Timeliness and Completeness Rates of Immunization of Children (12-23months) in rural and urban communities in Bayelsa State

ABSTRACT

Background: Immunization is the introduction of vaccines to a non-immune host to resist communicable diseases. It is a cost effective public health intervention. The aim of the study was to compare timeliness and completeness rates of immunization coverage of children aged 12 to 23 months in urban and rural communities in Bayelsa State, Nigeria.

Materials and Methods: A descriptive, cross-sectional study design was used to carry out this study among 427 respondents in urban and rural communities in Bayelsa state. Multistage sampling method was adopted to select study participants to whom semi-structured questionnaires having 4 sections were distributed. Data analysis was done using the Statistical Package for Social Sciences (SPSS) version 23. Association between study variables was tested using the Chi-squared test and p-value of ≤ 0.05 was considered statistically significant.

Results: Only 13 (6%) and 19 (9%) of children in urban and rural communities respectively were completely immunized (p-value < 0.001). The mean age of children who completed immunization in the rural community was 13.2 months but 10.2 months in the urban. Motivating factors of immunization included free cost, availability of immunization services, proximity to clinics and so on. Child's ill health, knowledge of mother and fear of complication were barriers to complete immunization. Certain vaccines recorded higher timeliness and completeness rates among the children in the urban community than those in the rural community and these were statistically significant.

Conclusion: Immunization timeliness and completeness rates of children for specific vaccines were good for both urban and rural communities. The urban community however had significantly better timeliness and completeness rates. Various factors were also found to influence timely immunization coverage. It is recommended that social mobilization activities to increase immunization awareness in both urban and rural communities be intensified in Bayelsa State

Keywords: Immunization, timeliness, completeness, rural, urban, barriers

INTRODUCTION

At present, Africa is undergoing health transitions with movements from predominantly communicable childhood diseases to the non-communicable ones already recorded in most countries, infectious diseases still pose a huge burden to most populations in the region.[1] According to the World Health Organization, communicable diseases rates, such as malaria, tuberculosis and HIV/AIDS in Africa seems to be the highest in the world.[2] The majority of these communicable diseases are vaccine-preventable. Vaccine preventable diseases (VPDs) such as tuberculosis, tetanus, poliomyelitis, diphtheria, pertussis, hepatitis B and yellow fever contribute substantially to reduce mortality and morbidity among children below five years in

developing countries.[3] In Nigeria, they are responsible for 22% and 17% of under-five mortality and morbidity respectively.[3] Communicable disease control involves mainly vaccination against viral and bacterial diseases. This not only reduces the incidence of that disease; but also reduces the economic and social burden of the disease on communities, as it confers herd immunity on the population.[4]

Many vaccine-preventable diseases (VPD) transmission can be prevented by providing high immunization coverage to specific diseases. Two excellent examples to this are the near eradication of polio and the worldwide eradication of smallpox from many countries. The National Programme on Immunization (NPI) guidelines, the World Health Organization (WHO), and the United Nations Children's' Fund (UNICEF), stipulated that a child should receive four doses of Oral Polio Vaccine (OPV), One dose of Hepatitis B Vaccine, three doses of Penta, three doses of Pneumococcal Conjugate Vaccine (PCV) and Tetanus vaccine and a dose of Bacille Calmette Guerin (BCG), measles and yellow fever vaccines.[5-7] Nigeria adopts the immunization schedule expressed by the Expanded Programme on Immunization (EPI) which prescribes five visits to receive one dose of Bacillus Calmette Guerin (BCG) and yellow fever, four doses of oral polio vaccines, three doses of pentavalent, three doses of pneumococcus conjugate vaccine (PCV) and tetanus vaccine, and a dose of measles vaccine. Additionally, doses of Vitamin A supplements are given at 6 and 12 months respectively.[8] These are aimed at protecting recipients from vaccine preventable diseases which are responsible for about 25% deaths among under-5 years. About a quarter of these resultant deaths are preventable by immunization[9]

Countries with low under-five mortality figures have an inverse relationship with their immunization coverage rates. Sweden, for instance, with immunization coverage of 98% has a reported 4/1000 under-five mortality rate; this is similar to that of Japan, United States of America and France that have immunization coverage above 90%.[3] In Nigeria the immunization coverage rates are below 80% with above 100/1000 under five mortality rates.[3] Despite the documented benefits of immunization, the Nigerian NPI reportedly suffers recurrent setbacks due to ethnic and religious factors. This explains the persistent high burden of childhood communicable diseases as a result of lack of herd immunity. For the same reason, Nigeria did not achieve the 2015 goal of reducing the under-five mortality by about two-thirds[10] One explanation for this trend has been the poor completeness rates and timeliness. Nigeria is among the 10 countries with the highest number of children that are incompletely immunized globally[9.] Whenever timeliness and completeness protocols of immunization are not adhered to, it has the capacity to severely limit the ability to prevent the occurrence of vaccine preventable diseases as well as the achievement of optimal immunization coverage.[11]

The problem of timeliness and completeness of immunization schedules among children in Nigeria thus exists and is known to occur more in rural settlements than the urban ones[9,10] which implies that similar problems could be existing in various States in the Country including Bayelsa State. There is however scanty published literature describing the timeliness and completeness rates of immunizations in Bayelsa State which makes it necessary to conduct this study to evaluate the timeliness and completeness rates of routine immunization among children aged 12-23 months in rural and urban communities in Bayelsa State, Nigeria. Conducting this study thus provide vital statistics that can be useful in health planning and development

especially regarding routine immunization and related concepts. This study would also provide scientific evidence on the rural-urban distribution of immunization timeliness and completeness. It would also provide a tool for evaluation of immunization efforts of the State Emergency Routine Immunization Coordination Centre (SERICC) in Bayelsa State.

MATERIALS AND METHOD

The descriptive cross-sectional study design was used to conduct this study in two communities selected from two Local Government Areas (LGAs) in Bayelsa State. They included an urban community (Biogbolo) in Yenagoa LGA and a rural community (Ogbia town) in Ogbia LGA. The population for this study incorporated mothers of children 12-23months selected randomly from households in the selected communities. The participants included both sexes of children in the communities with their immunization cards. There was no available population data for children between 12-23months in the two communities from the office of the National Population Commission (NPC) in the LGAs. The target population of interest in the study (under–5-year-old children) was thus estimated for Biogbolo and Ogbia towns as 3,086 and 2,269 respectively.[7]

This survey was carried out using the WHO simplified 30 by 7 cluster sample size formula to determine the number of children in each respective site.[12] From each of these sites (rural and urban), 30 clusters were randomly selected out of which 7 children were selected to participate in each cluster. Therefore, The sample size n= 30 x7 = 210 children (for each of the groups: rural and urban) Therefore, total sample size, n = 210 x 2 = 420.

A multi-stage sampling method was used to select the respondents from the respective communities. Instrument for data collection was a structured self- and interviewer-administered questionnaire and all items in the instrument were focused on assessing the completeness and timeliness of immunizations. Six pairs of well-trained community health extension workers (CHEWs) were used to administer the questionnaires to mothers having immunization cards. These were also interviewed on immunization status of their children. In order to ensure the quality of the interview and data collected, the principal investigator carried out regular supportive supervision on the research assistants while in the field.

Data collected was entered into Microsoft Excel spreadsheet for cleaning and sorting and was imported into the Statistical Package for Social Sciences (SPSS) version 23.0 for analysis. Descriptive statistics of bio-data was summarized in a frequency distribution table. Average monthly income was categorized into quartiles (Q1-Q4), and the latter was used to categorize "child's family" into one of four socio-economic classes. Inferential statistics were generated and the association between the immunization data (for each of the vaccines) for the two communities in terms of immunization timeliness and completeness was assessed using the Chi-square test. Level of statistical significance for this study was set at ≤ 0.05.

Ethical Clearance for this research was gotten from the University of Port Harcourt Research Ethics Committee. Ethics approval was also obtained from the Primary Health care Department of the Ministry of Health, Bayelsa state and permission to conduct the study was obtained from the respective council of chiefs of the selected communities. Furthermore, informed consent was solicited/obtained from each mother in the selected household. Confidentiality and anonymity

were assured and ensured during and after data collection.

RESULTS

There were two hundred and ten (210) respondents that participated in this study for urban community (Biogbolo-Yenagoa), while 217 respondents participated in rural community (Ogbia), therefore a total of 427 respondents participated in this study.

Table 1. shows the socio-demographic profiles of families of children recruited into the study. Maternal ages ranged from 18years to 61years, with a mean age of 30.3 ± 7.8years. Mothers of the children were mostly in their third, fourth and fifth decades of life, mostly received secondary and tertiary educations, and were involved in a range of occupations including Farming/Fishing, Civil Service, and Trading/Business. 18.9% and 17.6% of rural and urban mothers respectively were, however, housewives/unemployed. Most of the children were from Christian families. Most of the families had a family structure in which both parents (Married or cohabiting). Families were mostly of Ijaw origin and the main socio-economic status in the rural setting was the SES class I and SES class IV in the urban setting.

Table 2 shows the response to the question "has child been completely immunized according to NPI Schedule?" as was obtained from child's immunization card. Only 13 (6%) and 19 (9%) of children in urban and rural communities respectively had been completely immunized. Comparison between both urban and rural dwellings for completeness of immunization gave a statistically significant result (p-value = 0.000).

Table 3 shows the timeliness for the respective vaccines among the children in the communities. As shown, all but Hepatitis B, Measles, and Yellow Fever had significantly higher timeliness rates among the children in the urban community.

Table 1: Socio-demographic characteristics of respondents

Variable	Category	Ogbia Rural n (%)	Yenagoa Urban n (%)	Test of Association $\chi 2$	p-value
Mother's Age	Under-18	1 (0.5)	3 (1.4)	5.179	.394
	18-29	102(47)	107(51.0)		
	30-39	79(36.4)	56(26.7)		
	40-49	23(10.6)	26(12.4)		
	50-59	5(2.3)	3(1.4)		
	60 and Above	2(0.9)	2(1.1)		
	Mean age: 30.3 ± 7.8years				
Mother's Education	No formal	29(13.4)	11(5.2)	13.146	.004*
	Primary	18(8.3)	9(4.3)		
	Secondary	92(42.4)	113(52.8)		
	Post-secondary	78(35.9)	77(36.7)		
Mother's Occupation	Artisan	26(12.0)	0 (0.0)	31.603	.000*
	Farmer/Fisher	34(15.7)	29(13.8)		
	Housewife/Unemployed	41(18.9)	37(17.6)		
	Civil Servant	42 (19.4)	65 (31.0)		
	Trader/Business	74 (34.1)	79 (37.6)		
Religion	Christianity	201(92.6)	206(98.1)	7.504	.023*
	Islam	14(6.5)	4(1.9)		
	Others	2 (0.9)	0 (0.0)		
Family Structure	Both-Parent	176(81.1)	145(69.0)	10.844	.013*
	Single-Parent	25(11.5)	39(18.6)		
	Separated	10(4.6)	22(10.5)		
	Divorced	6(2.8)	4(1.9)		
Number of children in household	1-4	138(63.6)	128(61.0)	0.317	.573
	5 and above	79(36.4)	82(39.0)		
Ethnicity	Ijaw	124(57.1)	143(68.1)	5.464	.019*
	Non-Ijaw	93(42.9)	67(31.9)		
Family SES	SES Class I	64(34.2)	23(15.1)	28.223	.000*
	SES Class II	58(31.0)	38(25.0)		
	SES Class III	36(19.3)	36(23.7)		
	SES Class IV	29(15.5)	55(36.2)		

Table 2: Child immunization completeness

Child completely immunized	(Rural)	(Urban)	Test of Association	
	n (%)	n (%)	$\chi 2$	p-value
Yes	13 (6.0)	19 (9.0)	429.442	.000*
No	204 (94.0)	191 (91.0)		

***: Significant associations** **Source: Field Survey, 2019**

Table 3: Comparison of Timeliness of Administration of the various Vaccines

Vaccine	Ogbia (Rural)		Yenagoa (Urban)		Test of Association	
	N	(%)	n	(%)	$\chi 2$	p-value
BCG	167	(77.0)	184	(87.6)	8.390	0.004*
OPV 0	160	(73.7)	178	(81.9)	4.120	0.042*
Hep B	162	(74.7)	169	(81.0)	2.076	0.150
Penta 1	188	(86.6)	196	(96.7)	5.286	0.021*
PCV 1	188	(86.6)	196	(97.1)	5.286	0.021*
OPV 1	186	(85.7)	195	(92.9)	5.665	0.017*
Penta 2	182	(85.7)	196	(93.3)	8.667	0.003*
PCV 2	182	(83.9)	196	(93.3)	9.406	0.002*
OPV 2	184	(84.8)	196	(93.3)	7.947	0.005*
Penta 3	178	(82.0)	197	(93.8)	13.852	< .01*
PCV 3	177	(81.6)	197	(93.8)	14.713	< .01*
OsPV 3	177	(81.6)	197	(93.8)	14.713	< .01*
IPV	170	(78.3)	198	(94.3)	22.785	< .01*
Vit A	164	(75.6)	190	(90.5)	16.717	< .01*
Measles	165	(76.0)	166	(79.0)	0.555	0.456
Yellow Fever	163	(75.1)	164	(78.1)	1.913	0.167

***: Significant associations** **Source: Field Survey, 2019**

Table 4 shows the completeness rate of various vaccines. The mean age at completeness of immunization in the rural community was 13.2months but 10.2months among the urban children. This difference in mean was statistically significant (t = 5.231; p-value = 0.022). There were statistically significant differences in the proportions of children that had received Penta 1, PCV 1, OPV 1, Penta 2, PCV 2, Penta 3, PCV 3, OPV 3, IPV, and Vitamin A between the two communities with all of the above vaccines recording higher completeness rates among the children in the urban community.

Table 4: Comparison of Completeness rate for Vaccines among the study Population

	Ogbia (Rural)		Yenagoa (Urban)		Test of Association	
Vaccine	**n**	**%**	**n**	**%**	**$\chi 2$**	**p-value**
BCG	205	(94.5)	206	(98.1)	3.889	0.049
OPV 0	178	(82.0)	174	(82.9)	0.051	0.822
Hep B	174	(80.2)	170	(81.0)	0.040	0.841
Penta 1	200	(92.2)	203	(96.7)	4.075	0.044*
PCV 1	200	(92.2)	204	(97.1)	5.187	0.023*
OPV 1	200	(92.2)	203	(96.7)	4.075	0.044*
Penta 2	196	(90.3)	202	(96.2)	5.805	0.016*
PCV 2	194	(89.4)	202	(96.2)	7.307	0.007*
OPV 2	195	(89.9)	202	(96.2)	6.544	0.011*
Penta 3	195	(89.9)	203	(96.7)	7.807	0.005*
PCV 3	194	(89.4)	203	(96.7)	8.625	0.003*
OPV 3	194	(89.4)	203	(96.7)	8.625	0.003*
IPV	187	(86.2)	203	(96.7)	14.834	< .01*
Vit A	181	(83.4)	196	(93.3)	10.165	0.001*
Measles	194	(89.4)	175	(83.3)	3.347	0.067
Yellow Fever	191	(88.0)	175	(83.3)	1.913	0.167

Table 5: Comparison of barriers to immunization completeness

Barriers	(Rural) n(%)	(Urban) n (%)	Chi square $\chi 2$	p-value
I did not know I was to take child back for immunization	17(7.8)	15(7.1)	428.074	.000*
Fear of possible complications	45(20.6)	22(10.5)	436.514	.000*
I feel it is not necessary for my child to be immunized	4(1.8)	7(3.3)	429.530	.000*
No time to take child out for immunization	21(9.6)	12(5.7)	430.356	.000*
I felt child was not feeling well and might react to vaccine	19(8.7)	21(10.0)	428.599	.000*
Child was adjudged ill by a health worker and so was not given immunization	12(5.5)	14(6.7)	429.304	.000*
Bad attitude of health workers	4(1.8)	5(2.4)	431.333	.000*
Spouse's Support for Immunization	9(4.1)	4(1.9)	429.823	.000*
Other reasons	-	-	-	-

Table 5 shows the reasons given by some mothers for incomplete immunization of their children. The major reasons given by the mothers in both the rural and urban communities for child's incomplete immunization included not knowing that child was to receive other vaccines, fear of possible complications, not having enough time to take the child out for immunization, and feeling that child was too ill to be vaccinated.

Table 6 presents the motivations given by mothers for child's immunization. As shown, immunizations being administered free of cost, availability of immunization services, proximity to immunization clinics and spousal support for immunizations were given as common reasons children were completely immunized.

Table 6; Comparison of factors associated with immunization completeness rates

Factors	(Rural) n(%)	(Urban) n(%)	Chi-square $\chi 2$	p-value
Immunization is free	161 (74.2)	170 (81.0)	2.797	0.094
Immunization is readily available	128 (59.0)	149 (71.0)	6.706	.010*
Proximity of health facility	134 (61.8)	108 (51.4)	4.631	.031*
Spouse's insistence	93 (42.9)	55 (26.2)	13.090	.000*
Prerequisite for child's admission into school	2 (0.9)	4 (1.9)	0.745	.388

Discussion

In this study, it was found that as a whole, routine immunization completeness was poor in both urban and rural communities in Bayelsa State, Nigeria. This is evidenced by the extremely low proportion of the population whom had completely been immunized according to the NPI schedule. This notwithstanding, timeliness and completeness rates for individual vaccines among the population in this study was good in both urban and rural communities.

For completeness of vaccine administration, BCG, Pentavalent 1, PCV, OPV 1 and Pentavalent 2 vaccines had the highest rates in the rural Community. In the urban community, immunization completeness rates for specific vaccines were significantly better than what was obtainable in the rural community. This was evidenced by improved completeness rates for BCG, Pentavalent 1-3, PCV 1-3, OPV 1-3, IPV and Vitamin A supplement which all had completeness rates of greater than 96.5%. This finding is in agreement with the findings of a study in South-South, Nigeria, where completeness rate of 76.3% was reported.[11] However, the findings of the present study are not corroborated by the findings of other authors whom reported far much less completeness rates for specific vaccines.[13,14] The reason for the disparity of results can be related to the differential geographical locations in which these other studies were carried out and also the efforts and activities of the State emergency routine immunization coordination centre (SERICC) recently initiated in the present study area. Also worthy of note is that the finding of better immunization completeness in urban than in rural communities in this study is not corroborated by the findings of Trevor et al., (2012) who reported that immunization completeness was significantly higher in more socially disadvantaged communities (rural).[14]

For timeliness of vaccine administration, Pentavalent 1-3, PCV 1-3 and OPV 1-3 vaccines had the highest rates ranging from 81.6% to 86.6% in the rural community. In the urban community, immunization timeliness rates for specific vaccines were significantly better than what was obtainable in the rural community. This was evidenced by improved timeliness rates for Pentavalent 1-3, PCV 1-3, OPV 1-3, IPV and Vitamin A vaccines/supplement which all had timeliness rates greater than 90.0%. This finding is in agreement with the findings of Ibraheem et al., (2019) at an immunization centre in North-Central Nigeria, where timeliness rate of 94.6% was reported.[15] However, these findings are not corroborated by the findings of other authors in both South-South Nigeria and beyond.[11,14,16] The reason for the disparity of results can be related to the differing sample sizes used by the studies as well as the intensity of intervention strategies and funding from government and partner agencies. Another reason for the non-agreement could be as a result of the activities of the recently-initiated SERICC interventions in the present study area. The implication of these findings to public health and indeed the general health and wellbeing of children in Nigeria as well as globally is promotion of the capacity for improvement in the routine immunization indices in Nigeria. This invariably strengthens the immune functioning of children and boosts their capacity to withstand vaccine-preventable diseases.

Concerning the barriers to immunization timeliness and completeness in this present study, it was found that for both the rural and urban communities, certain barriers stood out. These included the fear of possible complications that could occur as a result of taking the vaccine, the child feeling unwell during the time period for the vaccine to be administered as well as mothers not being well informed of the need to take their children for more immunization administrations

after the initial ones that had been given. These findings corroborate the findings of other authors who reported similar barriers to the achievement of timely and complete immunizations[15,17-19] The implication of these findings points to the need to improve social mobilization and health promotion activities which can be useful in enlightening the populace on crucial events to take note of concerning the immunization of their children.

In this present study, it was identified that certain perceived motivational factors were useful in enhancing completeness and timeliness of immunization uptake. In the rural community, these included the availability of free immunization services as well as having the health facility in close proximity to their homes. In the urban community, however, the most selected factors that were attributed to achieving timely and complete immunizations included the availability of immunization services and also the free provision of these services. These reasons for achieving immunization completeness and timeliness are supported by the findings of Masaharu et al., (2007)[20]. The implication for this finding is that it can be seen that the immunization and primary health care efforts of government and other concerned stakeholders are yielding results considering that accessibility to primary health care facilities as well as and affordability of the services is being achieved. These are also useful steps that can be adopted in promoting immunization timeliness and completeness.

Conclusion

In this study which aimed at comparing the timeliness and completeness rates of immunization uptake in children aged 12-23 months in urban and rural communities in Bayelsa State, it was found that immunization timeliness and completeness rates for specific vaccines were good for both urban and rural communities. However, better rates for both timeliness and completeness were found to be achieved in the urban community.

Recommendations

Following the findings in this research work, the following have been recommended to improve coverage in terms of timeliness and completeness in immunization activities in Bayelsa State and Nigeria at large.

- There is need to intensify social mobilization activities to increase immunization awareness in both urban and rural communities in Bayelsa State.
- Immunization as well as Primary Health Care efforts of government and concerned stakeholders should be maintained and further strengthened in order to ensuring achievement of highest standards of PHC in Nigeria as a whole.
- Further studies should include assessment of mother's attitude towards immunization activities in both urban and rural communities in Bayelsa as well as an assessment of health workers and community efforts geared at improving immunization services in both urban and rural areas.

References

1. Defo, B. K. (2014). Demographic, epidemiological, and health transitions: are they relevant to population health patterns in Africa? *Global Health Action*, *7*(1), 22443. https://doi.org/10.3402/gha.v7.22443

2. Maher, D., Smeeth, L., & Sekajugo, J. (2010). Health transition in Africa: practical policy proposals for primary care. *Bulletin of the World Health Organization*, *88*, 943–948. https://doi.org/10.2471/BLT.10.077891

3. Eziuka Oladokun, R. (2012). *Immunization Coverage in A Rural Community in Southwestern Nigeria*. https://doi.org/10.4172/2157-7560.1000143

4. Whitney, C. G., Zhou, F., Singleton, J., Schuchat, A., & Centers for Disease Control and Prevention (CDC). (2014). Benefits from immunization during the vaccines for children program era - United States, 1994-2013. *MMWR. Morbidity and Mortality Weekly Report*, *63*(16), 352–355. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/24759657

5. NPI/UNICEF march, (2003). Assuring vaccine security in Nigeria. Report of NPI/UNICEF vaccine security mission.

6. World Health Organization. (2009). Epidemiology of the Unimmunized Child. Findings from the Peer Reviewed Published Literature, 1999 – 2009. Prepared for the World Health Organization, December 2009.

7. WHO/UNICEF, (2018) Nigeria estimates of immunization coverage https://www.who.int/news-room/fact-sheets/detail/immunization-coverage

8. Ophori, E. A., Tula, M. Y., Azih, A. V, Okojie, R., & Ikpo, P. E. (2014). Current trends of immunization in Nigeria: prospect and challenges. *Tropical Medicine and Health*, *42*(2), 67–75. https://doi.org/10.2149/tmh.2013-13

9. Adedokun, S. T., Uthman, O. A., Adekanmbi, V. T., & Wiysonge, C. S. (2017). Incomplete childhood immunization in Nigeria: a multilevel analysis of individual and contextual factors. *BMC Public Health*, *17*(1), 236. https://doi.org/10.1186/s12889-017-4137-7

10. Antai, D. (2009). Inequitable childhood immunization uptake in Nigeria: a multilevel analysis of individual and contextual determinants. *BMC Infectious Diseases*, *9*(1), 181. https://doi.org/10.1186/1471-2334-9-181

11. Nalley, J.C. &Maduka, O. (2019). Completeness and Timeliness of Immunization among Children aged 12 to 23 months in South-South Nigeria. *Journal of Community Medicine and Primary Health Care*, 31(1) 22-31.

12. Ngondi, J., Reacher, M., Matthews, F., Brayne, C., & Emerson, P. (2009). Trachoma survey methods: a literature review. *Bulletin of the World Health Organization*, *87*, 143–151. https://doi.org/10.1590/S0042-96862009000200017

13. Noh, J-W., Kim, Y-M., Akram, N., Yoo, K-B.,Park, J., Cheon, J., …, Stekelenburg, J. (2018) Factors affectingcomplete and timely childhood immunizationcoverage in Sindh, Pakistan; A secondary analysisof cross-sectional survey data. *PLoS ONE* 13(10), e0206766. Available online at: https://doi.org/10.1371/journal.pone.0206766

14. Trevor, J.B.D., Yunsong, C., Robert, S. & Louise, P. (2012). Immunization Completeness of Children Under Two Years of Age inNova Scotia, Canada. *Can J Public Health*, 103(5):e363-e367.

15. Ibraheem, R., Abdulkadir, M., Akintola, M. & Adeboye, M. (2019). Determinants of Timely Presentation for Birth Dose Vaccination at an Immunization Centre in North-central Nigeria. *Annals of Global Health,*85(1), 20, 1–9. DOI: https://doi.org/10.5334/aogh.725

16. Nurnabi, S., Marufa, S., Nausad, A., Raisul, A., Rashidul, A.M., Muhammad, A. & Abdur, R.S. (2018). Coverage, Timelines, and Determinants of IncompleteImmunization in Bangladesh. *Trop. Med. Infect. Dis.*, 3, 72; DOI:10.3390/tropicalmed3030072.

17. Abdulraheem, I.S., Onajole, A.T., Jimoh, A.A.G. &Oladipo, A.R. (2011). Reasons for incomplete Vaccination and factors formissed opportunities among rural Nigerian children.*Journal of Public Health and Epidemiology*, 3(4), pp. 194-203. Available online at:http://www.academicjournals.org/jphe

18. Aregawi, H.G., Gebrehiwot, T.G., Abebe, Y.G.,Meles, K.G., Wuneh, A.D. (2017) Determinants ofdefaulting from completion of child immunizationin Laelay Adiabo District, Tigray Region, NorthernEthiopia: A case-control study. *PLoS ONE* 12(9):e0185533. Available online at: https://doi.org/10.1371/journal.pone.0185533

19. Nalley, J.C. &Maduka, O. (2019). Completeness and Timeliness of Immunization among Children aged 12 to 23 months in South-South Nigeria. *Journal of Community Medicine and Primary Health Care,* 31(1) 22-31.

20. Maekawa M, Douangmala S, Sakisaka K, Takahashi K, Phathammavong O, Xeuatvongsa A, Kuroiwa C. (2005). Factors affecting routine immunization coverage among children aged 12-59 months in Lao PDR after regional polio eradication in Western Pacific region. Biosci Trends, 1(1):43-51.