



# Nigerian rural mothers' knowledge of routine childhood immunizations and attitudes about use of reminder text messages for promoting timely completion

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## Abstract

Mothers' poor knowledge and attitudes about routine immunization impede childhood immunization completion. This study assessed mothers' knowledge in rural communities about routine immunization and acceptability of mobile phone reminder text messages as an intervention for improving uptake and timely completion of routine immunization. The study adopted a descriptive cross-sectional design among 3440 consenting mothers of infants in six randomly selected Nigerian states and in the Federal Capital Territory (FCT). We used a Focus Group Discussion guide and validated questionnaire to collect data; we analysed data using a thematic approach and descriptive statistics. Respondents' ages were  $26.7 \pm 5.5$  years. Knowledge of routine immunization was poor; attitudinal disposition was positive. Most (90.5%) indicated willingness to accept reminder text messages for routine immunization and 91.5% opined that mobile phones can be effective in providing such information. Mothers' willingness to accept the use of SMS reminder text messages for promoting routine immunization completion requires well-designed and culture-sensitive persuasive messages.

**Keywords** Routine immunization · Mobile phone reminder text messages · Rural areas · Nigeria

## Background

In Nigeria, the Nigerian Ministry of Health considers children to be fully vaccinated when they receive one dose of Bacillus Calmette-Guérin (BCG) vaccine against tuberculosis; three doses of DPT vaccine to prevent diphtheria, pertussis, and tetanus; three doses of the polio vaccine; and one dose of measles vaccine [1]. While

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there has been an increase in the overall vaccination coverage in Nigeria from 13% in 2003 to 25% in 2014 [1], trends in immunization coverage have been consistently low. Data from the Nigerian National Demographic Health Surveys (NDHS) show that non-immunized children in 2003, 2008, and 2013 were 27%, 29%, and 21%, respectively [1]. The NDHS 2008 report indicates that overall, 23% of children aged 12–23 had months received all vaccinations at the time of the survey. Disaggregation shows overall coverage of 50%, and by antigen: for BCG, 52%; 35% for the first and third doses of DPT vaccine, respectively; 41% for measles vaccine, and 68% and 35% for the first and third doses of polio vaccine, respectively.

Research points to incomplete vaccination among infants as the likely cause for occasional reoccurring outbreaks of vaccine-preventable diseases in Nigeria [2]; full and timely completion of routine immunization remains a challenge. In response, the government has implemented several strategies with mothers to promote immunization coverage. However, wide gaps still exist for overcoming barriers of timeliness and completeness indicating a need to identify more innovative approaches [3, 4].

One innovative approach is the use of mobile phone message reminders. With the increasing mobile phone ownership in Nigeria, this innovation holds potential for increasing immunization coverage [5, 6] especially for measles and yellow fever vaccines given at 9 months [7].

Results from systematic reviews lend credence to the efficacy of mobile text messaging for improving health outcomes. Examples include reminding patients to adhere to medication regimens, increasing appointment keeping, and assisting patients to better manage chronic conditions such as asthma and diabetes [8–12]. However, evidence demonstrating the impact of mobile telephones as a tool for enhancing the uptake and timely completion of routine immunization in Nigeria remains scarce.

This paper is based on baseline results of a funded research project with the goal of assessing the effectiveness of using SMS reminder text messages to influence full and timely completion of all routine vaccinations by mothers of children aged 0–12 months in rural Nigerian communities. Our goal is to investigate knowledge and attitudes of mothers of children aged 0–12 months on routine childhood immunization and their views on use of reminder text messages to influence their full and timely completion of all routine childhood immunizations. We conducted this baseline component between November 2017 and March 2018. Findings will be used to design the SMS messages for implementation.

## Methods

**Study setting:** The study team conducted a cross-sectional survey in six randomly selected states and the Federal Capital Territory (FCT) in Nigeria (a total of 7 sites).

**Study population:** The primary study population consisted of mothers of children attending immunization clinics. The target population was mothers with children aged 0–2 months who attended immunization clinics during the study period.



**Study team:** Our team consists of the authors with assistance from three sorts of colleagues. The authors conceptualized the research idea, administered the project, managed software and the data, prepared the manuscript, and supervised the enrolled facility health workers and two sorts of Research Assistants (Field Research Assistants/FRAs and Technical Research Assistants/TRAs) who performed the tasks we describe below.

**Study design:** We employed Multi-Stage sampling. First, the authors randomly selected one state from each of Nigeria's six geo-political zones through drawing lots, yielding: 1. North-Central—Benue; 2. North-East—Bauchi; 3. North-West—Katsina; 4. South-East—Abia; 5. South-South—Bayelsa; 6. South-West—Ondo). Also, the authors intentionally selected the FCT as the seventh study area.

Second, we listed all rural Local Government Areas (LGAs: administrative county or district with representatives elected by those who live there) in each selected State and the FCT. Third, based on the routine immunization data from the LGAs, we categorized all the rural LGAs into “high” (80% or more) and “low” (under 40%) routine immunization coverage areas. From the list of LGAs with low immunization coverage, we randomly selected two LGAs by drawing lots. Fourth, we identified all the health facilities with routine immunization services in the selected LGAs and enrolled consenting mothers who met the inclusion criteria in the clinics.

Few if any studies have been conducted on the effects of using SMS text messages to remind mothers to keep all appointments and complete five basic routine immunizations on time. The expected levels of each are little known. This study is the baseline component of a quasi-experimental study; thus, we calculated sample size using the formula adopted from Kirkwood and Sterne [13] and Lwanga and Lemeshow [14]. We obtained a sample size of 166 for each LGA but increased it to 250 to adjust for attrition. Thus, our total sample consisted of 3500 eligible mothers for all 14 LGAs in all the six geopolitical zones and the FCT.

## **Data collection**

The study team employed a mix of methods and data tools. We used a Focus Group Discussion (FGD) guide to explore these mothers' perceptions about childhood immunization schedules, beliefs about immunization, and its benefits; misconceptions, inhibiting factors influencing uptake, and opinions on the use of mobile phone SMS messaging for facilitating mothers' appointment keeping and completion with all immunizations. Field Research Assistants (FRAs) conducted a total of 28 FGDs. We used a validated interviewer-administered semi-structured questionnaire with sections on mothers' socio-demographics, knowledge about vaccine-preventable diseases, and immunizations required for infants, usage of mobile phone, and readiness to adopt mobile phone SMS for promoting mothers' appointment keeping and assuring infants receive all immunizations.

FRAs recruited mothers seeking immunization for infants at the Primary Healthcare Centres. The Matron/Nurse on duty during the immunization clinic introduced the FRAs to the mothers, informed them of our mission and the purpose of the



study. The FRAs established rapport with the mothers and briefed them about the study's ethical considerations that appeared on the consent form in their local languages (Hausa, Igbo, and Yoruba). FRAs gave each mother a copy. Mothers willing to participate eventually signed the informed consent forms given by FRAs, most by thumb-printing. A few gave verbal consent only, expressing scepticism about signing any document (based on fear from previous experience that the government might use such signed documents to enrol them in future additional taxation). The FRAs interviewed the mothers following the semi-structured questionnaire.

### **Ethical considerations**

The Research and Ethics Committees of the University of Ibadan/University College Hospital (UI/EC/17/0561) approved the study.

### **Analysis**

Technical Research Assistants (TRAs) transcribed qualitative information from voice recorders and handwritten notes, word-processed, edited, and entered it into the computer using *Atlas Ti*, followed by content analysis. The authors and the TRAs reviewed completed questionnaires for random and systematic errors, and made corrections. TRAs cleaned and coded data prior to entry, using Statistical Package for Social Sciences (SPSS) version 21.0. We scored the knowledge items measured on a 25-point scale as “Knowledge scores” (KS)  $< 13$  and  $\geq 13$  and then categorized as “poor” and “good”, respectively. We measured attitude towards immunization items using a 7-point attitude scale, and classified attitude scores (AC scores)  $< 4$  and  $\geq 4$  as “negative” and “positive”, respectively. Data analysis used descriptive statistics with mean, standard deviation, median, and range generated. We present the findings in tables.

## **Results**

### **Qualitative findings**

#### **Participants' knowledge about routine immunization**

Some discussants had little knowledge of routine immunization. Below we offer illustrations of mothers' responses by topic and across groups in Zones as named. Each statement is by a different participant, even if from the same zone.

Routine immunization: only a few were able to explain correctly what routine immunization means, for example:

- “Immunization is the medicine that makes children strong”. (North-Central Zone)



- “It is the injection given in the health centre that makes children well”. (North-Central Zone)
- “Immunization is the prevention of diseases so that our children will not fall sick” (South-West Zone)

Types of immunization: some could not correctly name the different vaccines in the routine schedule; responses to the types include:

- “Not known, but mothers know they bring their children many times to the clinic to be vaccinated” (South-West Zone)
- “House to house”(North-East Zone)

Immunization schedule: responses about the routine immunization schedule identified specific antigens and corresponding age, showing some level of knowledge (each from South-West Zone):

- “Measles—9 months”
- “OPV—at birth”
- “BCG—tuberculosis at birth”

Other benefits of routine immunization: some mentioned as:

- “There was a time that my child was sick and almost crippled, but he survived it because he completed his immunization” (South-West Zone)
- “It prevents diseases” (North-East Zone)
- “It protects the children against deadly diseases” (North-Central Zone)

Uptake and completion: factors encouraging return for future appointments include (from—South-West Zone):

- “If they [health workers] attend to us well and in time”
- “Maybe if they start giving gifts to babies [who] complete their immunization”
- “Calling mothers to check on them”

Barriers to mothers taking children for routine immunizations. Responses include:

- “Religious belief” (North-East Zone)
- “Time spent during immunization” (South-West Zone)

Willingness to accept Reminder SMS for Routine Immunization appointments. Most expressed enthusiasm:

- “It will even serve as a reminder to mothers”



- “I think is good because mothers will be encouraged to bring their children for immunization”. (South-West Zone)
- “I would like text message”. (North-Central Zone)
- “It is good if they can be sending messages to us so that we will not forget” (South-West Zone)

Timing and frequency of the reminder text messages. Opinions varied:

- “A day before immunization date”.
- “Two days before immunization (North-East Zone)
- “Three times in a week” (South-West Zone)
- “Afternoon and morning”
- “At night and morning” “Afternoon and evening” (North-East Zone)
- “Morning and twice daily” (South-West Zone)

## Quantitative findings

### Respondents’ demographics

Almost all (95.7%) were married; most (64.7%) practiced the Christian faith, and about one-third (36.0%) completed high school (3 years of senior secondary education) education. Trading (34.4%) was the major occupation. Respondents’ mean age was  $26.72 \pm 5.5$  years and most (60.2%) fell into the 20–29-year-age category. Most (73.0%) had had multiple birth experiences. Their mean monthly income was thousand Naira (₦1000) or (\$2.9USD) (Table 1).

### Respondents’ level of knowledge

The mean knowledge score of the respondents was  $10.8 \pm 4.189$  (Table 2). Overall, most respondents (66.5%) had “low” knowledge of routine immunization. None identified whooping cough and tetanus as childhood vaccine-preventable diseases (Table 3). Respondents’ knowledge about the order and timing (routine immunization schedule) for immunization of children below 1 year of age was “low”. About one-third of the respondents correctly reported the routine immunization schedule (Table 4). The two most cited advantages of childhood immunization were “it prevents children from all diseases” (67.1%) and “it makes them strong and fit/of sound health” (51.2%)(Table 5).

### Barriers perceived to influence immunization uptake

Prominent factors perceived as affecting timely and full completion of routine immunizations for children aged below 12 months include lack of awareness of immunization (61.6%) and of subsequent doses (58.4%), and fear of side effects (59.7%). Others include rumours (for example, an association with future infertility)



**Table 1** Respondents' socio-demographic characteristics (*n* = 3440)

Demographic characteristics	N <sub>o</sub>	%
Marital status <sup>†</sup>		
Married	3291	95.7
Single	94	2.7
Others (divorced, widowed, co-habiting)	55	1.7
Religion <sup>†</sup>		
Christianity	2225	64.7
Islam	1141	33.2
Others	74	2.1
Highest education qualification <sup>†</sup>		
Primary school completed	341	9.9
Arabic/Quranic	386	11.2
Secondary school not completed	503	14.6
Secondary school completed	1240	36.0
NCE	267	7.8
Bachelor/HND	314	6.2
Others	489	14.2
Main occupation <sup>†</sup>		
Trading	1183	34.4
Fashion designing	265	7.7
Housewife	577	16.8
Farmer	269	7.8
Others	133	33.3
Ethnic group		
Yoruba	394	11.5
Igbo	692	20.1
Hausa	932	27.1
Others	1405	40.9
Age as at the last birthday (years)		
< 20	276	8.2
20–29	2027	60.2
30–39	1004	29.8
> 40	38	1.1
Mean (SD)	26.7 ± 5.5	
Birth experience		
First child	912	27.0
Multiple births	2465	73.0
Source of information on immunization <sup>†††</sup>		
Health worker/health facility	2135	20.7
Public announcement/town crier	817	7.9
Church or mosque	321	3.1
Media	1920	18.6
Friend or neighbour or spouse	426	4.1
School	34	0.3



**Table 1** (continued)

Demographic characteristics	N <sub>0</sub>	%
Self	9	0.1
Others	97	0.9
Average monthly income from all sources <sup>†</sup>		
< 1000	1735	50.4
N1000–N9999	953	27.7
N10000–N19999	431	12.5
N20000–N29999	154	4.5
N30000–N39999	76	2.2
N40000–N49999	27	0.8
> 50,000	63	1.8
Mean	₦5915.50	
Birth order of the enrolled child <sup>†</sup>		
First	917	26.7
Second	763	22.2
Third	629	18.3
Fourth and later	967	28.1

<sup>†††</sup>Multiple responses

<sup>†</sup>Non-responses were excluded

**Table 2** Respondents' overall knowledge score about diseases preventable by vaccines (N = 344)

Knowledge score	N <sub>0</sub> (%)	Mean	SD	X <sup>2</sup>	p Value
Poor	2695 (78.3)	10.8	4.189	50.319	0.000
Good	745 (21.7)				

**Table 3** Respondents' knowledge about diseases preventable by vaccines (N = 3440)

Vaccine-preventable diseases <sup>†</sup>	Yes		No	
	N <sub>0</sub>	%	N <sub>0</sub>	%
Malaria	1224	35.6	763	22.2
Tuberculosis*	2203	64.0	144	4.2
Measles*	2591	75.3	88	2.6
Yellow fever*	2159	62.8	180	5.2
HIV	559	16.3	912	26.5
Poliomyelitis*	2313	67.2	117	3.4
Whooping cough*	1986	57.7	197	5.7
Tetanus*	1834	53.3	190	5.5
Diarrhoea	1117	32.5	533	15.5

\*Correct responses

<sup>†</sup>Non-responses were excluded





**Table 4** Respondents' knowledge about the order and timing (routine immunization schedule) when immunization for children aged less than 1 year should be administered (*N* = 3440)

Vaccine <sup>†</sup>	Order and time when it is administered	Correct response		Incorrect response	
		N <sub>u</sub>	%	N <sub>u</sub>	%
BCG	At birth	1693	49.2	100	2.9
DPT	6, 10 and 14 weeks after birth	846	24.6	947	27.5
Hepatitis B	At birth, 10 and 16 weeks after birth	1014	29.5	779	22.6
OPV	0, 6, 10 and 14 weeks	1107	32.2	686	19.9
Measles	9 months after birth	1212	35.2	581	16.9
Yellow fever	9 months after birth	1064	30.9	729	21.2
Pentavalent (DPT+ Hep B + Hib)	6 weeks, 10 weeks and 14 Weeks after birth	875	25.4	917	26.7

<sup>†</sup>Non-responses were excluded

(56.3%), family problems including illness of mother (58.9%), and child illness (57.6%) (Table 6).

### Respondents' attitude towards routine immunization

Most respondents (73.6%) had a positive attitude towards routine immunization. The mean attitude score of the respondents was  $5.3 \pm 1.6$  (Table 7). Most (91.3%) "strongly agreed" or "agreed" that they trust the safety of the vaccines used. And most (71.6%) "strongly agreed" or "agreed" that it is necessary to immunize children against any communicable diseases, as a prayer to and faith in God is not sufficient to protect. Most (86.7%) "strongly agreed/agreed" that once a child is fully immunized, he or she is safe and free from vaccine-preventable diseases. Of concern: 18.0% of the respondents "strongly agreed/agreed" that mothers could be anxious concerning immunization because they perceive it as dangerous to children's health, while 20.0% held the view that immunization is not necessary because it makes children sick (Table 7).

### Respondents' ownership and use of mobile phones

All respondents possessed at least one mobile phone (mean =  $1.05 \pm 0.225$ ) and 11.7% had more than one active line. The majority, 89.3% and 87.5%, respectively, could open and read text messages on their mobile phone/s. Most (84.2%) reported knowing how to send text messages and 58.5% reported ability to read or send texts in the English language. Most (71.6%) never switch off their phones; of those who do, about half (49.1%) do so at night. Nearly half (49.7%) had experienced mobile phone network failure and the majority (70%) did not have difficulty charging their mobile phones. Most (62.3%) have access to other mobile phones if their own are faulty (Table 8).



**Table 5** Respondents' knowledge about routine immunization ( $N=3440$ )

Variable	N <sub>e</sub>	%
Advantages of routine immunization <sup>†††</sup>		
Prevents children from all diseases	2307	67.1
Makes children strong and fit/sound health	1762	51.2
Boosts children's immunity	324	9.4
Promotes Long life of children	179	5.2
Disadvantages of immunizing infants <sup>†††</sup>		
Increases children's body temperature after immunization	700	20.3
Makes children sick	713	20.7
Disrupts the mother's schedule	65	1.9
Promotes poor growth/diseases/discomfort/disability	979	28.5
Mothers' ignorance of immunization	7	0.2
Shortens life span of children	68	2.0
Time of the day a child should be immunized <sup>†</sup>		
Morning	3147	91.5
Afternoon	45	1.3
Anytime	135	3.9
Don't know	32	0.9
A sick child can be immunized <sup>†</sup>		
Yes	1689	49.1
No	1645	47.8
Immunization is healthy for a child <sup>†</sup>		
Yes	2836	82.4
No	510	14.8
Getting a child immunized for a disease prevents that child from that disease <sup>†</sup>		
Yes	3068	89.2
No	275	8.0
A child running temperature should be immunized <sup>†</sup>		
Yes	1274	37.0
No	2056	59.8

<sup>†††</sup>Multiple responses

<sup>†</sup>Non-responses were excluded

### Willingness to accept reminder SMS for routine immunization service delivery

Most respondents (90.5%) showed a willingness to accept mobile phone reminder text messages for routine immunization appointments. The majority (91.5%) indicated that mobile phones can be effective in giving health information to mothers. About two-fifths (41.1%) indicated a willingness to receive reminder text messages any time of the day; 31.8% preferred morning reminders. A little more than half,



**Table 6** Factors that can prevent mothers to complete immunization for their children aged less than 12 months ( $N=3440$ )

Factor <sup>†</sup>	Yes N <sub>e</sub> (%)	No N <sub>e</sub> (%)
Unaware of the need for immunization	2120 (61.6)	897 (26.1)
Unaware of the need to return for second or third dose	2008 (58.4)	994 (28.9)
Place and/or time of immunization unknown	1780 (51.7)	1162 (33.8)
Fear of side effects/adverse reactions	2054 (59.7)	960 (27.9)
Incorrect ideas about contraindications	1813 (52.7)	1074 (31.2)
Postponed until another time	1707 (49.6)	1186 (34.5)
No faith in immunization	1589 (46.2)	1310 (38.1)
Rumours	1935 (56.3)	1050 (30.5)
Place of immunization too far	1608 (46.7)	1309 (38.1)
Time of immunization not convenient	1656 (48.1)	1258 (36.6)
Vaccinator absent	1741 (50.6)	1166 (33.9)
Vaccine not available	1847 (53.7)	1112 (32.3)
Mother too busy	1810 (52.6)	1184 (34.4)
Family problem including illness of the mother	2025 (58.9)	960 (27.9)
Child ill, not brought to the clinic	1982 (57.6)	927 (26.9)
Child ill, brought but not given immunization	1809 (52.6)	996 (29.0)
Long waiting time	1570 (45.6)	1306 (38.0)
The attitude of health workers	1633 (47.5)	1226 (35.6)

<sup>†</sup>Non-responses were excluded

58.0% and 58.1%, would not have difficulties receiving or reading text messages on their phones, respectively, and 61.6% reported that reminder messages will help them keep immunization appointments (Tables 9 and 10).

## Discussion

Similar to an Ethiopian study, most respondents' education exceeded high school completion. This enhances ability to read SMS messages, and could influence their taking required actions. Mothers/caregivers' educational level and knowledge about vaccine and vaccine-preventable diseases have been found to be significantly associated with full child immunization [15].

Mothers' knowledge of vaccine-preventable diseases and routine immunization in our study was low. We did not expect this because most had given birth to more than one child. This suggests that educational messages from the clinic's health workers may not sufficiently equip them with adequate knowledge about the different diseases and vaccines. This knowledge deficit might have also affected previous



**Table 7** Respondents' attitude towards routine immunization ( $N=3440$ )

Attitude score	N <sub>2</sub> (%)	Mean	SD	$X^2$	df	$p$ Value
Negative	908 (26.4)	5.3	1.6	0.314	1	0.592
Positive	2532 (73.6)					
Attitude statement		SA N <sub>2</sub> (%)	A N <sub>2</sub> (%)	D N <sub>2</sub> (%)	SD N <sub>2</sub> (%)	NR N <sub>2</sub> (%)
Trust the safety of the vaccines used for immunizing children		2387 (69.4)	858 (24.9)	43 (1.3)	36 (1.0)	116 (3.4)
The notion that local herbs, "agbo", can equally prevent diseases for which children are vaccinated against		285 (8.3)	636 (18.5)	1233 (35.8)	1156 (33.6)	130 (3.8)
Whether a child is immunized or not, he will still fall sick of any of the immunizable diseases		421 (12.2)	1096 (31.9)	1150 (33.4)	632 (18.4)	141 (4.1)
Mind not at peace with immunization, feel it is dangerous to children's health and wellbeing		254 (7.4)	400(11.6)	1243 (36.1)	1385 (40.3)	158 (4.6)
Immunization makes children sick, so it is not necessary for them		275 (8.0)	418 (12.2)	1291 (37.5)	1293 (37.6)	163 (4.7)
It is necessary to immunize children against any communicable diseases, prayer to and faith in God is not enough to protect		1261 (36.7)	1199 (34.9)	484 (14.1)	317 (9.2)	178 (5.2)
Once a child is fully immunized, the child is safe and free from vaccine-preventable diseases		1964 (57.1)	1018 (29.6)	197 (5.7)	106 (3.1)	155 (4.5)

SA strongly agree, A agree, D disagree, SD strongly disagree, NR no response

low vaccination rates of children below 12 months of age. This finding was similar to those from other studies in which mothers had limited knowledge of vaccines [16–18]. Rainey et al. also found that parental knowledge of vaccination accounted for about 20% of under-immunization in developing countries [18]. Two studies in Bangladesh reported that the majority of study participants had poor or inadequate knowledge of routine immunization, vaccines, and diseases they prevent [19, 20].

Some of the barriers to routine immunization completion cited by participants in our study correlate with those reported in other studies. These studies similarly identified family lifestyle, perceptions about the child's body and immune system, vaccine efficacy, side effects, prior negative experience with vaccination, long-distance walking, and long waiting times at the health facility as major barriers to uptake of immunizations [21, 22].

The positive attitudinal disposition by mothers towards routine immunization in our study is welcome but we suggest caution. Nisar et al. found that despite a strong positive attitude, mothers' knowledge about vaccination was inadequate [20]. Other authors also reported that a strong positive attitude or attitudinal



**Table 8** Respondents' mobile phone ownership and usage (*N* = 3440)

Usage of phone	N <sub>e</sub>	%
<b>Number of phones owned</b>		
1	3164	92.0
2	176	5.1
<b>Number of active lines</b>		
1	2950	88.3
2	390	11.7
<b>Know how to open text messages</b>		
Yes	3072	89.3
No	263	7.6
<b>Know how to read text messages</b>		
Yes	3009	87.5
No	336	9.8
<b>Know how to send messages</b>		
Yes	2898	84.2
No	442	12.8
<b>Which language can you read or send text</b>		
English	2011	58.5
Yoruba	55	1.6
Hausa	610	17.7
Igbo	6	0.2
Yoruba and English	265	7.7
Hausa and English	41	1.2
Igbo and English	38	1.1
Others	78	2.3
<b>Do you switch your phone off at anytime</b>		
Yes	843	24.5
No	2464	71.6
<b>If yes what time of the day do you switch off your phone</b>		
Morning	84	10.0
Afternoon	21	2.5
Night	414	49.1
Occasionally	272	32.3
Others	8	0.9
<b>Do you experience network failure on your mobile phone</b>		
Yes	1708	49.7
No	1589	46.2
<b>How often do you experience network failure on your phone</b>		
Always	119	7.0
Occasionally	1209	70.8
Rarely	368	21.5
Others	11	0.6
<b>What time of the day</b>		



**Table 8** (continued)

Usage of phone	N <sup>†</sup>	%
Morning	81	4.7
Afternoon	131	7.7
Night	150	8.8
Anytime	869	50.9
Other problems experienced		
Flat battery	813	23.6
Not browsing	2	0.05
Network problem	270	7.84
Bad phone	72	2.09
Call card	24	0.7
Phone operation	8	0.23
Unnecessary text messages	3	0.09
The attitude of health workers	11	0.32
Forgetfulness	1	0.03
No mobile phone	10	0.29
No problem	1075	31.25
Difficulty charging your phone		
Yes	893	26.0
No	2408	70.0
How often		
Often	124	13.9
Rarely	563	63.0
Occasionally	200	22.4
What do you use your mobile phone for		
Calls	1411	41.0
Text messages	45	1.3
Calls and text messages	1532	44.5
Playing games	13	0.4
For browsing	47	1.4
Touch light	27	0.8
Playing music	33	1.0
In case the mobile phone does not work I have access to other phones		
Yes	2142	62.3
No	1016	29.5

<sup>†</sup>Non-responses were excluded

variable may not be a guarantee or a strong predictor of complete child immunization [23–26].

Respondents' willingness to accept a reminder SMS for routine immunization service delivery in our study was positive and the majority believed that the mobile phone can be effective in giving health information about immunization,



**Table 9** Willingness to adopt reminder SMS for routine immunization service delivery ( $N=344$ )

Adoption	N <sup>o</sup>	%
Mobile phones can be effective in giving health information to mothers <sup>†</sup>		
Yes	3146	91.5
No	179	5.2
Receiving reminder text messages about children next immunization appointment will encourage mothers <sup>†</sup>		
Yes	3058	88.9
No	252	7.3
Ever received a text message about your child immunization appointment <sup>†</sup>		
Yes	521	15.1
No	2771	80.6
The medium through which you are presently being reminded <sup>†</sup>		
Immunization card	1333	38.8
Town announcer/crier	350	10.2
Health facility/worker	579	16.8
Neighbourhood/friends/mother	55	1.6
Self	20	0.6
Church	20	0.6
Spouse	8	0.2
Ever received reminder message about your child immunization appointment <sup>†</sup>		
Yes	571	16.6
No	2727	79.3
If yes to be the above would you say that the reminder for the immunization appointment is useful and effective		
Yes	510	89.2
No	61	10.7
Willing to receive a reminder text messages of your child next immunization appointment		
Yes	3113	90.5
No	97	2.8

and that receipt of reminder text messages could reinforce their immunization appointment keeping. This finding corroborated other studies in which most mothers indicated a willingness to receive reminder text messages for immunization appointments through mobile phones [27]. This literature suggests that text messages are potentially effective tools for closing the immunization coverage gap. Thus, the subsequent intervention studies should exploit mothers' willingness to receive the SMS messaging to facilitate timely completion of all routine vaccinations.

While the reminder text messages helped mothers already attending immunization clinics to complete their children's vaccinations, there is a bigger contribution on which future studies should focus. That is, we need research on mothers who do not take their children to immunization clinics, even after sending



**Table 10** Willingness to adopt reminder SMS for routine immunization service delivery (*N*= 3440)

Adoption	N <sub>g</sub>	%
How should the message be framed <sup>*,†</sup>		
Short message (date, venue and time)	1669	48.5
Greetings/prayer	271	7.9
Reminder	634	18.4
Information/benefits of immunization and vaccination	105	3.1
Preferred language <sup>†</sup>		
English	2406	69.9
Yoruba	274	8.0
Hausa	914	26.7
Igbo	83	2.4
Others**	210	6.1
Difficulties in receiving a text message <sup>†</sup>		
None	1994	58.0
Flat battery	105	3.1
Damage or phone loss	9	0.3
Network problem	209	6.1
Don't know how to open message	14	0.4
Phone far from me	6	0.2
Husband will read for me	2	0.1
Big grammar	5	0.1
Language barrier	1	0.0
Difficulties in reading a text message <sup>†</sup>		
None	1997	58.1
Flat battery	169	4.9
Damage or phone loss	13	0.4
Network problem	20	0.6
Don't know how to open message	17	0.5
Phone far from me	3	0.1
Husband will have to read for me	10	0.3
Big grammar	10	0.3
Time of the day you prefer most to receive reminder text messages <sup>†</sup>		
Morning	1093	31.8
Afternoon	157	4.6
Night	267	7.8
Any time of the day	1415	41.1
How will the text message reminder help with child immunization appointment <sup>†</sup>		
Reminder/help to keep the date and time regularly	2118	61.6
None	77	2.2
Encouragement/go a long way	157	4.6
Improve the system	114	3.3
Completion of immunization	23	0.7





**Table 10** (continued)

Adoption	N <sup>a</sup>	%
Challenge in using text message		
None	1296	37.7
Flat battery	324	9.4
Damage or phone loss	44	1.3
Network problem	356	10.3
Others	300	8.7

\*Multiple responses

\*\*Others include some other local dialect across Nigeria

†Non-responses excluded

reminder text messages to them about desirable schedules. This is important given data from the Nigerian Demographic Health Survey (NDHS) [1] that show 27%, 29%, and 21% of children aged 12–23 months were not immunized at all in 2003, 2008, and 2013, respectively. Such mothers could be identified through the birth registries, Traditional Birth Attendants, and Faith-based maternity homes. Telephone numbers and home addresses could be extracted and put in a database, followed by sending reminder text messages about the next immunization schedules and dates. These strategies, in addition to the one used with the mothers already attending immunization clinics, offer better potential for improving timely completion of all routine immunizations nationwide.

## Conclusion

To achieve higher childhood routine immunization uptake, the proposed intervention should incorporate the mothers' preferred language and time of receiving the SMS messages into the messaging process. This would encourage mothers to act on the messages sent to their phones.

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