

Effects of Mobile Health Technologies on Uptake of Routine Growth Monitoring among Caregivers of Children Aged 9 to 18 Months in Kenya

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Abstract

This study aimed at finding out the effects of mobile health (*mhealth*) technologies on uptake of Routine Growth Monitoring (RGM) among caregivers of children aged above 9 months in Kenya. This was a quasi-experimental study. The experiment groups received Short Text Message (STM) and Voice Call (VC). The analysis demonstrates that in month 1, caregivers who received STM were 6.875 times more likely to take their children for RGM compared to control (OR = 6.875; 95 CI: 3.591–13.164); caregivers who received VC were 6.750 times more likely to take their children for RGM compared to those in control arm (OR = 6.750; 95 CI: 3.522–12.938). Policy makers and implementers in the health will find these study findings useful in deciding whether or not to adopt STM or VC in improving uptake of RGM for children above 9 months.

Keywords

children, routine growth monitoring, *mhealth* technologies, caregivers, access to care

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Introduction

Growth monitoring is defined as the regular weighing and measuring of a child's length or height and head circumference especially for children aged below 2 years and graphing the measurements taken on a growth chart.¹ One of the Sustainable Development Goals targets at reducing under-five mortality from 39 per 1000 live births to at least as low as 25 per 1000 live births.² There are a number of services offered in Maternal Neonatal and Child Health (MNCH) Clinics in health facilities including; routine growth monitoring, issuance of supplements for Vitamin A after every 6 months of a child's growth, vaccination, health education and counselling, treatment for minor ailments, nutritional and medical conditions screening for management, and tracing and following up of those who have defaulted clinic attendance.³ It is important to routinely monitor the growth of children below 2 years using all the 3 WHO recommended measurements including Weight-for-Age, Length-for-Age, and Weight-for-Length as well as Head Circumference since they enable identification of problems such as underlying chronic diseases, feeding practices, and recent and sudden illnesses.⁴ Growth failure among children aged 0 to 24 months

has critical lifetime consequences.⁵ Caregivers' failure to attend routine growth monitoring more especially for children aged more than 9 months has greater lifetime consequences. It may lead to malnutrition, increased spread of infectious diseases and high mortality rates.^{4,6} Caregivers stop attending child health clinics after their children receive the WHO recommended measles vaccine at the age of 9 months. This means that beyond the ninth month children will miss RGM. Children under the age of 5 years should receive vitamin A supplementation at 6, 12, 18, 24, 30, 36, 42, 48, 54, and 60 months thus if children are not taken to clinics after 9 months for routine growth monitoring then they will miss these important supplements. Deworming of children under 5 years normally begins at 24 months therefore continuation of routine growth monitoring beyond 9 months ensures children are dewormed in time.⁴ Mobile

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Health is a practice in medical and public health fields which is supported by mobile phones and tablets, that make use of text, audio, images, video, or coded data in the form of short messaging services (SMS), voice SMS, applications accessible via general packet radio service (GPRS), global positioning system (GPS), third and fourth generation mobile telecommunications, and Bluetooth.⁷ Globally, there is widespread use of mobile phones hence the application of mobile health.⁸ Various studies have reported increased access and use of mobile phones in especially low- and middle-income countries (LMIC).⁹⁻¹² Text messaging, voice calls, and internet are the major functions of mobile health.¹³

Mobile health application is quite often used to offer educational information to clients and enhance change of their behaviors, monitoring, as an interaction tool among healthcare providers, in data collection and reporting, management of human resources, and in managing chronic diseases.^{8,9,14} Nyamira County's under-five mortality rate stands at 81 per 1000 live births which is above the national average of 54 per 1000 live births and the global (WHO-African Region) average of 74 per 1000 live births.^{2,15} A study conducted in Kenya revealed that 46.7% of the caregivers don't routinely take their children for growth monitoring.¹⁶ This study therefore sought to determine the effects of mobile health technologies on uptake of routine growth monitoring among caregivers of children aged 9 to 18 months. The major study limitation was that the caregivers from the intervention and control arms had a likelihood of meeting and sharing information they received on text message or voice call. This was minimized by doing appropriate selection of the study participants from different health facilities. For instance, intervention arms and control arm were selected from different health facilities.

Methodology

This was a quasi-experimental study design. Study participants were recruited from 6 selected health facilities. Health facilities were purposively selected based on the high population of children visiting Maternal neonatal and child health clinics compared to the unselected health facilities.¹⁴ Randomization was done by use of simple random sampling to assign 2 health facilities for each of the 3 study arms. Upon randomization, the first experimental arm comprised Nyamira County Referral Hospital and Tinga Sub-County Hospital; the second experimental arm had Borabu Sub-County Hospital and Nyamusi Sub-County Hospital while the third had Keroka Sub-County Hospital and Ekeronyo Sub-County Hospital. Recruitment of the study subjects was done during their ninth month visit to clinic. During the recruitment period, all the caregivers with children aged 9 months visiting for measles vaccine were recruited until the correct sample was arrived at. The sample size (n=180) was arrived at using a formula by Charan

and Biswas.¹⁷ Those caregivers who had taken the selected health facilities as their regular child welfare centers and had access to a mobile phone within their household were included in the study. The selected caregivers in the intervention arm were asked to state the language in which STM and VC could be communicated. For the first experimental arm, caregivers received a Short Text Message (STM). A text message of about 15 words was designed by the study. STM was sent once to the participants before the next clinic visit (a day prior to appointment day). For the second experimental arm, caregivers received Voice Call (VC). VC that lasted for not more than 2 min served as a reminder for next clinic visit. The voice call was also done once before the next appointment (a day prior to appointment day). Both the STM and VC were done simultaneously before appointment. The study considered suggestions given by health care providers in Maternal, Neonatal, and Child Health (MNCH) sections on the content of the text message as a reminder to the caregivers for clinic visit. The content of the STM and VC included; the name of the child, appointment date and time, and name of the health facility. Caregivers in the control arm did not receive STM nor VC. All caregivers in both intervention and control arms received usual care including health education. The researcher then followed up the intervention arms from the 10th month for a period of 9 months while the control arm was not followed up. Questionnaires with both closed and open-ended questions were used to obtain information from the 180 caregivers involved in the study. Key Informant Interview guide was used to collect information from 6 key informants. Statistical Package for Social Sciences (SPSS) version 23 was used for the analysis of the quantitative data collected. Chi-square test and Odds Ratio were used to test the association between the dependent and independent variables and the association was deemed significant when *P*-value was less than .05 at 95% confidence level. Approval to conduct the study was obtained from Kenyatta University Graduate School. Ethical clearance was obtained from Kenyatta University Ethics and Review Committee. Research permit was sought from National Commission for Science, Technology and Innovation (NACOSTI). Further approval was sought from ethics and review committee in the County. The study sought informed consent from the respondents before proceeding with the research.

Results

Socio-Demographic and Socio-Economic Characteristics of the Study Participants

The study results revealed that the age of the caregivers ranged from below 18 years to between 38 and 42 years. Most of the caregivers were aged between 23 and 27 years old in intervention arm 1 (STM) 20 (33.3%), intervention

arm 2 (VC) 23 (38.3%), and control arm 24 (40%). There was no significant difference in the distribution of age of the caregivers between intervention arm 1 and control arm ($P=.243$), intervention arm 2 and control arm ($P=.751$), intervention arm 1 and intervention arm 2 ($P=.566$) (Table 1). The study results showed that more than 80% of the caregivers in all the 3 study arms were married (Table 1). There was no significant difference in the distribution of marital status of the caregivers between study arm 1 and control arm ($\chi^2=0.069$; $df=1$; $P=.793$), study arm 2 and control arm ($P=.362$), study arm 1 and study arm 2 ($P=0.239$) (Table 1). Analysis of the study results showed that all the caregivers in both the intervention arms and the control arm were female (100%). Among the children in the intervention arm 1 (STM), the proportion of male children was equal to that of female at 50%. In the intervention arm 2 (VC), 33 (55%) of the children were male and 27 (45%) were female while in the control arm 26 (43.3%) were male and 34 (56.7%) female (Table 1).

The study did not establish any significant statistical difference in the distribution of gender of the children between intervention arm 1 and control arm ($\chi^2=0.536$; $df=1$; $P=.464$), intervention arm 2 and control arm ($\chi^2=1.634$; $df=1$; $P=.201$), intervention arm 1 and intervention arm 2 ($\chi^2=0.301$; $df=1$; $P=.583$) (Table 1). Results of the study indicated that among the respondents in the intervention arm 1 (STM), 18 (30%) had primary education qualification, 30 (50%) secondary, and 12 (20%) tertiary.

In intervention arm 2 (VC), 27 (45%) had primary education, 23 (38.3%) secondary, and 10 (16.7%) tertiary education and in the control arm, 21(35%) had attained primary level of education, 25 (41.7%) secondary, and 14 (23.3%) tertiary education (Table 1). There was no significant statistical difference in proportion of caregivers at all education levels in intervention arm 1 and control arm ($\chi^2=3.026$; $df=4$; $P=.553$), intervention arm 2 and control arm ($\chi^2=3.642$; $df=4$; $P=.457$), intervention arm 1 and intervention arm 2 ($\chi^2=2.934$; $df=3$; $P=.402$) (Table 1). The study found out that among the intervention arm 1 (STM), 24 (40%) were peasant farmers, 20 (33.3%) housewives, 12 (20%) self-employed, and 4 (6.7%) salaried workers. In the intervention arm 2 (VC), 21 (35%) were housewives, 25 (41.7%) peasant farmers, 13 (21.7%) self-employed, and 1 (1.7%) salaried workers. In the control arm, 24 (40%) were housewives, 25 (41.7%) peasant farmers, 4 (6.7%) self-employed, and 7 (11.7%) salaried workers (Table 1). There was no significant difference in proportion of caregivers with different occupations in intervention arm 1 and control arm ($P=.149$), intervention arm 2 and control arm ($P=.025$), intervention arm 1 and intervention arm 2 ($P=.495$) (Table 1). Results of the study revealed that most of the study participants were either dependants or earned a monthly income of less than Kshs 5000. In the intervention arm 1 (STM), 28 (46.6%) earned less than Kshs 5000 and 22(36.7%) were dependants. In the intervention arm 2 (VC), 25 (41.7%)

earned less than Kshs 5000 and 21 (35%) were dependants and in the control arm, 24 (40%) earned a monthly income of less than Kshs 5000, and 24 (40%) were dependants (Table 1). There was no significant difference in the distribution of study participants' monthly income between intervention arm 1 and control arm ($P=.852$), intervention arm 2 and control arm ($\chi^2=0.911$; $df=3$; $P=.823$), intervention arm 1 and intervention arm 2 ($P=.862$) (Table 1).

Distance to the Health Facility

The study inquired of the distance from the caregivers' residence to the health facility where they took their children for RGM. From the analysis of the results, it was evident that most of the caregivers in all the 3 study arms accessed their health facilities within a radius of 2 to 5 km (Table 2). There was no significant difference in the perceived distance to the health facility among the study participants between intervention arm 1 and control arm ($\chi^2=0.420$; $df=2$; $P=.811$), intervention arm 2 and control arm ($\chi^2=0.649$; $df=2$; $P=.723$), intervention arm 1 and intervention arm 2 ($\chi^2=1.304$; $df=2$; $P=.521$) (Table 2)

It is worth noting that caregivers in the intervention arms and control arm showed the same socio-demographic characteristics with no significant differences among them. That means that the participants were all of the same characteristics and therefore would not affect subsequent results in the study.

Effects of mHealth Technologies (STM and VC) on Uptake of RGM

Pre-intervention result analysis revealed that only 11 (18.3%) caregivers from intervention arm 1, 13 (21.7%) from intervention arm 2, and 14 (13.3%) caregivers from control arm maintained RGM prior to recruitment in the last 8 months (before STM and VC intervention) (Table 3). Further analysis revealed that there was no significant association between the proportion of caregivers who maintained RGM prior to recruitment in the last 8 months in the intervention arm (STM) and that of the control arm ($\chi^2=0.455$; $df=1$; $P=.500$); intervention arm (VC) and that of the control arm ($\chi^2=0.048$; $df=1$; $P=.827$); and intervention arms STM and VC ($\chi^2=0.208$; $df=1$; $P=.648$).

At the end of the study, analysis of caregivers' monthly visits for RGM was done to demonstrate the actual effect of using mobile phone. Analysis was done to compare the proportion of caregivers who received STM and those in the control arm from months 1 to 9 (Table 3). Month 1 of the study was the first month of intervention after recruitment of caregivers to the study. Month 9 was the last month of the intervention, and the time when caregivers were expected to bring their children for second measles immunization.

Analysis of month 1 results indicated that majority of caregivers 55 (91.7%) who received STM compared those

Table 1. Socio-Demographic and Economic Characteristics of the Study Participants.

Variable	STM ^a (n=60) (%)	Control (n=60) (%)	Significance	VC ^b (n=60) (%)	Control (n=60) (%)	Significance	STM ^a (n=60) (%)	VC ^b (n=60) (%)	Significance
Age (years)									
<18	3 (5)	0 (0)	P = .243*	1 (1.7)	0 (0)	P = .751*	3 (5)	1 (1.7)	P = .566*
18-22	11 (18.3)	14 (23.3)		13 (21.7)	14 (23.3)		11 (18.3)	13 (21.7)	
23-27	20 (33.3)	24 (40)		23 (38.3)	24 (40)		20 (33.3)	23 (38.3)	
28-32	17 (28.3)	14 (23.3)		18 (30)	14 (23.3)		17 (28.3)	18 (30)	
33-37	6 (10)	8 (13.3)		5 (8.3)	8 (13.3)		6 (10)	5 (8.3)	
38-42	3 (5)	0 (0)		0 (0)	0 (0)		3 (5)	0 (0)	
Marital status									
Married	51 (85)	52 (86.7)	$\chi^2 = 0.069$; df=1;	56 (93.3)	52 (86.7)	P = .362*	51 (86.7)	56 (93.3)	P = .239*
Single	9 (15)	8 (13.3)	P = .793	4 (6.7)	8 (13.3)		9 (13)	4 (6.7)	
Education level									
Primary	18 (30)	21 (35)	$\chi^2 = 3.026$; df=4;	27 (45)	21 (35)	$\chi^2 = 3.642$; df=4;	21 (35)	27 (45)	$\chi^2 = 2.934$;
Secondary	30 (50)	25 (41.7)	P = .553	23 (38.3)	25 (41.7)	P = .457	25 (41.7)	23 (38.3)	df=3; P = .402
Tertiary/College	12 (20)	14 (23.3)		10 (16.7)	14 (23.3)		14 (23.3)	10 (16.7)	
Occupation									
Peasant farmer	24 (40)	24 (40)	P = .149*	21 (35)	24 (40)	P = .025*	24 (40)	21 (35)	P = .495*
Housewife	2 (33.3)	25 (41.7)		25 (41.7)	25 (41.7)		20 (33.3)	25 (41.7)	
Self-employed	12 (20)	4 (6.7)		13 (21.7)	4 (6.7)		12 (20)	13 (21.7)	
Employed	4 (6.7)	7 (11.7)		1 (1.7)	7 (11.7)		4 (6.7)	1 (1.7)	
Monthly income									
<5000	28 (46.6)	24 (40)	P = .852*	25 (41.7)	24 (40)	$\chi^2 = 0.911$; df=3;	28 (46.6)	25 (41.7)	P = .862*
5000-10000	6 (10)	6 (10)		9 (15)	6 (10)	P = .823	6 (10)	9 (15)	
10000 and above	4 (6.7)	6 (10)		5 (8.3)	6 (10)		4 (6.7)	5 (8.3)	
Dependant/none	22 (36.7)	24 (40)		21 (35)	24 (40)		22 (36.7)	21 (35)	
Gender of child									
Male	30 (50)	26 (43.3)	$\chi^2 = 0.536$; df=1;	33 (55)	26 (43.3)	$\chi^2 = 1.634$; df=1;	30 (50)	33 (55)	$\chi^2 = 0.301$;
Female	30 (50)	34 (56.7)	P = .464	27 (45)	34 (56.7)	P = .201	30 (50)	27 (45)	df=1; P = .583

^aShort text message.^bVoice call.

*Fisher's exact test.

Table 2. Distance to the Health Facility.

Variable	STM ^a (n=60) (%)	Control (n=60) (%)	Significance	VC ^b (n=60) (%)	Control (n=60) (%)	Significance	STM ^a (n=60) (%)	VC ^b (n=60) (%)	Significance
Distance from caregivers' residence to health facility									
<2KM	17 (28.3)	14 (23.3)	$\chi^2=0.420$; df=2; P=.811	14 (23.3)	14 (23.3)	$\chi^2=0.649$; df=2; P=.723	17 (28.3)	14 (23.3)	$\chi^2=1.304$; df=2; P=.521
2-5KM	37 (61.7)	39 (65)		36 (60)	39 (65)		37 (61.7)	36 (60)	
>5KM	6 (10)	7 (11.7)		10 (16.7)	7 (11.7)		6 (10)	10 (16.7)	

^aShort text message.^bVoice call.**Table 3.** Proportion of Caregivers Who Turned Up for RGM In Intervention Arm I and Control Group Before and After STM and VC Intervention.

Variable	STM ^a (n=60) (%)	Control (n=60) (%)	OR ^b	95% CI ^c		Significance
				Lower	Upper	
Baseline						
Attended	11 (18.3)	14 (13.3)	0.786	0.389	1.589	$\chi^2=0.455$; df= 1; P= .500
Failed to attend	49 (81.7)	46 (86.7)	1.356	0.559	3.289	
Month 1						
Attended	55 (91.7)	8 (13.3)	6.875	3.591	13.164	$\chi^2=73.818$; df= 1; P< .001
Failed to attend	5 (8.3)	52 (86.7)	0.096	0.041	0.224	
Month 2						
Attended	58 (96.7)	7 (11.7)	8.286	4.124	16.649	P< .001*
Failed to attend	2 (3.3)	53 (88.3)	0.038	0.010	0.148	
Month 3						
Attended	58 (96.7)	4 (6.7)	14.500	5.619	37.415	P< .001*
Failed to attend	2 (3.3)	56 (93.3)	0.036	0.009	0.140	
Month 4						
Attended	58 (96.7)	4 (6.7)	14.500	5.619	37.415	P< .001*
Failed to attend	2 (3.3)	56 (93.3)	0.036	0.009	0.140	
Month 5						
Attended	59 (98.3)	3 (5)	19.667	6.524	59.285	P< .001*
Failed to attend	1 (1.7)	57 (95)	0.018	0.003	0.123	
Month 6						
Attended	59 (98.3)	2 (3.3)	29.500	7.549	115.284	P< .001*
Failed to attend	1 (1.7)	58 (96.7)	0.017	0.002	0.120	
Month 7						
Attended	59 (98.3)	2 (3.3)	29.500	7.549	115.284	P< .001*
Failed to attend	1 (1.7)	58 (96.7)	0.017	0.002	0.120	
Month 8						
Attended	59 (98.3)	2 (3.3)	29.500	7.549	115.284	P< .001*
Failed to attend	1 (1.7)	58 (96.7)	0.017	0.002	0.120	
Month 9						
Attended	59 (98.3)	35 (58.3)	1.686	1.358	2.093	P< .001*
Failed to attend	1 (1.7)	25 (41.7)	0.040	0.006	0.286	

^aShort text message.^bOdds ratio.^cConfidence interval.

*Fisher's exact test.

in control arm 8 (13.3%) turned up for RGM (Table 3). The analysis demonstrates that in month 1 those caregivers who received STM were 6.875 times more likely to take their children for RGM compared to those who didn't receive

anything (OR=6.875; 95 CI: 3.591-13.164; $\chi^2=73.818$; df=1; P<.001) (Table 3). It was observed that those caregivers who received STM were more likely to take their children for RGM compared to those who didn't receive

Table 4. Proportion of Caregivers Who Turned Up for RGM in Intervention Arm 1 and Control Group Before and After STM and VC Intervention.

Variable	VC ^a (n=60) (%)	Control (n=60) (%)	OR ^b	95% CI ^c		Significance
				Lower	Upper	
Baseline						
Attended	13 (21.7)	14 (13.3)	0.929	0.478	1.805	$\chi^2=0.048$; df= 1; $P=.827$
Failed to attend	47 (78.3)	46 (86.7)	1.022	0.843	1.239	
Month 1						
Attended	54 (90)	8 (13.3)	6.750	3.522	12.938	$\chi^2=70.612$; df= 1; $P<.001$
Failed to attend	6 (10)	52 (86.7)	0.115	0.054	0.248	
Month 2						
Attended	59 (98.3)	7 (11.7)	8.429	4.198	16.923	$P<.001^*$
Failed to attend	1 (1.7)	53 (88.3)	0.019	0.003	0.132	
Month 3						
Attended	58 (96.7)	4 (6.7)	14.500	5.619	37.415	$P<.001^*$
Failed to attend	2 (3.3)	56 (93.3)	0.036	0.009	0.140	
Month 4						
Attended	60 (100)	4 (6.7)	15.000	5.820	38.660	$P<.001^*$
Failed to attend	0 (0)	56 (93.3)				
Month 5						
Attended	60 (100)	3 (5)	20.000	6.638	60.260	$P<.001^*$
Failed to attend	0	57 (95)				
Month 6						
Attended	60 (100)	2 (3.3)	30.000	7.680	117.191	$P<.001^*$
Failed to attend	0	58 (96.7)				
Month 7						
Attended	60 (100)	2 (3.3)	30.000	7.680	117.191	$P<.001^*$
Failed to attend	0	58 (96.7)				
Month 8						
Attended	60 (100)	2 (3.3)	30.000	7.680	117.191	$P<.001^*$
Failed to attend	0 (0)	58 (96.7)				
Month 9						
Attended	60 (100)	35 (58.3)	1.714	1.384	2.123	$P<.001^*$
Failed to attend	0	25 (41.7)				

^aVoice call.^bOdds ratio.^cConfidence interval.

*Fisher's exact test.

anything in month 2 (OR=8.286; 95 CI: 4.124-16.649; $P<.001^*$), month 3 (OR=14.500; 95 CI: 5.619-37.415; $P<.001^*$), month 4 (OR=14.500; 95 CI: 5.619-37.415; $P<.001^*$), month 5 (OR=19.667; 95 CI: 6.524-59.285; $P<.001^*$), month 6 (OR=29.500; 95 CI: 7.549-115.284; $P<.001^*$), month 7 (OR=29.500; 95 CI: 7.549-115.284; $P<.001^*$), and month 8 (OR=29.500; 95 CI: 7.549-115.284; $P<.001^*$) (Table 3). In month 9 (Table 3) caregivers who received STM 59 (98.3%) were more likely to take their children for RGM compared to 35 (58.3%) in control arm (OR=1.686; 95 CI: 1.358-2.093; $P<.001^*$). Many 35 (58.3%) caregiver turned up for RGM in ninth month compared to previous months because of the second schedule of measles recommended by World Health Organization (WHO) and the Government of Kenya (GoK).

Analysis of results of caregivers who received VC was compared with those in the control arm. In month 1 results showed that majority of caregivers 54 (90%) who received VC compared to those in control arm 8 (13.3%) turned up for RGM (Table 3). In months 2 and 3 a higher proportion of caregiver 59 (98.3%) and 58 (96.7%) respectively turned up for RGM compared to a small and declined number of caregivers 7 (11.7%) and 4 (6.7%) in control arm during the same period of time. The rest of the months 4 to 9, recorded all caregivers 60 (100%) turning up for RGM in intervention arm 2 (Table 3).

The analysis demonstrates that in month 1 those caregivers who received VC were 6.750 times more likely to take their children for RGM compared to those who didn't receive anything (OR=6.750; 95 CI: 3.522-12.938; $\chi^2=70.612$; df= 1; $P<.001$) (Table 4).

Table 5. Proportion of Caregivers Who Turned Up for RGM in Intervention Arm 1 and 2 Before and After STM and VC Intervention.

Variable	STM ^a (n=60) (%)	VC ^b (n=60) (%)	OR ^c	95% CI ^d		Significance
				Lower	Upper	
Baseline						
Attended	11 (18.3)	13 (21.7)	0.846	0.412	1.736	$\chi^2=0.208$; df=1; $P=.648$
Failed to attend	49 (81.7)	47 (78.3)	1.043	0.872	1.247	
Month 1						
Attended	55 (91.7)	54 (90)	1.019	0.909	1.141	$\chi^2=0.100$; df=1; $P=.752$
Failed to attend	5 (8.3)	6 (10)	0.833	0.269	2.584	
Month 2						
Attended	58 (96.7)	59 (98.3)	0.983	0.928	1.041	$P=1.000^*$
Failed to attend	2 (3.3)	1 (1.7)	2.000	0.186	21.473	
Month 3						
Attended	58 (96.7)	58 (96.7)	1.000	0.936	1.069	$P=1.000^*$
Failed to attend	2 (3.3)	2 (3.3)	1.000	0.146	6.869	
Month 4						
Attended	58 (96.7)	60 (100)	0.967	0.922	1.013	$P=.496^*$
Failed to attend	2 (3.3)	0 (0)				
Month 5						
Attended	59 (98.3)	60 (100)	0.983	0.951	1.016	$P=1.000^*$
Failed to attend	1 (1.7)	0 (0)				
Month 6						
Attended	59 (98.3)	60 (100)	0.983	0.951	1.016	$P=1.000^*$
Failed to attend	1 (1.7)	0 (0)				
Month 7						
Attended	59 (98.3)	60 (100)	0.983	0.951	1.016	$P=1.000^*$
Failed to attend	1 (1.7)	0 (0)				
Month 8						
Attended	59 (98.3)	60 (100)	0.983	0.951	1.016	$P=1.000^*$
Failed to attend	1 (1.7)	0 (0)				
Month 9						
Attended	59 (98.3)	60 (100)	0.983	0.951	1.016	$P=1.000^*$
Failed to attend	1 (1.7)	0 (0)				

*Fisher's exact test.

^aShort text message.^bVoice call.^cOdds ratio.^dConfidence interval.

It was observed that those caregivers who received VC were more likely to take their children for RGM compared to those who didn't receive anything in month 2 (OR=8.429; 95 CI: 4.198-16.923; $P<.001^*$), month 3 (OR=14.500; 95 CI: 5.6193-7.415; $P<.001^*$), month 4 (OR=15.000; 95 CI: 5.820-38.660; $P<.001^*$), month 5 (OR=20.000; 95 CI: 6.638-60.260; $P<.001^*$), month 6 (OR=30.000; 95 CI: 7.680-117.191; $P<.001^*$), month 7 (OR=30.000; 95 CI: 7.680-117.191; $P<.001^*$), and month 8 (OR=30.000; 95 CI: 7.680-117.191; $P<.001^*$) (Table 4). In month 9 caregivers who received VC 60 (100%) were 1.714 times more likely to take their children for RGM compared to 35 (58.3%) in control arm (OR=1.714; 95 CI: 1.384-2.123; $P<.001^*$).

The study further analyzed results of the turn up for RGM among caregivers who received STM and compared with those who received VC (Table 5).

Analysis of results showed that there was no significant difference in proportion of caregivers who received STM compared to those who received phone call in month 1 ($\chi^2=0.100$; df=1; $P=.752$), months 2 to 3 ($P=1.000^*$ for both), month 4 ($P=.496$), and months 5 to 9 ($P=1.000^*$ for each of them) (Table 5).

Analysis of STM and VC intervention results demonstrated that their use can significantly improve uptake of RGM among caregivers (Table 5). The results further showed that there was no significant difference between use of short text message and phone call (Table 5). Both STM

and VC improved uptake of RGM almost equally since the proportion of caregivers who turned up for RGM was virtually the same (Table 5).

Discussion

The study revealed a great improvement in uptake of RGM among caregivers who received STM and VC intervention compared to those in the control arm. This finding agrees to the findings of a systematic review conducted in LMIC in which mhealth technology increased uptake of vaccination.¹⁸ Use of text and voice messages among Nigerian mothers significantly improved breastfeeding practices in the neonatal period.¹⁹ Vaccination rates for newborn babies in India increased significantly when unidirectional text messages were sent to mothers to remind them to take their children for vaccination.²⁰ A similar study in Thailand revealed that ANC visits were higher after mothers were sent text messages as reminders to attend clinic.²¹

Caregivers who missed to take their children for RGM in the health facilities in which they were recruited among the intervention arms and control arm reported to have visited nearby health facilities for RGM. Child welfare clinic services including RGM are decentralized in all levels of healthcare in Kenya including health centers and dispensaries. Perhaps, this explains why caregivers opt to seeking RGM services from health facilities nearby their homes. In addition, caregivers might opt to attend RGM in nearby health facilities if attendance in previous health facilities they were registered entails economic losses (opportunity costs and transport costs).

Non-attendance was observed to be low among caregivers who received STM, VC intervention. This finding concurs to the findings of a similar other study conducted in Saudi Arabia which reported lower rates of non-attendance among patients who received SMS reminders.²² This finding is also consistent to a study conducted in Brazil in which non-attendance was lower among patients who were sent SMS reminders to attend medical clinics.²³

mhealth (STM and VC) intervention was found to have improved uptake of RGM during the entire study period. mHealth interventions in health care has been reported previously by various researchers given the relatively emerging field of research and wide interest in mHealth interventions to improve uptake of services in Low- and Middle-Income Countries (LMIC).^{10,24-26} mhealth technologies had great potential to impact management of chronic diseases since many people have strong attachments to their mobile phones and tend to carry them everywhere thus can easily connect to their Healthcare Provider (HCP) irrespective of where they are making monitoring of their health conditions easier.²⁷

It is important to note that mhealth interventions cannot only be used to improve uptake of RGM as revealed in this study but can also be used for long-term sustainability of

behavior change with regards to taking children below 5 years for monthly child welfare clinics. Studies conducted found out that mHealth intervention using text messages and voice calls contributes significantly to behavior change and management of diseases.^{28,29}

Conclusion

The Uptake of RGM significantly improved at endline upon implementation of STM and VC intervention. It is therefore important to consider using these mhealth reminders to ensure high uptake of RGM services.

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