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Using Mobile Phones to Improve Child Nutrition Surveillance in Malawi

UNICEF Malawi and UNICEF Innovations

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TABLE OF CONTENTS

5 Executive Summary

6 Introduction

7 Background

12 RapidSMS in Malawi

15 Methodology

22 Key Findings

28 Future Challenges

33 Recommendations

35 Proposed Next Steps

36 References

38 Appendix

GLOSSARY OF TERMS

ACF	Action Against Hunger
GMC	Growth Monitoring Clinic
GSM	Global System for Mobile Communications
HMIS	Health Management Information Systems
HSA	Health Surveillance Assistant
INFSS	Integrated Nutrition and Food Security Surveillance
MCH	Mother and Child Health Coordinator
MoH	Malawi Ministry of Health
MUAC	Middle Upper Arm Circumference
OPC	Office of Presidential Cabinet
PPP	Purchasing Power Parity
RUTF	Ready-to-Use Therapeutic Food
SIPA	Columbia University's School of International and Public Affairs
SMS	Short Messaging System (mobile phone text message)
WHO	World Health Organization

EXECUTIVE SUMMARY

This study is the result of a collaboration between Columbia University's School of International and Public Affairs, UNICEF Malawi, and UNICEF's Division of Communications Innovations Team in an attempt to use mobile communication devices to facilitate the surveillance of child nutrition in Malawi. As part of the pilot study, health workers at three district growth monitoring clinics were trained to submit child nutrition data via mobile phone SMS (text messages). Using an open-source software platform (RapidSMS), this data was received by a central server and automatically analyzed for indicators of child malnutrition. Health workers received instant feedback messages confirming the information sent and provided additional directions if malnutrition was indicated by the data received. Finally, a website was created to provide the Malawian government and other stakeholders real-time access to this data and its analysis.

This pilot study yielded a number of findings that may be applicable to other development projects using similar mobile phone technology. The results of this particular program included:

- Significant reduction in data transmission delay compared to Malawi's current paper-based system.
- Increase in data quality reported by health workers.
- Elimination of the need for time-consuming manual data-entry.
- Increased two-way flow of information between stakeholders at the national government level and health workers in the field.
- Increased system and personnel monitoring capabilities.
- Elimination of costs related to transporting paper forms and manually entering data.

However, technology can only aid development within a limited scope. The true value of this innovation will be dependent on several other factors, including the integration of RapidSMS into the larger context of health activities and policy making in Malawi; the willingness of the Government of Malawi to take ownership of the platform; the ability to build and develop local technical capacity; and the maintenance of training and monitoring at all levels of participation.

The following report will detail the pilot study's findings and outline recommendations for the future use of RapidSMS in Malawi.

INTRODUCTION

Can an inexpensive technology be used to improve Malawi's child malnutrition surveillance? This was the essential question at the heart of a collaboration between Columbia University's School of International and Public Affairs (SIPA), UNICEF Malawi's Health and Nutrition Unit, and UNICEF's Division of Communications Innovations Team. As graduate students of SIPA's program in economic and political development, our team of six was tasked to explore sustainable technological tools that might improve the process of collection and distribution of child nutrition data within Malawi.

Malawi's current system for child nutrition data collection, the Integrated Nutritional and Food Security Surveillance (INFSS) system, uses a random sample of children visiting growth monitoring clinics (GMCs) throughout the country to measure trends in child nutrition. However, the system faces challenges of poor data quality, time delays between data collection and analysis, and high participant dropout. Since chronic and widespread child malnutrition remains a serious problem in the country, the limitations of the INFSS system are a serious threat to the country's ability to anticipate and plan for current and future nutrition and food security crises.

To address these problems, the team explored the use of mobile phones as a tool to collect and transmit child nutrition information via text messages (SMS). Using an open-source software platform (RapidSMS), the mobile phone can function as an electronic input device for health workers in the field, allowing them to send raw data directly to a central server at the national government level.

To test the viability of this technology, the team selected three pilot sites in different districts of Malawi where GMC health workers were trained to enter child nutrition information via text message format. Health workers used this mobile system for data reporting from January 2009 to May 2009. Information received by the server was automatically entered into a database and analyzed for indicators of child malnutrition.

The pilot study has shown that government and development workers can benefit from real-time data access and analysis. Health workers received instant feedback messages confirming the information sent and provided additional directions if malnutrition was indicated by the data received. This proved very helpful, as mathematical calculations were made automatically. RapidSMS also provided more accurate information to caregivers regarding the health of their children. Children who had previously gone unrecognized as moderately malnourished were better identified via automated calculations of weight for height percent of median. To date, UNICEF has been instrumental in creating and maintaining the pilot. The next step will involve transferring ownership of RapidSMS to the Government of Malawi for national scale-up and full integration into the INFSS system.

This report describes in detail the successes and shortcomings revealed in this pilot study and, more generally, the issues associated with using mobile technology to address development challenges.

The Nkhamenya GMC in the Kasungu District was one of three sites where RapidSMS was tested.

BACKGROUND

COUNTRY DEVELOPMENT CONTEXT

Malawi is one of the world's most densely-populated, yet least-developed countries. A small, landlocked country bordered by Mozambique, Zambia, and Tanzania, Malawi has remained below the United Nation's average human development index score of sub-Saharan Africa countries due to a combination of slow economic development, poor infrastructure, the catastrophic public health effects of HIV/AIDS, and chronic child malnutrition. The 2008 UNDP Human Development Report ranked the country 164th out of 177 countries in factors such as average life expectancy (46.3 years), adult literacy (64 percent), GDP per capita (US$667), and percentage of underweight children under five years (22 percent)[1].

Although the country is striving to attract tourism income from its national park wildlife and develop a mineral sector for its uranium deposits, economic development remains stagnant in Malawi. GDP in 2008 was estimated at US$11.6 billion (PPP adjusted), though the country owes a staggering 49 percent of this GDP in public debt[2]. The vast majority of the population works in farming, with 85 percent of people residing in rural areas. Agriculture makes up one-third of Malawi's GDP and 90 percent of its exports. Over half of all export agriculture comes from tobacco, followed by other cash crops such as tea, cotton, and sugar[3]. The economic situation has been improving recently. Annual GDP growth has risen from just over 1% in 2003 to 8% in 2008, food production has increased consistenly over the past three years, and political stability has continued with the recent presidential reelection of Dr. Bingu Wa Mutharika to a second term.

Food security in Malawi is dependent on local cultivation of maize, groundnuts, potatoes, cassava, and pulses, among other food crops. The country's staple crop is maize, which is grown mostly in small household plots and then ground by hand to produce the staple corn porridge, nsima. Intensification of regional patterns of drought and flooding in recent years in part due to climate change has increased the risk to food and nutrition security. The country suffered a series of severe droughts over the last decade that led to widespread famine during 2002 and 2006. In 2007, the government broke with World Bank recommendations by implementing a fertilizer and seed subsidization program for small plot farmers. This program, in combination with good seasonal rains, led to a bumper crop in 2007 and increased yields in 2008; however, dramatic fluctuations in world food prices have threatened these improvements in food security. Child malnutrition remains widespread throughout the country.

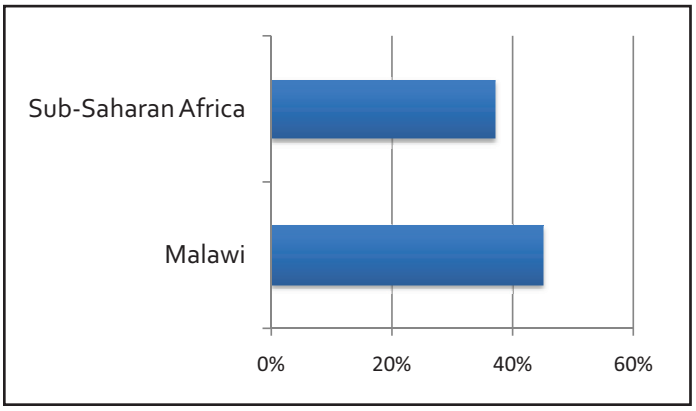
The goal of this project was to assist UNICEF and the Government of Malawi to quickly respond to trends in child malnutrition by opening the channels of communication between decision-makers in Lilongwe and health workers in the field. While RapidSMS has demonstrated its potential for improving child nutrition monitoring, it has also been effective as a means of sharing information among all stakeholders.

[1] See http://hdrstats.undp.org/countries/country_fact_sheets/cty_fs_MWI.html for greater detail.
[2] CIA World Factbook, Malawi. https://www.cia.gov/library/publications/the-world-factbook/geos/mi.html
[3] World Bank. Malawi: Country Brief. http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/AFRICAEXT/MALAWIEXTN/0,,menuPK:355882~pagePK:141132~piPK:141107~theSitePK:355870,00.html

HEALTH AND NUTRITION

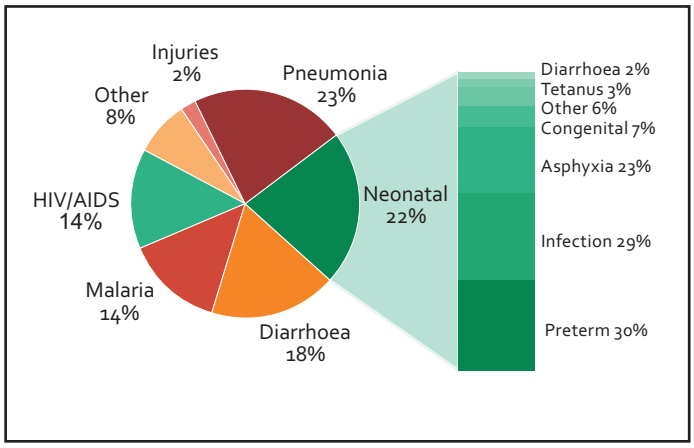
Malnutrition remains a major challenge in Malawi, where it contributes to high morbidity and mortality rates among children under five years old and other vulnerable groups such as pregnant and lactating mothers. The World Bank estimates that 35 percent of Malawians consume an insufficient amount of calories[4]. This chronic problem is compounded by persistent food shortages and high incidence of diseases, including HIV and AIDS. It is estimated that 13 percent of children in Malawi die before the age of five, and that at least one-third of these deaths are related to acute malnutrition[5]. Over half of all children suffer from stunting (52.5 percent) and 18.4 percent of children under five years old are underweight for their age[6].

Percent of Children Under Five Suffering from Moderate or Severe Stunting



(Source: UNICEF State of the World's Children 2009)

Causes of Child Mortality in Malawi



(Source: World Health Organzation 2006)
(Source: Lawn JE, Cousens SN for CHERG, Nov 2006)

[4] World Bank. Malawi: Country Brief.
[5] UNICEF Malawi Multiple Indicator Cluster Survey, www.unicef.org/infobycountry/malawi_statistics.html.
[6] World Health Organization, Malawi Core Health Indicators. http://www.who.int/whosis/

MALAWI'S INFSS SYSTEM

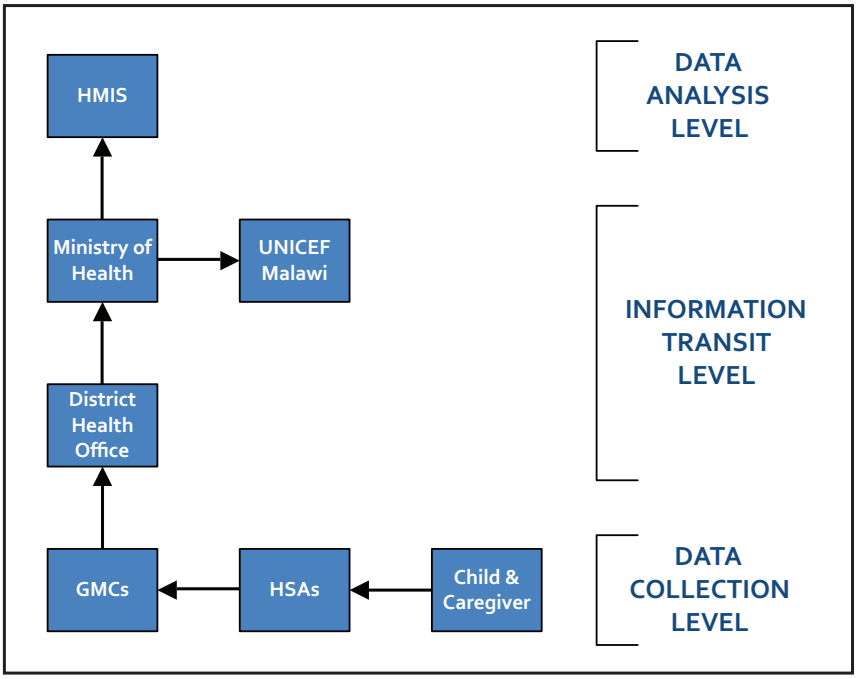
In the wake of Malawi's severe 2002 famine, the Integrated Nutrition and Food Security Surveillance System (INFSS) was set up with technical assistance from Action Against Hunger (ACF) and the support of the Malawi government, UNICEF, the European Union, and other partners. The surveillance system monitors trends in nutritional status of approximately 9100 children (350 per district) from five growth monitoring clinics (GMCs) in 26 districts. These children are randomly selected from the population of children visiting GMCs, thereby including a combination of healthy, malnourished, and sick children. These same children were tracked and measured monthly for a period of 12 months. The GMCs send the nutrition data each month to the local district office which forwards it to the national level for data entry and analysis.

In early 2008, ACF handed over the INFSS system to the Government of Malawi. However, the INFSS system functionality quickly began to decline. The departure of ACF created a lack of ownership in the system, a deficiency of human resources capacity for data entry and analysis, and unclear roles and responsibilities for the maintenance of the system by government employees. Presently, ownership of the INFSS system is split between the Department of Nutrition, HIV & AIDS and the Ministries of Health and Agriculture.

Partly due to this lack of ownership and human resources capacity for monitoring, data reporting dropped significantly since ACF departed from the project, and monthly reporting of child nutrition trends throughout the country abruptly halted. Paper data forms continued to trickle up to the central government level, yet much of the data was never entered into computers or analyzed. This left the government, UNICEF, and its development partners without any systematic means of identifying child malnutrition problems throughout the country and with little information with which to make effective decisions about allocation of resources.

The Columbia University team was asked to investigate uses of technology to rebuild the flow of child nutrition information for the INFSS system. Specifically, the team was tasked with improving the speed of nutrition data transmission and the quality of the data received. The Malawi Government is investigating other weaknesses in the current INFSS system, beyond data collection and data transmissions. Two evaluations by independent advisers have been performed on the overall performance of the system, and numerous areas of improvement have been identified. Problems with the current INFSS system are varied, including user limitations (such as child measurement practices and child dropout handling) and system design limitations (such as sample bias, data bootstrapping, and analysis and reaction capacity)[7]. While RapidSMS is a flexible platform and can be easily incorporated into an improved INFSS system once it is complete, its benefits are mainly focused on addressing system design limitations[8].

Flow of Information Using the Current INFSS System



[7] World Health Organization, Malawi Core Health Indicators. http://www.who.int/whosis/
[8] For further reading on specific challenges of the INFSS system, please see the report by Charles Teller and the response report by Neil Fisher.

MOBILE TECHNOLOGY AND RAPIDSMS

Several recent studies indicate a growing adoption rate of information and communication technologies (ICT) in the developing world. A common proxy for this is the use and ownership of mobile phones. According to a recent report, mobile phone networks now cover nearly 90 percent of the world, with mobile phone penetration at approximately 50 percent[9]. Not surprisingly, international development efforts are increasingly focused on leveraging this technology to improve program reach and plan results. According to a UN report, 86 percent of NGO employees are using mobile phones in their work, and 76 percent say they anticipate increasing their use in the future[10].

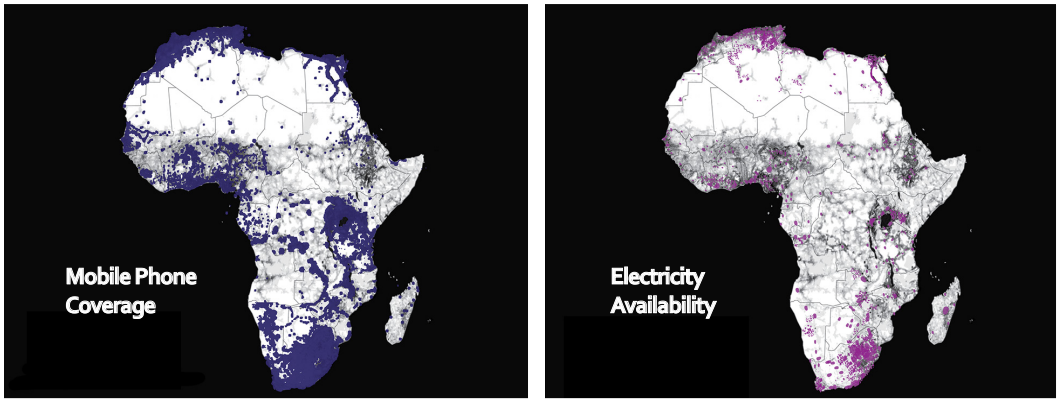
The use of mobile phones is growing particularly fast in Africa, with over 280 million mobile subscribers as of 2007. While ownership is generally lower in Malawi than other African countries, the market is growing rapidly. Between 2006 and 2007, mobile phone usage increased by 51 percent, with a total of 600,000 subscribers (4.6 percent of population)[11]. Adoption of mobile phones in Africa represents a "technology leap" in the sense that the continent has largely skipped land-based networks in favor of cellular networks.

In an effort to improve the INFSS system's data monitoring efficiency and accuracy, several technology options were considered. The ubiquity of the mobile phone in Malawi made it an ideal device for the project's purpose. Even though SMS is more limited in scope than alternative technologies, it represents the lowest common denominator in terms of technology, thereby helping to assure the highest level of compliance and program participation. In addition, while UNICEF may have the resources to secure hardware to implement testing of PDAs or Smartphones, concerns over equipment theft, system compatibility and scalability outweigh the potential benefits these other devices could provide.

UNICEF has previously used the RapidSMS platform for field data collection purposes in Ethiopia. The Ethiopia system was built to monitor the supply and distribution of a ready-to-use therapeutic food (RUTF) called Plumpy'Nut. With assistance from UNICEF Innovations, this platform was significantly modified to meet the needs of the Malawi INFSS system.

From a technical requirements point of view, RapidSMS has extremely basic requirements. The RapidSMS platform is comprised of three parts – the end-user's mobile phone, the server-based backend, and the server-based frontend website. Minimum platform requirements include a central server with Internet access and attached GSM modems.

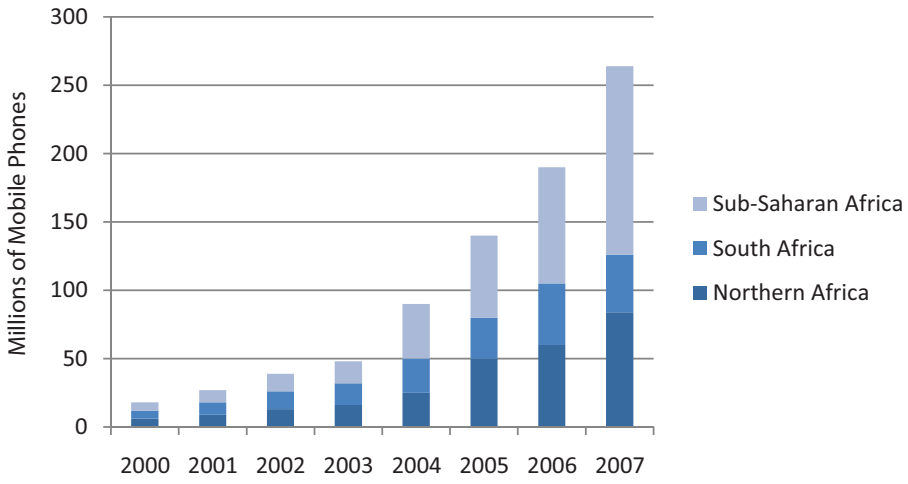
Mobile Phone Coverage vs. Electricity Availability in Africa



Mobile phone service in Africa (left) is currently more broadly available than electricity (right).
(Source: National Aeronautics and Space Administration)

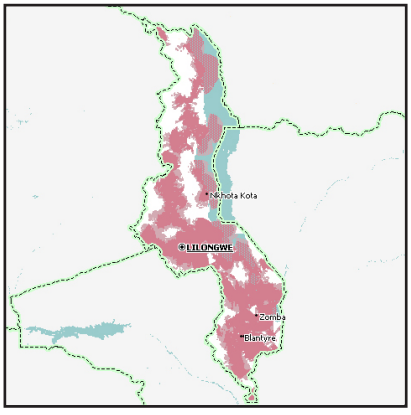
[9] Africa Mobile Fact Book 2008, Blycroft Publishing, 2008.
[10] Kinkade, Sheila and Katrin Verclas. Wireless Technology for Social Change: Trends in Mobile Use by NGOs. Washington, DC: United Nations Foundation, 2008.
[11] Ibid.

Number of Mobile Phones in Africa

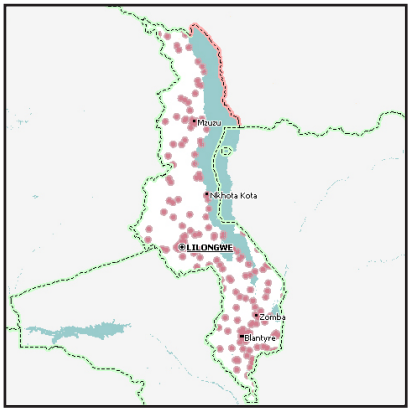


(Source: Africa Mobile Fact Book 2008)

Mobile Phone Coverage in Malawi



Zain GSM Malawi Coverage Map
(Source: www.gsmworld.com)



TNM GSM Malawi Coverage Map
(Source: www.gsmworld.com)

RAPIDSMS IN MALAWI

Following current INFSS guidelines, HSAs record each sample child's monthly measurements on paper forms. Measurements include height, weight, middle upper arm circumference (MUAC), edema, and presence of persistent diarrhea. The data is collected and delivered to the district nutrition managers at each district's central hospital. From there, the information is sent to the national government level in Lilongwe, where it is manually typed into a spreadsheet. Using a Microsoft Excel-based analysis software (AnalyNut), the data is then analyzed based on child malnutrition indicators.

The nutrition component of the INFSS system is functional, yet it has been plagued by a number of persistent problems as previously described. The Columbia University team focused on the following challenges:

- **Poor data quality:** Datasets are often incomplete or contain significant outliers.
- **Participant dropout and decrease in reporting rates:** After a few visits, mothers stop coming to GMCs with their children. HSAs subsequently stop their reporting.
- **Delays in transmission of data:** Data is transferred between government health departments via postal mail or alternative means of transportation. At the national level, lack of human resources lead to long delays before data is analyzed.

As a result of these limitations, there are too few complete datasets to analyze on a monthly basis, and effectiveness of the early warning system is subsequently compromised. Policy makers and development practitioners are unable to receive timely information regarding trends in child malnutrition throughout the country and are subsequently unable to react appropriately with increased support to areas facing high levels of malnutrition.

It was hoped that, through the implementation of RapidSMS as part of the INFSS system, many of these limitations would be addressed, allowing for greater functionality of the system.

Mobile phone usage is growing rapidly in Malawi.

RapidSMS

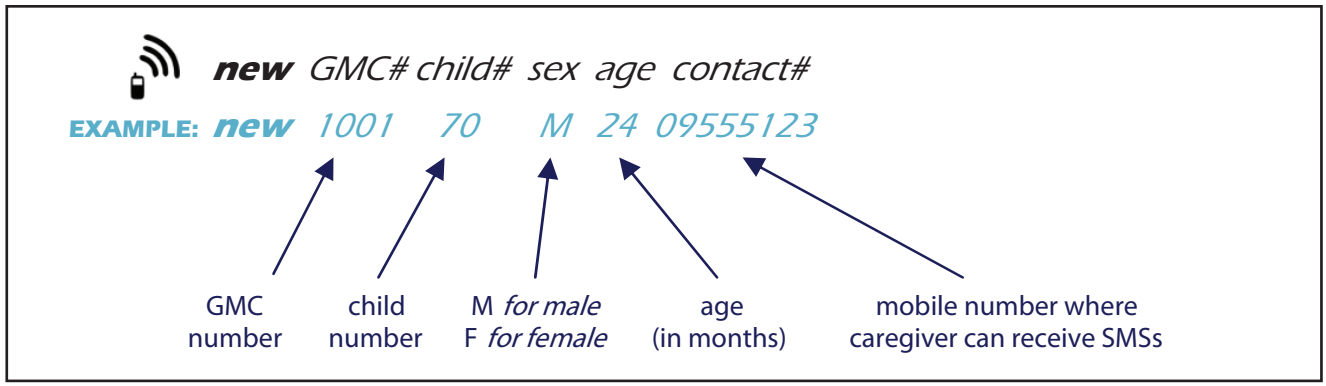
HOW RAPIDSMS WORKS

1. The HSA sends an SMS using a pre-determined format (see below) to the phone number of one of the GSM modems. (There are two major mobile providers in Malawi: Zain and TNM). Each GMC is assigned a 4-digit number which, combined with child ID (1-70), creates a unique child identifier.
2. The SMS is received by the server.
3. The server populates a master database with the SMS data and compares the data to previous SMS submissions and predetermined variable standards.
4. The server automatically sends an SMS back to the HSA confirming that the data sent is correct.
5. If the SMS sent indicates a data entry error (for example, the child's entered height is physically impossible), the server sends an SMS back to the HSA requesting that a corrected SMS be sent.
6. If the SMS sent indicates a health condition requiring further attention (for example, the child is malnourished based on his/her weight for height percent of median), the server sends back an SMS providing specific instructions to the HSA.
7. Simultaneously, the website is automatically updated with the new data received and child malnutrition indicators for each site are instantly adjusted.

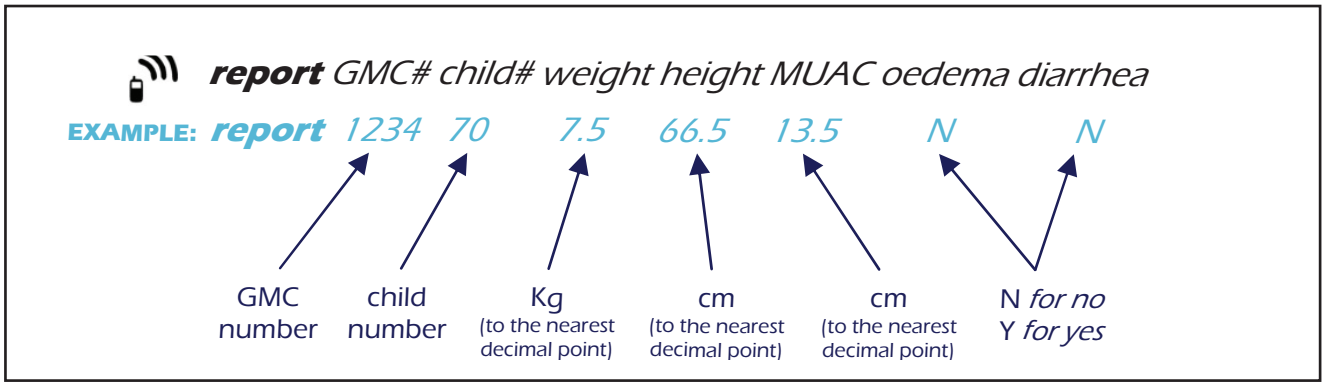
CONVERTING FROM PAPER TO SMS

Child #	Sex	Age	Weight	Height	% Weight for Height	MUAC	Oedema	Diarrhoea
70	M	24	7.5	66.5		13.5	N	N
28	F	13	6.7	55.4		12.1	N	N
42	F	42	8.6	65.8		13.8	Y	N

Example of original paper-based form



Example of RapidSMS text message for registering a child



Example of RapidSMS text message for reporting child measurements

METHODOLOGY

PROJECT OBJECTIVES

The Columbia University team designed and implemented the RapidSMS pilot study with the following objectives:

1. Identify possible improvements in data transmission and quality by using mobile technology.
2. Quantify the quality and transmission improvements.
3. Customize RapidSMS for use with the existing INFSS system.
4. Adapt, if necessary, for national roll-out.

The pilot study was implemented with UNICEF providing essential technical, logistical, and financial support. Two teams from Columbia University traveled to Malawi in January and March 2009 to meet with stakeholders, initiate the pilot study, and monitor the study's progress. The activities undertaken by the team can be grouped in four phases: information gathering, platform design, study implementation, study monitoring and assessment.

The Columbia University team trained HSAs in Dedza.

INFORMATION GATHERING

In order to create an effective technology-driven pilot study that addressed the key deficiencies of the INFSS system, the Columbia University team undertook a comprehensive review of associated research and materials, including:

- Mobile phone use trends and application in health and nutrition data collection.
- Child malnutrition developments in Malawi.
- Design and application of the existing INFSS system.
- Mobile phone access and usage behaviors in Malawi.
- Mobile phone industry and network coverage in Malawi.
- Data from the 2007/2008 INFSS system data collection forms.

The team then conducted meetings with officials from the Government of Malawi, NGO partners, multilateral donor agencies, and other stakeholders to introduce, gather support, and solicit feedback for the project. Key participants in these meetings included:

- Dr. Mary Shawa
  Principal Secretary for Nutrition and HIV/AIDS, Office of the President and Cabinet
- Dr. Tapiwa Ngulube
  Principal Nutritionist, Ministry of Health
- Ernest Kaluda and Sylvester Kathumbe
  Ministry of Health, Health Management Information Systems
- *Ruth Bulao Ayoade*
  FAO Division of Nutrition and HIV/AIDS
- Carrie Auer
  UNICEF Malawi Country Representative
- Susan Kambale
  World Health Organization
- Dr. Beatrice Mtimuni
  University of Malawi's Bunda College of Agriculture
- Aart Van Der Heide
  Technical Advisor on Food Security and Nutrition to the Government of Malawi, European Union

Focus group discussions were also held with UNICEF Malawi staff members, field health workers, and child caregivers participating in the nutritional surveillance program. These discussions were instrumental in better understanding mobile phone usage behaviors, observing nutritional data collection at the clinic level and gauging the comfort level among HSAs with using RapidSMS, and greatly assisted the team in proceeding with the pilot study in an effective manner.

The Columbia University team trained HSAs in Dedza.

RAPIDSMS PLATFORM DESIGN

The Malawi RapidSMS platform was designed to keep the data input format as close to the paper format as possible. In order to make RapidSMS compatible with all mobile phones, the platform used a string of variables entered in a predefined order within a single SMS, with the same health indicators inputted in the same order as the original system.

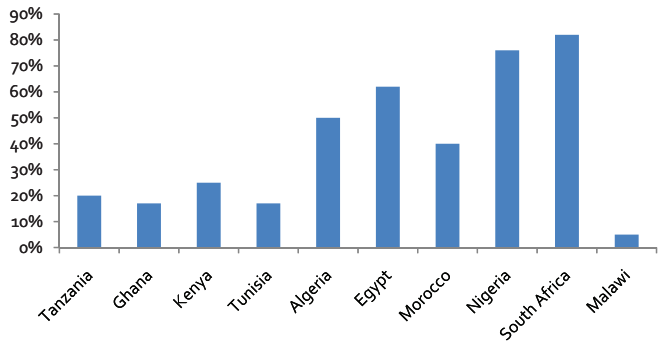
Variables were kept to a minimum, with separate child registration and child measurement commands defined to avoid errors or confusion. It was determined from previous tests that including any more than five variables in a single SMS significantly increased the chance for error. Posters and laminated training cards were created to serve as reference materials. After the initial training period, HSAs were monitored on their ability to accurately and consistently use the RapidSMS platform to submit data.

The RapidSMS platform was designed to also provide valuable feedback to the HSAs. Feedback loops were incorporated to guide HSAs in their work and alert them of any data entry errors. For example, after submitting a child's measurements via SMS, HSAs automatically received an SMS confirming the data submission. In the event that the data submitted indicated malnutrition, the HSA would also receive an SMS providing them with specific instructions for treating the child. If the HSA observed any inaccuracies in the confirmation SMS, he/she could immediately cancel the previous submission and resend a corrected one. In the event of a significant data entry error (for example, a height measurement outside the range of physical possibility), the HSA would automatically receive an SMS instructing them to re-send the corrected data. This automation was based on a series of program rules configured on the central server.

The platform incorporated a wide range of automatic responses, including some that simply thanked the HSA for sending a correct report and some instructing him/her to admit a child into specific supplementary feeding programs. By incorporating this bilateral communication, RapidSMS was designed to use real-time data to provide HSAs important feedback on their work and the status of the children they were treating. For example, RapidSMS used the height, weight, and age data reported for each child to perform the complex calculation of child weight for height percent of median, a common barometer of malnutrition. RapidSMS automatically performed this calculation and sent the result back to the HSAs

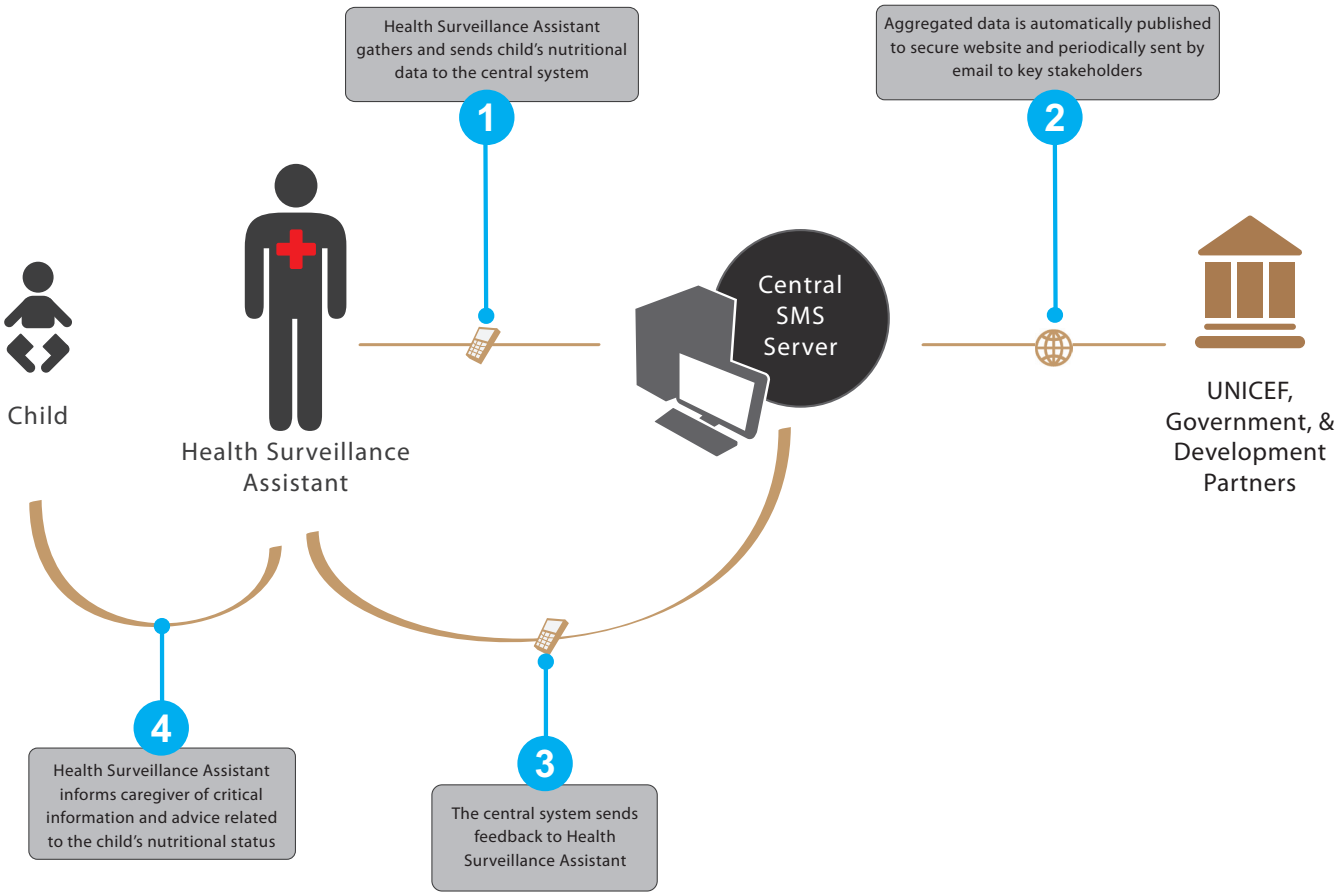
During consultation with UNICEF's software developers, the team discussed platform requirements and exchanged ideas on implementation. Lessons learned from the previous implementation of RapidSMS in Ethiopia were also assessed and integrated into the Malawi platform design. UNICEF maintains a practice of completing the majority of programming work in the host country, and this provided the implementation team the flexibility to make modifications to the platform based on new information acquired in the field.

Mobile Phone Usage Rates



(Source: Africa Mobile Fact Book 2008)

RAPIDSMS INFORMATION FLOW

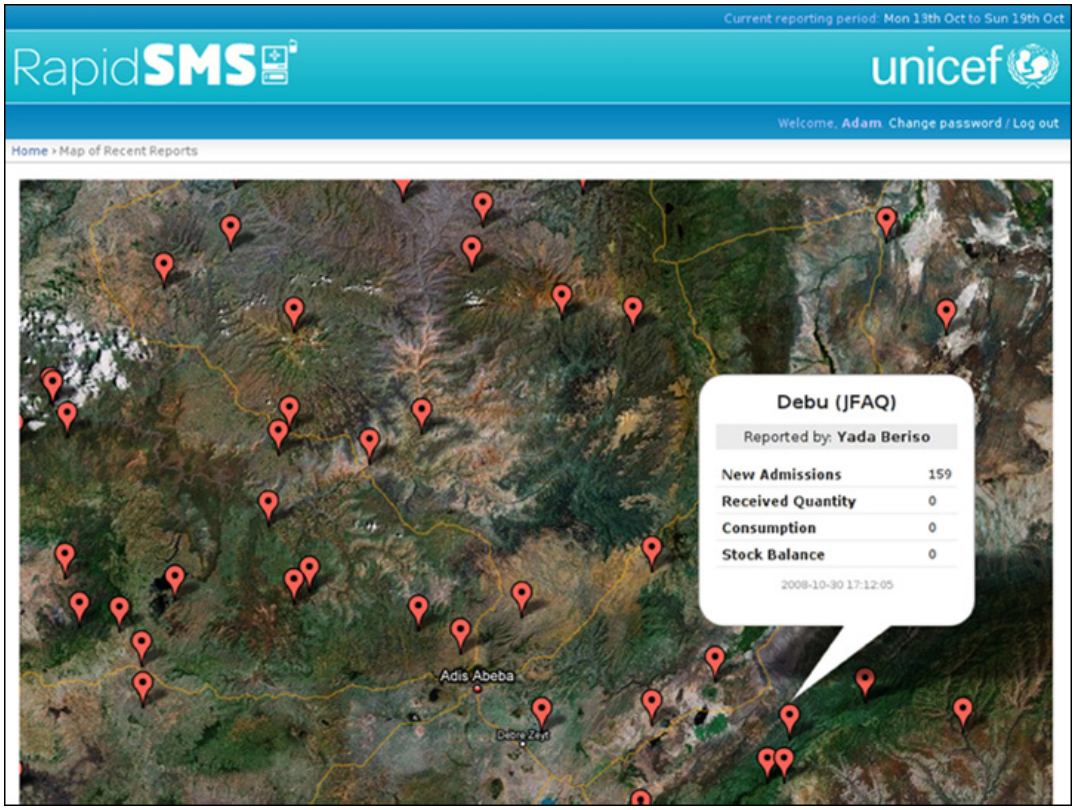


Example of Data Collection on RapidSMS Website

Latest Reports from all GMCs

District	GMC	Reporter	Child#	Weight	Height	MUAC	Oedema?	Diarrhea?	Received
Dedza	Chikuse	+265995840849	68	8.8	69.9	12.0	false	false	2:26 PM
Dedza	Chikuse	+265999795733	70	10.3	77.4	14.3	false	false	2:25 PM
Dedza	Chikuse	+265999795733	69	9.0	70.9	14.5	false	false	2:23 PM
Dedza	Chikuse	+265995840849	68	8.8	69.9	12.0	false	false	2:14 PM

Example of Data Spatial Mapping on RapidSMS Website



METHODOLOGY

PILOT STUDY IMPLEMENTATION

Partnerships

In January 2009, the pilot study was launched at three GMC sites in central Malawi. HSAs at the selected clinics were trained in using RapidSMS by a joint Columbia University/ UNICEF team. In order to provide additional assistance to the HSAs and capture program feedback, nutrition specialists from University of Malawi's Bunda College of Agriculture in Lilongwe were contracted by UNICEF Malawi to conduct twice-monthly monitoring visits to the three sites. The results of these frequent visits were shared with both UNICEF Malawi and the Columbia University team.

Site Selection

The pilot study sites were selected in an effort to represent three unique data trends: consistency in data quality and reporting, high data reporting with low data quality, and low data reporting and/or low data quality. Due to time constraints and the difficulty of rural travel during the rainy season, the team was restricted to sites within the central region of Malawi.

Given these objectives and constraints, the following sites were selected:

- Nkhamenya GMC, Kasungu District
  (high data reporting, low data quality)
- Chipoka GMC, Salima District
  (low data reporting)
- Chikuse GMC, Dedza District
  (high data quality and reporting)

Training

During the initial site visits, the joint Columbia University/ UNICEF team was accompanied by an official from each of the GMCs' respective district health offices. At each clinic, the team met with all available HSAs to introduce the RapidSMS platform, then conducted two-hour training sessions on how to properly enter child nutrition data via SMS. During the training, every HSA received individual attention to ensure that he/she was comfortable entering data, sending SMS messages, and cancelling sent messages in the event of an error.

Each HSA also received a small laminated training card with RapidSMS instructions and a mobile phone card with US$1.00 credit as an allowance for use during practice. Six large instructional posters containing the same information as the instruction cards were also provided to each pilot study site. Training discussions were conducted in both English and Chichewa, and each session ended with one HSA reciting back to his colleagues how the RapidSMS platform worked in his/her own words.

HSAs were provided laminated training cards to help learn how to use the RapidSMS platform.

MONITORING, EVALUATION, & ASSESSMENT

To solicit feedback from participants in the pilot program and in order to ensure the smooth follow-up while our team was not in the field, the project contracted University of Malawi's Bunda College of Agriculture to provide routine monitoring and supplemental training at the three GMC pilot sites. As part of this process, the Bunda College team visited the pilot sites and conducted interviews with HSAs every two weeks for the first two months of the pilot.

During March 2009, the Columbia University team visited each of the pilot study sites along with representatives from Bunda College to conduct in-depth interviews with the participating HSAs. The goal was to better understand their learning-curve in adapting the new technology, indentify any technical difficulties with the platform, and note any impacts the platform was having on the HSAs work patterns. Data trends and errors were identified and improvements in the platform were incorporated, including additional feedback loops and signaling features.

In anticipation of a possible national rollout, the Columbia University team met with the government committee working on the development of the new INFSS system. This allowed the team to address concerns that the RapidSMS platform could easily be adapted to meet any proposed changes in the INFSS system. The team also met with several government officials who will be involved in any potential national rollout. Based on these meetings, guidelines were developed for key roles and responsibilities to facilitate increasing government ownership of the platform.

Finally, as an early indicator of the possibility for growing private sector partnerships, the Columbia University team met with representatives from the two major mobile phone companies to discuss how they could support the government's effort to address child malnutrition. There was significant interest from both mobile companies, and there is clearly more potential for bilateral partnerships in this space.

The Columbia University team trained HSAs on how to send SMS messages.

KEY FINDINGS

The pilot study indicated that the use of the RapidSMS platform can help address some of the key limitations of the present paper-based system, including:

1. Reduced delays in data transmission

Data was received by the central server immediately upon receipt of the SMS.

2. Improved data quality

Automated SMS responses prompted HSAs to correct data entry errors, and data entry errors were flagged on the frontend website.

3. Reduced manpower requirement for data entry and analysis

The need to manually re-enter data from submitted paper forms was eliminated, basic data analysis was automated, and data was easily exportable from the frontend website.

4. Reduced participant dropout rates and improved reporting rates

By providing automated feedback, the platform encouraged participation by both child caregivers and HSAs.

Children looked on as HSAs were being trained.

FASTER DATA TRANSMISSION

RapidSMS eliminated both the data transfer and data entry time delays by implementing automated data-entry into a central database. Once data was collected by the HSA and sent by SMS, it was also immediately stored, analyzed, and accessible to stakeholders at all levels. Transmission times that previously took from 1 to 3 months were reduced to an average of 2 minutes. This is essentially 64,800 times faster than the paper-based system.

The need for centrally-based full-time staff dedicated to manually inputting the data was eliminated.[12] As a result, the significant time delay between data collection and data availability disappeared.

Delays in parsing and analyzing the data critically undermined the original paper-based INFSS system. Prior to 2008, the delay between data collection and data analysis was anywhere from two months to a year. After ACF departed in 2008, data entry and analysis effectively stopped. During the January 2009 site visit, it was noted that much of the 2008 data had yet to be inputted or analyzed. Generally, there were two separate causes for these delays:

- First, initial delays occurred as paper forms were transported from GMC sites to district offices, where they were assembled and then transferred to the national level.

- Second, data entry and analysis was performed at the national level by ACF employed staff. In 2007, an average of approximately 3,500 forms per month was manually inputted into computer spreadsheets. As the system was originally designed, this number could have been as high as 9,100.

As indicated by this pilot study, these constraints should no longer be encountered with the RapidSMS platform. As data trends will be instantly available to district and national stakeholders, it is hoped that the INFSS system will be once again be instrumental in targeting famine and malnutrition in a timely manner.

IMPROVED DATA QUALITY

During the first three months of the pilot study, there were a total of 535 unique reports submitted with 15 data entry errors, representing an error rate of 2.8 percent. These errors consisted of wrong measurements entered, wrong association of child ID number with measurements, or entry of data strings with one or more missing values. It should be noted that all of these types of errors were also common with the previous page-based system.

With the paper-based system, a significant number of forms had to be discarded due to illegible handwriting, missing decimals, or outliers. Based on a review of the paper forms from 2007, ACF discarded an average 14.2 percent of the data due to the aforementioned errors. Monthly data discard rates ranged from as low as 1.5 percent to as high as 29.1 percent (see appendix).

The 2.8 percent data entry error rate for RapidSMS during the first three months of the pilot study was a significant improvement over the 2007 data discard rate. A large part of this success could be attributed to the feedback loop system which flagged incorrect entries and allowed HSAs to correct mistakes. Moreover, nearly all of these errors occurred during the first month of the pilot study. In the past two months, there has not been a single data entry error.

[12] HSAs estimated it took approximately 30 seconds to send each SMS. With a maximum of 70 children in the surveillance program visiting each clinic, the additional burden imposed on the HSAs should be no more than 9 minutes per week. With multiple HSAs carrying out these measurements and taking into account the automation of height for weight calculations, the HSAs should in fact be saving time with the RapidSMS platform.

IMPROVED INFORMATION SHARING

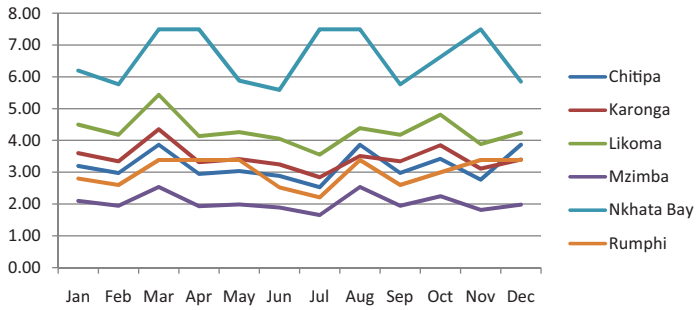
RapidSMS was designed not only to provide better information to the national government but also to provide valuable information to the HSAs that will facilitate patient care. Approximately 30 feedback loops were programmed to assist HSAs in accurately reporting patient data and offer specific information on patient current health status.

One of the most significant automated functions is the weight for height calculations. Despite being the most reliable method of identifying malnutrition in children, most HSAs stated that they were not trained in these calculations and did not feel competent carrying them out. HSAs stated that the original implementers of the INFSS system had instructed them that these calculations should only be completed when a child "looked malnourished."[13] Children with visible signs of severe malnutrition, such as advanced edema or changes in hair texture, were targeted for intervention, while children with less obvious symptoms were often overlooked. Due to this very subjective method of initial screening, many moderately malnourished children were not being identified and properly treated.

RapidSMS automatically performed this calculation for every patient and instantly alerted HSAs of their patient's nutritional status. HSAs stated that they felt empowered by this new platform. At the Salima GMC, HSAs proudly noted that they had identified and treated ten mildly malnourished children who would have otherwise been missed. This two-way flow of information was critical in creating a sense of ownership that was absent in the previous system.

The two-way flow of information not only empowered the HSAs, but its importance was also reflected in the ability of the HSAs to share health-related information with the caregivers of the participating children. The feedback loops built into RapidSMS were shown to provide a method of continuous information-sharing between different levels of stakeholders. They have the potential for creating greater confidence among community members and caregivers, providing them with incentives for sustained participation, and creating a increased feeling of ownership of the surveillance system.

Example of Automated Report on RapidSMS Website



Average Moderate Malnutrition

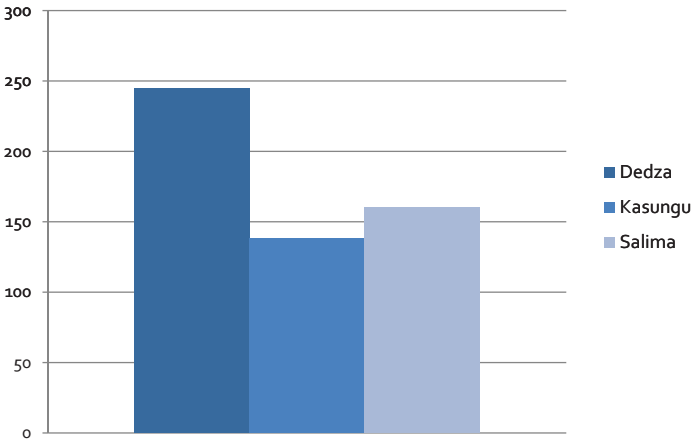
[13] This directive could not be verified in ACF's training materials.

MORE EFFICIENT MONITORING OPTIONS

RapidSMS helped improve the monitoring of the surveillance system by making the inputted data immediately available to supervisors at the district level via a secure website. Data was immediately visible and the nature of errors clearly indicated. By differentiating between individual and GMC-wide errors, monitoring and follow up could be more efficiently targeted. This process also helped identify patterns of high patient dropout.

An expressed governmental concern with the paper-based INFSS system was that it did not give enough responsibility to the district level MCHs in the monitoring and analysis of the data. Previously, most of the analysis had been tasked to the national level of government, but officials at the national level wanted to see the district offices take on more responsibility. Future iterations of RapidSMS will be able to facilitate this change, as data will be available via the secure website to district level government employees. This will allow them to follow-up on participant dropouts, catch data-entry errors, and provide monitoring and feedback to HSAs within their district. While the pilot study was not intended to test the impact at the district level, it did point out significant opportunities for district-level management to be more involved in the monitoring, evaluation and analysis of data.

Total Unique Reports (by GMC)

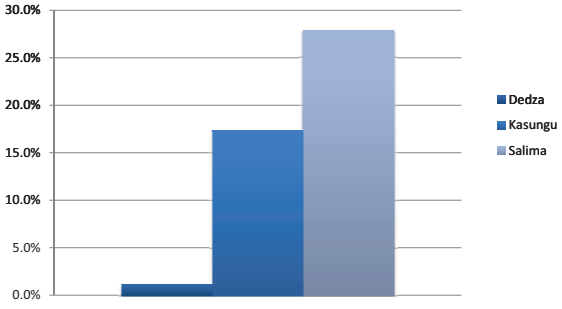


INCORRECT MEASUREMENT PRACTICES

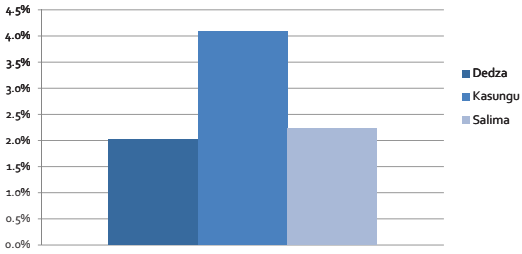
While RapidSMS cannot directly address many broader constraints of the INFSS system, including the high prevalence of improper measurement techniques, it can help identify potential problems. Measurement inaccuracy is difficult to identify in a system of INFSS's size, since it is impossible to observe whether child measurements are actually being taken correctly. However, improper height measurements are easy to identify within datasets, as children do not generally lose height from one month to the next. Subsequently, height-loss errors were used as a proxy for improper measurement techniques.

During the second two months of the study, height-loss was reported for 36 children (10.7 percent). In Salima, height-loss was reported for 25.8 percent of children during this period. Not surprisingly, this site had received little supervision or training while using the original paper-based system. In Dedza, where HSAs historically benefited from more regular training and monitoring, height-loss was reported for only one child during this period (0.6 percent) (see Appendix). Feedback loops have been programmed to immediately alert HSAs when their submissions indicate that a child has lost height, prompting them to re-measure the child.

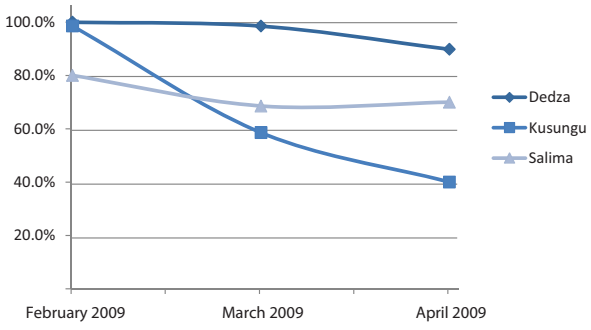
Percentage of Reports Indicating Child Height Loss (by GMC)



Total Uncorrected Errors & Data Omissions (by GMC)



Percentage of Monthly Reports Submitted for Registered Children (by GMC)



REDUCED CHILD DROPOUT RATES AND IMPROVED HSA PARTICIPATION RATES

Child and HSA participation rates were fairly high during the RapidSMS pilot study, averaging 76 percent for all three sites. Predictably, participation rates were highest at the outset of the study, with a slow decline towards the last month. Moreover, participation rates differed over time by district, indicating disparities in the supervision and training under the previous paper-based system. Specifically, Dedza maintained a high 91 percent reporting rate, while Kasungu dropped as low as 47.1 percent.

One of the primary causes of patient dropouts is that mothers have less interest participating in the program after their child has reached 3 years old, since their child is no longer a baby and they frequently don't see the same benefit of the monthly clinic visits. In addition, mothers often have another baby by this point. Taking two children to the clinic can be difficult, and mothers often feel that their newest baby should be monitored, not the older one. Part of the job of the HSAs is to make follow-up visits to surrounding villages when a child does not show-up for monthly appointments.

To try to address this issue, caregivers were asked to provide a phone number where they could be reached, whether it was a phone of their own, a relative, or someone within their village. This information makes it possible for HSAs to follow-up with dropout children without requiring travel into remote villages. However, it is important to note that only a small percentage of caregivers have provided phone numbers. Subsequently, high reporting rates still depend on HSA local community follow-up.

Nevertheless, considering no targeted monitoring had been available from the district level, the 76% reporting rate could be considered a success. Moreover, in 2007 the national reporting rate for all GMCs in the INFSS system was only 40.9 percent. This rate was due both to high child dropouts and low HSA participation levels, as indicated by the complete absence of reports for several months during 2007. With such considerable data gaps, making assumptions based on the INFSS data was highly problematic.

Overall, when combined with a responsive human element, RapidSMS can greatly improve the INFSS system in Malawi. The objectives of the pilot study were met, though the challenge will now be to adapt the platform for larger deployment.

HSAs referred to previous paper forms during training with the Columbia University team.

FUTURE CHALLENGES

There are key issues that must be addressed in order to successfully expand the pilot study to additional sites or implement a national deployment of the RapidSMS platform. These issues can be broken down into two categories – technical and non-technical.

TECHNICAL ISSUES

RapidSMS Platform

The Malawi RapidSMS platform has not been upgraded since its installation in January 2009. Work is underway with both UNICEF Innovations and Columbia University's Earth Institute to update the software to support better reporting, a more robust frontend website, and a greater number of platform features. Specifically, these changes will include:

- a more comprehensive list of feedback loops
- an updated, password-protected website featuring different levels of data aggregation
- an easier mechanism to cancel and/or replace SMSs
- a better mechanism to identify HSAs and children within the platform
- more options for sending and recording free-form SMS messages
- an improved mechanism for recording child deaths and dropouts
- the capability for automated reports via SMS or email to key stakeholders

This update should be ready for deployment during Summer 2009.

Mobile Network Coverage

The pilot study revealed instances when HSAs experienced delayed responses after sending SMSs. For instance, at the Dedza GMC, HSAs indicated that they often sent multiple SMSs at the end of the day because they only had adequate network reception in one particular part of the GMC, far away from where they measured children. Salima GMC also experienced sustained delays in receiving feedback loops. Identifying these issues in a timely manner is essential for the HSAs to fully benefit from the programmed feedback loops.

The cost of sending a text message is also a major concern. Currently, a government-mandated nationwide phone number conversion process has delayed the change of the RapidSMS phone numbers to toll-free numbers. Zain and TNM had indicated that they will be able to provide toll-free numbers soon.

Indicating the ease of training for the RapidSMS platform, HSAs often teamed up to help each other during training sessions.

Electricity Issues

On more than one occasion, power interruptions in Lilongwe shutdown the central RapidSMS server, disrupting operations. Depending on the frequency and duration of the power outages, the best way to mitigate the effects of recurrent power outages is to install an enterprise-level uninterrupted power supply (UPS) or a fuel-powered electricity generator.

Computers/Internet Availability

It was clear that increased district-level involvement is critical to the success of both RapidSMS and the INFSS system, in general. To date, districts have been primarily tasked with transferring data from the GMCs to the national government level. In order for district-level stakeholders to play a more central role in any nutritional surveillance program, they must have access to the RapidSMS website via internet-connected computers. The district officials could then view data trends, manage HSA responses, and provide feedback to the GMCs within their specific districts. Having recognized this need, the European Union is currently exploring providing internet connection to the districts health offices.

HSAs actively participated during GMC training sessions.

NON-TECHNICAL ISSUES

NATIONAL LEVEL

Malawi government officials showed a high level of interest in the RapidSMS pilot study. Government officials were enthusiastic about the potential of RapidSMS during consultative meetings and expressed preliminary desire to expand its use on a national scale. However, there may be challenges ahead in the handover of RapidSMS from UNICEF to the Government of Malawi. The following points should be considered. First, since ACF's departure in 2008, government officials have not taken ownership of the program or established concrete assignment of roles and responsibilities relating to the platform. The lack of clear responsibility and decision-making procedures has impaired the existing INFSS system and is delaying any national rollout of the RapidSMS.

Second, the main priority of the government is currently not to incorporate RapidSMS into the INFSS system. Instead, the present focus is on improving the functionality of the INFSS system itself. While it is agreed that INFSS should be critically re-evaluated, it is important to note that RapidSMS is a platform designed to improve the overall functioning of the INFSS system. It is not a parallel surveillance system. It is more accurate to see RapidSMS as a mechanism for addressing the weaknesses of the current INFSS system and an important component to any redesign of the overall program. While the ideal way to proceed with RapidSMS would be as an integrated part of INFSS system, there may still be challenges in synergizing the two parts of the system.

Lack of Technical Knowledge

In response to the pilot study's success, the government has expressed interest in implementing RapidSMS on a national level. While this is a promising sign, there is presently a lack of people in Malawi with the specific software programming knowledge to make changes to the RapidSMS platform as necessary. Until this capacity is developed locally, the Government of Malawi will have to depend on assistance from UNICEF Innovations in New York. This is clearly not a sustainable solution. The EU has previously sent technical advisors to Malawi to work with the INFSS system. However, someone familiar with both the INFSS system and RapidSMS would best be able to address challenges during a possible national rollout.

Data Analysis

RapidSMS eliminates the lengthy process of data-entry, and it is designed to perform basic analysis of the collected data. However, it is crucial that someone at the national government level be dedicated to completing a more comprehensive analysis of the data collected on the RapidSMS website. Such analysis is presently not being done on a regular basis. If no data analysis is done, faster transmission time will not produce the desired improvement in the surveillance system.

Monitoring

By using RapidSMS, stakeholders at the national level will be able to track nutritional trends in each district. The data's easy accessibility and legibility facilitates the identification of data-entry errors. However, there is presently no one trained at the national level on how to monitor incoming data using the RapidSMS platform. Without close monitoring, the full benefits of RapidSMS will not be realized.

Training

Adequate training will be a critical component in a national rollout of RapidSMS. Presently, there is no one at the national level dedicated to training district and local-level health workers in using RapidS MS. In order for a national rollout of RapidSMS to be effective, there needs to be a team of trainers at the national level.

DISTRICT LEVEL

Similarly, district-level participation and capacity must be significantly expanded. HSAs reported that they receive little feedback from their district-level supervisors. One HSA stated that it had been several months since his district supervisor had visited his clinic. Presently the district-level Health Management Information Systems (HMIS) and Mother and Child Health Coordinators (MCHs) have limited roles within the INFSS system. While the pilot study did not fully address the role of district-level employees in monitoring HSAs, greater district-level involvement will be necessary to better provide performance feedback to HSAs. Training will be necessary for district level MCHs and HMIS. This will take communication, training, and positive feedback from the national level. District health workers serve an important role in monitoring local trends in child malnutrition and mobilizing resources to their respective GMCs. Subsequently, their full participation is crucial to the success of RapidSMS as part of INFSS.

UNICEF Innovations staff assisted with training in Malawi.

LOCAL LEVEL

HSAs quickly adapted to using RapidSMS. Virtually all HSAs owned mobile phones and were comfortable sending text messages after only brief training instructions. However, the issues below will need to be addressed in preparation for a national rollout.

Duplicate SMS Reports

Due to technological problems or gaps in mobile phone coverage, HSAs did not always receive response SMSs in a timely manner. Subsequently, HSAs sometimes sent duplicate SMSs, assuming that their first SMS was never received. Similarly, there were cases when two different HSAs sent the same report, not knowing that the other had already sent it. For instance, in Salima, 24.6 percent of all reports were discarded as redundant. Although duplicate reporting may pose a technical challenge, it can likely be addressed through future HSA training programs.

Cancelling SMS Reports

RapidSMS has a cancel function that HSAs could use in the event that they sent an SMS in error. This involves sending a separate SMS as a follow-up to an incorrect one. HSAs generally did not use this function. When errors were made, HSAs simply sent a second SMS with the corrected information without cancelling the previous SMS. A modified mechanism should be incorporated in the next version of RapidSMS to address this.

Taking Measurements

The ease of learning how to use RapidSMS is promising. Overall, nominal training was enough to allow participants to understand how to use the technology. However, it became clear that HSAs were often poorly trained in actually taking child measurements. The Bunda College monitoring team observed up to 50 percent of HSAs taking incorrect height measurements and up to 80 percent taking incorrect MUAC measurement.

Nearly all HSAs recognized this as a problem and blamed lack of training and difficulty in finding appropriate reference material. There is clearly a need to better train HSAs on properly taking child measurements. While RapidSMS can improve data transmission and analysis, it cannot replace the crucial skill of accurate child measurement.

Feedback and Training

HSAs were generally satisfied with the amount of feedback and training that they received during the pilot study, but they voiced concern that this assistance will no longer be available if the program is rolled-out on a national level. How to best provide consistent feedback and training to HSAs will be a significant challenge during any large-scale implementation.

Communication Between UNICEF Offices

Due to the technical nature of the RapidSMS platform, a large amount of computer programming support was required by UNICEF Innovations. As UNICEF Innovation's capacity was limited, it was not able to address all technical issues during the pilot study. Additional support was subsequently provided by independent programmers and Columbia University's Earth Institute. As this was only possible due to one-time funding by USAID, it is recommended that future RapidSMS deployments secure more consistent sources of technical support throughout the program.

One of the children participating in the Dedza GMC's surveillance program.

RECOMMENDATIONS

1. RAPIDSMS SHOULD BE GRADUALLY DEPLOYED FOR NATIONWIDE CHILD NUTRITION SURVEILLANCE.

This pilot study has demonstrated that RapidSMS is a feasible, reliable, and fast means of data collection compared to paper-based data collection systems. Incorporated into the existing INFSS system, it can improve the government's capacity to identify trends in child malnutrition, enhance monitoring at the district level, facilitate health clinic quality, and provide child caregivers fast and accurate diagnoses. In addition, the platform can significantly reduce paperwork and automate health indicator calculations.

2. RAPIDSMS SHOULD NOT BE CONSIDERED AN APPROPRIATE PLATFORM FOR ALL DATA COLLECTION PURPOSES.

RapidSMS is a versatile platform that could be used to monitor various types of data, but its current configuration is limited. For example, given the low number of feasible data fields, the platform is not appropriate for lengthy surveys like Malawi's current food security data collection questionnaire. Caution should be applied in considering its adaptation for projects beyond its current scope.

Nevertheless, the platform could be useful in various similar collaborations between UNICEF and the Government of Malawi, such as:

- Supply chains monitoring to ensure efficient and timely delivery of goods and services in various sectors. For example, RapidSMS could be used to monitor the delivery of educational supplies to schools or the distribution of medicines to hospitals and clinics.

- Community-based reporting to connect citizens with essential government services. For instance, RapidSMS could facilitate the reporting of water and sanitation problems that might pose public health risks.

3. A NATIONAL ROLLOUT OF RAPIDSMS WILL REQUIRE STRONG OWNERSHIP BY THE NATIONAL GOVERNMENT AND COORDINATION WITH ALL KEY STAKEHOLDERS.

I. **Strong Ownership by National Government:** In order for RapidSMS to be used as a national platform for nutrition monitoring, a clearly defined structure of decision-making and responsibility needs to be established at the national level. Roles and responsibilities need to be established among the various ministries involved in health and child nutrition work within the country. The Ministry of Health's Health Management Information Systems (HMIS) should be the key department for data monitoring and interpretation. While this may reflect a change in its responsibilities, there are already HMIS employees at the national and district level who should be able to take on this task.

II. **Coordination with All Project Stakeholders:** The success of RapidSMS depends on the coordination and support of all stakeholders: UNICEF and its development partners, the Government of Malawi, Bunda College, district supervisors, HSAs, and child caregivers.

a. Stakeholders at all levels of government (including with OPC and the MoH) should have clearly defined roles and responsibilities during the national rollout.

b. UNICEF should continue its role as an incubator for RapidSMS while the government makes efforts to take full ownership. It should continue to support the platform with technical knowledge and support.

c. Bunda College should assist with the training of district and national-level workers in data monitoring and data analysis.

4. LOCAL TECHNICAL CAPACITY SHOULD BE DEVELOPED TO ENABLE MAINTENANCE AND FUTURE CHANGES TO RAPIDSMS PLATFORM.

In addition to the resources needed for a national rollout, significant local technical capacity (specifically in regard to computer programming languages upon which the platform is built) will be necessary to allow for requisite changes to the platform in the future. In addition, although the platform is designed to simplify the function of monitoring via the Malawi RapidSMS website, stakeholders will need to be trained in how to access and effectively utilize the data from this site.

5. THE MALAWI RAPIDSMS PLATFORM SHOULD BE UPGRADED TO NEWER VERSIONS AS THEY BECOME AVAILABLE.

UNICEF Innovations and Columbia University's Earth Institute are presently working on the next iteration of the RapidSMS platform. The Malawi platform should be upgraded to this newer version when it is complete and available. UNICEF Malawi should continue to collaborate with the Columbia University team to communicate specific benefits and functions of this upgraded platform.

PROPOSED NEXT STEPS

1. UNICEF Malawi, in collaboration with the Government of Malawi, should:

a. Implement a staged rollout of RapidSMS beginning with all five participating GMCs in each of the three districts of the initial pilot study, followed by districts with the highest levels of child malnutrition;

b. Communicate clear responsibilities and roles for all key stakeholders;

c. Involve key stakeholders in using RapidSMS for data monitoring and analysis in order to build support for the platform at a national level;

d. Clarify roles and responsibilities of the UNICEF Malawi country office and UNICEF headquarters; and

e. Continue to work in partnership with Columbia University in preparation for a national rollout.

2. Department of Nutrition and HIV/AIDS, Office of the President and Cabinet (OPC) and the Ministry of Health should:

a. Finalize restructuring plans for the INFSS system while incorporating RapidSMS into the new system design;

b. Assign clear roles and responsibilities for maintaining and deploying the integrated platform;

c. Create a reporting mechanism to ensure that all responsibilities at the national, district and GMC-levels are being carried out in a timely and effective manner; and

d. Recruit and hire a computer programmer to work in OPC who is skilled in working with the RapidSMS platform.

3. Columbia University team should:

a. Work with UNICEF Innovations and Columbia University's Earth Institute to finalize the next version of the RapidSMS platform;

b. Assist in identifying and funding an intern with appropriate technical skills to increase technical capacity within the national government; and

c. Provide a proposal to UNICEF Malawi for the development and delivery of a development toolbox to assist in the national rollout of the RapidSMS platform.

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APPENDIX

TOTAL COMBINED REPORTS

Total unique and correct reports	517	
Total Redundancies	54	9.00%
Data Corrections without cancelling	13	2.20%
Accepted entries with 1 or more missing data points	9	1.70%
Uncorrected errors	6	1.10%
Total Data Entry Errors and Omissions	15	2.70%
Children losing height	36	10.70%
Unique and Correct Reports for data period		
1st period	181	86.60%
2nd period	156	74.60%
3rd period	144	68.90%
4th period *(in progress)*	36	17.20%

DEDZA DATA SUMMARY

Total Unique and correct reports	235	
Total Redundant Entries	18	7.00%
Data Corrections without cancelling	2	0.80%
Accepted entries with 1 or more missing data points	3	1.30%
Uncorrected errors	2	0.80%
Total Data Entry Errors and Omissions	5	2.10%
Children losing height	1	0.60%
Unique and Correct Reports for data period		
1st period (2/09)	69	100.00%
2nd period (2/10-3/13	68	98.60%
3rd period (3/14 - 4/06)	62	89.90%
4th period *(in progress)*	36	

KASUNGU DATA SUMMARY

Total Unique and correct reports	129	
Total Redundant Entries	6	4.20%
Data Corrections without cancelling	6	4.20%
Accepted entries with 1 or more missing data points	3	2.30%
Uncorrected errors	3	2.10%
Total Data Entry Errors and Omissions	6	4.30%
Children losing height	10	13.70%
Unique and Correct Reports for data period		
1st period (2/06 - 2/19)	56	80.00%
2nd period (2/20 - 3/19)	40	57.10%
3rd period (3/20 - 4/19))	33	47.10%
4th period *(in progress)*	0	

SALIMA DATA SUMMARY

Total Unique and correct reports	153	
Total Redundant Entries	30	14.90%
Data Corrections without cancelling	5	2.50%
Accepted entries with 1 or more missing data points	3	2.00%
Uncorrected errors	1	0.50%
Total Data Entry Errors and Omissions	4	2.30%
Children losing height	25	25.80%
Unique and Correct Reports for data period		
1st period (2/06 - 2/19)	56	80.00%
2nd period (2/20 - 3/19)	48	68.60%
3rd period (3/20 - 4/19)	49	70.00%
4th period *(in progress)*	0	

NUMBER OF PARTICIPATING CHILDREN

Dedza	69	
Kasungu	70	
Salima	70	
Total Children Registered	**209**	

TOTAL ERROR RATES (PREVIOUS PAPER-BASED SYSTEM)

Month, 2007	Usable data	Total children measured	% Not usable data
1	2443	3446	29.11%
2	3640	3750	2.93%
3	3135	3184	1.54%
4	3098	3801	18.50%
5	2925	3692	20.77%
6	3943	4033	2.23%
7	3059	3162	3.26%
8	2213	3006	26.38%
9	3076	3899	21.11%
10	3154	35750	16.49%
Total	**30686**	**35750**	**14.17%**

TOTAL ERROR RATES (RAPIDSMS PILOT STUDY)

	Total participating children in 3 periods	Usable observations	Error affecting usable data
Dedza	240	235	2.08%
Salima	157	153	2.55%
Kasungu	135	129	4.44%
Total	**532**	**517**	**2.82%**

PARTICIPATION RATES (PREVIOUS PAPER-BASED SYSTEM)

	Total reports (2007)	Monthly Reports Submitted as Percentage of Registered Children
Kasungu	679	17.6%
Salima	820	21.3%
Dedzda	2255	58.6%
Total	**3754**	**32.5%**

PARTICIPATION RATES (RAPIDSMS PILOT STUDY)

	Total reports	Monthly Reports Submitted as Percentage of Registered Children
Dedza	199	96.14%
Salima	153	72.86%
Kasungu	129	61.43%
Total	**481**	**76.71%**

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