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# Association of Volunteer Communication Mobilizers' Polio-Related Knowledge and Job-Related Characteristics With Health Message Delivery Performance in Kano District of Nigeria

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Volunteer communication mobilizers (VCMs) were deployed in Nigeria to increase community awareness for polio vaccination. To understand whether VCMs' knowledge and job-related characteristics were associated with performance, we conducted a cross-sectional survey in the Nassarawa and Ungogo Local Governance Areas (LGAs). We asked VCMs about the consequences of polio, preventive strategies, and health communication messages to assess knowledge. We considered VCMs' performance satisfactory if they delivered more messages during their last visit, and knew the number of <5 children and neonates in their settlement. We used *t*-tests to compare continuous and chi-square tests for categorical variables, and ran linear and ordinal logistic regression to understand if knowledge and job-related characteristics were associated with performance. Of the VCMs, 69% (118/170) were enrolled from Ungogo. We found that 63% of VCMs in Nassarawa had appropriate levels of knowledge about health education messages, compared to 26.3% in Ungogo ( $p < .001$ ). We also found that 32.7% of VCMs in Nassarawa and 15.3% of VCMs in Ungogo mentioned that polio vaccination protects children from paralysis ( $p = .040$ ). Among VCMs, 75% in Nassarawa and 31% in Ungogo knew the total number of <5 children in their catchment area of work ( $p = .001$ ). We identified that for every 10 additional months of experience, VCMs delivered 1.3 more messages during household visits (95% confidence interval, 0.56–1.9,  $p = .001$ ). VCMs who knew that polio cause paralysis delivered 0.5 more health messages than VCMs who did not have that knowledge (95% confidence interval, 0.08–2.3,  $p = .018$ ). Our results demonstrated VCMs' polio-related knowledge was associated with health message delivery performance.

## Background

Despite extensive efforts since 1988, polio has not yet been eradicated. In 2012, polio cases occurred in three countries, namely Nigeria, Pakistan, and Afghanistan (Abimbola, Malik, & Mansoor, 2013). More than 50% of these 2012 cases were identified in Nigeria (Etsano et al., 2014). These areas had low vaccination coverage, chronically missed children, a high-number of non-compliant families, and very little community awareness (Kaufmann & Feldbaum, 2009) due to armed conflicts (Aylward & Tangermann, 2011) and religious propaganda (Jegade, 2007; Yahya, 2007). The local communities had not been involved in earlier polio eradication campaigns (Obregón & Waisbord, 2010). To address these problems, after 2012, a number of initiatives were undertaken in Nigeria by the polio eradication partners. One

such initiative was the establishment of a volunteer communication mobilizer (VCM) network to increase the coverage of polio vaccination. Three years after the introduction of these initiatives, the World Health Organization (WHO) declared Nigeria a polio non-endemic country on September 25, 2015 (Cooper, 2000).

The VCM network aimed to reduce the number of missed children through house-to-house visits particularly among non-compliant families in the resistant areas (Hossain, Reza, Rahman, & Kayes, 2012). Initially 613 VCMs were selected from their immediate communities and deployed in the Kano, Kebbi, and Sokoto states to identify, characterize, and enlist chronically missed children using community friendly approaches (Matthews, Woodall, & Allen, 1993). Each VCM was involved for mobilizing 200 to 250 families for health education on polio and routine immunization, maternal and child health, malaria, and personal hygiene. After their involvement, the number of polio cases, the proportion of missed children, and the proportion of non-compliance families came down in some Local Government Areas (LGAs) (Matthews et al., 1993). In subsequent years, a number of new VCMs were added to the already-recruited pool in the low-coverage areas.

The success of any community health awareness interventions including polio eradication programs largely depends on

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health workers having appropriate knowledge and skills, and on their quality delivery of health messages (Obregón et al., 2009). Although involving the VCMs was one of the significant interventions for polio eradication in Nigeria, limited data are available on VCM performance. While different experts made recommendations to improve VCM performance, their knowledge on polio, job-related characteristics, workload, and performances were never evaluated. To fill this gap, we conducted a study to (1) assess and compare the knowledge, job-related characteristics, and performance of VCMs in two LGAs of Kano state: Nassarawa and Ungogo, and (2) assess whether VCMs' knowledge and job-related characteristics were associated with performance.

## Methods

### Study Sites

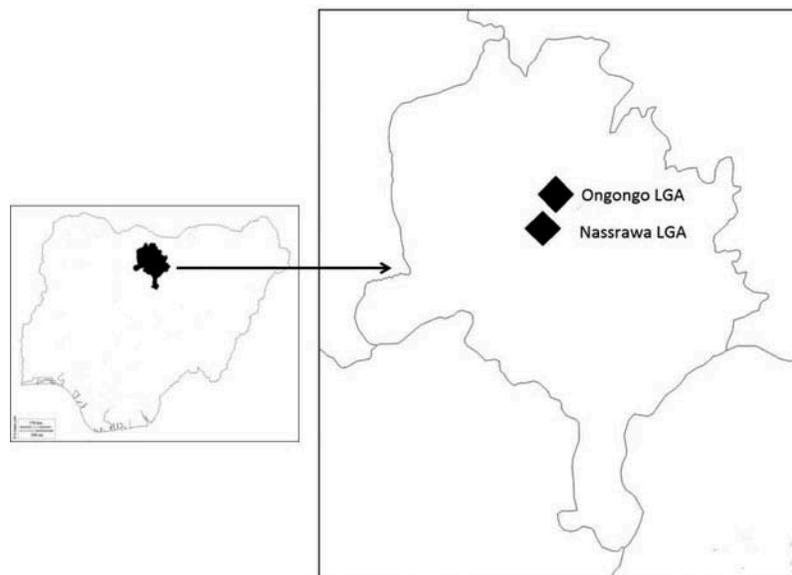
We conducted the study in Nassarawa and Ungogo LGAs of the Kano state of Nigeria (Figure 1). Kano is one of the 11 states in northern Nigeria where religious propaganda to boycott oral polio vaccination occurred (Gammino et al., 2014; Renne, 2010) and UNICEF has its field office in Kano State. As per the 2006 census, Ungogo has an area of 204 km<sup>2</sup> and a population of 0.4 million, whereas Nassarawa has an area of 34 km<sup>2</sup> and a population of 0.6 million. The United Nation's Children's Emergency Fund (UNICEF) has a field office in Kano State and deployed the highest number of VCMs in these two LGAs (206 in Ungogo, and 88 in Nassarawa) in 16 wards, considering the poor coverage of polio immunization and low compliance. VCMs in both LGAs received a similar type of training and supplies. These two LGAs were also selected to generate evidence for future planning to enhance the performance of VCMs.

### Study Design and Sampling Methods

We conducted a cross-sectional survey during June through October 2014, using a structured questionnaire among 170 VCMs in both LGAs. Since the number of VCMs in Ungogo is more than twice than in Nassarawa, we interviewed 118 VCMs from Ungogo and 52 from Nassarawa. There are seven wards in Ungogo containing almost an equal number of VCMs. Therefore, we randomly selected either 16 or 17 VCMs from each ward in Ungogo. There are nine wards in Nassarawa with an unequal number of VCMs (range 1–15). We used a proportional sampling method and randomly selected total 52 VCMs from nine wards. Informed written consent was taken prior to interviewing the VCMs. The questionnaire was pre-tested and discussed among the lead investigator and one research assistant for better understanding of each question, codes, and expected responses from the VCMs. Both the lead investigator and one research assistant interviewed the VCMs in the primary care health facilities of the wards in both LGAs. These were the health facilities under which VCMs were recruited.

### Knowledge Assessment

We asked VCMs three separate questions focusing on the consequences of polio infection, prevention strategies, and what messages they had delivered in their last household visits. We instructed them to give their single most important answer for each of the three questions. We considered VCMs knowledge sufficient if they responded that polio causes paralysis, that it can be prevented by vaccination, and that all under 5 children need to be vaccinated regardless of age and sex, and whether they were ill or asleep when vaccinations were offered, or that polio vaccination can protect your child from paralysis (see Appendix Table A1).



**Figure 1.** Study sites showing Ungogo and Nassarawa LGAs in Kano State in northern Nigeria. LGA = local government area.

### Performance Measurement

We collected secondary data on LGA-level vaccination coverage and measured individual-level performance of the VCMs. We collected secondary data from the WHO Kano Office on the clustered lot quality assurance sampling (LQAS) for Nassarawa and Ungogo LGA between January and April, 2014. We collected the four months' preceding LQAS data because both LGAs were part of supplementary immunization activities during these rounds before study the was conducted. LQAS is an operational tool to assess the coverage in each LGA local-level office (Global Polio Eradication Initiative, 2012), where 60 children (one child per household) are randomly selected in six clusters (10 children from each cluster) and the number that remain unvaccinated is assessed (Appendix Figure A1). Coverage is considered in the higher band (>90%) if 0–3 unvaccinated children are identified, in medium band (80–90%) if 4–8 unvaccinated children are identified, and in lower band if  $\geq 9$  unvaccinated children are identified.

As a proxy for individual-level performance, we constructed a scale by adding three variables: number of health messages delivered by VCMs during last household visit (continuous variable, range 0–6), whether VCMs were able to report the number of under 5 children in their settlements (binary variable, “0” if they did not report and “1” if they reported), and whether VCMs reported the number of newborns in their settlements (binary variable, “0” if they did not report and “1” if they report) (see Appendix Table A2). VCMs were trained to provide a range of important health promotional messages using flipcharts during their household or community visits, including information on polio and other routine vaccination, exclusive breast feeding and complementary feeding, antenatal care and danger signs for pregnancy, hand washing, and diarrhea management. We associated better performance of the VCMs with their delivery of a high number of key messages in their last household visit because it has been demonstrated that families pay more attention to polio vaccination when VCMs also talk about other key household practices including breast feeding, malaria prevention, hygiene, and sanitation (Matthews et al., 1993). We considered the performance of the VCMs who could report the number of under 5 children and newborns in their settlement would be better, as knowing the number of under 5 children and newborns indicated that VCMs both were well-informed and that they had indeed scheduled a high number of household visits.

### Data Analysis

We calculated the proportions of the categorical variables and used a chi-square test to compare the difference of such variables among two LGAs. We reported the frequencies, means, and standard deviations for the continuous variables, and used a *t*-test to compare the means across two LGAs. We conducted univariate linear regression to assess whether the number of health messages delivered by VCMs was separately associated

with a number of demographic, job related and knowledge variables. The list of all these variables are given in Appendix Table A3. We then modeled a multivariate regression keeping the statistically significant predictors ( $p < .05$ ) in univariate analyses and their pair-wise interaction terms. We used a backward elimination method and considered confounding assessment to identify the best model. We measured the same univariate and multivariate analysis considering performance score as outcome variable using ordinal logistic regression.

## Results

### Sociodemographic Characteristics (Table 1)

All of the VCMs were female. Of the 170 VCMs, 31% (52/170) were from Nassarawa, and 69% (118/170) were from Ungogo LGA. Of the total VCMs, 85% were married and 14% were either separated or widowed (Table 1). The proportion of married VCMs were higher in Ungogo LGA compared with Nassarawa (90% vs. 73%,  $p = .412$ ). Of the VCMs, 26% had no institutional education, 9.4% could only read and write, 27% had primary-level education, 27% had secondary-level education, and the remaining 11% had diploma-level education. Of the VCMs, 98% were homemakers. The mean number of children in VCM's household was 4.9 and the mean number of earning members in their household was 2.9. There were no statistical difference in marital and educational status, and mean number of children and earning members in households of the VCMs in two LGAs.

### Knowledge About Polio

When we asked the VCMs what they meant by polio, 21.2% of those in Nassarawa reported that polio causes paralysis, whereas 55.1% of the VCMs in Ungogo reported that polio causes paralysis ( $p = .007$ ). Ninety eight percent of VCMs in Nassarawa believed vaccination prevents polio compared to 77% in Ungogo ( $p = .319$ ) (Table 2). Sixty three percent of VCMs in Nassarawa had appropriate levels of knowledge about health education message compare to 26.3% in Ungogo ( $p < .001$ ) (Table 2). Regarding knowledge of polio specific key messages during household visits, 30.8% of VCMs in Nassarawa and 11.0% of VCMs in Ungogo reported all <5 children need to be at home during polio campaigns and to be vaccinated, regardless of age, sex, illness, and sleep status during campaigns ( $p = .004$ ). In addition, 32.7% of VCMs in Nassarawa and 15.3% of VCMs in Ungogo district mentioned that polio vaccination protect children from paralysis ( $p = .040$ ) (Table 2).

### Performance of VCMs

Secondary LQAS data revealed more than 90% polio coverage in Nassarawa LGA in each successive month between January and April, 2014. Nevertheless, in Ungogo, polio coverage was greater than 90% in January, 2014 but 80–90% in between February and April 2014 (Table 2). The mean number of messages delivered by VCMs during household visits preceding interview was 2.3 in Nassarawa compared to 2.4 in Ungogo ( $p = .284$ ). Of the VCMs, 75% in Nassarawa and 31% in

**Table 1.** Demographic and Socioeconomic Characteristics of the VCMs in Nassrawa and Ungogo LGAs of Kano State, Nigeria

Participants' demographic and socioeconomic characteristics	LGA		
	Nassrawa ( <i>N</i> = 52), <i>n</i> (%)	Ungogo ( <i>N</i> = 118), <i>n</i> (%)	All ( <i>N</i> = 170)
Marital status			
Married	38 (73.1)	106 (89.8)	144 (84.7)
Separated or widowed	14 (26.9)	11 (9.3)	25 (14.7)
Single	—	1 (0.9)	1 (0.6)
Level of education			
Diploma	6 (11.5)	13 (11.0)	19 (11.2)
Secondary	21 (40.4)	24 (20.3)	45 (26.5)
Primary	6 (11.5)	40 (33.9)	46 (27.1)
Can read and write only	1 (1.9)	15 (12.7)	16 (9.4)
No institutional education	18 (34.6)	26 (22.0)	44 (25.88)
Proportion of participants who were housewives, <i>n</i> (%)	51 (98)	116 (98)	167 (98)
Number of children in the household, <i>M</i> ( <i>SD</i> )	5.3 (2.7)	4.7 (3.2)	4.9 (3.1)
Number of people earning in the household, <i>M</i> ( <i>SD</i> )	2.6 (2.3)	3.0 (2.7)	2.9 (2.6)

Note. LGA = local government area.

**Table 2.** Polio Coverage From LQAS in Nassarawa and Ungogo LGA During January–April, 2014

	Nassarawa			Ungogo		
	Number of unvaccinated children in LQAs ( <i>N</i> = 60)	Coverage	Interpretation	Number of unvaccinated children in LQAs ( <i>N</i> = 60)	Coverage	Interpretation
January, 2014	2	>90%	Pass (Maintain current coverage)	3	>90%	Pass (Maintain current coverage)
February, 2014	0	>90%	Pass (Maintain current coverage)	5	80–90%	Warning (In-process monitoring)
March, 2014	1	>90%	Pass (Maintain current coverage)	5	80–90%	Warning (In-process monitoring)
April, 2014	0	>90%	Pass (Maintain current coverage)	5	80–90%	Warning (In-process monitoring)

Ungogo knew the total number of < 5 children in their catchment area of work ( $p = .001$ ) (Table 3). Ninety four percent of the VCMs in Nassrawa knew the number of newborns in their catchment area of work in the preceding week of interview compared to 76% in Ungogo ( $p = .385$ ).

**Job-Related Characteristics**

The mean job experience of the VCMs in Nassaraw was 11.8 months compared to 9.2 months in Ungogo (Table 4). The proportion of VCMs who changed their job station was higher in Ungogo LGA compared to Nassrawa (16.1% vs. 11.5%,  $p < .001$ ) (Table 4). All VCMs reported having received job-related trainings, and possessed and used a registration book for enrolling children. All VCMs in Nassrawa LGA had flip charts, but only 92% of the VCMs in Ungogo had flip charts. The polio eradication program provided hizab for the VCM;

however, only 15% of VCMs in Nassrawa LGA and 12.7% in Ungogo LGA used the hizab during their work. They worked a mean of 3.9 days per week and for a mean of 3.5 hours per day, with seventy percent working a morning shift. There were no statistical differences between the LGAs in the working days per week, working hours per day and proportion of VCMs working the morning shift. The mean < 5 children in the settlement of each VCM was 405 in Nassrawa and 250 in Ungogo ( $p < .001$ ) (Table 4). The mean number of newborns in the week preceding the interview date was 3.7 in Nassrawa and 2.7 in Ungogo ( $p = .018$ ) (Table 4). Each VCM spent a mean 13 minutes during each household visit in Nassrawa LGA and 20 minutes in Ungogo ( $p < .001$ ). Nevertheless, during their visit preceding the interview date, VCMs provided a mean of 2.4 ( $SD = 1.4$ ) messages from all those available to them. Only 14% VCMs had provided more than three messages during their last visit.

**Table 3.** Performance of VCMs in Terms of Health in Nassrawa and Ungogo LGAs of Kano State, Nigeria

Characteristics	LGA		
	Nassrawa ( <i>N</i> = 52)	Ungogo ( <i>N</i> = 118)	All ( <i>N</i> = 170)
Number of health message delivered, mean ( <i>SD</i> )	2.31 (1.19)	2.42 (1.44)	2.39 (1.36)
Proportion who knew the number of <5 children	75% (39/52)	31% (36/118)	44% (75/170)
Proportion who knew the number of newborn	94% (49/52)	76% (90/118)	82% (139/170)

**Table 4.** Job-Related Characteristics of the VCMs in Nassrawa and Ungogo LGAs of Kano State, Nigeria

Participants' job-related characteristics	LGA		
	Nassrawa ( <i>n</i> = 52)	Ungogo ( <i>n</i> = 118)	All ( <i>N</i> = 170)
Job experience as VCM (in months), <i>M</i> ( <i>SD</i> )	11.8 (9.4)	9.2 (5.1)	10 (6.9)
Job station ever changed, <i>n</i> (%)	6 (11.5)	19 (16.1)	25 (14.7)
Job-related training received, <i>n</i> (%)	52 (100)	118 (100)	170 (100)
Owned register book for the children, <i>n</i> (%)	52 (100)	118 (100)	170 (100)
Used the register book, <i>n</i> (%)	52 (100)	118 (100)	170 (100)
Had flip chart, <i>n</i> (%)	52 (100)	108 (92)	160 (94)
Used the flip chart, <i>n</i> (%)	52 (100)	108 (100)	160 (100)
Had hizab, <i>n</i> (%)	8 (15)	15 (12.7)	23 (14)
Worked days per week, <i>M</i> ( <i>SD</i> )	3.9 (1.2)	3.9 (0.83)	3.9 (0.95)
Worked hours per day, <i>M</i> ( <i>SD</i> )	3.6 (0.95)	3.4 (1.3)	3.5 (1.2)
Proportion of participants worked in morning shift	36 (69.2)	83 (70.3)	119 (70)
Average <5 children served by per VCM, <i>M</i> ( <i>SD</i> )	405 (181)	250 (119)	331 (173)
Average newborns served per VCM, <i>M</i> ( <i>SD</i> )	3.7 (2.3)	2.7 (2.6)	3.1 (2.5)
Time spent in a household visit (in minutes), <i>M</i> ( <i>SD</i> )	13 (6.5)	19.9 (13.5)	17.9 (12.2)

Note. There were only 160 participants (52 for Nasrawa and 108 in Ungogo) who had flip charts. All of them used the flip charts.

#### **Association of VCMs Performance With Job-Related Characteristics and Knowledge on Polio**

Univariate linear regression demonstrated that participants who worked during morning hours significantly delivered less key messages during their household or community visits (Table 5). Experience of work in months, and VCMs knowledge that polio can cause paralysis were also statistically associated with delivering more key messages during their household or community visits (Table 5). In multivariate analysis, VCMs' experience and knowledge that polio causes paralysis remained statistically significant, but we identified a modification effect of VCMs' experience among those who worked in the afternoon (Appendix Figure A2). We identified that for every 10 months more experience, VCMs delivered 1.3 more messages during household visits (95% confidence interval, 0.56–1.9,  $p = .001$ ), when adjusted for the effect of knowledge and the work shift. VCMs who knew that polio cause paralysis delivered 0.5 more health messages than VCMs who didn't have that knowledge (95% confidence interval, 0.08–2.3,  $p = .018$ ). Ordinal logistic regression of the performance score demonstrated that performance is associated with experience, knowledge

that vaccination prevents polio, and the effect modification of work experience gained in the afternoon (Appendix Table A4).

#### **Discussion**

Our analysis identified a low level of knowledge about the consequences of the polio virus among the VCMs of both LGAs, despite having polio training. Three out of four VCMs in Nassarawa and half of the VCMs in Ungogo did not report that polio causes paralysis. This demonstrates that VCMs were not aware of the irreversible and incurable crippling sequelae of polio. The health belief model suggests that preventive measures are adopted when the negative health outcome is perceived as serious (Janz & Becker, 1984). With this in mind, such lack of knowledge among the frontline workers may be seen to present challenges for community-level demand and attitudes about vaccination. Nevertheless, a high proportion of VCMs from Nassarawa had accurate preventive knowledge for polio. Almost all VCMs in Nassarawa and three-fourth VCMs in Ungogo reported that polio can be prevented by vaccination. Moreover, a higher proportion of VCMs from Nassarawa reported delivering accurate health

**Table 5.** Characteristics Associated With Number of Key Messages Delivered by the VCMs in Last Household

Characteristics of the VCMs	Univariate analysis (crude analysis)		Multiple regression analysis	
	Regression coefficients (95% CI)	<i>p</i>	Regression coefficients (95% CI)	<i>p</i>
Education	0.101 (-.058, 0.259)	.212	—	—
Marital status	0.015 (-.584, 0.613)	.961	—	—
Work station ever changed	0.279 (-.317, 0.876)	.357	—	—
Working hour in morning	-0.775 (-1.219, -0.330)	.001*	0.163 (-0.811, 0.844)	.969
Experience (in months)	0.040 (0.009, 0.069)	.009*	0.127 (0.056, 0.199)	.001*
Knowledge that polio causes paralysis	0.567 (0.145, 0.989)	.009*	0.418 (0.084, 0.880)	.018*
Knowledge that polio is preventable by vaccination	0.233 (-0.345, 0.811)	.427	—	—
Knowledge that polio vaccination can prevent paralysis	0.159 (-0.381, 0.699)	0.56	—	—
Knowledge that all children under 5, regardless of age, sex, illness, and sleep status need to be vaccinated (yes, no)	0.394 (-0.191, 0.980)	0.186	—	—
Interaction between: Experience and working in morning	—	—	-0.095 (-0.173, -0.017)	0.017*

Note. VCM = volunteer communication mobilizers.

\* $p \leq .05$ .

messages during household visits, such as all under 5 children, regardless of age, sex, illness, and sleep status need to be vaccinated, and that the polio vaccination can protect the child from paralysis. These health messages help mothers and caregivers recognize the value of the vaccines, and coverage is likely to be higher when caregivers know its purpose (Harmancı, Gürbüz, Torun, Tümerdem, & Ertürk, 2003).

We also identified that a higher proportion of VCMs in Nassarawa knew the actual number of under 5 children and newborns in the settlement, suggesting that they were better informed about their responsibilities in their settlements. VCMs' polio prevention and appropriate health education messages were also consistent with the higher vaccination coverage in Nassarawa than Ungogo, as reflected in the LQAS data. In the four months between January and April 2014, Nassarawa had greater than 90% vaccination coverage compared to 80–90% coverage in Ungogo between February and April 2014. This suggests a performance gap in the communication campaign in Ungogo, requiring in-process monitoring. The knowledge gap of the VCMs in Ungogo may underlie the lower vaccination coverage in that LGA.

A low level of knowledge is one of the important determinants of low performance of community health volunteers (Brugha & Zwi, 1998). Our findings indicate that authorities in Ungogo need to focus on increasing the knowledge of existing VCMs. One of the important means of increasing health workers' knowledge is appropriate training to disseminate the guidelines of health promotion. Although all low-performance problem cannot be solved by providing training solely, it does need to be considered as the first step of improving low performance when knowledge level is low (Rowe, de Savigny, Lanata, & Victora, 2005). Our data on prevalence of low-level knowledge, particularly in Ungogo,

suggests scope of quality trainings and retraining to boost VCM's knowledge for effective health education message during household visits. Supportive supervision may also increase the knowledge and skills of the health workers.

We identified several factors that determined the individual-level performance of VCMs. Experienced VCMs delivered more health education messages during household visits. Perhaps their motivation for work is due to several factors, including social recognition and improved interpersonal skills, that increased with their increased work experience (Gopalan, Mohanty, & Das, 2012). We identified that less-experienced VCMs delivered fewer health messages regardless of whether they worked in the morning or afternoon. Nevertheless, experienced VCMs who worked in the afternoon delivered more messages compared to experienced VCMs who worked in the morning. A number of factors from both caregivers' and VCMs' sides may have contributed to this: caregivers were likely to be busier with household chores in the morning such as preparing food and readying children for school. This may have resulted in them having less time to hear VCMs' messages. Given that most of the VCMs were homemakers with an average of five children in their households, VCMs' morning work might also have been more hurried and may have led to them delivering fewer messages. In contrast, working in the afternoon after completing their household chores may have allowed VCMs and caregivers enough time to deliver and receive more messages. We did not identify any association between the educational status of the VCMs and their performance.

Workload plays an important role in the quality and productivity of VCMs work. Although VCMs in Nassarawa had more knowledge, they had an increased workload compared to VCMs' in Ungogo. They covered 1.6 times more children

under 5, and 1.4 times more newborns in their catchment areas than the VCMs in Ungogo. To compensate for this increased workload, VCMs in Nassrawa spent considerably less time during each household visit, although their average working hours per day were more than the VCMs from Ungogo. VCMs in Nigeria do not have a regular monthly salary but they receive a nominal amount (10000 Naira [U.S. \$50] for UNICEF VCMs, and 5000 Naira [U.S. \$25] for Core Group VCMs) in each round of vaccination as an honorarium from their employee, to cover their transportation and as a token of appreciation (personal communication with Mr. Panchanan Achari, State Team Lead). Workload is a function of the number of households that needs to be covered by each VCM in the catchment area and the distance among the households (Jaskiewicz & Tulenko, 2012). If there are more households in the catchment area per VCM, there is a greater need to recruit more VCMs in the LGA.

All the VCMs received polio training and all were equipped with the necessary logistical and promotional materials such as a register books, flip charts, and hizabs for delivering health messages. All the VCMs reported using their register books and flip charts. The flipcharts were used to engage caregivers with behavior-changing dialogue, and contained message on polio vaccination as well as other key household practices such as treatment of diarrhea, prevention of malaria, breast feeding, and hand washing. Most of the population in Northern Nigeria is Muslim. Hizab, a head cover used even by the non-Muslim VCMs, is both the dress code for VCMs and functions as a form of community identification and recognition. It is mandatory for every VCM to wear hizab during health education and social mobilization session because it provides them with some sort of security and indicates that VCMs are friends of the family and community. Nevertheless, we identified that only a small proportion of the VCMs reported wearing the hizab.

Our analysis has several important limitations. First, we collected information only from two LGAs in one state, which limits the generalizability of our findings for the other 11 states of northern Nigeria where polio cases have been identified. VCMs characteristics and polio contexts in other northern states and LGAs of Nigeria may be different from our study sites. We were unable to implement a stratified study design including all representative areas from northern other states because of financial and logistic constraints. Second, we considered the number of key messages delivered during last household visit and implementation of community visits as performance variables of VCMs. A more appropriate performance measure would have been the total number of children vaccinated in each of the VCMs catchment areas. Nevertheless, the current reporting system of immunization does not capture this information. Third, we only administered a structured survey instrument to the VCMs, but some qualitative evaluations of the VCMs knowledge and performance evaluation would likely complement our findings.

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**APPENDIX**

**Table A1.** Polio Related Knowledge Assessment of the VCMs

Questions	Response	Decision
What is the consequence of polio?	It causes paralysis	If yes, knowledge sufficient, otherwise insufficient
How can polio be prevented?	By vaccination	If yes, knowledge sufficient, otherwise insufficient
What is the most important message to deliver in household visit?	All children under 5, regardless of age, sex, illness, and sleep status need to be vaccinated Polio vaccination can protect your kids from paralysis	If yes to any of these two response, knowledge sufficient, otherwise insufficient

**Table A2.** VCMs Individual-Level Performance Assessment

Questions	Response	Decision
How many health education message did VCMs provided in last household visit?	0–6, continuous response	Higher number correspond higher performance
Was able to report number of < 5 children in their settlement?	If yes “1”, no “0”	Better performance if yes “1”
Was able to report number of newborn in their settlement?	If yes “1”, no “0”	Better performance if yes “1”
Construction of performance scale By adding responses to all three above question	0–8, score	Higher score correspond higher performance

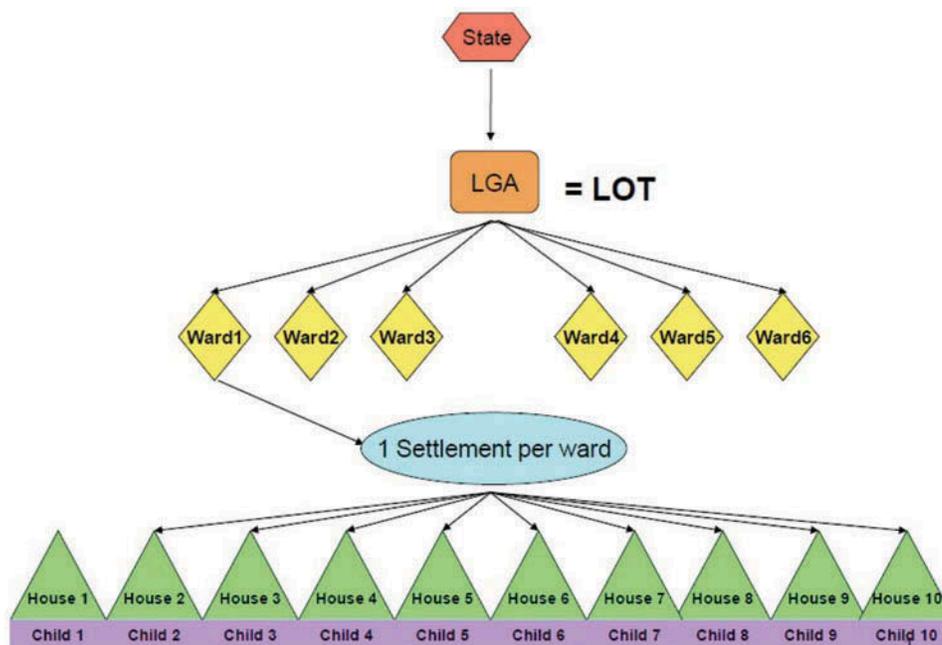
**Table A3.** Covariates Used in Model Selection for Adjusted Analyses

Category	Covariate
Job related characteristics	Experience, month Change in job station (yes, no) Work shift (morning, afternoon)
Demographic characteristics	Marital status (married, single/separated) Education (illiterate, can read or write, primary, secondary, diploma)
Knowledge variables	Reported polio cause paralysis (yes, no) Reported polio is preventable by vaccination (yes, no) Reported polio vaccination can prevent paralysis Reported all children under 5, regardless of age, sex, illness, and sleep status need to be vaccinated (yes, no)

**Table A4.** Association Between Performance Score and Job Related, Demographic Characteristics and Knowledge of VCMs

Characteristics of the VCMs	Univariate analysis (crude analysis)		Multivariate regression analysis	
	Regression coefficients (95% confidence interval)	<i>p</i>	Regression coefficients (95% confidence interval)	<i>p</i>
Education	0.172 (-.033, .377)	.100	-	-
Marital status	-0.359 (-1.095, 0.377)	.339	-	-
Work station ever changed	0.068 (-0.706, 0.843)	.863	-	-
Working hour in morning	-1.480 (-2.119, -0.840)	.000*	-0.353 (-1.688, 0.982)	.604
Experience (in months)	0.050 (0.010, 0.090)	.014*	0.216 (0.089, 0.344)	.001*
Knowledge that polio cause paralysis	0.172 (-0.386, 0.731)	.546	-	-
Knowledge that polio is preventable by vaccination	0.870 (-0.050, 1.68)	.037*	-	-
Knowledge that polio vaccination can prevent paralysis	0.741 (0.014, 1.46)	.046*	0.810 (0.077, 1.542)	.030*
Knowledge that Reported all <5 kids regardless of age, sex, illness and sleep status need to be vaccinated (yes, no)	0.582 (-0.159, 1.324)	.124	-	-
Interaction between: experience and working in morning	-	-	-0.159 (-0.293, -0.026)	.020*

\**p* statistically significant ( $p \leq .05$ ).



**Figure A1.** Sampling strategy for lot quality assurance survey (LQAS) (Global Polio Eradication Initiative, 2012).

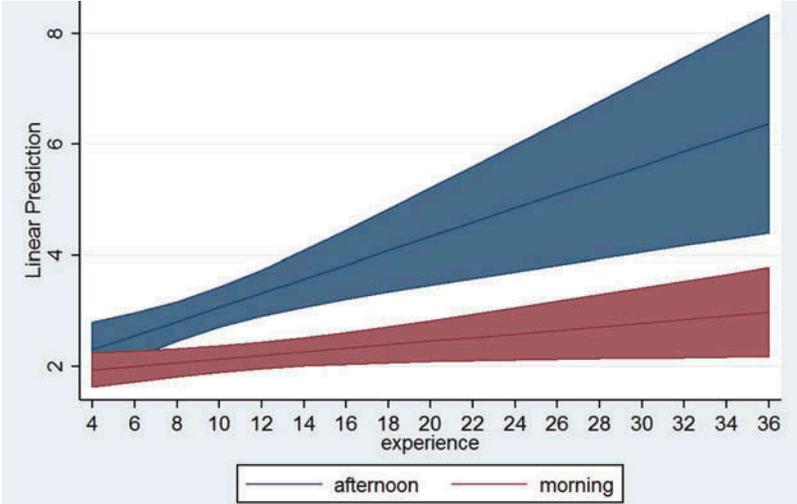


Figure A2. Interaction between experience level and work in afternoon session to predict performance.