BUMJ

RESEARCH ARTICLE   OPEN ACCESS

Immunization coverage among children aged 0-23 months at a tertiary hospital, Southwestern, Nigeria: a retrospective study

Temitayo-Oboh AO[1][ID], Adegbola AA[2][ID], Dedeke IOF[3][ID], Adeniyi MA[1][ID], Soyannwo T[1][ID], Ajewole GA[1][ID], Sanni SB[1][ID]

[1]*Department of Community Medicine and Primary Care, Federal Medical Centre, Idi-Aba, Abeokuta, Ogun State, Nigeria*
[2]*Shiloh Childcare Ltd, 19, Saki Crescent Aguda, Surulere, Lagos State, Nigeria.*
[3]*Department of Pediatrics, Federal Medical Centre, Idi-Aba, Abeokuta, Ogun State, Nigeria.*

Abstract
Objective: This study aimed at assessing the immunization coverage and dropout rates of children aged 0-23 months at a tertiary hospital in Ogun State, Southwestern Nigeria.
Methods: This retrospective descriptive study reviewed the routine immunization data of children immunized at the Federal Medical Centre, Abeokuta, between January and December 2021. A proforma created on Microsoft Excel 2015 was used to extract data from the NHMIS register. Also, analysis was done using Microsoft Excel 2015 to generate the frequencies and proportion graphs.
Results: The mean coverage rate of administered antigens was 58.9%; BCG had the highest coverage (74.9%), MCV 2 had the least (39.0%), and persistently low coverage with a nadir in January (16.7%) while coverage for the other antigens ranged from 57.6% to 61.5%. The BCG coverage was consistently high except for June, September, and October but peaked in May (133.3%) when the Pentavalent 1 vaccine had the highest coverage. Other vaccines had less than 80.0% coverage except in July, where Yellow fever and MCV 1 had coverage of 82.0%. Overall, there was a sharp drop in the dropout rate from January (78.0%) to March (27.0%); the least was Penta 1 to Penta 3 (6.3%), then BCG to MCV 1 (19.8%) while the highest was MCV 1 to MCV 2 (35.0%).
Conclusion: The vaccine coverage rate was suboptimal, with an unacceptably high dropout rate, especially for vaccines with longer intervals. Measures to improve vaccine coverage and reduce dropout rates, such as daily immunization and reminders to caregivers, are necessary.

Keywords: Immunization, Coverage rate, Dropout rate, Children 0-23 months, Tertiary facility

Plain English Summary

One of the most cost-effective public health interventions to reduce child mortality and morbidity, particularly in low- and middle-income countries, is immunization. Routine vaccination coverage has remained very low, especially in Nigeria, making it difficult to achieve the Sustainable Development Goal (SDG) 3 target. This study aimed at knowing the immunization coverage and dropout rates of children aged 0-23 months at a tertiary hospital in Ogun State, Southwest Nigeria.

The routine immunization data of children immunized at the Federal Medical Centre, Abeokuta, between January and December 2021 were reviewed.

Correspondence:
Temitayo-Oboh, Abiola O
Department of Community Medicine and Primary Care,
Federal Medical Centre, Idi-Aba, Abeokuta,
Ogun State, Nigeria,
+2348033540268, biolatemitayooboh@gmail.com

The average coverage rate of administered antigens was 58.9%; BCG had the highest coverage (74.9%), MCV 2 had the least (39.0%), and the coverage for the other antigens ranged from 57.6% to 61.5%. The least dropout rate was Penta 1 to Penta 3 (6.3%), then BCG to MCV 1 (19.8%), while the highest was MCV 1 to MCV 2 (35.0%). The vaccine coverage was suboptimal, with high dropout rates, especially for vaccines with longer intervals. Hence, there is a need to put measures in place to improve vaccine coverage and reduce dropout rates.

Introduction
Access to vaccines has significantly reduced the hitherto high child mortality and morbidity associated with vaccine-preventable diseases (VPDs), particularly in low and middle-income countries such as Nigeria (1). Vaccine-preventable diseases such as Tetanus, Tuberculosis, Poliomyelitis, Pertussis, Diphtheria, Yellow fever, Hepatitis B, and Measles have continuously increased morbidity and mortality among children less than five years (2). In 2018, it was estimated that over 700,000 children died from VPDs, ninety-nine percent (99%) of whom lived in low- and middle-income countries (3). More than 2,300 Nigerian children in 2021 died every day from diseases that could easily be treated or prevented by vaccination (4). Immunization has been one of the most cost-effective public health interventions to reduce child mortality and morbidity (5). Globally, it is estimated to avert between two to three million deaths yearly (5). The World Health Organisation (WHO) launched the Expanded Program on Immunization (EPI) in 1974 intending to reduce morbidity and mortality from six VPDs (6). According to the WHO childhood revised immunization schedule, children are fully immunized when they have received one dose of the Bacillus Calmette Guerin (BCG) vaccine, three doses of Diphtheria, Pertussis, Tetanus toxoid, Hepatitis B, and Haemophilus influenza type B (Pentavalent) vaccine, three doses of Oral Polio Vaccine (OPV), one dose of Yellow fever (YF) vaccine and two doses of Measles Containing Vaccine (MCV) by the fifteenth month of age (7).

In Nigeria, the EPI was introduced in 1978 to provide routine immunization to children less than two years. This program recorded initial successes, which were associated with the reduction of childhood mortality (5). The National Demographic Health Survey (NDHS) 2018 reported that only 21% of children aged 12 – 23 months had received all age-appropriate vaccinations in Nigeria, while 31% of children aged 12 – 23 months had received all basic vaccination (one dose of Bacillus Calmette Guerin [BCG], three doses of Diphtheria, Pertussis, Tetanus toxoid [DPT], three doses of

Oral Polio Vaccine [OPV] and one dose of Measles [MCV]. This survey also showed that 19% of children aged 12-23 months had not received any form of vaccination during the period under the survey (8). Ogun state has a vaccination coverage of between 20% -30%; this figure is way below the Sustainable Development Goal (SDG) 3 target of more than 90% coverage for children aged 12-23 months (8).

In 2020, 17.1 million infants did not receive an initial dose of DPT, and an additional 5.6 million were partially vaccinated globally (9). More than 60% of these 23 million children live in 10 countries: Angola, Brazil, the Democratic Republic of the Congo, Ethiopia, India, Indonesia, Mexico, Nigeria, Pakistan, and the Philippines (9). Nigeria has the world's highest number of unimmunized children, estimated at 4.3 million in 2018 (10). Even though the government provides vaccines free of charge, coverage rates for routine immunization antigens in many parts of Nigeria still fall below 50% (11). Despite the narrow range of antigens currently available to the average Nigerian child from the government schedule (including BCG, OPV, Pentavalent vaccine, Hepatitis B vaccine, Yellow fever, and Measles), routine vaccination coverage remained very low (12). Also, numerous programs and strategies designed by the government and development partners have failed to improve vaccination coverage in some parts of the country (13).

This study aimed at assessing the immunization coverage and dropout rates of children aged 0-23 months at a tertiary hospital in Ogun state, Southwest Nigeria. We believe that findings from this study could help tailor strategies and operational plans to address immunization gaps and reach children in every district with life-saving vaccines. In addition, findings from this study will also go a long way to help policymakers develop strategies and guide decision-making on achieving the SDG 3 of >90% vaccine coverage.

Methods
Study Area
The study was conducted at Federal Medical Centre Abeokuta (FMCA), one of the tertiary hospitals in Ogun State, Nigeria. It is in the city of

Abeokuta, the state capital. The center is a 550-bedded regional tertiary health facility that provides specialized medical care to indigenes of Ogun state and neighboring states as well as immunization services to children and adults alike. The child welfare clinic renders immunization services under the Community Medicine and Primary Care (CMPC) department's purview. It serves about ten communities within Abeokuta South and Obafemi-Owode Local Government Areas (LGAs), mainly in the urban parts of the LGAs. The total population of the catchment areas under FMCA and the target population for routine immunization for 2021 were 30,800 and 1,262 (4% of the total population), respectively, using two fixed immunization sessions per week. The immunization clinic is a bungalow building close to the hospital's second entrance. It has a staff strength of nine (9) comprising nurses (2), community health extension workers (3), scientific officers (3), and one health attendant. Its immunization activities are carried out on Mondays and Wednesdays.

Study Design
A retrospective descriptive review of routine immunization data of children immunized in the Federal Medical Centre, Abeokuta, was conducted for 52 weeks between January 1st, 2021, and December 31st, 2021.

Study Population
Children aged 0-23 months who received vaccines at FMCA and had their records in the immunization register within the study period.

Sample Size and Sampling Technique
All children (928) on record who received vaccination for the period under review were assessed.

Description of Data Base / Data Collection
Routine data on immunization for FMCA is captured through the daily National Health Management Information System (NHMIS) register for immunization, collected, and submitted monthly to the LGA monitoring and evaluation officer and the LGA immunization officer. Routine data captured includes but is not limited to daily and monthly numbers of antigens administered in the immunization unit.
Data were extracted from the NHMIS register, 2019 version, for immunization using a proforma created on Microsoft Excel 2015, and this was used to calculate immunization indices to assess antigen coverage and dropout rate. The proforma was designed to capture monthly coverage of specific vaccines and dropout rates. The antigens of interest were BCG, OPV (OPV1 and 3), Penta (Penta 1 and 3), MCV (MCV 1 and 2), and YF vaccines.

Operational terms (14, 15, 16, 17)
Immunization coverage
Immunization coverage is the percentage of eligible fully-immunized infants compared to the total number of surviving infants in the target population.

Immunization coverage rate (for a particular vaccine)
$$= \frac{\text{The number receiving all doses}}{\text{Number in the target population}} \times 100$$

Mean immunization coverage is the average coverage rate of all the six antigens

Mean immunization coverage
$$= \frac{\text{coverage(BCG + Penta 1 + Penta 3 + MCV 1 + YF + MCV 2)}}{6}$$

Dropout rates
The dropout rate is defined as the percentage of children that started their immunization series but did not finish it for some reasons. The dropout rate was calculated by comparing the number of infants initiated in the vaccination schedule to those who completed it.

$$\text{Penta 1 to Penta 3} = \frac{(\text{Penta1 doses} - \text{Penta 3 doses})}{\text{Penta 1 doses}} \times 100$$

$$\text{BCG to MCV 1} = \frac{(\text{BCG doses} - \text{MCV 1 doses})}{\text{BCG doses}} \times 100$$

$$\text{MCV 1 to MCV 2} = \frac{(\text{MCV 1 doses} - \text{MCV 2 doses})}{\text{MCV 1 doses}} \times 100$$

Data Analysis
Analysis was done using Microsoft Excel 2015 to generate the frequencies and proportion graphs. The trends of immunization coverage across the reporting months were computed, and dropout rates were calculated. These outputs were used to deduce the accessibility and utilization of the healthcare facility.

Results
Over the year of review, 928 babies presented for the first vaccine, BCG. The mean coverage rate of antigens administered to children between January and December 2021 was 58.9%. The BCG antigen had the highest coverage of 74.9%, while MCV 2 had the least coverage at 39.0%. Coverage for the other antigens ranged from 57.6% to 61.5% (Table 1).

Table 1: Annual immunization coverage rate of vaccines in 2021 at FMCA

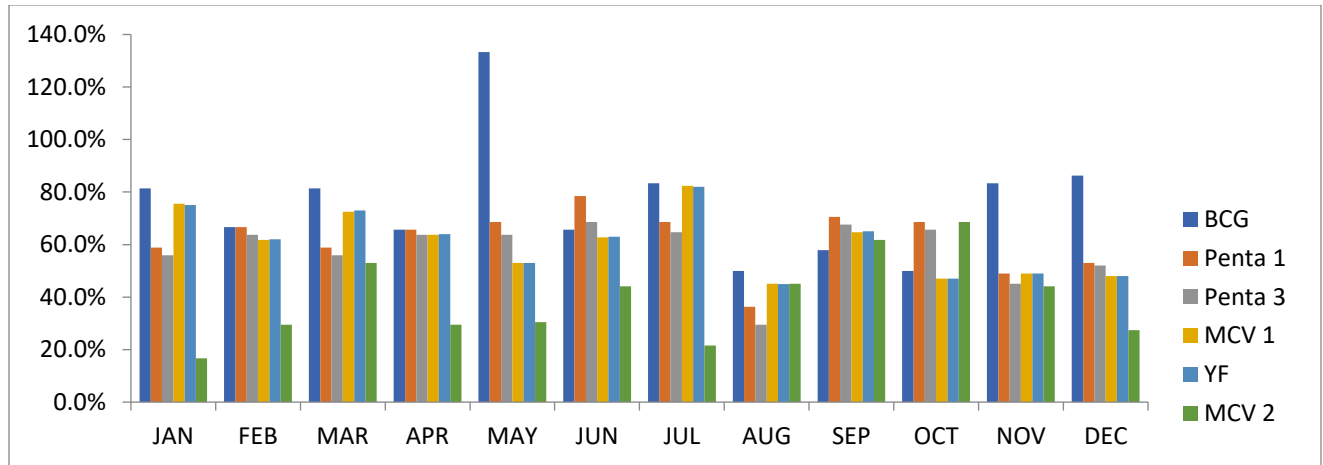| Antigens	Total number of vaccine doses administered (N= 928)	Coverage rate (%)
BCG	928	74.9
Penta 1	758	61.5
Penta 3	710	57.6
MCV 1	740	60.1
YF	740	60.1
MCV 2	481	39.0
Mean coverage rate (%)	*58.9%*	

Figure 1: Monthly vaccine coverage in 2021 at FMCA

The BCG antigen had the highest coverage of all the antigens across the months in 2021, apart from June, September, and October, where the Penta 1 vaccine had the highest coverage. BCG coverage was highest in May (133.3%). However, MCV 2 vaccine had the least coverage for most of the months, with its lowest coverage in January at 16.7%. Every other vaccine had less than 80.0% coverage from January to December except in July, where YF and MCV 1 had coverage of 82.0% (Figure 1).
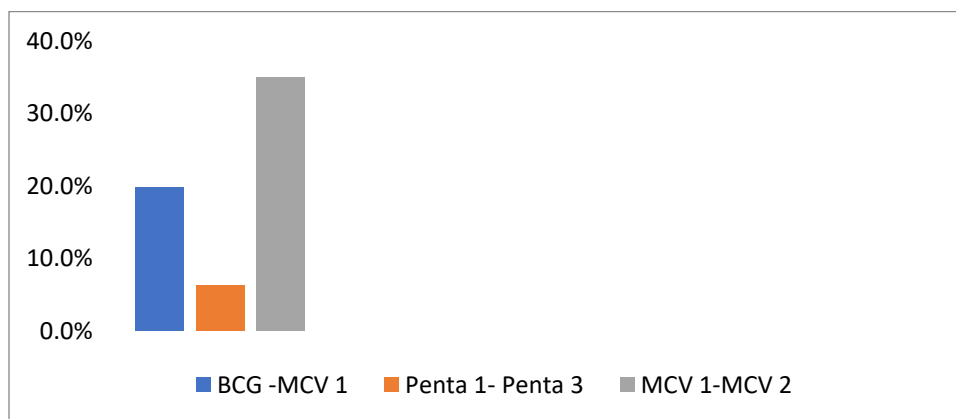

Figure 2: Annual dropout rate of vaccines

Relative to the other calculated annual dropout rate (DOR), Penta 1 to Penta 3 had the least dropout rate at 6.3%, followed by BCG to MCV 1 at 19.8%, while MCV 1 to MCV 2 had the highest DOR at 35.0% (Figure 2).
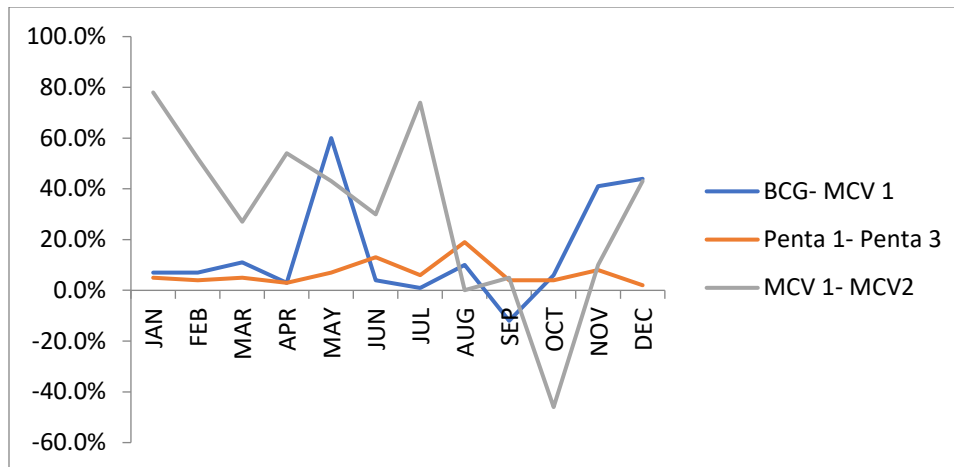
Figure 3: Monthly vaccine dropout rate

The MCV 1 to MCV 2 dropout rate fell from 78.0% in January to 27.0% in March, after which it peaked at 74.0% in July. It dipped to a nadir of -46.0% in October, then rose to 43.0% in December.

The proportion of those that dropped out between BCG and MCV1 followed almost the same pattern with MCV 1 to MCV 2 dropout rate. It was relatively stable from January to March at around 10.0%, after which it rose to a peak of 60.0% in May. It plummeted to its lowest in September at -12.0% and rose to 41.0% in December.

The proportion of those that dropped out from Penta 1 to Penta 3 was relatively stable from January to May at just below 10.0%. It rose to 19.0% in August but fell to less than 10.0% in subsequent months (Figure 3).

Discussion

The study determined the coverage and dropout rates of specific vaccines among children aged 0-23 months based on the review of immunization records in a tertiary facility. The overall immunization coverage was slightly above half (58.9%), which is below the Reaching Every District (RED) subnational benchmark of 80.0% immunization coverage for sustained control of vaccine-preventable diseases and SDG 3 target of more than 90.0% coverage for children aged 12-23 months (8, 18). Although higher than vaccination coverage of between 20.0% - 30.0% in Ogun State revealed by the NDHS 2018 report and coverage rates for routine immunization antigens in many parts of Nigeria (8, 11).

There were variations in the coverage rate for individual vaccines, but BCG still had the highest. Similarly, BCG antigens had the highest target across the months except in June, September, and October. Only BCG antigen hit the required

subnational target of 80.0% for immunization for five months out of twelve months in 2021 (January, March, May, July, November, and December). The required target for other vaccines was not met throughout 2021. Consequently, studies have documented a trend showing higher coverage with antigens given at birth (BCG, OPV, Hepatitis B Virus 1) and poor compliance with those given at later ages (2, 11). The coverage rate for BCG is higher than in other African studies (19). Other studies have recorded much higher figures among children aged 12-23 months in Enugu, Ghana, and Nepal (12, 20, 21). This immunization coverage variation in our study might be due to various reasons. Adduced for high coverage with BCG might be due to the vaccination of all babies delivered in the health facility before they are discharged home. The overall low coverage could result from active immunization of babies occurring just twice a week, as this tends to increase the chances of missed opportunities.

Recent missed opportunity for vaccination (MOV) country assessments in the Americas and African regions of the WHO showed that 23.0% to 96.0% of eligible children who visited a health facility for vaccination or medical care left the health facility without receiving the vaccine doses that they needed (22). A study carried out in Ondo state Nigeria by Fatiregun et al. observed that MOV was mainly among those who were at the health facility for a non-vaccination visit, and the highest prevalence was observed among those who had medical consultations, followed by those who accompanied their caregiver and those who were brought for healthy child visits (22). Furthermore, MCV 2 recorded the least coverage in 2021, and about 35.0% of children who had MCV 1 did not return for the second dose of the vaccine. MCV 2

recording the least could be attributed to the fact that the government newly introduced it; based on this, community awareness might be low.

Dropout rates are measured to determine immunization program continuity. It shows the number of children who start but fail to complete the immunization process (2). The WHO standard is that a dropout rate greater than 10.0% is unacceptable. The dropout rate was highest for MCV 1 to MCV 2, followed by BCG to MCV 1, but a standard rate with Penta 1 to Penta 3. A similar trend was observed in West Cameroon in a descriptive cross-sectional study where the dropout rate increased from 23.3% - 31.7% for BCG and the last vaccine planned (19).

Many reasons have been attributed to an unacceptable dropout rate. A study found that a longer interval between antigens increases the dropout rate. It is also suggested that longer intervals could make the mother forget the time scheduled for immunization and may not have the time to make scheduled visits (23). Other reasons found in studies include non-availability of vaccines, maternal knowledge of vaccines and routine immunization, attending antenatal care and postnatal care, sociodemographic factors such as place of delivery, geographical accessibility, children (birth order and sex), household number, number of children (2, 11, 23, 24, 25, 26).

Strengths and Limitations

This study being a record-based evaluation of access and utilization of immunization services in a tertiary institution, could not examine the factors responsible for the low coverage and high dropout rate. Another possible limitation of this study is that it was based on records that could have errors, mistakes in recording data, etc. We believe that because it was in a tertiary institution and records are taken by skilled professionals, if there were record errors, they would be minimal. However, this study provides valuable information for stakeholders to work with to improve immunization services.

Conclusion

The vaccine coverage rate among children aged 0-23 months in a tertiary hospital was suboptimal, and the dropout rate was high. An unacceptable drop rate was observed with vaccines with longer intervals. Implementing measures such as creating more awareness through community outreaches, making vaccination services available on all days of the week, using tracer cards to identify children that missed their appointments, and sending regular reminders to parents/ caregivers can help improve vaccine coverage and reduce dropout rates.

List of abbreviations

BCG: Bacillus Calmette Guerin
CMPC: Community Medicine and Primary Care
DOR: Dropout rate
DPT: Diphtheria, pertussis, and tetanus toxoid
EPI: Expanded program on immunization
FCMA: Federal Medical Centre Abeokuta
LGAs: Local Government Areas
MCV 1: Measles containing vaccine 1
MCV 2: Measles containing vaccine 2
MOV: Missed opportunity for vaccination
NDHS: National Demographic Health Survey
NHMIS: National Health Management Information System
OPV: Oral polio vaccine
Penta1: Pentavalent 1
Penta3: Pentavalent 3
RED: Reaching every district
RI: Routine immunization
SDG: Sustainable Development Goal
VPDs: Vaccine-preventable diseases
WHO: World Health Organization
YF: Yellow fever

Declarations

Availability of data and materials
The datasets used and analyzed in this study are available from the corresponding author upon reasonable request.

Authors' contributions
T-OAO conceptualized the research idea and designed the study. AGA & SSB participated in data acquisition, analysis, and interpretation. AMA participated in the literature search and provided technical inputs. AAA and ST prepared the draft manuscript. T-OAO and DIOF participated in revising the manuscript for intellectual content. All the authors read and approved the final version of the manuscript.

References

1. Durowade KA, Musa OI, Sanni TA, Adeniyi MA, Osagbemi GK, Mudashiru RB. Correlates, Predictors and Cluster Analysis of Routine Vaccination Status among Infants in Ido-Osi Local Government Area, Ekiti State, Southwest Nigeria. Annals of RSCB 2021 Apr 13;25(4):4533-53.
2. Adebayo BE, Oladokun RE, Akinbami FO. Immunization coverage in a rural community in southwestern Nigeria. J Vaccines Vaccin. 2012;3(4):1-6. https://doi.org/10.4172/2157-7560.1000143
3. Frenkel LD. The global burden of vaccine-preventable infectious diseases in children less than 5 years of age: Implications for COVID-19 vaccination. How can we do better? In Allergy and Asthma Proceedings OceanSide Publications, Inc. 2021 Sep 1;42(5):378-385. https://doi.org/10.2500/aap.2021.42.210065
4. UNICEF Nigeria. UNICEF Nigeria and Facebook test the effectiveness of immunization messages in Nigeria. 2021. https://www.unicef.org/nigeria/press-releases/unicef-nigeria-and-facebook-test-effectiveness-immunization-messages-nigeria
5. Adenike OB, Adejumoke J, Olufunmi O, Ridwan O. Maternal characteristics and immunization status of children in North Central of Nigeria. Pan Afr Med J. 2017 Mar 20;26. https://doi.org/10.11604/pamj.2017.26.159.11530
6. Tamirat KS, Sisay MM. Full immunization coverage and its associated factors among children aged 12–23 months in Ethiopia: further analysis from the 2016 Ethiopia demographic and health survey. BMC public health. 2019 Jul 30;19:1-7. https://doi.org/10.1186/s12889-019-7356-2
7. Duru CB, Iwu AC, Uwakwe KA, Diwe KC, Merenu IA, Emerole CA, Adaeze CA, Onyekuru CU, Ihunnia O. Assessment of immunization status, coverage, and determinants among under 5-year-old children in Owerri, Imo State, Nigeria. Open Access Library Journal. 2016 Jun 15;3(06):1. https://doi.org/10.4236/oalib.1102753
8. Nigeria Population Commission (NPC) [Nigeria] and ICF. Nigeria Demographic and Health Survey 2018 Key Indicators Report. 2019. https://ngfrepository.org.ng:8080/jspui/handle/123456789/3145
9. World Health Organization (WHO). Immunization coverage. 2022. https://www.who.int/news-room/fact-sheets/detail/immunization-coverage
10. United bank for Africa(UBA). Gavi champion for immunization in Africa. 2019. https://www.ubagroup.com/nigeria/gavi-champion-for-immunisation-africa/
11. Adedire EB, Ajayi I, Fawole OI, Ajumobi O, Kasasa S, Wasswa P, Nguku P. Immunisation coverage and its determinants among children aged 12-23 months in Atakumosa-west district, Osun State Nigeria: a cross-sectional study. BMC public health. 2016 Aug;16:1-8. https://doi.org/10.1186/s12889-016-3531-x
12. Tagbo BN, Eke CB, Omotowo BI, Onwuasigwe CN, Onyeka EB, Mildred UO. Vaccination coverage and its determinants in children aged 11-23 months in an urban district of Nigeria. World Journal of Vaccines. 2014;4:175-183. https://doi.org/10.4236/wjv.2014.44020
13. National Bureau of Statistics (NBS) and United Nations Children's Fund (UNICEF). Multiple indicator cluster survey 2016-17, survey findings report. 2018. https://www.unicef.org/nigeria/reports/multiple-indicator-cluster-survey-2016-17-mics
14. World Health Organization, UNICEF. Increasing immunization coverage at the health facility level. 2002. http://apps.who.int/iris/bitstream/handle/10665/67791/WHO_V&B_02.27.pdf;jsessionid=71A551546F7CB31C7CA7AF3097AA3476?sequence=1
15. Health Education and Training (HEAT). Immunization module: monitoring your immunization programme. How to measure

immunization coverage rates. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=53371&section=1.4.1

16. Health Education and Training (HEAT). Immunization module: monitoring your immunization programme. How to measure dropout rates. https://www.open.edu/openlearncreate/mod/oucontent/view.php?id=53371&section=1.4.2

17. Masresha BG, Luce R, Okeibunor J, Shibeshi ME, Kamadjeu R, Fall A. Introduction of the second dose of measles-containing vaccine in the childhood vaccination programs within the WHO Africa Region–lessons learnt. J Immunol. Sci. 2018 Jul 28:113. https://doi.org/10.29245/2578-3009/2018/si.1117

18. Gunnala R, Ogbuanu IU, Adegoke OJ, Scobie HM, Uba BV, Wannemuehler KA, Ruiz A, Elmousaad H, Ohuabunwo CJ, Mustafa M, Nguku P. Routine vaccination coverage in northern Nigeria: results from 40 district-level cluster surveys, 2014-2015. PloS one. 2016 Dec 9;11(12):e0167835. https://doi.org/10.1371/journal.pone.0167835

19. Ateudjieu J, Yakum MN, Goura AP, Tembei AM, Ingrid DK, Bita'a Landry B, Kenfack B, Amada L, Tadzong I, Bissek AC. EPI immunization coverage, timeliness, and dropout rate among children in a West Cameroon health district: a cross-sectional study. BMC public health. 2020 Feb;20(1):1-11. https://doi.org/10.1186/s12889-020-8340-6

20. Adokiya MN, Baguune B, Ndago JA. Evaluation of immunization coverage and its associated factors among children 12–23 months of age in Techiman Municipality, Ghana, 2016. Archives of Public Health. 2017 Dec;75:1-10. https://doi.org/10.1186/s13690-017-0196-6

21. Rauniyar SK, Iwaki Y, Yoneoka D, Hashizume M, Nomura S. Age-appropriate vaccination coverage and its determinants in children aged 12–36 months in Nepal: a national and subnational assessment. BMC Public Health. 2021 Nov 10;21:1-12. https://doi.org/10.1186/s12889-021-11841-2

22. Fatiregun AA, Lochlainn LN, Kaboré L, Dosumu M, Isere E, Olaoye I, Akanbiemu FA, Olagbuji Y, Onyibe R, Boateng K, Banda R. Missed opportunities for vaccination among children aged 0–23 months visiting health facilities in a southwest State of Nigeria, December 2019. Plos one. 2021 Aug 27;16(8):e0252798. https://doi.org/10.1371/journal.pone.0252798

23. Sadoh AE, Eregie CO. Timeliness and completion rate of immunization among Nigerian children attending a clinic-based immunization service. Journal of health, population, and nutrition. 2009 Jun;27(3):391-395. https://doi.org/10.3329/jhpn.v27i3.3381

24. Mekonnen D, Derbie A, Desalegn E. TB/HIV co-infections and associated factors among patients on directly observed treatment short course in Northeastern Ethiopia: a 4 years retrospective study. BMC research notes. 2015 Dec;8:1-6. https://doi.org/10.1186/s13104-015-1664-0

25. Kayembe-Ntumba HC, Vangola F, Ansobi P, Kapour G, Bokabo E, Mandja BA, Bompangue D. Vaccination dropout rates among children aged 12-23 months in the Democratic Republic of the Congo: a cross-sectional study. Archives of Public Health. 2022 Dec;80(1):1-0. https://doi.org/10.1186/s13690-021-00782-2

26. Baguune B, Ndago JA, Adokiya MN. Immunization dropout rate and data quality among children 12–23 months of age in Ghana. Archives of Public Health. 2017 Dec;75(1):1-8. https://doi.org/10.1186/s13690-017-0186-8