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“Against all Odds”-Increasing Demand and Uptake of Immunization Services Among Non-Fully Immunized Children in Northern Nigeria Using a Positive Deviance Approach: Implementation Science Research

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ABSTRACT

Introduction: Children still die from vaccine-preventable diseases. Nigeria contributes 30% of unimmunized children <5 years globally. This study was conducted in 4 Local Government Areas (LGA) in Niger and Gombe States employing the positive deviance (PD) approach to increase vaccination demand in low child immunization coverage settings.

Methodology: The was a quasi-experimental study, conducted between December 2019 and April 2021, comparing pre- and post- intervention vaccination uptake after 5 months of intervention among 400 caregivers of non-fully immunized children (CNFIC). We trained 40 caregivers of fully immunized children (CFIC) as mentors using a participatory learning and action tool. The CNFIC were matched in ratio 10:1 with CFIC and exposed to 8 impact meetings and 10 home-visits using communication materials to increase vaccination knowledge. Paired T-test and adjusted odd ratios from logistic regression models were used to determine change in immunization uptake and factors associated with full immunization for age, respectively.

Result: A total of 343 CNFIC were successfully followed up during intervention. The age range of children in the study was 2 to 12 months with the female (178) slightly more than the male (165). The mean vaccine uptake rate increased from 43.7% to 85.9% (T= -29.3, P<0.005) with 55.4% fully vaccinated for age post-intervention. Safer LGA residence, being a housewife caregiver, and younger caregivers <30 years were positive determinants of full vaccination.

Conclusion: Adopting the PD approach to low uptake vaccination settings can increase vaccination demand and coverage. This approach can be leveraged in other public health challenges.

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Received: March 09, 2023; **Accepted:** March 15, 2023; **Published:** March 20, 2023

Keywords: Vaccination, Positive Deviance, Caregivers

Introduction

Vaccination uptake in many countries remains sub-optimal despite the vital role it plays in reducing child morbidity and mortality due to vaccine-preventable diseases (VPD)[1]. The Global Vaccine Action Plan envisions a world free of vaccine preventable diseases and continues to support strategies to realise this vision. However, despite substantial progress in global immunization coverage over the decades, 20 million children remain unprotected from VPDs in 2019 with half of this number located in Sub-Sahara Africa [2]. Nigeria contributes 30% of the global number of unimmunised

children under-5 years with 40% unvaccinated children [3, 4]. In 2016, the coverage of the 3rd dose of pentavalent vaccine (diphtheria, pertussis and tetanus containing vaccine) – a measure of immunization program performance – in Nigeria was 33%, far from the national target of 90% [4].

Achieving the Sustainable Development Goal 3 target to end preventable deaths of new-borns and children under-5 year’s old hinges on improved coverage of completed basic vaccinations among this target population. Vaccine benefits are optimized when children complete all recommended vaccine doses [5, 6]. A child is fully immunized if s/he has received all recommended basic

vaccinations: one dose of BCG vaccine (against tuberculosis); three doses of DPT-containing vaccine (against diphtheria, pertussis, and tetanus); three doses of oral polio vaccine (excluding the birth dose); and one dose of measles vaccine [7, 8].

Nigeria continues to experience challenges with demand for routine immunization (RI) especially in the northern regions which host about 64% of the total population [9]. According to the National Immunization Coverage Survey (NICS) 2016/2017, only 1 in 4 Nigerian children received all recommended vaccines [7], with significantly less children fully immunized in the northern geopolitical zones of Nigeria compared to the south. The survey highlighted 18 poor performing states with full-vaccination coverage rates less than 50% among children aged 12-13 months, which included Niger (14%) and Gombe States (17%) [7]. The reasons for poor RI demand include ignorance of the potential benefits, cultural and religious inhibitions, fear of side effects, and poor attitude of healthcare providers, among others. These factors constitute a barrier to increasing immunization coverage in Nigeria [7,9,10].

Efforts to improve national immunization program have been based on various strategies and plans including with the comprehensive multi-year plan 2011–2015 and the current Nigeria Strategy on Immunisation and Primary Health Care Systems Strengthening (NSIPSS) 2018–2028 [11]. The strategies included promoting RI provision in health facilities and community-based immunisation campaigns through the Child Health Week and the Reaching Every Ward strategy, and focused on strengthening the building blocks of the health systems, programme integration, and community participation and ownership [12]. Despite all the above strategies, vaccination coverage remains low highlighting the need to identify and deploy innovative approaches with potential for achieving universal vaccination coverage amongst Nigerian children.

The positive deviance (PD) concept is an approach to behavioural and social change based on the observation that in any community there are people (positive deviants) whose uncommon but successful behaviours or strategies enable them to find better solutions to a problem than their peers, despite facing similar challenges and having no additional resources or knowledge than their peers [13,14]. It involves partnering with communities to develop case definitions and identify positive deviants who are engaged to identify potential enabling factors for outcomes of interest. These enabling factors are accessible and are used to design behaviour change activities in the community while monitoring implementation and evaluating the results. The PD concept was first used in nutrition research to plan nutrition programs following observations that some poor families had well-nourished children despite living in poverty [15,16]. While it has found extensive applications in other health and social research programmes (e.g. female genital mutilation, infectious diseases, and hand washing and hygiene, among others [15-18]). only few studies have successfully deployed it to improve immunization uptake, none of which was conducted in Nigeria [19]. In 2019, the Centre for Integrated Health Programs (CIHP) received funds from Bill and Melinda Gates Foundation through the Grand Challenges Exploration Round 22 initiative to explore, through implementation science research, how uptake for childhood vaccination could be optimised using the positive deviance approach in two Northern Nigerian states - Gombe and Niger. CIHP is a leading indigenous Non-Governmental Organization, which currently provides reproductive maternal neonatal and child health services and family-focused comprehensive HIV care and

treatment services in four states of Nigeria (including Gombe). The primary and secondary objectives of this study are:

Primary Objective

• To increase demand and uptake of immunization services in low uptake settings using the positive deviance approach.

Secondary Objectives

1. To identify key drivers enabling caregivers to fully immunize their children in low uptake settings.
2. To assess the effectiveness of the positive deviance approach in increasing demand for immunization services in low uptake settings.

This paper discusses our adaptation of the PD approach for the study intervention and the quantitative results: measuring the level of vaccination uptake and identifying factors associated with full vaccination among non- or under-vaccinated children in the two states.

Methodology

The Intervention

The Leveraging Enablers of Positive Deviancy (LEOPOD) study aimed to increase the demand and uptake of vaccination services using the PD approach by investigating why some caregivers fully immunize their children/wards when others, with similar socio-demographic characteristics, do not. Identified enablers informed the design of a Participatory Learning and Action (PLA) package delivered to caregivers of non-fully immunized children through trained community based 'immunization mentors' identified from a caregiver pool of fully immunized children. We hypothesized that the adoption of similar behaviour by caregivers who do not fully immunize their children will increase vaccination demand and uptake in low coverage settings. For this study, a fully immunized child is defined as one who has received the following six basic antigens or vaccines: BCG; 3 doses each of Hepatitis, DPT, and OPV; and measles.

Study Settings

Nigeria consists of 36 States and the Federal Capital Territory. Each state is administratively sub-divided into Local Government Areas (LGAs) which are in turn sub-divided into wards as the lowest administrative level [8]. Gombe and Niger States, which are situated in the North-East and North-Central geo-political zones respectively were selected for the study based on the low immunization coverage (Gombe - 13.8%; Niger- 16.7%) and availability of structural facilities and human resources to efficiently implement the project.

Gombe State

Gombe state is located in the north east of Nigeria and has 11 LGAs with a predominant Fulani and Muslim population. Hausa and English languages are generally spoken along with other dialects such as Fulfulde, Tangale and Kanuri [20]. With an estimated population of 3,435,109 in 2018, the under-5 population consisted of 687,022 children. In 2018, Gombe ranked as one of the top-5 states with high under-5 mortality rate in Nigeria (189 deaths per 1000 live births) [21]. The state has 615 health facilities (592 primary health care facilities, 22 secondary facilities, and one tertiary facility). Most primary health care centres provide routine immunization (RI) services based on the National Programme on Immunization as part of primary health care services free of charge

Niger State

Located in north central Nigeria, Niger State consists of 25 LGAs with an estimated population of 5,900,257 and an under-5 population of 1,180,051 children in 2018. It is the largest state in Nigeria in terms of land mass with three main ethnicities (Nupe, Gbagyi and Hausa) and several other ethnicities [22]. The State has an under-five mortality of 98 per 1000 live births [21]. Health services are delivered by the State Government through 1,323 primary health care facilities, 18 secondary health facilities and two tertiary health facilities in Niger State. Immunization services are provided at no charge to both pregnant women and children under-5 years of age using the primary health care facilities.

Selection of administrative areas for study

In each state, two LGAs (Kaltungo and Kwami in Gombe state and Paikoro and Bida in Niger State) are purposively selected on the basis of availability of functional primary health centres providing routine immunization services (RI), senatorial districts mapping, religious and ethnic diversities, poor immunization uptake and security. Subsequently five wards were selected purposively from each LGA following defined selection criteria [Box 1]. See sampling technique in Figure 1. The RI centres in each ward were classified as "high performing" or "low performing" based on availability of immunization supplies. Two RI centers were randomly selected from the "high performing" stratum of each ward for a total of 10 per LGA.

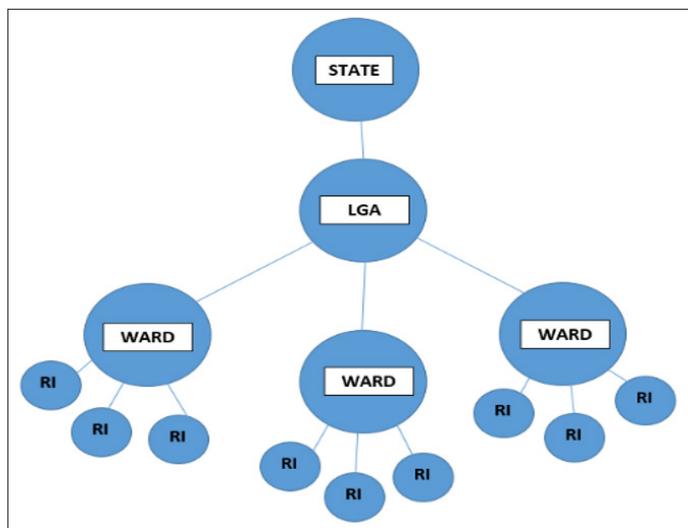


Figure 1: Showing sampling technique

Box 1: Ward Selection Criteria

1. Has estimated population of at least 30 pregnant women per year.
2. Communities within the wards should be within close distance to a health facility or immunization centre.
3. Adequate balance of rural and urban wards representation
4. Not security prone

Study design

This study is a quasi-experimental study design to compare pre- and post-intervention changes in vaccine uptake. This study was implemented over three phases: 1. Formative research involving the caregivers of fully immunized children (CFIC) – the positive deviants – assisted the development of the intervention package (PLA package), and training of selected CFICs as immunization mentors (IMs); 2. The implementation of the intervention through home visits and impact sessions delivered by the IMs to the

caregivers of non-fully or never immunized children (CNFIC); and 3. The evaluation of the intervention.

Study population

The study population consists of the CNFIC and the CFIC (positive deviants). The caregiver must, in the last 6 months prior to the study, have spent a minimum of 8 hours daily attending to the daily care and raising of the child. Immunization mentors were selected from among the positive deviants.

Sample Size Estimation and Selection of Participants

The study enrolled 160 CFIC and 400 CNFIC (40 CFICs and 100 CNFIC per LGA) in the study. The sample size for CNFIC was calculated using the formula below for estimating sample size for one sample proportion.

$$N = \frac{p_0q_0 \left\{ z_{1-\alpha/2} + z_{1-\beta} \sqrt{\frac{p_1q_1}{p_0q_0}} \right\}^2}{(p_1 - p_0)^2}$$

Where p_0 = known LGA proportion (using the LGA with the largest known proportion of 44.9% fully immunized); $q_0 = 1 - p_0$; p_1 = expected sample proportion;

$q_1 = 1 - p_1$; α = significance level at 0.05;

$z_{1-\alpha/2}$ = the two-tailed critical value for the normal distribution at $\alpha = 0.05$ corresponding to 95% confidence limit, i.e. 1.96;

$z_{1-\beta}$ = power at 80% i.e. 0.84;

$p_1 - p_0$ = expected difference between sample and known LGA proportions = 0.15

$$N = \frac{0.45 \times 0.55 \left\{ 1.96 + 0.84 \times \sqrt{\frac{0.60 \times 0.40}{0.45 \times 0.55}} \right\}^2}{0.60 - 0.45}$$

$$= (0.2475 \times 7.602) / 0.15^2 = 83.6$$

Allowing for an attrition rate of 15% = $N / (1 - 0.15) = 84 / (1 - 0.15) = 98.8$

This was rounded up to 100 so that 100 CNFICs were sampled in each LGA.

Development and Deployment of the Intervention Package

Focus group discussion: Selected and consenting CFICs participated in focus group discussions (FGDs) to identify the unique practices or enablers which aided the full immunization of their children. A total of 4 FGDs (with 8 – 10 CFICs per FGD) were conducted per LGA to elicit responses to guide the development of the PLA package. Each FGD was facilitated by a moderator and a note taker among a pool of eight trained research personnel selected after an initial training of 12 facilitators. FGD topic guides were pretested on the field to improve the validity of the data collection tools. Topics discussed included reasons for fully immunizing the child, access to immunization services, experiences about delivery of vaccination services, motivations for adhering to subsequent vaccinations despite negative experiences, how negative experiences were overcome, and recommendations for improving clinic service delivery. The PLA package was developed using the documentation and analyses of the FGDs and pilot tested.

Training of immunization mentors: A total of 40 CFICs selected as immunization mentors (IM) were trained over a 5-day period

during a step-down training by community-based trainers to facilitate active learning impact sessions for CNFICs. The trainers, who had experience in community maternal and child health, were trained as Training of Trainers on the PLA package. Training focused on facilitation and communication skills building, conduct of community impact sessions, use of tools, and roles and responsibilities as mentors.

Training of ward-level Local Immunization Officers: Twenty indigenous Local Immunization Officers (LIOs) experienced in routine immunization programs were trained on the project's data collection tools to ensure accurate data collection, collation and entry. The LIOs were responsible for all documentation processes to ensure data entered is accurate, reliable, complete and timely. They also attended all community dialogue meetings (impact sessions) with the mentors.

Implementation of Intervention

The PLA package were delivered by the IMs to the CNFICs through community impact sessions and home visits to facilitate a shift in socio-behavioural change towards uptake of immunization (Figure 2). The PLA package consisted of a flipchart and a picture storybook. The flipchart provided a compelling narrative of a woman's journey to complete vaccination for her baby with key messages on immunization gleaned from the formative research. The picture storybook was a mini-handbook showing picture collage of key messages associated with vaccination. Community impact sessions: The impact sessions were community participatory learning meetings where IMs met with the CNFICs at a chosen location to discuss challenges relating to immunization and how to overcome such challenges guided by the flipchart and picture story book. One IM was paired with 10 assigned CNFICs for a period of eight weeks teaching one episode on immunization per week to cover the eight episodes as designed in the flipchart and picture book. Each episode covered a socio-behavioural change-related key message on immunization starting from knowledge in episode-1 to practice in episode-8 stimulating discussions. Eight impact sessions were conducted through eight contacts with the IM over an 8-week period.

Home Visit

Supporting the impact sessions, each IM conducted twice-monthly home visits making a total of 10 visits) for each CNFIC allocated for the 5-month follow up – including check-ins on the family wellbeing. IM also made case referrals to other health services. The delivery model for the intervention is shown in Figure 2. Overall, the intervention was designed to encourage caregivers' visits to the RI centres for completion of outstanding vaccines which the child had not received.

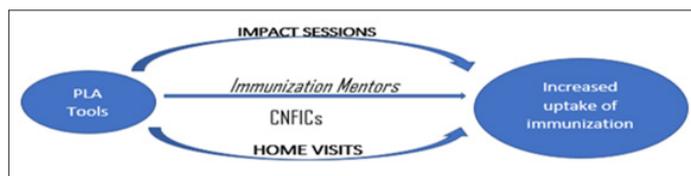


Figure 2: Schema showing delivery model of the intervention and expected outcome

Evaluation of Intervention

Quantitative data collection

A structured questionnaire was administered among CNFICs to elicit baseline socio-demographic characteristics including age, sex, marital status, level of education, occupation, age of

child to be enrolled and baseline vaccination status. Additionally, during and post-intervention, data related to the intervention – number of home visits received, impact sessions attended, and post immunization status of the child – were collected using the study monitoring tools. Data were entered electronically in the database designed for the study and stored for data analysis.

Eligibility for immunization at all enrolment and post-intervention were determined using the age of each child. The average vaccine uptake rate was determined by dividing the total vaccines received by total vaccines eligible adjusted for age. A fully immunized child post-intervention is a child who has received all eligible vaccine while taking into consideration that some vaccines like HBV0 and BCG are not given after age two weeks and 11 months respectively. Children were classified by vaccination status into fully vaccinated (1) and not fully vaccinated (0) post-intervention.

Data Analysis

Univariate analysis using frequencies and percentages were reported for categorical variables; and mean, median and standard deviation for numerical variables. Bi-variate analysis using the McNamara's Chi-square test and paired T-test were used to assess differences between pre- and post-intervention individual vaccine uptake rate and average vaccine uptake, respectively. We used Pearson's Chi-square test to determine the association between socio-demographic characteristics and immunization status post-intervention. A binary logistic regression analysis was used to determine factors most associated with being fully vaccinated post-intervention. We applied a conservative cut-point p-value of 0.25 at bivariate level for variable model selection and used the Akaike Information Criterion (AIC) to determine the model with the best fit, accounting for multi-collinearity. Data were analysed using Stata software, version 14. A p-value of less than 0.05 was considered significant for inferential statistical tests.

Ethical Consideration and Confidentiality

Ethical approvals were obtained from Gombe and Niger State Health Research Ethics Committees respectively. Informed consent was obtained from all study participants. All data and records generated by the study were kept confidential and with access given only to study personnel for study-related purposes. Data was stored on a password-protected and firewall-secured laptop. Limited paper copies of data were safely stored in locked cabinets.

Results

Socio-demographic characteristics of study participants and uptake of intervention

A total of 343 eligible CNFIC (156 in Gombe and 187 in Niger) and their children were enrolled into the study and successfully followed over a 5-month period (December 2020 – April 2021). A mean 7.5 (SD = 1.0) impact sessions and a mean 5.3 (SD = 1.5) home visits were received by the participants, respectively. All, except one, of the CNFIC were female (mothers), with majority (72%) being housewives, more than half (60%) 20-29 years old, and 34% having completed secondary education. Most (92%) of CNFIC attended ANC during the pregnancy of the index child. Only 11% of CNFIC earned more than 1000 Naira daily at the household level. The distribution of enrolled children by gender was comparable (male – 48% and female – 52%), while majority (52%) of children were aged between 6-11 months old [Table 1].

Table 1: Socio-demographic characteristics of caregivers of non-fully immunized children (CFNIC)

Variables	Frequency N=343	Percentage
State		
Gombe	156	45.48
Niger	187	54.52
LGA		
Bida	92	26.82
Kaltungo	74	21.57
Kwami	82	23.91
Paikoro	95	27.70
Religion		
Christianity	53	15.45
Muslim	281	81.93
Traditional	9	2.62
Caregiver		
Mother	340	99.71
Father	1	0.29
Caregiver Marital Status		
Married	337	98.25
Single	6	1.75
ANC Attendance		
Attended	317	92.42
Did not attend	26	7.58
Age of Caregiver		
less than 20 years	12	3.50
20-29 years	205	59.77
30-39 years	101	29.45
40 years & above	25	7.28
Educational Status		
No education	71	20.70
Primary	60	17.49
Quranic	76	22.16
Secondary	116	33.82
Tertiary	20	5.83
Occupation		
Housewife	246	71.72
Trader	69	20.12
Farmer	11	3.21
Others	17	4.96
Daily household income		
Less than 500 Naira	225	65.60
500 to 1000 Naira	81	23.62
More than 1000 Naira	37	10.79
Number of children		
1-2 children	154	44.90
3-4 children	108	31.49
5 and above	81	23.62
Child Age		

Less than 6 months	112	32.65
6 to 11 months	180	52.48
12 months and above	51	14.87

Uptake of Basic Vaccine Pre and Post- Intervention

The uptake of all basic vaccines recommended for a child up till 9 months of age increased significantly ($p < 0.001$) from baseline through post intervention. (Table 2) The vaccines with the highest uptake at baseline were BCG and OPV at birth (both at 76%). The trend consistently decreased across vaccines on the RI schedule, going from 62% for OPV1 and Penta1 to 0% for measles (the last basic vaccination on the RI schedule). Following the PD intervention, the uptake of vaccines increased remarkable with a notably substantial increase in measles vaccine uptake post intervention (0% vs 63.6%). (Table 2). Overall, the average vaccine uptake increased from 44% at baseline to 86% post-intervention ($t = -29.31$; $df = 399$; $p < 0.001$).

Table 2: Immunization uptake Pre and Post- intervention

Vaccine type	Pre-intervention uptake (%)	Post-intervention uptake (%)	McNemar Chi 2 (df)	p-value
BCG	75.80	87.72	40(1)	<0.001
OPV0	75.80	89.80	48(1)	<0.001
OPV1	62.20	91.25	109(1)	<0.001
Penta1	62.20	91.55	110(1)	<0.001
OPV2	34.85	87.46	189.08(1)	<0.001
Penta2	34.85	87.46	189.08 (1)	<0.001
OPV3	13.93	85.13	249.06(1)	<0.001
Penta3	13.93	85.13	249.06 (1)	<0.001
Measles vaccine	0	63.57	178(1)	<0.001

Vaccination Status Post Intervention and Associated Factors

At enrolment, none of the selected children was fully vaccinated. However, post-intervention, more than half (55.4%) were fully vaccinated (Figure 3). Comparing the two states, the proportion of children fully vaccinated was higher in Gombe (69%) than in Niger (44%) ($\chi^2 = 20.166$, $p < 0.001$). (Table 3). At the LGA level, Kaltungo (74%) and Kwami (63%), both in Gombe State, had the highest proportions of fully immunized children, with the lowest rate observed for Bida (37%) in Niger state ($\chi^2 = 26.5422$, $p < 0.001$).

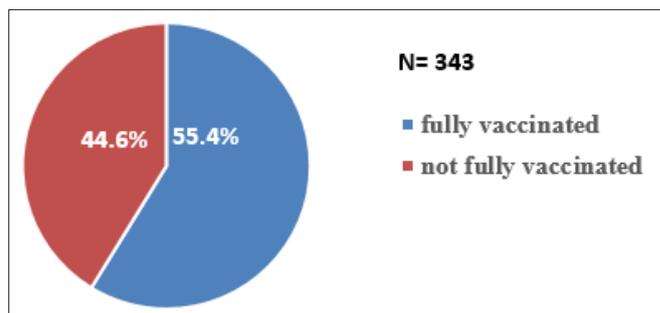


Figure 3: Vaccination Status Post-Intervention

Educational status, religion, occupation, marital status, daily household income, and availability of immunization card were variables significantly associated with vaccination status. The proportion of caregivers whose children were fully immunized appeared to consistently decrease with increasing age across the age groups (< 20 years – 83%, 20-29 years – 58%, 30-39 years – 47%) except until 40 years and above (60%). Neither number of home visits nor impact sessions was significantly associated with full immunization at the bivariate analysis level.

Table 3: Sociodemographic characteristics of caregivers by vaccination status post-intervention

Variable	Fully vaccinated (N = 190) Freq (%)	Not fully vaccinated (N = 153) Freq (%)	P-value
State			
Gombe	107 (68.59)	49 (31.41)	<0.001
Niger	83 (44.49)	104 (55.61)	
Total	190 (55.39)	153 (44.61)	
LGA			
Bida	34 (36.96)	58 (63.04)	<0.001
Kaltungo	55 (74.32)	19 (25.68)	
Kwami	52 (63.41)	30 (36.59)	
Paikoro	46 (51.58)	46 (48.42)	
Total	190 (55.39)	153 (44.61)	
Child Age Pre-Intervention			
Less than 6 months	56 (50.00)	56 (50.00)	0.125
6 - 11 months	109 (69.56)	71 (39.44)	
12 months or more	25 (49.02)	26 (50.98)	
Total	190 (55.39)	153 (44.61)	
Education			
No Education	39 (54.93)	32 (45.07)	0.014
Primary	40 (66.67)	20 (33.33)	
Quranic	33(43.42)	43 (56.58)	
Secondary	71 (61.21)	45 (38.79)	
Tertiary	7 (35.00)	13 (65.00)	
Total	190 (55.39)	153 (44.61)	
Religion			
Christianity	40(75.47)	13(24.53)	<0.001
Islam	149 (53.02)	132 (46.98)	
Traditional	1 (11.11)	8 (88.89)	
Total	190 (55.39)	153 (44.61)	
Occupation			
Housewife	153 (62.2)	9 (37.80)	<0.001
Trader	25 (36.23)	44 (63.77)	
Farmer	6 (54.55)	5 (45.45)	
Others	6 (35.29)	11 (64.71)	
Total	190 (55.39)	153 (44.61)	
Caregiver Marital Status			
Married	184 (54.60)	153 (45.40)	0.035* ¹

Single	6 (100)	0 (0)	
Total	190 (55.39)	153 (44.61)	
Caregiver Age			
less than 20 years	10 (83.33)	2 (16.67)	0.055 ²
20-29 years	118 (57.56)	87 (42.44)	
30-39 years	47 (46.53)	54 (53.47)	
40 years and above	15 (60.00)	10 (40.00)	
Total	190 (55.39)	153 (44.61)	
Relationship to Child			
Father	1 (100)	0 (0)	NR ³
Mother	189 (55.59)	151 (44.28)	
Total	190 (55.59)	151 (44.41)	
Caregiver Gender			
Male	1 (100)	0 (0)	NR ⁴
Female	189 (55.59)	151 (44.28)	
Total	190 (55.59)	151 (44.41)	
Daily Household Income			
less than 500 Naira	134 (59.56)	91 (40.44)	0.039
500 to 1000 Naira	35 (43.21)	46 (56.79)	
more than 1000 Naira	21 (56.76)	16 (43.24)	
Total	190 (55.39)	153 (44.61)	
Number of Children			
1-2 children	92 (59.74)	62 (40.26)	0.232
3-4 children	59 (54.63)	49 (45.37)	
5 and Above	39 (48.15)	42 (51.85)	
Total	190 (55.39)	153 (44.61)	
Child Gender			
Male	95 (57.58)	70 (42.42)	0.434
Female	95 (53.37)	83 (46.63)	
Total	190 (55.39)	153 (44.61)	

¹ Fisher’s exact p-value

² Likelihood ratio chi-square test

³ Not reportable due to cell size problem

⁴ Not reportable due to cell size problem

Multivariate Analysis of Determinants of Full Vaccination

Before entering variables meeting the p-value threshold of 0.25 into binary logistic models, we assessed multi-collinearity between candidate variables using Spearman Rho. Age-group of caregiver was highly correlated with number of children while state was strongly correlated with LGA. We considered two models, both having LGAs (and dropped state as LGA more precisely specifies the geographical distribution of the respondents) and each having either age group or number of children. The model of best fit (AIC = 437.01 versus 440.75) is presented in Table 4. In this model, LGA and caregiver’s occupation were significant factors associated with full vaccination. For LGA, children in Kaltungo (Adjusted odds ratio [AOR]=3.03, p=0.013) and Kwami (AOR=4.95, p<0.001) were more than three times likely to be fully vaccinated compared to others. By occupation, children of caregivers that were traders (AOR=0.35, p=0.002) or

had other occupations (AOR=0.14, p=0.001) were less likely to be fully vaccinated compared to children of housewives. Finally, by caregiver's age: children of older caregivers (30-39 years) are about 40% less likely to be fully vaccinated than children of caregivers aged less than 29 years (AOR=0.57, p=0.05). (Table 5).

Table 4: Association between health-seeking characteristics and vaccination status post-intervention

Variable	Fully vaccinated. Freq (%)	Not fully vaccinated. Freq (%)	P-value
ANC attendance			
Yes	176 (55.52)	141 (44.48)	0.867
No	14 (53.85)	12 (46.15)	
Total	190 (55.39)	153 (44.61)	
Immunization card available			
Yes	172 (57.91)	125 (42.09)	0.017
No	18 (39.13)	28 (60.87)	
Total	190 (55.39)	153 (44.61)	
PLA Session Attendance			
Mean(sd) = 7.53(1.01); Median (8)			
6 - 8 sessions	166 (54.43)	139 (45.57)	0.307
5 or less sessions	24 (63.16)	14 (36.84)	
Total	190 (55.39)	153 (44.61)	
Total Home Visit			
Mean = 5.34; SD = 1.51			
6 - 8 visits	91 (59.87)	61 (40.13)	0.137
5 or less visits	99 (51.83)	92 (48.17)	
Total	190 (55.39)	153 (44.61)	

Table 5 : Logistic regression model with adjusted odds ratios for full immunization among children of CNFIC

Independent Variables	Odds Ratio	p-value	95% Confidence Interval	
			Lower	Upper
LGA				
Bida (REF)	1			
Kaltungo	3.033	0.013	1.265	7.269
Kwami	4.954	0.000	2.060	11.909
Paikoro	1.148	0.736	0.515	2.559
Occupation				
Housewives (REF)	1			
Farmer	0.429	0.230	0.107	1.710
Others	0.136	0.001	0.041	0.448
Trader	0.354	0.002	0.186	0.674
Religion				
Islam (REF)	1			
Christianity	2.003	0.122	0.830	4.837
Traditional	0.197	0.148	0.022	1.780
Education				
No Education (REF)	1			
Quranic	1.884	0.160	0.778	4.564
Primary	0.692	0.367	0.311	1.541

Secondary	1.717	0.182	0.776	3.797
Tertiary	0.684	0.570	0.185	2.536
Immunization Card				
No (REF)	1			
Yes	1.478	0.283	0.724	3.017
Daily Household Income				
Less than 500 Naira (REF)	1			
500 to 1000 Naira	0.552	0.076	0.286	1.065
more than 1000 Naira	0.862	0.743	0.354	2.097
Age of Caregiver				
less than 29 years (REF)	1			
30 to 39 years	0.571	0.050	0.326	1.000
40 years and above	1.438	0.485	0.519	3.984
Child Age Pre-Intervention				
Less than 6 months (REF)	1			
6 - 11 months	1.374	0.262	0.788	2.395
12 months or more	1.123	0.774	0.509	2.480
Total Home Visit	1.177	0.137	0.950	1.459

Discussion

This paper describes the innovative adaptation of the PD approach to improve immunization uptake, assessed how much vaccination uptake improved post- intervention, and identified predictors of full vaccination among non- or under-vaccinated children in settings of low vaccination uptake. We found a high average attendance of 7.5 impact session (out of an expected eight sessions) which showed a high degree of exposure to the community level discussions. Although, on the average, exposure to home visits were moderate with only about 5 out of the expected 10 visits received by CNFIC, every CNFIC had at least one visit. Some plausible reasons for the reduced uptake of home visits include poor socioeconomic status of the families making them transient during different times of the day or the mentor not keeping appointments with planned visits.

The study found that average vaccination uptake almost doubled (95% increase) following the intervention. One key success to this intervention is while PD has been proven to be effective, CNFIC were able to gain knowledge and be empowered through the peer-to-peer mentorship, fostering unity and trust among themselves. Also, the use of PLA tools – the flipchart and Picture book which portray pictures and storytelling of two main characters and their journey to completing vaccination against all odds were drivers to increased vaccination uptake. A study in Egypt found that providing birth spacing messages to low parity women during antenatal and postpartum care and to husbands through community activities was feasible and acceptable and led to an increase in the use of contraception at 10-11 months postpartum [23]. A study in Bangladesh using a fictional story on improving post-partum family planning (PPFP) uptake offers a promising approach for motivating shifts as respondents cited the story as an important

contributor to shifts in their PPF knowledge, perceptions, and practices. The story seemed to resonate on a personal level with many respondents who indicated that they or their family members/peers had similar experiences. [24]. When the audience feels they connect with characters in a story, they may be less likely to discount its messages [25].

Also, we found that a moderately high proportion of children were fully immunized following the intervention. This was particularly remarkable in Gombe State, especially in Kaltungo LGA where majority of the children in the LGA were fully vaccinated. However, the picture was less promising in Niger State with much lower rates compared to Gombe LGAs. The lower rates in Niger State may be partly explained by increasing insecurity which may impede access to RI centres and travels for health services. However, the completion rates in Paikoro (52%) was much higher than was observed in a recent study in another LGA in Niger state where full vaccination rate of 36% was reported [26]. The PD project results supports prior study findings that that an "enlightenment campaign" is needed for immunization. This supports the importance of the LEOPOD intervention which encompasses knowledge and experience-sharing during the impact sessions. Finally, the study revealed the importance of occupation as a predictor of full child immunization. Similar to other findings [27,28]. Homemakers are more likely to fully vaccinate their children compared to employed caregivers. One reason often given for failing to complete a child's vaccination is that caregivers are busy [27]. This may suggest that the homemakers have more time to visit or spend at the health facilities to receive vaccinations for their children than the latter. Although religion, education, marital status, and household income have been shown in other studies as significant predictors of immunization uptake [27,29, 30]. These effects were only significant at the bivariate level of analysis in our study.

Implications for Public Health Practice

Although singular strategies, including home visits and community-based education to increase vaccination uptake have been previously deployed, a systematic review showed very low uncertainly levels with the outcomes [31]. This study integrated and tested an innovative PD approach to complement previous methods, anchored on the deployment of a communication tool (developed from formative research among positive deviants) relevant to unique intervention settings. The implementation of the positive deviance approach intervention, results and findings obtained from this study suggest the potential for increasing demand for vaccination while we scale up to other parts of Nigeria. This would also further provide guidance on where vaccination system strengthening interventions should focus on to improve immunization coverage amongst the most vulnerable children in Nigeria. Findings from this study would benefit both program managers and policymakers who make decisions on national and sub-national immunization programs.

Limitations of the Study

The study experienced some limitations

- The global COVID-19 pandemic in 2020 led to a 6-months stall on the project implementation due to the lock-down. This was further complicated by some staff testing positive for COVID-19.
- The two LGAs in Niger state were affected by military insurgencies resulting in deserted communities, curfews, restricted movements and in some instance, no movement at all. This could have affected the immunization uptake.

- There were no uniform guidelines on how-to catch-up vaccine schedule and as such previously missed vaccines were administered at the discretion of the Healthcare workers. This may have contributed to some children not completing their vaccinations during the intervention.

Conclusions

The LEOPOD Project was successful in piloting this intervention in the communities of Niger and Gombe states despite arising security challenges. This study portrays the importance of peer-to-peer mentorship and how it improves vaccination uptake through community sessions and home visits. PLA materials including fictional story and pictures delivered by peer mentors through community sessions and home visits can cause a shift in behaviour change as caregivers tend to resonate with the characters portrayed, shift norms through continuous engagement with community leaders and empower caregivers with the information needed. The study has produced evidence that adopting PD approach in immunization can help improve demand and uptake which can be simple and cost effective, hence significant impact on coverage. Therefore, we advocate for the PD approach for improving immunization uptake to be further scaled-up and tested in other settings, especially in northern states of Nigeria, where vaccination uptake is markedly suboptimal. In addition, future studies should test strategies for more effective implementation taking into consideration variations in caregiver's sociodemographic characteristics and accessibility of location since uptake of immunization may depend on demographics of caregivers (e.g. geopolitical location with insecurity challenges, as seen in Niger, age, and occupation).

Role of the Funding Source

The study sponsors had no role in the study design, data collection, analysis, interpretation, or dissemination, or in the decision to submit this paper for publication. The corresponding author had full access to all the data in the study and had the final responsibility for the decision to submit for publication.

Conflict of Interest Statement

The authors declare they have no competing interests.

Acknowledgments

Funding for this study was made possible through support provided by Bill and Melinda Gates Foundation (BMGF) leveraging from The Grand Challenges Explorations (GCE) Team/initiative platform for rare opportunities under the terms of Award No INV-009076/ OPP1212287. The contents are the responsibility of the authors and do not necessarily reflect the views of the Bill and Melinda Gates Foundation. The authors thank the study participants, field staff, and the Ministries of Health, States Immunization program, Government of Niger and Gombe States as well as the study participants for their support and collaboration in all phases of the study.

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