J Community Health (2016) 41:265–273
DOI 10.1007/s10900-015-0092-3

ORIGINAL PAPER

Effects of Community Health Nurse-Led Intervention on Childhood Routine Immunization Completion in Primary Health Care Centers in Ibadan, Nigeria

V. B. Brown[1] · O. A. Oluwatosin[2] · J. O. Akinyemi[3] · A. A. Adeyemo[4]

Published online: 22 September 2015

Abstract Immunization coverage of vulnerable children is often sub-optimal in many low- and middle-income countries. The use of a reminder/recall (R/R) system has been one of the strategies shown to be effective in improving immunization rates. In the resent study, we evaluated the effect of R/R and Primary Health Care Immunization Providers' Training (PHCIPT) intervention on routine immunization completion among 595 infants in Ibadan, Nigeria. The design was a group randomized controlled trial with Local Government Area (LGA) being the unit of randomization. Four randomly selected LGAs were randomized to receive a cellphone R/R only (A), a PHCIPT only (B); combined R/R and PHCIPT (C) intervention or serve as a control group (D). Children aged 0–12 weeks were consecutively recruited into each group and followed up for 12 months. The primary outcome measure was routine immunization completion at 12 months of age. At the study endpoint, immunization completion rates were: group A, 98.6 %; group B, 70 %; group C, 97.3 %; and group D, 57.3 %. Compared to the control group, the cellphone R/R group was 72 % (RR 1.72, 95 % CI 1.50–1.98) and the combined RR/PHCIPT group 70 % (RR 1.70, 95 % CI 1.47–1.95) more likely to complete immunization. In contrast, immunization completion in the PHCIPT group was marginally different from the control group (RR 1.22, 95 % CI 1.03–1.45). These findings remained robust to adjustment for potential predictors of immunization completion as covariates. In conclusion, cellphone reminder/recall was effective in improving immunization completion in this Nigerian setting. Its use is recommended for large scale implementation.

Keywords Cellphone reminder/recall · Childhood · Immunization · Vaccine-preventable-diseases

✉ V. B. Brown
vicbrown2010@gmail.com

[1] School of Nursing, University College Hospital, Ibadan, Nigeria

[2] Department of Nursing, Faculty of Clinical Sciences, College of Medicine, University of Ibadan, Ibadan, Nigeria

[3] Department of Epidemiology and Biostatistics, Faculty of Public Health, College of Medicine, University of Ibadan, Ibadan, Nigeria

[4] National Institutes of Health, Bethesda, MD, USA

Introduction

Childhood immunization is one of the most cost-effective public health interventions. Routine immunizations are estimated to prevent more than 2.5 million annual child deaths globally [1]. The World Health Organization (WHO) also estimated that if available vaccines against childhood diseases were widely adopted, and recommended vaccination coverage of ≥90 % nationally and ≥80 % in every district by 2020 is achieved, millions of deaths will be prevented [1].

Vaccine preventable diseases account for about a quarter of the 8 million deaths occurring annually among children under 5 years of age especially in low-income countries [2]. Statistics has shown that about 13 % of the world's under-five deaths in 2012 still occurred in Nigeria [3]. Approximately one in four of those deaths are preventable through routine immunization (RI). Routine immunization is considered as one of the priority child survival interventions [4], but coverage of routine childhood vaccines in Nigeria

remains lower than the global recommended level for the sustained control of vaccine preventable diseases.

The Nigerian health system is based on a three-tier structure that corresponds to the structure of government (federal, state and local government). The Local Government Area (LGA) is the operational level for primary health care implementation. For administrative purpose, each LGA is divided into an average of 10 electoral wards which are the lowest political units.

A ward is also the lowest unit of health services delivery in Nigeria. Nigeria adopted the Ward Heath System (WHS) and the Reaching Every Ward (REW) strategy, an adaptation of the WHO–AFRO Reaching Every District (RED) approach to facilitate routine immunization coverage and further bring healthcare nearer to the people [5]. Nigeria's routine immunization schedule reflected that infants should be vaccinated with the following vaccines: a dose of Bacillus Calmette–Guerin (BCG) vaccine at birth (or as soon as possible); three doses of diphtheria, pertussis and tetanus (DPT) vaccine at 6 (six), 10 and 14 weeks of age; at least four doses of oral polio vaccine (OPV)—at birth, 6 (six), 10 and 14 weeks of age; hepatitis B vaccine is administered at birth, 6 weeks of age, and 14 weeks of age and one dose each of measles and yellow fever vaccine at 9 months of age. In 2012, the Pentavalent vaccine was introduced to replace the DPT vaccine administered at 6 (six), 10, and 14 weeks and HBV administered at birth, six and 14 weeks [6].

To ensure effective coverage, over the years Nigeria has adopted diverse immunization strategies such as the Expanded Program on Immunization (EPI), which was later changed to National Program on Immunization (NPI). In December 2004, the country adopted the Reaching Every Ward (REW) approach during a National Review and Planning meeting to strengthen routine immunization in every ward. The objective of these strategies is to reduce morbidity and mortality rates among infants and children from six childhood immunizable diseases. In May 2006, the Immunization Plus Days (IPDs) strategy was introduced as an additional way to further strengthening of routine immunization. Despite these strategies, the 2010 National Immunization Coverage Survey (NICS) showed that only about 10 % of children ages 9–12 months and 53 % of children ages 12–23 months in the country were fully vaccinated.

The same NICS also showed that only 37 % of children ages 9–12 months and 59 % of children ages 12–23 months were fully vaccinated in Oyo State [7]. The National Primary Health Care Development Agency also reported a significant drop in immunization coverage in 2012 and this has left more than 3.2 million children at the age of 12 months unimmunized adding to the existing large pool of susceptible under-five children. A large number of children without any form of immunization is predictable of outbreaks of vaccine-preventable disease across the country [8]. In summary, the country has not improved childhood immunization to the WHO recommended 90 % level for the sustained control of vaccine preventable diseases, despite various immunization strategies.

Evidence from previous studies in the developed countries has shown that reminder/recall system or reminder/recall system in conjunction with other interventions (multi-components intervention) can improve coverage for routinely recommended immunization for children, adolescents, and adults [9, 10, 11, 12, 13]. Meanwhile, there is dearth of information on the use of immunization reminder/recall system as a strategy for improving immunization in Nigeria. This study, taking into consideration the existing evidence, employed and evaluated the individual and combined effects of reminder/recall system and PHC immunization providers' training on routine childhood immunization completion among the study children.

Methods

The study design was a group randomized controlled trial in Ibadan, Southwest Nigeria. Local Government Area (LGA) was the unit of randomization. Ibadan is made up of eleven LGAs and it is divided into two parts clustered along two senatorial districts on the map. One part which is the urban area contains five LGAs and the other part which is the sub-urban area contains six LGAs. Two LGAs from the urban area and two LGAs from the sub-urban area were randomly selected out of the eleven LGAs. Using ballot system, the four randomly selected LGAs were then allocated into three intervention groups and one control group of reminder/recall (R/R) group (A), Primary Health Care Immunization Providers' Training (PHCIPT) group (B); combination of R/R and PHCIPT group (C) and control group (D). One ward was randomly selected from each LGA and one PHC facility was purposively selected from each ward.

The target population for the study were children aged 0–12 months paired with their mothers.

The formula [14] to estimate the sample size per group was used as follows:

$$\mathrm{n} = \frac{(Z_{\alpha/2} + Z_{\beta})^2 \bar{p}(1-\bar{p})(r+1)}{(d^*)^2 r}$$

For this study, applying this formula with the assumptions stated above yielded a sample size of 98 per group of subjects. An allowance of 20 % (in this case, ~20 subjects) were added to cater for drop-out or attrition in order to allow a sufficient number to be analyzed at the end of the

study. Therefore, the minimum sample size per group was 118. Overall, about 150 children were recruited per group.

A total of 605 eligible children aged 0–12 weeks at their first immunization visits having their parents living in the study communities were consecutively recruited into four different study groups from August to November 2012. The study was approved by the Oyo State Research Ethical Review Committee gave an Ethical approval for the study. Written informed consent was obtained from the mother of each child.

Intervention

For group A (R/R intervention), cellphone calls for reminder/recall intervention sessions were implemented. The cell phone reminder/recall intervention was initiated in August 2012 and continued until September 2013. Telephone reminder intervention involved one session of two cell phone reminder calls made to either a parent of a child or any contact person whose cell phone number has been recorded in the study by the mother of the child. One cell phone reminder contact was made 2 days before and another one a day before the child's immunization appointment. Recall was for missed appointment despite the reminder and the pattern of recall cell phone calls were similar to that of reminder. Intervention exposure was a cell phone call that reached a child's family. A child was considered a 'drop-out' in reminder/recall intervention for a particular scheduled immunization visit after one session of failed reminder and four sessions of failed recall for that immunization appointment schedule (that is if the child was not brought for immunization at the end of one session of reminder and four sessions of recall).

For group B, (PHCIPT intervention), 2 days refresher training on theory and practice of immunization was conducted for Primary Health Care immunization providers (nurses, midwives, Community Health Officers (CHOs) and Community Health Extension Workers (CHEWs). Workers who had worked for at least 3 months in the study health facility and had not participated in any form of immunization training in the last 6 months were eligible to participate in the training. The manual for the training consisted of four modules adapted from two manuals on immunization training developed by WHO. The first WHO manual "Identifying and Overcoming Obstacles to Increase Immunization Coverage in Health Catchment Area was developed in 1997 and the second one "Immunization in Practice: A Resource Guide for Health Workers" was developed in 2004. The content of the four modules were as follows: (1) Module one: vaccine preventable diseases, vaccines, and cold chain. (2) Module two was on ensuring safe injections as well as planning and holding immunization sessions. (3) Module three was on building community support for immunization and gathering immunization information from the community. (4) Module four was on communication with mothers about immunization. Group C had a combined intervention of R/R and PHCIPT. In the control group (group D), the usual care was followed without any form of intervention.

Each child in the three intervention groups and the control group was followed-up till he/she was 12 months old. The follow-up took place during scheduled immunization clinics in the different study groups' health facilities on immunization appointment days to evaluate the children's immunization completion rate. The duration of follow-up ranged from 9 to 12 months based on the age of a child at recruitment.

Outcome Measures

The primary outcome measure was "immunization completed" or "immunization not completed" (that is the receipt or non-receipt of all scheduled routine childhood immunization in Nigeria of one dose of BCG vaccine, at least four doses of OPV vaccines, three doses of DPT vaccine, three doses of Hep B vaccines, and one dose each of measles and Yellow fever vaccine by participated children at the study endpoint (aged 12 months). The secondary outcome measure was to isolate the effect of each intervention independently and also to evaluate whether combination of both interventions is superior to only one intervention (that is to determine which of the three intervention strategies is most effective in increasing the percentage of routine childhood immunization completion among the children in the study.

Data Collection

A culturally accepted instrument (questionnaire) adapted from the "Reminder/Recall in Immunization Information Systems" published by the American Immunization Registry Association (AIRA) [15] was used in the study. This instrument was used to collect an integrated child immunization data system and also to record the process of reminder/recall intervention. The instrument consisted of four sections: The first section was used to gather information on each participating child and his/her parents' socio-demographic characteristics; (used in groups A, B, C and D); The second section was used to document the child comprehensive immunization records (used in groups A, B, C and D); The third section was used to record reminder/recall activities for each child in reminder/recall system intervention groups (groups A and C only) during the intervention phase. The fourth and last section was used for the appraisal of immunization reminder/recall system (used in groups A and C only).

In the groups (B and C) with training intervention, pre and post-intervention data were collected using questionnaire and observation checklist. The questionnaire was used to assess the socio-demographic and professional characteristics of the participants, their immunization knowledge and self-reported practice including vaccine-preventable diseases, vaccines and vaccine administration, cold-chain, safe injection practices, conducting immunization sessions, contraindications and side effects of each vaccine. Other assessment done with questionnaire was the participants' knowledge and self-reported practice on building community support for immunization, gathering immunization information from the community and communication with mothers about immunization.

The questionnaire consisted of questions drawn from the immunization training question database developed by the World Health Organization (WHO) in 1997 and 2004. The checklist was used for direct observation and assessment of the participants, communication practice with the mothers.

The validity and reliability of the instruments were estimated through test–retest method and correlation coefficient was r = 0.90.

Statistical Analysis

This study was powered at 80 % to detect intervention effect on the immunization completion rate of at least 20 % higher post-intervention than the estimated 37 % in Oyo State [7] (that is, to detect an effect of 57 % or higher in contrast to the estimated 37 % immunization completion rate).

In the analysis, the proportion of children who completed routine childhood immunization were computed. Frequencies and percentages of participating children's socio-demographic characteristics across study groups were compared. The immunization status at 12 months was the main outcome variable. Statistical significance of the effect of independent variables (i.e. test of the coefficient being different from zero) was set at $p < 0.05$. All statistical analyses were performed using the SPSS Version 21 software (IBM Corporation, Armonk, NY).

Results

The socio-demographic characteristics of the children in the study are presented in Table 1. At the study end point, 595 children were evaluated while 10 children were lost to follow up. The study flow chart is presented Fig. 1. Of the children evaluated, 289 (48.6 %) were male while 306 (51.4 %) were female, their mean age was 18.3 ± 16.6 days at baseline. The characteristics of the children across the four study groups are presented in Table 2. No significant differences were noted among the four groups with regard to mother's age ($p = 0.32$). However, significant differences were noted in the mean age (in days) at first immunization visits among the participated children across the four study groups, ($p < 0.05$).

Table 1 Socio-demographic characteristics of children in the study

Socio-demographic characteristics	No (n = 595)	%
Gender		
Male	289	48.6
Female	306	51.4
Child's age at first immunization visit		
0–7 days	168	28.2
8–14 days	171	28.7
15–21 days	82	13.8
22–28 days	45	7.6
29–35 days	29	4.9
36–42 days	28	4.7
Above 42 days	72	12.1
Family tribe		
Yoruba	511	85.9
Ibo	39	6.6
Hausa	5	0.8
Other tribes	40	6.7
Birth order		
1	195	32.8
2–3	309	51.9
≥4	91	15.3
Family type		
Monogamy	556	92.3
Polygamy	32	5.5
Mother not married	7	1.2
Family religion		
Christianity	385	64.7
Islam	210	35.3
Child's place of birth		
Public health facility	135	22.7
Private health facility	238	40.0
Mission/TBAs	190	31.9
Home	32	5.9

Endpoint Comparison of Immunization Status of Children by Study Group

At the study endpoint, immunization completion rate was 98.6 % among children in group A (R/R intervention group), and 57.3 % among children in group D (usual care) (Fig. 2). Compared to the control group, the cellphone R/R group was 72 % (RR 1.72, 95 % CI 1.50–1.98) and the

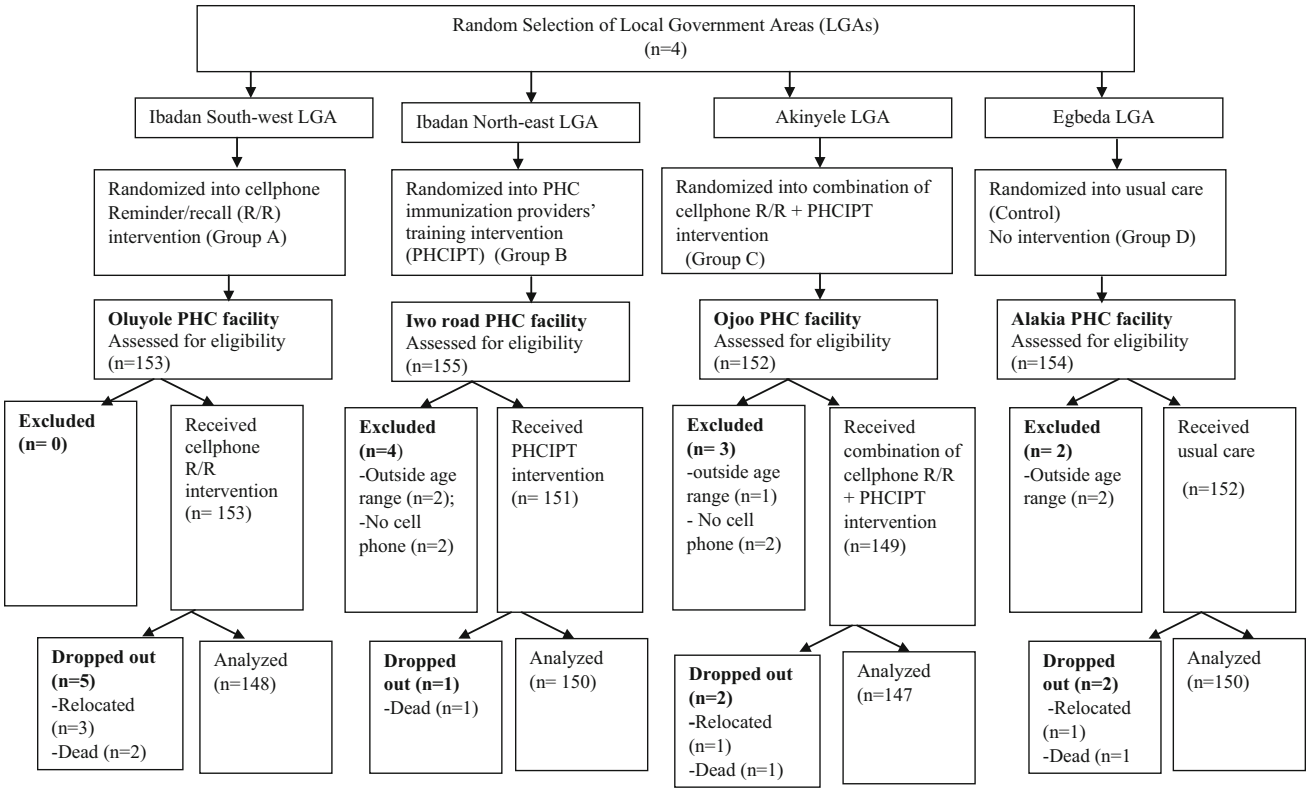

Fig. 1 The study participants' flow chart

combined RR/PHCIPT group 70 % (RR 1.70, 95 % CI 1.47–1.95) more likely to complete immunization. In contrast, immunization completion in the PHICPT group was marginally different from the control group (RR 1.22, 95 % CI 1.03–1.45). In terms of odds ratios (OR), children in groups A (R/R intervention group) (OR 54.33, 95 % CI 13.68–464.56, $p < 0.0001$) and group C (Combination or R/R and PHCIPT intervention group) (OR 26.60, 95 % CI 9.32–103.13, $p < 0.0001$) were more likely to complete immunization than those in group D. In contrast, the difference between groups B (PHCIPT intervention group) (OR 1.73, 95 % CI 1.05–2.88, $p = 0.023$) and D (usual care group) was much smaller. Adjusting for potential predicting factors of immunization completion such as family type, religion, maternal education and place of delivery as covariates and for the type of intervention, the results showed that none of the predicting factors was independently associated with immunization completion (Table 3). Only the intervention type was found to have significant influence on immunization completion. Children in groups A (R/R intervention group) (OR 46.60, 95 % CI 10.92–198.9) and group C (Combination or R/R and PHCIPT intervention group) (OR 31.38, 95 % CI 10.57–93.17) were more likely to complete immunization than those in group D. However, the difference between groups B (PHCIPT intervention group) (OR 1.58, 95 % CI 0.96–2.59) and D (usual care group) was not significant (Table 3).

Discussion

The results of this study show that that cell phone reminder/recall is associated with the highest immunization completion rates among the children in the study. The combination of cell phone reminder/recall and immunization providers training intervention was not superior to cell phone reminder/recall intervention alone while immunization providers' training alone showed no difference with routine care in improving immunization completion. The effect of cell phone reminder/recall in increasing immunization completion rates in this study support the published evidence in the developed countries and suggests that the intervention can be effective in Nigeria as it is in industrialized countries. In a systematic review to assess the effectiveness of patient reminder and recall systems in improving immunization rates, Jacobson Vann and Szilagyi [16] compared the effects of various types of reminder/recall in different settings and different patient populations. Overall results of the 47 studies showed that all types of reminder/recall were effective (postcards, letters, telephone or autodialer calls), with telephone being

Table 2 Baseline comparison of participated children across study groups

Variables	Study groups								χ^2	*p* value
	Reminder/recall intervention group (A)		PHC immunization providers' training intervention group (B)		Reminder/recall and immunization providers' training intervention group (C)		Control group (D)			
	No	%	No	%	No	%	No	%		
Gender									8.466	0.037*
Male	59	39.9	74	49.3	71	48.3	85	56.7		
Female	89	60.1	76	50.7	76	51.7	65	43.3		
Family type									12.609	0.05
Monogamy	142	95.9	144	96.0	138	93.9	132	88.0		
Polygamy	5	3.4	6	4.0	6	4.1	15	10.0		
Mother not married	1	0.7	0	0.0	3	2.0	3	2.0		
Birth order									12.111	0.060
1	47	31.8	36	24.0	51	34.7	61	40.7		
2–3	78	52.7	84	56.0	79	53.7	68	45.3		
≥4	23	15.5	30	20.0	17	11.6	21	14.0		
Family religion									38.556	<0.001*
Christianity	127	85.8	88	58.7	85	57.8	85	56.7		
Islam	21	14.2	62	41.3	62	42.2	65	43.3		
Maternal education									12.520	0.051
Below secondary	8	5.4	17	11.3	11	7.5	22	14.7		
Secondary	82	55.4	66	44.0	83	56.5	72	48.0		
Post-secondary	58	39.2	67	44.7	53	36.1	56	37.3		
Mother's employment status									24.229	0.019*
Unemployed	11	7.4	9	6.0	26	17.7	13	8.7		
Petty trading	67	45.3	83	55.3	63	42.9	80	53.3		
Artisan	44	29.7	32	21.3	38	25.9	41	27.3		
Civil servant	20	13.5	21	14.0	19	12.9	12	8.0		
Others	6	4.1	5	3.3	1	0.7	4	2.7		
Place of delivery									38.695	<0.01*
Public health facility	21	14.2	28	18.7	51	34.7	35	23.3		
Private health facility	49	33.1	69	46.0	51	34.7	69	46.0		
Mission/TBAs	70	47.3	45	30.0	34	23.1	41	27.3		
Home	8	5.4	8	5.3	11	7.5	5	3.3		

* Statistically significant

the most effective. Increases in immunization rates due to reminder/recall were in the range of 1–20 % points. Thus far, there is a dearth of information in the study environment (Nigeria) that has evaluated the use of cellphone reminder/recall intervention to improve childhood immunization uptake that is comparable in this study.

The findings in the study showed that the intervention effect detected in the combination of cell phone reminder/recall and providers' training in improving immunization completion among the children in the study was marginally lower than the effect detected in the cell phone reminder/recall intervention alone. Considering the finding in the study that showed that providers training intervention did not significantly improve immunization completion, the effect detected in the combined intervention may probably be due to the cell phone reminder/recall component of the combined intervention. However, studies have shown that community-based interventions implemented in combination (multi-components intervention) have been proven to improve immunization uptake in developed countries [17, 18].

The ineffectiveness of immunization providers' training on immunization completion in this study is an important finding which suggests that capacity building training

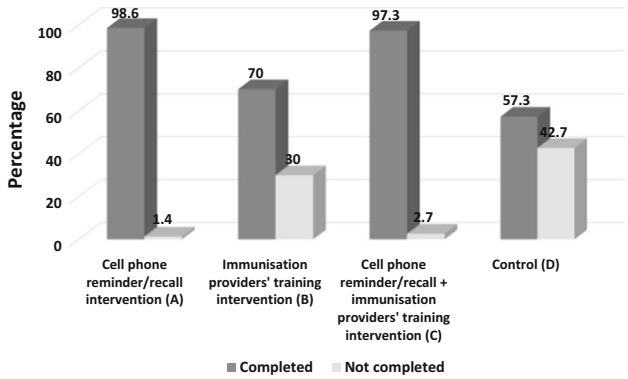

Fig. 2 Endpoint comparison of immunization status of children aged 12 months by study groups

interventions for health care providers may increase their knowledge without improving their performance and job-related attitudes and behaviors. Notably, this intervention is targeted towards health care providers, rather than the mothers who are responsible for actually remembering and keeping appointments. Therefore, the intervention may be less effective as, unlike a reminder/recall system targeted to mothers, it is a step removed from the people most responsible for bringing children for immunization.

The implication of this is that immunization policy makers in Nigeria and other developing countries need to consider interventions other than just health worker training, especially those that will focus more directly on improving the performance, attitude and behavior of immunization providers. Strategies like supportive supervision [19, 20], audit and feedback [21] as well as AFIX approach [22] can be considered. (AFIX means: Assessment of the immunization coverage of public and private providers, Feedback of diagnostic information to improve service delivery, Incentives to motivate providers to change immunization practices or recognition of improved or high performance, and eXchange of information among providers) [22]. AFIX is a program designed to move healthcare personnel from a state of unawareness about the problem of low immunization rates in their practice to one in which they are knowledgeable, concerned, motivated to change their immunization practices and capable of sustaining new behaviors [22].

Meanwhile, knowledge, attitudes and behavior of healthcare providers have been found to have significant impact on immunization uptake [23, 24]. Interestingly, the reviews of interventions for improving coverage of child immunization conducted by the Society of America

Table 3 Mixed effects logistic model of the influence of potential predictors on routine childhood immunization completion among children in the study

Predictor	OR	95 % CI	Z	*p*
Intervention				
Control (usual care) (reference group) (group D)				
Cell phone reminder/recall (group A)	46.60	10.92–198.9	5.19	<0.0001*
PHC immunization providers' training (Group B)	1.58	0.96–2.59	1.82	0.069
Combination of cell phone reminder/recall and PHC immunization providers' training (group C)	31.38	10.57–93.17	6.21	<0.0001*
Family type				
Mother not married (reference group)				
Monogamy	5.84	0.69–49.15	1.62	0.14
Polygamy	3.26	0.33–31.88	1.02	0.309
Religion				
Islam (reference group)				
Christian	1.24	0.76–2.02	0.85	0.396
Maternal education				
Post-secondary (reference group)				
Below secondary	0.54	0.25–1.18	–1.55	0.121
Secondary	0.67	0.39–1.14	−1.48	0.139
Place of delivery				
Home (reference group)				
Public health facility	1.50	0.49–4.63	0.71	0.480
Private health facility	1.65	0.56–4.85	0.90	0.366
Mission house/TBA	2.99	0.98–9.12	1.92	0.055

* Statistically significant

Clinical Infectious Diseases [25], Mathew [26], the American Task Force on Community Preventive Services [27] and Oyo-Ita et al. [28] showed that there is a very limited evidence for the effectiveness of providers' education alone in improving vaccination rates but when it is combined with one or more type of intervention (multicomponent interventions), it yields better result. However, some studies have been found to show the effectiveness of immunization providers' training intervention in improving immunization coverage [29].

As with all studies, this study has its limitations. Firstly, the study was a cluster randomized controlled trial conducted in few PHC centers; based on this, statistical significance may be difficult to achieve with the design. However the design was necessary in the study being a community study to avoid intervention contamination within the study communities. Secondly, the study can only be generalized to urban and sub-urban population in the city of Ibadan, Nigeria, it did not include rural setting, and the effect of the intervention may vary between urban and rural settings.

Conclusion

In conclusion, this study though conducted in a low-resource setting confirmed the previous evidence from high-income countries of the effectiveness of reminder/recall intervention and multicomponent intervention in improving immunization compliance and completion. The need for policy makers to consider the adoption of the strategy on a large scale to enhance immunization completion in Nigeria and other low-resource settings is recommended.

References

1. Center for Disease Control and Prevention (CDC). (2011) *CDC global immunization strategic framework 2011–2015*. US Department of Health and Human Services. Retrieved June 14, 2015, from http://www.cdc.gov/globalhealth/immunization/docs/gid-strat-framewk.pdf.
2. United Nations Children's Fund (UNICEF). (2011). *Levels and trends in child mortality report 2011: Estimates developed by the United Nations inter-agency group for child mortality estimation*. New York, USA: UNICEF.
3. World Health Organization (WHO). (2014). *Global Health Observatory (GHO): Child health.* Retrieved January 31, 2014, from http://www.who.int/gho/child_health/en/.
4. United Nations Children's Fund (UNICEF). (2013). *Accelerated child survival*. Retrieved on June 14, 2015, from http://www.unicef.org/health/index_childsurvival.html.
5. Ojo, K., Yisa, I., Soyibo, A., Olubajo L., & Schoen, P. (2011). *Cost of routine immunization in Nigeria*. Centre for Health Economics and Development (CHECOD) Working Paper Series. Retrieved May 09, 2015, from http://www.checod.org/wp-content/uploads/2013/11/Publication-0011.pdf.
6. Sadoh, A. E., & Sadoh, W. E. (2014). Does Nigeria need the birth dose of the hepatitis B vaccine? *Nigerian Journal of Pediatrics, 41*(2), 104–109.
7. National Primary Health Care Development Agency (NPHCDA). (2010). *Nigeria 2010 national immunization coverage survey*. Abuja, Nigeria: NPHCDA.
8. Federal Ministry of Health (FMOH) Nigeria. (2013). *National routine immunization strategic plan 2013–2015* (p. 17). Abuja, Nigeria: FMOH.
9. Pickering, L. K., Baker, C. J., Freed, G. L., et al. (2009). Immunization programs for infants, children, adolescents, and adults: Clinical practice guidelines by the infectious diseases society of America. *Clinical Infectious Diseases, 15*(49), 817–840.
10. Cushon, J. A., Neudorf, C. O., Tanis, M., Kershaw, T. M., Dunlop, T. G., & Muhajarine, N. (2012). Coverage for the entire population: Tackling immunization rates and disparities in Saskatoon health region. *Canadian Journal of Public Health, 103*(1), S37–S41.
11. Suh, C. A., Saville, A., Daley, M., et al. (2012). Effectiveness and net cost of reminder/recall for adolescent immunizations. *Pediatrics, 129*(6), e1437–e1445. doi:10.1542/peds.2011-1714.
12. Stockwell, M. S., Kharbanda, E. O., Martinez, R. A., et al. (2012). Text4Health: Impact of text message reminder–recalls to improve pediatric and adolescent immunizations. *American Journal of Public Health, 102*(2), e15–e21.
13. Stockwell, M. S., Kharbanda, E. O., Martinez, R. A., Vargas, C. Y., Vawdrey, D. K., & Camargo, S. (2012). Effect of a text messaging intervention on influenza vaccination in an urban, low income pediatric and adolescent population: A randomized controlled trial. *Journal of American Medical Association, 307*(16), 1702–1708.
14. Kelsey, J. L., Whittemore, A. S., Evans, A. S., & Thompson, W. D. (1996). *Methods in observational epidemiology* (2nd ed., pp. 311–340). New York: Oxford University Press.
15. American Immunization Registry Association (AIRA): Modeling of Immunization Registry Operations Work (MIRROW) Group. (2009). *Reminder/Recall in immunization information systems* (pp. 18–102). Atlanta, GA, American Immunization Registry Association. Retrieved June 08, 2010, from http://www.immregistries.org/resources/AIRA-MIROW_RR_041009.pdf.
16. Jacobson Vann, J. C., & Szilagyi, P. (2005). Patient reminder and recall systems to improve immunization rates. *Cochrane Database of Systematic Reviews 3*. doi:10.1002/14651858.CD003941.pub2.
17. Zimmerman, R. K., Hoberman, A., Nowalk, M. P., et al. (2006). Improving influenza vaccination rates of high-risk inner-city children over 2 intervention years. *Annals of Family Medicine, 4*(60), 534–540.
18. Melinkovich, P., Hammer, A., Staudenmaier, A., & Berg, M. (2007). Improving pediatric immunization rates in a safety-net delivery system. *Joint Commission Journal on Quality Patient Safety, 33*, 205–210.
19. Djibuti, M., Gotsadze, G., Zoidze, A., Mataradze, G., Esmail, L. C., & Kohler, J. C. (2009). The role of supportive supervision on immunization program outcome—A randomized field trial from Georgia. *BMC International Health and Human Rights, 9*(1), S11. doi:10.1186/1472-698X-9-S1-S11.
20. Som, M., Panda, B., Pati, S., et al. (2014). Effect of supportive supervision on routine immunization service delivery-a randomized post-test study in Odisha. *Global Journal of Health Science, 6*(6), 61–67.
21. Jamtvedt, G., Young, J. M., Kristoffersen, D. T., O'Brien, M. A., & Oxman, A. D. (2006). Does telling people what they have been doing change what they do? A systematic review of the effects of audit and feedback. *Quality and Safety in Health Care, 15*(6), 433–436.

22. Center for Disease Control and Prevention (CDC). (2012). *Epidemiology and prevention of vaccine-preventable diseases. The pink book* (12th ed., p. 33). Atlanta, GA: Centre for Disease Control and Prevention.
23. Anastasi, D., Di Giuseppe, G., Marinelli, P., & Angelillo, I. F. (2009). Pediatricians' knowledge, attitudes, and practices regarding immunization for infants in Italy. *BMC Public Health, 14*(9), 463–469.
24. Pelly, P. L., Pierrynowski MacDougall, D. M., Halperin, B. A., et al. (2010). An assessment of immunization education in Canadian health professional programs. *BMC Medical Education 10*, 86.
25. Society of America Clinical Infectious Diseases. (2009). Immunization programs for infants, children, adolescents, and adults: Clinical practice guidelines by the Infectious Diseases Society of America. *Clinical Infectious Diseases, 49*, 817–840.
26. Mathew, J. L. (2009). Evidence-based options to improve routine immunization. *Indian Pediatrics, 49*, 993–996.
27. American Task Force on Community Preventive Services. (2010). *Vaccinations to prevent diseases: Universally recommended vaccinations.* Retrieved March 14, 2011, from http://www.thecommunityguide.org/vaccines/universally/index.html.
28. Oyo-Ita, A., Nwachukwu, C. E., Oringanje, C., & Meremikwu, M. M. (2012). Interventions for improving coverage of child immunization in low- and middle-income countries (Review). *Evidence-Based Child Health: A Cochrane Review Journal, 7*(3), 959–1012.
29. Uskun, E., Uskun, S. B., Uysalgenc, M., & Yagız, M. (2008). Effectiveness of a training intervention on immunization to increase knowledge of primary health care workers and vaccination coverage rates. *Public Health, 122*, 949–958.