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Socio-Economic Determinants of Routine Immunization Coverage in Dutse, Jigawa State, Northern Nigeria, May 2018

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Abstract

Immunization is a cost-effective public health intervention to reduce morbidity and mortality associated with infectious diseases. The Nigeria Demographic and Health Survey of 2018 indicated that only 5.4% of children aged 12-23 months in Dutse, Jigawa State was fully immunized. The study was conducted to identify the determinants of routine immunization coverage in Dutse area of Jigawa state. The study adopted a cross-sectional method.450 children aged 12-23 months were sampled. Interviews of mothers of these children were carried out using a structured questionnaire to collect data on socio-demographic characteristics, knowledge of immunization, vaccination status of children and reasons for non-vaccination. The study defined a fully immunized child as a child who had received one dose of BCG, three doses of the oral polio vaccine, three doses of Diptheria-Pertussis-Tetanus vaccine and one dose of measles vaccine by 12 months of age. The study performed bivariate analysis and logistic regression using Epi-info software. The findings of the study reveal that the mean age of mothers and children were 27 years (standard error (SE): 0.27 year) and 17 months (SE: 0.8 months) respectively. 79% of mothers had no formal education while 84% did not possess satisfactory knowledge of immunization. Only 7.6% of children were fully immunized. Logistic regression showed that possessing satisfactory knowledge (Adjusted OR=18.4, 95% CI=3.6-94.7) and at least secondary education (Adjusted OR=3.6, 95% CI=1.2-10.6) were significantly correlated with full immunization. The major determinants of immunization coverage were maternal knowledge and educational status. Raising the level of maternal knowledge and increasing maternal literacy level is essential to improve immunization coverage in this community.

Keywords: Dutse, Immunization, Jigawa, Mortality, Routine.

Introduction

Immunization is a proven tool and a cost-effective public health intervention to reduce morbidity and mortality associated with infectious disease(Omer, 2017). It is one of the key elements of primary health care(Anderson et al., 2015). Immunization services are usually delivered via two main strategies namely routine immunization (RI) and supplemental immunization activities (SIAs) (Petrosky et al., 2015). RI is the regular provision of immunization services to successive cohorts of infants through the administration of vaccines (antigens) in a scheduled regimen(Brenzel, Young, & Walker, 2015). SIAs are mass campaigns targeting all children in a defined age group with the objective of reaching a high proportion of susceptible individuals(Verguet et al., 2015). RI services are usually provided at the fixed post at the health facility and through outreach to remote and hard-to-reach communities(Ducusin et al., 2017).

In 1974, the World Health Organization (WHO) launched the Expanded Programme on Immunization (EPI)(Roca et al., 2015). EPI's goals were to ensure that every child received protection against childhood tuberculosis, poliomyelitis, diphtheria, pertussis, tetanus and measles by 1 year of age(Muloiwa, Kagina, Engel, & Hussey, 2015). In Nigeria, EPI was initiated in 1979(Agboola et al., 2015). The country achieved modest progress in immunization coverage during 1980 -1990(Mpabalwani, Mwenda, Tate, & Parashar, 2017). However, the 1990s witnessed a major decline in RI coverage mainly due to the collapse of the Primary Health Care system, poor funding by governments and lack of political commitment and ownership. In 1996, Nigeria's EPI program was revitalized with renewed government ownership and oversight. Although this led to an increase in immunization coverage, immunization surveys conducted in the country in 2003 and 2006 indicated that the coverage for all the antigens was still below 50%(Adeloye et al., 2017).

Of the six geo-political zones in Nigeria, the north-west zone has the worst RI coverage in the country(Eboreime, Abimbola, & Bozzani, 2015). The low RI coverage in this zone has been a major factor for the continuous transmission of wild poliovirus and circulating vaccine-derived polio-virus (cVDPV) in Nigeria(Eboreime et al., 2015). Among the seven states in north-west Nigeria, Jigawa State has one of the poorest immunization coverage - in 2018, the state recorded a Diptheria-Pertussis-Tetanus (DPT) 3 vaccine coverage of 8.8%, Oral Polio Vaccine (OPV) 3 of 22.8% and measles vaccine coverage of 14.1% (Gunnala et al., 2016).

Nigeria has witnessed a gradual but consistent reduction in immunization coverage. By 1996, the national data showed less than 30% coverage for all antigens, and this decreased to 12.9% in 2003(Odusanya, Alufohai, Meurice, & Ahonkhai, 2008). This figure which is consistent with the 2003 national immunization coverage survey figures is among the lowest in the world and explains the poor health status of children in the country. It is the worst in the West African sub-region, only better than Sierra Leone. For instance, the polio epidemic in Nigeria is the worst in the African region and constitutes a threat to other nations(Adebayo, Oladokun, & Akinbami, 2012)

immunization and vaccination are two of the most important public health interventions and constitute a cost-effective strategy to reduce both the morbidity and mortality associated with infectious diseases.

Over two million deaths are delayed through immunization each year worldwide(Itimi, Dienye, & Ordinioha, 2012). Despite this fact, vaccine-preventable diseases remain the most common cause of childhood mortality with an estimated three million deaths each year(Jenkins et al., 2008). In recent times, vaccination has had a major impact on measles deaths. From 2000 to 2005, more than 360 million children globally received measles vaccine through supplementary immunization activities. Moreover, improvements have been made in routine immunization over this period.

These accelerated activities have resulted in a significant reduction in estimated global measles deaths. Overall, global measles mortality decreased by 60% between 1999 and 2005. The largest gains occurred in Africa where measles cases and deaths decreased by nearly 75%

(Jenkins et al., 2008). Thus, there is a lot of pressure on health facilities in different countries in controlling the disease through vaccination. Indeed, measles is targeted by the WHO in its expanded program of immunization (EPI).

In their study, Henry et al. (Fatiregun & Okoro, 2012) showed only immunizations completed for children aged 12–23 months, the usual age group for reporting immunization rates. Their results revealed that one-fourth of all children aged 12–23 months had received the three recommended doses of polio but many missed the corresponding third dose of DPT3, which was received by only 5.1% of one-year-olds. Only 2.2% of children 12–23 months of age received all recommended doses. More children in Yobe (3.8%) than in Katsina (2.5%) and Zamfara (0.2%) received all recommended doses ($p = 0.05$). Further analysis of the data shows that 67% of parents who were unable to receive all immunizations reported a lack of vaccine as a problem, and 13% had difficulties with the long wait. Children in urban areas have consistently higher immunization rates than those in rural areas. Overall, 4.6% of children 12–23 months of age had received all of the recommended doses by one year of age, compared to only 1.1% in the rural areas ($p = 0.005$).

Like many other sub-Sahara African countries, Nigeria is still experiencing tremendous crises in maternal and child health care. These crises reflect more on under-five morbidity and mortality, which has not witnessed a significant improvement from its level since the 1990s. For instance, in 1990, the under-five mortality rate was 147 deaths per 1000 births, while in 1995 it increased to 176 deaths per 1000 births, and in 2000 it was 153 deaths per 1000 births. According to the latest Nigerian demographic and health survey 2018, out of every 1000 children born in Nigeria, 70.49 died before reaching five years of age, with female and male infant mortality estimated at 67.34 and 73.55 deaths/1000 live births respectively. In recognition of the risks faced by Nigerian children, one of the important services covered by PHC in Nigeria is immunization. Although immunization began in Nigeria in 1956 when smallpox was severe nationwide the national immunization tagged Expanded Program on Immunization started in 1979 to combat deadly childhood diseases, which were regarded as the cause of high infant morbidity and mortality in Nigeria. These diseases are polio, measles, yellow fever, whooping cough, diphtheria, tuberculosis of and marasmus(Angela, Babatunde, Akinwumi, & Edet, 2012). Although malaria is not included in the list of childhood diseases, researches are ongoing to develop a malaria vaccine that will hitherto prevent and reduce infant malaria. Recently, a purified irradiated PFSPZ vaccine administered to individuals by inoculation in the skin proved safe, suboptimally immunogenic and protective. Also, efforts are on towards an effective vaccination to combat influenza. In a recent report, changing the amino acid residue in the stem cell region of the HA2 subunit of the haemagglutinin molecule showed promise as a strategy for cell culture-based influenza vaccines

The vision of EPI in Nigeria is to improve the health of Nigerian children by eradicating all the six killer diseases, which are polio, measles, diphtheria, whooping cough, tuberculosis, and yellow fever. Between 1985 and 1990, as outlined in the national health plan for that period, the objectives of EPI were to strengthen immunization, accelerate disease control and introduce new vaccines, relevant technologies, and tools. In1995 in line with the above, Nigeria became a signatory to the World Health Assembly, adopted the World Health Assembly Resolution (WHAR) and United Nations General Assembly Special Session (UNGASS) goals for all countries to achieve by 2005 (i) polio eradication, (ii) measles mortality reduction and (iii) maternal and neonatal tetanus elimination (MNTE). Nigeria also adopted the millennium development goals (MDGs) calling for a two-thirds reduction in child mortality, as compared to 1990, the year 2005. In addition to the above, the country ratified the United Nations General Assembly Special Session (UNGASS) goals urging Nigeria to achieve by 2010 (i) ensure full immunization of children under one year of age at 90% coverage nationally with at least 80% coverage in every district or equivalent administrative unit, and (ii) vitamin A deficiency elimination. In 1998 following from the above, Nigeria laid out the core activities of EPI policies which included the following: (i) monitoring of the performance, quality and safety of the immunization system through indicators; (ii) assessment of the current burden of vaccine-preventable diseases as well as the "future" burden of vaccine-preventable diseases in terms of sickness, death and disability, as well as the economic burden; (iii) assessment of the impact of vaccination strategies, through on-going epidemiological surveillance and reliable laboratory confirmation, as well as impact assessments in Nigeria; (iv) monitoring of the national immunization policies, particularly the vaccines used in the country and the target population for these vaccines (immunization schedules); and (v) monitoring of the overall proportion of children and women who are vaccinated (immunization coverage) and ensuring that all districts of the country are well covered with vaccination. In 2000, following the African Regional Summit on EPI held in Harare in November 1999, the Federal Ministry of Health specifically stated its policies on the country's initial visions for EPI as follows:

(i) Immunization System Strengthening: By the year 2004, Nigeria should achieve the EPI district-focused plan and attain 80% DPT3 coverage in all the states of the federation. The specific policy also stated that the government should ensure increased funding for EPI.

(ii) Accelerated Disease Control: By the year 2004, there should be no cases of acute flaccid paralysis associated with wild poliovirus in Nigeria. As for measles, by the year 2004, the country should have reduced measles morbidity by 90% and measles mortality by 95%; while the coverage for yellow fever is expected to increase to at least 80%.

(iii) Innovations: By the year 2004, Nigeria should include vitamin A and hepatitis B (HB) in its national immunization programs; and the vaccination coverage should not be less than 80% as with other antigens. Under the new technology-driven, the country should adopt the multi-dose vial policy (MDVP) and vaccine vial monitor (VVM) and also introduce new methods for monitoring its use.

Immunization against childhood diseases such as diphtheria, pertussis, tetanus, polio, and measles is one of the most important means of preventing childhood morbidity and mortality. Achieving and maintaining high levels of immunization coverage must,, therefore, be a priority for all health systems. In order to monitor progress in achieving this objective, immunization coverage data can serve as an indicator of a health system's capacity to deliver essential services to the most vulnerable segment of a population.

Dutse represents a typical rural community in Jigawa State and the coverage for RI antigens in this community is below the 80% average required for herdimmunity against vaccine-preventable diseases (VPDs)(Eboreime et al., 2015). The administrative coverage for OPV3 and DPT3 in Dutse were 22% and 54% respectively in 2006, and 35% and 59% for OPV3 and DPT3 respectively in 2017(Touray et al., 2016). A nation-wide demographic and health survey conducted in 2018 indicated that only 5.4% of children aged 12-23 months in this community were fully immunized(Abubakar, 2018). Based on this, this study was conducted to assess the knowledge of mothers (caregivers) on RI, determine the coverage for RI antigens and identify the determinants of full immunization to guide evidenced-based interventions to improve immunization coverage in the community.

Methods

Description of Study area

Dutse Local Government Area is in the Jigawa State of Nigeria. It is located between latitudes 11° 45' 22.25" N and between longitudes 9° 20' 20.26" E. The local government area is bounded in the North by Ringim L.G.A, in the South by Birnin Kudu L.G.A, East by Kiyawa L.G.A all in Jigawa state and in the west by Kano state(Figure 1) (Idi, 2017). The Dutse town serves as both the state capital and the headquarters of the Local Government Area. The major languages spoken in the local government area are Hausa, Fulfude and Banawa. The local government area is made of the following towns Ruru, Dundubus, Karnaya, Dutse, Chamo, Sakwaya, Jaudi, Madobi, and Kudai and villages such as Chaichai, Yargaba, Dagwaje, Wurma, Warwade, Yalwa, Hammayayi and Baranda. Some of the crops grown in the L.G.A are maize, millets, beans, sorghum, rice, groundnuts, cotton, sesame, and the tree crops are Date palm, cashew, citrus, mangoes and Guava (JARDA). Lastly, the NIFOR, Date palm substation is cited in Dutse town.

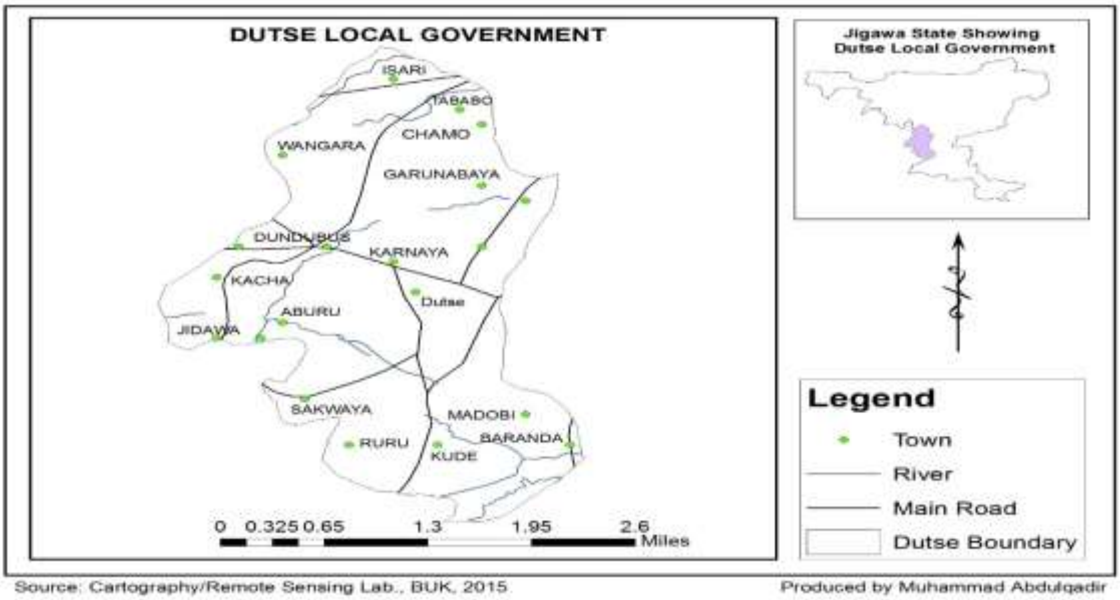

Figure1: Map of the Study area

The community (Dutse) has an estimated population of 69, 906 people projected from the 2006 National population census. The majority of the inhabitants are Hausas and are predominantly farmers. RI services in the community are delivered by six primaries and two secondary health facilities (all government-owned), and through immunization outreach services(Yahaya & Dogara, 2018). The community is divided into three districts and each district has four villages. Altogether, there are 47 settlements in the community; each settlement consists of several households. For the purpose of this study, each settlement constituted a cluster.

Study Design

A community-based cross-sectional study was conducted for this study. The respondents were mothers or caregivers of sampled children. For a child to be eligible for sampling, he or she must have been between 12- 23 months old at the time of the study.

Sample size determination: The study determined the number of children to be sampled using the methods recommended by the World Health Organization (WHO) for Immunization

Coverage Cluster Survey (13). The calculation of the sample size was based on a hypothesized full immunization coverage of 5.4% (9), a significance level of 5% - corresponding to a standard normal deviate (z) of 1.96, power of 80%, precision (d) of 3% and design effect (DEFF) of 2. The study used the formula: n = {(z2pq/d2) x DEFF} and obtained a minimum sample size of 436 children. However, we sampled an equal number of children from each of 30 clusters; thus, 15 children were sampled per cluster giving a total sample size of 450 children.
Sampling Method: The study employed a two-stage cluster sampling technique to sample eligible children. A random number using tables of random numbers was used. The selected random number was 1359; - To determine the village in which cluster one was located, we identified the first village listed in which the cumulative population equals or exceeds the random number (1359). To determine the village where cluster two was located, we added the sampling interval to the random number (2330 + 1359 = 3689) and identified the village whose cumulative population contained this number (3689). To identify the villages where subsequent clusters (clusters three to thirty) were located, we kept on adding the sampling interval to the "preceding sum (running total) of the sampling interval and random number" and locating the village whose cumulative population contained this number (Table 1).

Table 1
Study cluster in different villages in Dutse

Villages	Population	Cumulative population	Cluster Number
Ruru	3500	3500	1
Dundubus	7480	10980	2,3,4,5
Dutse	7601	18851	6,7,8
Madobi	5800	24381	9,10,11
Jaudi	4132	28513	12.13
Chaichai	4300	32813	14,15
Yargaba	2851	35664	16
Hammayayi	4117	39781	17,18
Baranda	7060	46841	19,20,21
Sakwaya	6800	58206	24,25
Chamo	11700	69906	26,27,28,29,30

Selection of households: At stage two, selected 15 households from each of the 30 clusters selected at stage one. The first household in each cluster was selected randomly using the table of random numbers. Subsequent households were selected contiguously in the right direction until the number of households for that cluster was completed. From each selected household, one eligible child was selected. If a selected household had more than one eligible child, only one was randomly selected. If a selected household had no eligible child, the next contiguous household was visited and one eligible child selected.
Respondents knowledge grading: To assess the knowledge of mothers, their responses scored to five questions on various aspects of RI and VPDs. Each correct response was scored one point while each wrong response was scored zero. Mothers, who scored below two points, were graded as having poor knowledge while those who scored three points and above were graded as having satisfactory knowledge. To reduce the possibility of guessing by the mothers, we asked only open-ended questions to assess the level of knowledge.
Routine Immunization antigens Validity: For any antigen administered to a child to be considered valid, that antigen must have been administered at the recommended age; and

for multiple-dose antigens, not less than 4 weeks interval between the doses. We considered a child's BCG vaccine valid if a scar was present irrespective of whether the vaccination was recorded on the card or obtained by history. BCG vaccination recorded on the card but without a scar was also considered valid.

Vaccination status of children: Based on the type and doses of valid RI antigens received, we categorized the children as fully immunized, partially immunized, or un-immunized. We defined these categories of vaccination status as follows: - Fully immunized child: a child who had received one dose of BCG, three doses of OPV (excluding OPV given at birth), three doses of DPT vaccine and one dose of measles vaccine by 12 months of age; - Partially immunized child: a child who missed at least any one of the above doses; - Un-immunized child: a child who had not received any vaccine by 12 months of age.

Data processing and analysis: The study reviewed all completed questionnaires prior to electronic data entry. Double data entry was performed to minimize errors. Univariate analysis was conducted in order to obtain frequency and proportions, and bivariate analysis to identify factors that determine full immunization status. The study used the chi-square test to determine statistical significance; a p-value of less than 0.05 was considered statistically significant. A logistic regression model was created for factors that were significant at bivariate analysis. Data analysis was performed using Epi-info software version 3.5.1.

Ethical considerations: Ethical clearance for this study was obtained from the ethical committee of the Jigawa State Ministry of Health, Dutse. Informed consent was obtained from each respondent. The confidentiality of the respondents was assured and maintained during and after the study.

Results

Socio-demographic characteristics of mothers and children

The mean age of the mothers was 27 years (standard error (SE) = 0.27 years). The age ranged from 15 to 44 years. Thirty-one percent of mothers were between 20 to 24 years old. All the mothers (100%) practiced Islam, 79% had no formal education, 81% were traders, and 98% were married. The mean age of the children was 17 months (SE= 0.8 month); the age ranged from 12 to 23 months. Fifty-two percent of the children were males (Table 2).

Table 2
Socio-demographic characteristic of Respondent

Age	Number of Respondents	Percentage (%)
15-19	17	3.8
20-24	138	30.7
24-29	122	27.1
30-34	109	24.2
35-39	45	10.0
40-44	19	4.2
Religion		
Islam	450	100
Educational status		
None	355	78.9
Primary	50	11.1
Secondary	35	7.8
Tertiary	10	2.2
Occupation		
Trader	363	80.7
Housewife	64	14.2
Tailor	9	2.0
Teacher	8	1.8
Health worker	4	0.9
Civil servant	2	0.4
Marital status		
Married	441	98.0
Divorced	5	1.1
Widow	4	0.9

Knowledge and attitudes on RI and VPD
Forty-four percent(44%) of the mothers knew the correct purpose of childhood immunization, 20% knew the timing of first RI visit, 14% knew the timing of the second visit while 16% knew the timing of the last visit; only 12% knew the correct number of visits to health facility to complete RI. Sixty-one percent (61%) mentioned measles while 50% mentioned poliomyelitis as VPDs. Malaria and diarrhea diseases were also mentioned as VPDs by 12% and 6% of mothers respectively. The commonest symptoms of VPDs recalled by the mothers were fever (57%), followed by cough (48%), skin rash (34%) and paralysis (19%). Seventy-nine percent of the mothers believed that immunization is beneficial to children, 81% believed that immunization is safe, while 66% believed that immunization is very effective in preventing VPDs in children. However, 14% of mothers believed that immunization can cause infertility later in the life of children, while 63% believed that immunization prevents all childhood diseases.

Grading of Knowledge
Forty-three percent (43%) of mothers had a knowledge score of zero, 28% scored one point while 12% scored 2 points. Five percent of mothers had a score of 3 points; another 5% scored 4 points while 7% scored 5 points. Based on the scores, 84% possessed poor knowledge (score of 0 - 2 points) while 16% possessed satisfactory knowledge (score of 3 - 5 points). High

education level was significantly associated with satisfactory knowledge - 46% of mothers whose knowledge was satisfactorily possessed high education level (secondary/post-secondary) (p-value: < 0.05).

Coverage for RI antigens

The coverage for all RI antigens obtained by both maternal history and immunization cards is shown in Table 3.

Table 3

Immunization coverage in Dutse, Jigawa State

Routine Immunization Antigens	Maternal History Coverage	Coverage by immunization card
Antigens Administration at birth		
BCG	80(17.8)	40(8.9)
OPV0	89(19.8)	41(9.1)
HBV1	84(18.7)	41(9.1)
Antigens Administration at 6 weeks		
OPV2	73(16.2)	38(8.4)
DPT1	76(16.9)	41(9.1)
HBV2	66(14.7)	38(8.4)
Antigens Administration at 10 weeks		
OPV2	55(12.2)	33(7.3)
DPT2	60(13.3)	35(7.8)
Antigens Administration at 14 weeks		
OPV3	41(9.1)	26(5.8)
DPVT3	43(9.6)	27(6.0)
HBV3	44(9.8)	28(6.2)
Antigens Administration at 9 months		
Measles	68(15.1)	24(5.3)
Yellow fever	35(7.8)	22(4.9)

For all antigens, coverage obtained by maternal history was higher than coverage obtained by immunization card. The proportion of children vaccinated with OPV 0 (19.8%), HBV 1 (18.7%) and BCG (17.8%) - all given at birth, were more than the proportion of children vaccinated with antigens given at other times. According to maternal history, 7.6% of the children had been fully immunized, 18.9% were partially immunized, while 73.6% were un-immunized. However, according to the immunization cards, 4.7% of the children had been fully immunized while 4.9% were partially immunized.

Reasons for non-vaccination

The reasons given by the mothers for the non-vaccination of their children are shown in Figure 1.

Sixty-six percent of mothers who had never vaccinated their children gave reasons relating to lack of knowledge on RI for non-vaccination of their children, 37% gave reasons relating to lack of permission from the husband. Nine percent gave no reason for non-vaccination of their children.

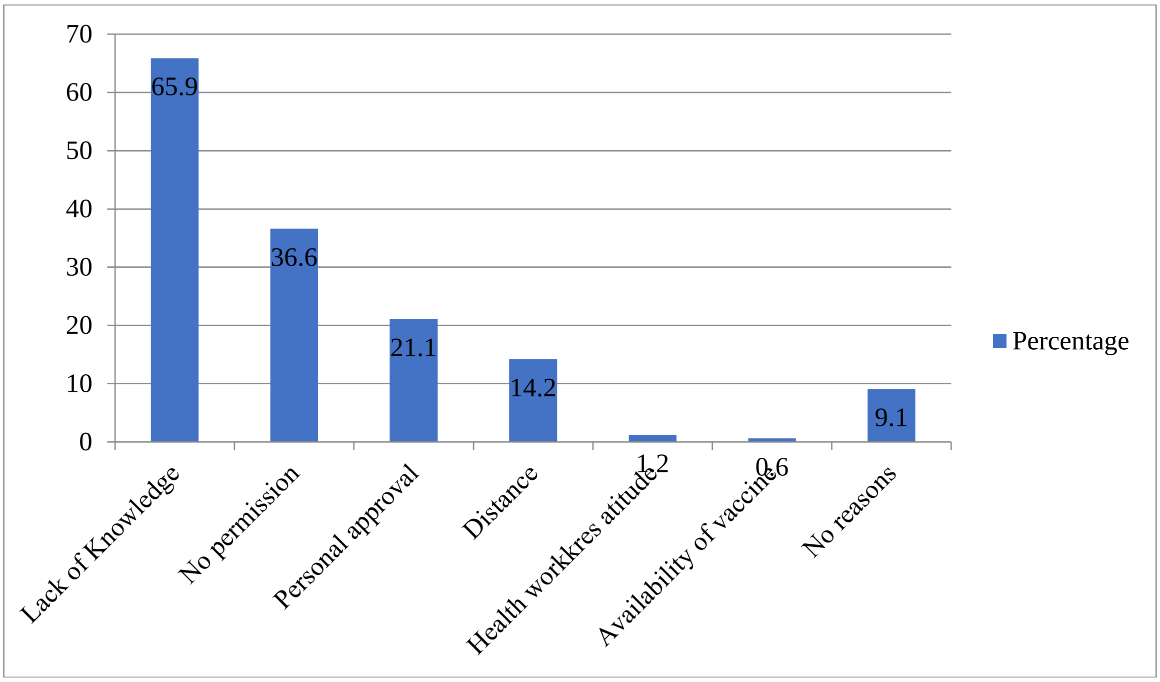

Figure 1: Reasons for not Vaccination

Determinants of full immunization

Five factors were significantly associated with full immunization at bivariate analysis: possessing a satisfactory level of knowledge on RI, possessing at least secondary education, receiving ante-natal care, having received information on RI in the 12 months preceding the study, and delivery at a health facility (Table 4). Of these factors, possessing a satisfactory level of knowledge on RI (p-value: < 0.05) and possessing at least secondary education (p-value: < 0.05) remained as the only independent determinants of full immunization after performing logistic regression (Table 5).

Table 4
Bivariate analysis of factors associated with immunization

Factors	Partially/unimmunized	Fully immunized	X^2
Educational level			
None/primary	392(94.2)	13(38.2)	
Secondary/tertiary	24(5.8)	21(61.8)	103.4
Knowledge grade			
Poor	374(89.9)	2(5.9)	
Satisfactory	42(10.1)	32(94.1)	155.4
Received ANC			
No	324(77.9)	0(0)	
Yes	92(22.1)	34(100.0)	90.8
Received RI Information			
No	111(85.1)	1(2.9)	
Yes	305(73.3)	33(97.1)	8.2
Place of delivery			
Home	354(85.1)	4(11.8)	
Hospital	62(14.9)	30(88.2)	99.5

Table 5
Logistic Regression Analysis of factors with full immunization

Factors	Odd ratio	95% C.I	Coefficient	S.E	P-value
Educational status	3.63	1.24-10.57	1.29	0.55	0.0183
Knowledge	18.39	3.57-94.70	2.91	0.84	0.0005
Place of delivery	2.70	0.73-10.00	0.99	0.67	0.1374
Access to RI	0.51	0.03-8.72	-0.67	1.44	0.6443
ANC attendance	1.75	0.00-1.02	12.6324	1.53	0.9038

Discussion of Results

The study found that the majority of mothers in our study in a rural community in Jigawa State possessed poor knowledge of RI and VPDs. High education level was found to be significantly associated with satisfactory knowledge. Although the attitude of mothers towards immunization was generally positive, some believed that immunization can cause infertility in children. The finding of this study revealed very low coverage for all RI antigens. Less than 10% of the children were fully immunized(Liso, Massenzio, & Stracci, 2017). Almost three out of every four mothers had never vaccinated their children(Habib et al., 2017). The study found that possessing satisfactory knowledge on RI and possessing high education level were the independent determinants of full immunization in these communities.

The majority of mothers in this study community possessed poor knowledge of RI, similar to findings obtained in North India (Paul & Sahoo, 2015). The poor knowledge of mothers in this study may be partly, attributed to the low level of education in these communities. The study established that mothers with low educational level were less knowledgeable on RI compared to those with a high educational level. Education has been described as the root of knowledge. It is expected that mothers with high education levels ought to understand scientific information more easily than those with a low educational level. This finding is consistent with that obtained in Edo, Southern Nigeria and Istanbul, Turkey(Abhulimhen-Iyoha & Ibadin, 2015; Carrasco et al., 2015).

Measles and poliomyelitis were the most common VPDs recalled by mothers in our study, similar to findings obtained in some states in Nigeria(Saleh, 2016). Both diseases(Measles and poliomyelitis) are on the center stage of both national and global public health activities, while measles is targeted for elimination in Nigeria, poliomyelitis is targeted for global eradication(Fowotade et al., 2015). Most mothers especially, in northern Nigeria are familiar with the characteristic maculopapular rash associated with measles infection(Faneye, Adeniji, Olusola, Motayo, & Akintunde, 2015). In addition, the repeated polio SIAs in Nigeria has popularized poliomyelitis especially in rural communities in northern Nigeria.

Fourteen percent of mothers in our study community believed that immunization can cause infertility in children. This finding readily brings to mind the event that led to the suspension of immunization activities in Northern Nigeria between 2003 and 2005. During this period, OPV was erroneously perceived to possess anti-fertility constituents(Iduseri & Osemwenkhae, 2016). The widespread misconception resulted in poor acceptability and outright suspension of immunization activities in several northern states, perhaps due to the decision of parents to defy purported plots of the western world to reduce Nigeria's population. This period witnessed a major set-back for immunization activities in Nigeria as both RI and SIAs dipped profoundly. This study provides a rationale to scale up public enlightenment and social mobilization activities and engagement of religious, traditional and political leaders to correct this misconception.

The coverage obtained for all antigens in this study was lower than that reported by several other researchers(Abad et al., 2015). The proportion of children found to be fully immunized in our study was lower than the findings in Edo, Southern Nigeria, Brazil and Turkey(Andrade et al., 2017). However, it is comparable to the figure obtained by NDHS 2018(Nakayiza, 2018). The 9.1% OPV3 coverage obtained in this study has a great implication for the global polio eradication initiative; this OPV3 coverage is far below the 80% recommended by the WHO for polio eradication (Ongwae et al., 2017), and creates a substantial population gap - a key risk factor for the emergence and circulation of cVDPV(Adekanle, Ndububa, Olowookere, Ijarotimi, & Ijadunola, 2015). Similarly, the 15.1% coverage we obtained for the measles vaccine is lower than the 90% recommended by the WHO/ UNICEF strategic plan for measles morbidity and mortality reduction(Gibson et al., 2015)

In a study in India, found that there is satisfactory maternal knowledge on RI is an independent determinant of full immunization in this community(Healy, Rench, Montesinos, Ng, & Swaim, 2015). This finding is consistent with those of other studies. As expected, knowledge regarding the benefit and schedule of RI is a powerful tool that positively influences a mother's decision to fully immunize her child. However, the educational level, which was found to be significantly associated with knowledge, is very low in this community. This correlates with the finding of this study which shows that only 7.6% of mothers had fully immunized their children. Furthermore, findings from our study indicated that high education level was an independent determinant of full immunization similar to findings obtained in Edo State, Southern Nigeria and Turkey(Carrasco et al., 2015).

However, a study conducted in an urban area of Brazil demonstrated that maternal literacy was not associated with full immunization(Healy et al., 2015). This contrasting finding in Brazil may possibly, be due to the urban setting of the study area and the recruitment of study participants from the health facilities rather than the community. The independent effect of high education level on full immunization demonstrated by this study highlights the need for inter-sectoral collaboration between the health and education sectors to improve immunization coverage in these communities.

The interpretation and generalization of the findings from this study are subject to three limitations. Firstly, the study did not explore factors related to immunization service delivery including vaccine availability, health care personnel and logistics. Secondly, the study could not verify the information provided by the respondents regarding the antigens received by their children. The researcher tried their best to describe the site, dose and timing of the antigens to obtain accurate information. Finally, the study was limited in geographical scope. Although our study community is a good prototype of rural communities in northern Nigeria, the researchers acknowledged that conducting this study in the entire Jigawa State or Northern Nigeria could have produced different results. However, the study used an absolute precision of 3% instead of 5%-10% to achieve a sufficiently large sample size to increase the precision and allows for generalization of the findings, at least in Jigawa State.

Conclusion

In conclusion, the maternal knowledge and literacy level in this community is very low. Uptake of RI antigens was also, generally very low. Poor maternal knowledge and low level of education independently, determine full childhood immunization in the community. The community, supported by the State Ministry of Health and the State Ministry of Information should embark on focused public enlightenment and health education activities on the benefits, schedule, and doses of RI, targeting both mothers and fathers to improve the level of knowledge and correct misconceptions regarding some aspects of RI. Inter-sectoral collaborations between the health and education sector should be strengthened. In this light, the State Ministry of Education and other relevant partner agencies should support the organization of flexible adult education classes as well as the enrolment of the girl child into primary and secondary school.

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