much for taking your precious time to share your personal experience with the RapidSMS system with us.

Is there any information you would like to share with me that did not get covered in this interview?

Once again thank you so much.

Appendix 2: Informed Consent Documents

<p style="text-align:center">Informed consent form for study participants</p>

<p style="text-align:center">Research Title: Evaluating the impact of RapidSMS</p>

<p style="text-align:center">Principal Investigator: Michael Law, PhD</p>

<p style="text-align:center">Qualitative Lead Investigator: Angèle Musabyimana, MD, MPH</p>

<p style="text-align:center">University of Rwanda-College of Medicine and Health Sciences/ School of Public Health, Kigali</p>

Part I: Information Sheet

Introduction

My name is ………………………………………, from the University of Rwanda, College of Medicine and Health Sciences, School of Public Health. I am part of a research study aiming to evaluate the impact of the RapidSMS system in Rwanda. My component of this study will be conducted through an interview, the topics of which will include the purpose and uses of the RapidSMS system, the changes that RapidSMS produced on health care processes, and the impact of the RapidSMS system on key maternal and child health indicators. We would also like to discuss the sustainability of the system moving forward.

We are approaching you to participate in this study based on your professional role and knowledge about the RapidSMS system.

Interview Procedures

If you agree to participate in this study, the research team members will interview you using an interview guide. This will be audio-recorded if you agree. The interview will last about one hour. After the interview, we may return to you in order to clarify or discuss questions that emerge from our data analysis.

Confidentiality

If you agree to participate in this study, you will not be identified by name. Your responses will only be used for research purposes. Your name and position or any other identifier will only appear on this consent form which will be kept separately from other interview records. In addition, pseudonyms or identifier codes will be used to enhance the confidentiality of any information. No named attribution will be given to any quotes or individual responses that are presented in any reports, publications, or presentations.

Risks and Benefits

This is a low risk research protocol. One possible risk may be that readers might detect where a piece of information came from. To mitigate this risk, we will take measures to protect your privacy as outlined above. Benefits from participation in this study include your contribution to a better understanding of the RapidSMS system. You will also be able to share your ideas for the eventual improvement of RapidSMS. In addition, the knowledge gained from this research will be shared both with you and more broadly through publications and conferences. This will provide important evidence for policy makers from both Rwanda and other countries on the RapidSMS system. There will be no compensation for your participation in this study.

Voluntary Participation

Your participation in this research is entirely voluntary. You may change your mind later and stop participating even if you did agree earlier to participate. You also have the right to decline to answer any question during your interview or in follow-up. Your choice to participate or not will not have any bearing on your job or your job-related evaluations.

Questions related to this research

If you have any questions about this research, you may contact the lead qualitative investigator, Dr. Angèle Musabyimana on Tel 0788666609. If you have concerns about your rights or any other ethical issues, you may contact the Chair Person of the UR/CMHS IRB, Prof. Kato Njunwa, on Tel 0788490522.

Part II: Certificate of Consent

I have read the foregoing information and have had the opportunity to ask questions about it and any questions I have asked have been answered to my satisfaction. I consent voluntarily to be a participant in this study.

I agree to be tape recorded: Yes / No

Print Name of Participant_____

Signature of Participant _____

Date _____

     Day/month/year

Statement by the researcher/person taking consent

I have accurately read out the information sheet to the participant and confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Print Name of Researcher/person taking the consent_____

Signature of Researcher /person taking the consent_____

Date _____

     Day/month/year

ICYEMEZO CYO KUGIRA URUHARE MU BUSHAKASHATSI KU BUSHAKE

Izina ry'ubushakashatsi: Gusuzuma impinduka zatewe na RapidSMS mu Rwanda

Umuyobozi mukuru w'ubushakashatsi: Michael Law, PhD

Ukuriye gahunda y'ubu bushakashatsi ishingiye ku biganiro: Angèle Musabyimana, MD, MPH

Kaminuza y'uRwanda-Koleji y'ubuvuzi n'ubumenyi mu by'ubuzima-Ishuri ry'ubuzima rusange, Kigali

Igice cya mbere: Amakuru yerekeye ubushakashatsi

Iliburiro

Nitwa…………………………………………, naturutse muri Kaminuza y'u Rwanda-Koleji y'ubuvuzi n'ubumenyi mu by'ubuzima-Ishuri ry'ubuzima rusange. Ndi umwe mu bagize itsinda riri gukora ubushakashatsi bwo gusuzuma impinduka zatewe na RapidSMS mu Rwanda. Igice cy'ubushakashatsi turimo ni igishingiye ku makuru muduha binyuze mu kiganiro tugirana. Ibyo tuganiraho bikaba bifitanye isano n'intego ya gahunda ya RapidSMS, akamaro kayo, impinduka iyo gahunda yazanye mu mikorere ya servisi z'ubuvuzi no ku bipimo ngenderwaho bireberaho uko ubuzima bw'abana n'ababyeyi buhagaze. Turifuza kandi no kuganira na mwe ku hazaza ha gahunda ya Rapid SMS.

Twabagannye twifuza ko mugira uruhare muri ubu dushingiye ku ruhare n'ubumenyi mufite ku mikorere ya Rapid SMS.

Uko ikiganiro gikorwa

Nimuramuka mwemeye kugira uruhare muri ubu bushakashatsi, bamwe mu bagize itsinda ry'ababukora baraganira namwe bifashishije inyandiko nyoborakiganiro. Iki kiganiro kirafatwa amajwi nimubitwemerera. Iki kiganiro kiramara nk'isaha imwe. Nyuma yo kuganira namwe, dushobora gukenera kuzongera kubavugisha turamutse hari icyo tudasobanukiwe mu byo mwatubwiye, cyangwa tukababaza ibindi bibazo tutaganiriyeho igihe tuzasanga ari ingenzi turi kwandikura no gusuzuma ibyo twaganiriye.

Ibanga

Nimuramuka mwemeye kugira uruhare muri ubu bushakashatsi, ntabwo amazina yanyu azagaragazwa. Ibisubizo byanyu bizakoreshwa gusa kubw'ubu bushakashatsi gusa. Amazina yanyu n'abo muri bo/akazi mukora cyangwa ikindi kintu cyose cyatuma mumenyekana bizagaragara kuri iki cyemezo cyonyine kandi kizabikwa ahantu hanyuranye n'aho ibiva mu kiganiro tugirana bizabikwa. Ikindi kandi, tuzakoresha ikibaranga kinyuranye n'amazina yanyu kugira ngo ibibaranga nyabyo bibe ibanga. Nidushyira ibyo mutubwira muri raporo yacu, amazina yanyu n'ikindi cyose cyatuma mumenyekana ntituzabishyiramo.

Inyungu n'ingaruka zishobora guturuka kuri ubu bushsakashatsi

Urebye, ubu bushakashatsi nta ngaruka zifatika bwabagiraho. Gusa, ingaruka zishoboka ni uko uzasoma raporo tuzakora yamenya amakuru aho yaturutse. Kugira ngo tubikumire tuzifashisha ingamba zavuzwe haruguru. Inyungu zo ni uko binyuze mu makuru muduha muzadufasha tugasobanukirwa biruseho na gahunda ya RapidSMS. Binyuze muri iki kiganiro kandi, muraza kudusangiza ibyo mubona bikwiriye kunozwa neza muri iyi gahunda yo gukoresha RapidSMS. Ikindi ni uko ubumenyi buzava muri ubu bushakashatsi buzagezwa ku bantu benshi na mwe murimo hakoreshejwe uburyo bunyuranye bwo gusakaza ibyavuye mu bushakashatsi. Ibi tuganira bizatanga amakuru yagenderwaho mu gihe hagenwa imirongo ya politiki yo kugena imikoreshereze ya Rpid SMS haba mu Rwanda no mu bindi bihugu. Nta nsimburamubyizi muri buhabwe ku bwo kugira uruhare muri ubu bushakashsatsi.

Kugira uruhare muri bushakashatsi ni ubushake

Kugira uruhare kwanyu muri bushakashatsi ni ubushake. Mushobora guhindura icyemezo cyanyu cyo kugira uruhare muri bushakashatsi. Mufite n'uburenganzira bwo kudasubiza ikibazo runaka mu gihe tuganira cyangwa igihe tuzaba tubahamagaye nyuma y'aha. Kwemera cyangwa kutemera kugira uruhare muri ubu bushakashatsi nta ngaruka bibazanira ku bijyanye n'akazi kanyu/imivurirwe yanyu.

Aho mwabariza ibibazo byerekeye ubu bushakashatsi

Muramutse mugize ikibazo cyerekeye ubu bushakashatsi, mwahamagara ukuriye gahunda y'ubu bushakashatsi ishingiye ku biganiro, Dr. Angèle Musabyimanaon kuri nimero ya telefoni igendanwa 0788666609. Muramutse mufite ikibazo cyerekeye uburenganzira bwanyu nk'abagize uruhare mu bushakashatsi, mwahamagara ushinzwe iby'uburenganzira bw'abagira uruhare mu bushakatsi muri Kaminuza y'u Rwanda-Koleji y'ubuvuzi n'ubumenyi mu by'ubuzima Prof. Kato Njunwa kuri nimero ya telefoni igendanwa 0788490522.

Igice cya kabiri: Kwemera kugira uruhare mu bushakashatsi

Nasomye/nasomewe ibikubiye muri iyi nyandiko mpabwa n'umwanya wo kubaza ibibazo kandi ibibazo nabajije byosee byasubijwe mu buryo bwanyuze. Nemeye ku bushake bwanjye nta gahato kugira uruhare muri ubu bushakashatsi.

Ndemera ko bafata amajwi mu gihe tuganira: Yego /Oya

Amazina y' uwemeye kugira uruhare mu bushakashatsi _____

Umukono w'uwemeye kugira uruhare mu bushakashatsi _____

Itariki _____
            Umunsi/Ukwezi/Umwaka

Ubuhamya bw'ubaza/uwakira iki cyemezo
Nasomeye iyi nyandiko uko iri uwiyemeje kugira uruhare muri ubu bushakashatsi kandi ndahamya ko yahawe umwanya wo kubaza ibibazo byerekeye ubu bushakashastsi, ibibazo yabajije nabisubije mu kuri uko nshoboye kose. Ndahamya kandi ko uyu muntu atahatiwe kwemera kugira uruhare muri ububushakashatsi ahubwo yabwyemeye ku bushake bwe no mu mudendezo usesuye.

Iyi nyandiko yahawe uwemeye kugira uruhare muri ubu bushsakashatsi.

Amazina y'ubaza/uwakira iki cyemezo_____

Umukono w'ubaza/uwakira iki cyemezo_____

Itariki _____
            Umunsi/Ukwezi/Umwaka