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

Oladimeji Oladeapo1 · Isaac Oluwafemi Dipeolu1 · Opeyemi Oladunni1

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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 ± 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
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 ≥ 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 ≥ 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 ± 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 ± 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 | № | %   |
|-----------------------------|---|-----|
| **Marital status** †         |   |     |
| Married                     | 3291 | 95.7|
| Single                      |   | 2.7 |
| Others (divorced, widowed, co-habiting) |   | 1.7 |
| **Religion** †              |   |     |
| Christianity                | 2225 | 64.7|
| Islam                       | 1141 | 33.2|
| Others                      | 74  | 2.1 |
| **Highest education qualification** † |   |     |
| 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** †       |   |     |
| 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** ††† |   |     |
| 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 | №  | %  |
|-----------------------------|-----|----|
| Self                        | 9   | 0.1|
| Others                      | 97  | 0.9|

Average monthly income from all sources

| <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 ᾶ₦ 5915.50

Birth order of the enrolled child

| First           | 917  | 26.7 |
|-----------------|------|------|
| Second          | 763  | 22.2 |
| Third           | 629  | 18.3 |
| Fourth and later| 967  | 28.1 |

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

| Knowledge score | № (%) | Mean | SD  | $X^2$ | 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† | Yes | No |
|-------------------------------|-----|----|
|                               | №  | %  | №  | %  |
| 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
†Non-responses were excluded
Nigerian rural mothers’ knowledge of routine childhood immunization

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† | Order and time when it is administered | Correct response | Incorrect response |
|----------|---------------------------------------|------------------|-------------------|
|          |                                       | №    | %   | №    | %   |
| 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 | 875   | 25.4| 917  | 26.7|

†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 ± 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 ± 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).
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,
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
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 7 Respondents’ attitude towards routine immunization (N=3440)

| Attitude score | N (%)  | Mean  | SD   | $\chi^2$ | df | $p$ Value |
|---------------|-------|-------|------|---------|----|-----------|
| Negative      | 908 (26.4) | 5.3   | 1.6  | 0.314   | 1  | 0.592     |
| Positive      | 2532 (73.6) |       |      |         |    |           |

| Attitude statement                                                                 | SA N (%) | A N (%) | D N (%) | SD N (%) | NR N (%) |
|------------------------------------------------------------------------------------|----------|---------|---------|----------|----------|
| 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
Table 8  Respondents’ mobile phone ownership and usage (N=3440)

| Usage of phone                                           | №  | %  |
|----------------------------------------------------------|----|----|
| Number of phones owned                                    |    |    |
| 1                                                        | 3164| 92.0|
| 2                                                        | 176 | 5.1 |
| Number of active lines                                    |    |    |
| 1                                                        | 2950| 88.3|
| 2                                                        | 390 | 11.7|
| Know how to open text messages                           |    |    |
| Yes                                                      | 3072| 89.3|
| No                                                       | 263 | 7.6 |
| Know how to read text messages                           |    |    |
| Yes                                                      | 3009| 87.5|
| No                                                       | 336 | 9.8 |
| Know how to send messages                                |    |    |
| Yes                                                      | 2898| 84.2|
| No                                                       | 442 | 12.8|
| Which language can you read or send text                 |    |    |
| 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 |
| Do you switch your phone off at anytime                  |    |    |
| Yes                                                      | 843 | 24.5|
| No                                                       | 2464| 71.6|
| If yes what time of the day do you switch off your phone  |    |    |
| Morning                                                  | 84  | 10.0|
| Afternoon                                                | 21  | 2.5 |
| Night                                                    | 414 | 49.1|
| Occasionally                                             | 272 | 32.3|
| Others                                                   | 8   | 0.9 |
| Do you experience network failure on your mobile phone    |    |    |
| Yes                                                      | 1708| 49.7|
| No                                                       | 1589| 46.2|
| How often do you experience network failure on your phone |    |    |
| Always                                                   | 119 | 7.0 |
| Occasionally                                             | 1209| 70.8|
| Rarely                                                   | 368 | 21.5|
| Others                                                   | 11  | 0.6 |
| What time of the day                                     |    |    |


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 8 (continued) |
|----------------------|
| **Usage of phone**   |
| **№**  | **%**  |
| Morning | 81 | 4.7 |
| Afternoon | 131 | 7.7 |
| Night | 150 | 8.8 |
| Anytime | 869 | 50.9 |

**Other problems experienced**

| Item                        | №  | %   |
|-----------------------------|----|-----|
| 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**

| Item                        | №  | %   |
|-----------------------------|----|-----|
| Yes                         | 893 | 26.0 |
| No                          | 2408 | 70.0 |

**How often**

| Item   | №  | %   |
|--------|----|-----|
| Often  | 124 | 13.9 |
| Rarely | 563 | 63.0 |
| Occasionally | 200 | 22.4 |

**What do you use your mobile phone for**

| Item                        | №  | %   |
|-----------------------------|----|-----|
| 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

| Item                        | №  | %   |
|-----------------------------|----|-----|
| Yes                         | 2142 | 62.3 |
| No                          | 1016 | 29.5 |

† Non-responses were excluded
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

| Adoption                                                                 | N  | %  |
|--------------------------------------------------------------------------|----|----|
| Mobile phones can be effective in giving health information to mothers† | 3146 | 91.5 |
| No                                                                       | 179 | 5.2 |
| Receiving reminder text messages about children next immunization appointment will encourage mothers† | 3058 | 88.9 |
| No                                                                       | 252 | 7.3 |
| Ever received a text message about your child immunization appointment†   | 521 | 15.1 |
| No                                                                       | 2771 | 80.6 |
| The medium through which you are presently being reminded†                |    |    |
| 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† | 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 |
| Table 10 | Willingness to adopt reminder SMS for routine immunization service delivery (N=3440) |
|----------|-----------------------------------------------------------------------------------|
| **Adoption** | **N** | **%** |
| **How should the message be framed** | | |
| 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** | | |
| 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** | | |
| 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** | | |
| 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** | | |
| 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** | | |
| 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 |
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 data-
based, followed by sending reminder text messages about the next immunization
schedules and dates. These strategies, in addition to the one used with the moth-
ers 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 interven-
tion 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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Oladepo Oladimeji MPH, PhD, is a Professor at the Department of Health Promotion and Education, Faculty of Public Health, College of Medicine, University of Ibadan, Nigeria.

Dipeolu Isaac Oluwafemi MPH, PhD, is a Lecturer at the Department of Health Promotion and Education, Faculty of Public Health, College of Medicine, University of Ibadan, Nigeria.

Oladunni Opeyemi MPH, is a Doctoral student at the Department of Health Promotion and Education, Faculty of Public Health, College of Medicine, University of Ibadan, Nigeria.