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Research Article

Performance of Routine and Supplementary Poliovirus Immunisation Activities in Kano and Katsina States, Nigeria, 2020–2024

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Abstract

Background: Routine immunisation and supplementary immunisation activities are central to maintaining population immunity against poliovirus, but state-level averages may conceal local service and data-quality gaps. This study assessed their performance in Kano and Katsina States, Nigeria, from 2020 to 2024.

Methods: A retrospective longitudinal ecological study reviewed eligible routine-immunisation and supplementary-immunisation programme records from 78 local government areas. Indicators were summarised by state, year and local government area. State differences were assessed using Welch’s independent-samples t test, while Penta3 trends were examined using a linear mixed-effects model.

Results: OPV3, IPV1 and Penta3 coverage increased in both states, while Penta dropout, vaccine stock-outs and estimated zero-dose prevalence generally declined. Katsina’s outreach-session implementation fell to 59.00% in 2024. Independent-monitoring coverage increased and missed-child proportions declined, reaching 8.38% in Katsina and 5.64% in Kano in 2024. LQAS pass rates improved but remained suboptimal. Penta3 coverage increased by 4.136 percentage points annually ($p<0.001$). These findings support subnational monitoring and targeted corrective action across both states.

Conclusion: Immunisation performance improved, but denominator anomalies, local coverage inequalities, outreach weaknesses, missed children and delayed outbreak-response rounds persisted.

Keywords: routine immunisation; supplementary immunisation activities; poliovirus; OPV3; Penta3; zero-dose children; missed children; LQAS; Nigeria.

Introduction

Sustained population immunity is required to prevent the emergence and spread of circulating vaccine-derived polioviruses. Routine immunisation protects successive birth cohorts through scheduled oral and inactivated poliovirus vaccine doses, while supplementary immunisation activities provide additional doses to children within targeted age groups irrespective of previous vaccination status. The two delivery platforms are complementary: routine services maintain immunity over time, whereas campaigns rapidly close immunity gaps and support outbreak control [1].

Routine-immunisation performance cannot be judged by a single administrative coverage estimate.

It also depends on completion of multidose schedules, implementation of fixed and outreach sessions, vaccine availability, reporting quality and the extent to which zero-dose and under-immunised children are reached.

Administrative coverage may be distorted by inaccurate target-population denominators, movement across administrative boundaries, duplicate reporting and weak reconciliation of doses. Consequently, values above 100% may coexist with communities in which substantial numbers of children remain unvaccinated [2,3].

Supplementary immunisation activity performance is similarly multidimensional. Administrative coverage is supplemented by independent monitoring, lot quality assurance sampling, missed-child data, household non-compliance, settlement accessibility and the timeliness of outbreak-response rounds. These measures are important because favourable state averages can conceal settlements, households or population groups that vaccination teams did not reach [4–8].

Northern Nigeria has implemented several approaches to strengthen immunisation, including mobile teams, household-based microplanning, community mobilisation, engagement with resistant households and systematic use of campaign-monitoring data [4,8–12]. These interventions have improved access in high-risk settings, but insecurity, population mobility, vaccine hesitancy, inaccurate microplans, service interruptions and weak data quality continue to create geographically concentrated immunity gaps [2,3,13,14].

Kano and Katsina States contain 78 local government areas with heterogeneous urban, rural, mobile, border and hard-to-reach populations. Although both states have implemented routine and supplementary poliovirus immunisation activities, evidence comparing performance across states, years and local government areas during 2020–2024 has been limited. This study therefore assessed routine-immunisation coverage, service delivery, dropout, stock-outs, reporting, zero-dose and under-immunised prevalence, supplementary-immunisation quality and outbreak-response timeliness in Kano and Katsina States.

Materials and Methods

Study design and setting

A retrospective longitudinal ecological design was used. The study covered Kano and Katsina States in Northwest Nigeria from 1 January 2020 to 31 December 2024. Kano State has 44 local government areas and Katsina State has 34, giving 78 local government areas. The local government area-year was the unit for routine-immunisation analyses, while state-year and local government area-round records were used for supplementary-immunisation analyses.

Study population and sampling

The study population comprised eligible routine-immunisation and supplementary-immunisation programme records generated in the 78 local government areas during the study period. A total-population sampling approach was used, and all records meeting the eligibility criteria were included. Records were eligible when the state, local government area, year or campaign round and the variables required for the relevant indicator could be established. Duplicate records, records outside the two states or study period and records that could not be reconciled to a valid reporting unit were excluded.

Data sources and extraction

Data were obtained from District Health Information System 2 routine-immunisation reports, vaccine-utilisation and stock records, fixed- and outreach-session reports, supplementary-immunisation activity microplans, campaign-preparedness records, independent-monitoring reports, lot quality assurance sampling results, missed-child registers, non-compliance reports and outbreak-response assessments. A structured programme-data extraction form captured state, local government area, reporting period, target population, vaccine doses administered, service-delivery indicators, vaccine availability, reporting indicators, campaign-monitoring results and outbreak-response intervals.

Data quality procedures included range and consistency checks, review of duplicate identifiers, reconciliation of conflicting totals and comparison of state summaries with local-government records. Administrative coverage estimates above 100% and negative dropout values were retained as reported because they constituted findings relevant to denominator and reporting quality rather than values to be automatically corrected.

Study indicators

Routine-immunisation indicators included OPV1, OPV3, IPV1, IPV2, Penta1 and Penta3 administrative coverage; pentavalent-vaccine dropout; implementation of planned fixed and outreach sessions; vaccine stock-out rate; reporting completeness and timeliness; estimated zero-dose prevalence; estimated under-immunised prevalence; and the number of local government areas with OPV3 or Penta3 coverage above 100%. Penta dropout was calculated from the difference between first- and third-dose coverage relative to first-dose coverage.

Supplementary-immunisation indicators included the number of campaign rounds, administrative coverage, independent-monitoring coverage, missed-child proportion, contribution of non-compliance to missed children, inaccessible-settlement rate and lot quality assurance sampling outcomes. Outbreak-response timeliness was measured from Day 0 to the rapid-response round, first large-scale round and second large-scale round, using the prescribed response periods in the applicable programme procedures [15].

Statistical analysis

The analytical datasets were processed in Python. Frequencies, percentages and means were used to summarise performance by state, year and local government area. Five-year local-government summaries were obtained by averaging annual indicator values, while state-year summaries were calculated from the programme records. No composite immunisation-performance index was created because combining indicators could conceal failure in a specific programme component.

Mean performance in Kano and Katsina was compared using Welch's independent-samples t test because equality of variances was not assumed. Temporal and state differences in Penta3 administrative coverage were examined using a linear mixed-effects model containing a random intercept for local government area and fixed effects for state and year. The state coefficient is presented as the adjusted percentage-point difference, while the year coefficient represents the annual percentage-point change. All tests were two-sided, statistical significance was set at $p<0.05$ and estimates are reported with 95% confidence intervals.

Ethical considerations

Ethical approval was obtained from the Research Ethics Committee of Nasarawa State University, Keffi. Administrative permission to access the required programme records was obtained from the relevant federal and state health authorities. The study involved retrospective review of programme records without direct contact with children or caregivers. Personal identifiers were excluded, and findings were reported in aggregate form.

Results

Routine-immunisation performance by state and year

Routine-immunisation performance generally improved between 2020 and 2024. In Katsina, OPV3 coverage increased from 89.29% to 100.88%, while Penta3 coverage increased from 89.22% to 103.09%. In Kano, OPV3 increased from 83.10% to 99.27% and Penta3 from 81.20% to 100.00%. IPV1 coverage also increased in both states. Penta dropout declined from 9.07% to 6.04% in Katsina and from 12.89% to 6.84% in Kano. Vaccine stock-out rates and estimated zero-dose prevalence generally declined, while reporting completeness improved (Table 1).

Table 1. Routine-immunisation performance indicators by state and year

State	Year	Target population	OPV3 (%)	IPV1 (%)	IPV2 (%)	Penta3 (%)	Penta dropout (%)
Katsina	2020	346,666	89.29	96.03	81.43	89.22	9.07
Katsina	2021	357,065	93.02	100.20	84.60	93.87	8.92
Katsina	2022	367,779	96.03	102.82	87.20	96.79	8.17
Katsina	2023	378,816	99.51	106.20	89.31	99.63	8.48
Katsina	2024	390,175	100.88	106.60	92.05	103.09	6.04
Kano	2020	521,975	83.10	74.88	56.73	81.20	12.89
Kano	2021	538,156	87.09	81.20	64.56	86.82	11.47
Kano	2022	554,838	92.10	88.28	73.33	90.64	11.00
Kano	2023	572,033	96.48	95.25	81.76	96.17	7.85
Kano	2024	589,769	99.27	101.25	87.74	100.00	6.84

Panel A: vaccine coverage and dropout indicators. Administrative coverage above 100% was retained as reported.

State	Year	Fixed sessions (%)	Outreach sessions (%)	Stock-out (%)	Reporting complete (%)	Reporting timely (%)	Zero-dose (%)	Under-immunised (%)	LGAs OPV3 >100%	LGAs Penta3 >100%
Katsina	2020	84.09	78.01	8.62	91.28	84.09	12.07	9.81	9	9
Katsina	2021	86.36	81.40	6.76	92.60	86.31	9.31	9.97	11	12
Katsina	2022	87.65	82.70	6.09	93.72	88.51	8.03	9.40	11	12
Katsina	2023	97.09	92.96	4.91	96.00	91.98	7.75	9.57	12	13
Katsina	2024	98.00	59.00	4.04	96.96	93.42	7.24	8.21	15	17
Kano	2020	85.50	79.86	7.74	91.99	85.93	9.76	13.75	1	2
Kano	2021	88.09	83.47	6.49	93.50	87.64	5.81	13.17	5	4
Kano	2022	89.95	83.94	5.57	95.18	89.77	4.41	12.21	9	6
Kano	2023	92.67	86.99	4.25	95.96	91.42	3.48	9.03	16	16
Kano	2024	94.74	89.66	3.05	97.76	93.31	3.05	8.25	21	24

Panel B: service delivery, vaccine stock, reporting and immunisation-gap indicators.

Fixed-session implementation increased in both states. Outreach-session implementation improved in Kano but fell sharply in Katsina to 59.00% in 2024. Administrative coverage above 100% occurred increasingly in later years. By 2024, 15 Katsina local government areas and 21 Kano local government areas reported OPV3 coverage above 100%, while 17 Katsina and 24 Kano local government areas reported Penta3 coverage above 100%.

Local-government variation in routine immunisation

Substantial variation was observed across the 78 local government areas. In Katsina, mean OPV3 coverage ranged from 53.9% in

Zango to 182.8% in Danja, and mean Penta3 coverage ranged from 55.3% to 176.0% in the same local government areas. Bindawa had the highest mean Penta dropout at 21.5%, while Daura, Ingawa, Zango and Sandamu recorded mean zero-dose prevalence above 25%. Outreach implementation was lowest in Ingawa at 67.9%.

In Kano, mean OPV3 coverage ranged from 74.0% in Bichi to 110.3% in Kibiya, while mean Penta3 coverage ranged from 73.4% in Bichi to 109.4% in Kibiya. Karaye recorded the highest mean Penta dropout at 15.0%. Bichi had the highest mean zero-dose prevalence at 17.3%, and Karaye had the highest under-immunised prevalence at 17.1%. Outreach implementation ranged from 79.9% in Madobi to 88.0% in Sumaila (Table 2).

Table 2. Five-year local-government variation in routine-immunisation indicators

State	Indicator	Lowest LGA/value	Highest LGA/value	Interpretation
Katsina	OPV3 coverage	Zango, 53.9%	Danja, 182.8%	Low coverage and denominator anomalies coexisted
Katsina	Penta3 coverage	Zango, 55.3%	Danja, 176.0%	Marked geographical and data-quality variation
Katsina	Penta dropout	Maiadua, -0.4%	Bindawa, 21.5%	Negative and high values require dose-data reconciliation
Katsina	Zero-dose prevalence	Matazu, 1.0%	Daura, 26.8%	High-risk pockets persisted
Katsina	Outreach implementation	Ingawa, 67.9%	Sandamu, 93.0%	Outreach delivery was less consistent than fixed sessions
Kano	OPV3 coverage	Bichi, 74.0%	Kibiya, 110.3%	Low coverage and values above 100% occurred
Kano	Penta3 coverage	Bichi, 73.4%	Kibiya, 109.4%	Subnational variation remained
Kano	Penta dropout	Kunchi, 5.5%	Karaye, 15.0%	Completion gaps differed across LGAs
Kano	Zero-dose prevalence	Bagwai, 0.9%	Bichi, 17.3%	Initial access remained unequal
Kano	Outreach implementation	Madobi, 79.9%	Sumaila, 88.0%	Outreach performance was below fixed-session levels

Supplementary-immunisation activity performance

Supplementary-immunisation performance improved in both states. Independent-monitoring coverage increased from 86.94% to 91.62% in Katsina and from 88.41% to 94.36% in Kano. The missed-child proportion declined from 13.06% to 8.38% in Katsina and from 11.59% to 5.64% in Kano. Non-compliance continued to account for approximately 28%–31% of missed children, while inaccessible-settlement rates remained higher in Katsina.

Lot quality assurance sampling performance improved but remained suboptimal. The proportion of lots passing increased from 22.06% to 36.27% in Katsina and from 14.77% to 59.09% in Kano. Despite this progress, substantial numbers of lots remained in warning or failure categories, particularly in Katsina (Table 3).

Table 3. Supplementary-immunisation activity performance by state and year

State	Year	Rounds	Administrative coverage (%)	Independent monitoring (%)	Missed-child proportion (%)	Non-compliance contribution (%)	Inaccessible settlements (%)	LQAS pass (%)	LQAS warning	LQAS fail
Katsina	2020	2	95.53	86.94	13.06	29.92	2.23	22.06	19	34
Katsina	2021	3	96.18	88.97	11.03	27.97	2.32	17.65	59	25
Katsi	202	3	97.79	90.28	9.72	30.50	2.20	27.4	53	21

State	Year	Rounds	Administrative coverage (%)	Independent monitoring (%)	Missed-child proportion (%)	Non-compliance contribution (%)	Inaccessible settlements (%)	LQAS pass (%)	LQAS warning	LQAS fail
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Katsina	2023	2	99.33	91.15	8.85	28.44	2.20	33.82	35	10
Katsina	2024	3	100.33	91.62	8.38	31.25	2.02	36.27	51	14
Kano	2020	2	96.24	88.41	11.59	29.92	1.56	14.77	46	29
Kano	2021	3	99.87	90.90	9.10	30.32	1.69	28.03	73	22
Kano	2022	3	99.53	91.62	8.38	29.12	1.93	37.12	60	23
Kano	2023	3	101.01	92.63	7.37	30.14	1.68	46.97	55	15
Kano	2024	3	102.62	94.36	5.64	31.26	1.81	59.09	49	5

LQAS, lot quality assurance sampling. Administrative coverage above 100% was retained as reported.

Timeliness of outbreak-response immunisation

Outbreak-response timeliness varied by state and year. In Katsina, the rapid-response and first large-scale rounds were delayed in 2021 and 2022, while all three stages were timely in 2024. Kano implemented all three stages within the prescribed periods in 2021 and 2022. The rapid-response round was delayed in Kano in 2023, and the first large-scale round was delayed in 2024. The second large-scale round was timely in every recorded outbreak year (Table 4).

Table 4. Timeliness of cVDPV outbreak-response immunisation activities

State	Year	Human cases	Day 0 to rapid round	Rapid timely	Day 0 to first large-scale	First large-scale timely	Day 0 to second large-scale	Second large-scale timely
Katsina	2021	3	16	0	29	0	56	1
Katsina	2022	4	16	0	29	0	36	1
Katsina	2024	16	14	1	22	1	51	1
Kano	2021	5	14	1	24	1	25	1
Kano	2022	7	10	1	19	1	38	1
Kano	2023	4	17	0	24	1	37	1
Kano	2024	11	12	1	32	0	39	1

1 = implemented within the prescribed period; 0 = not implemented within the prescribed period.

State comparisons and temporal change

Katsina had significantly higher mean OPV3 coverage than Kano (96.70% versus 91.85%; $p=0.029$), higher IPV1 coverage (103.35% versus 88.25%; $p<0.001$) and higher Penta3 coverage (97.41% versus 91.11%; $p=0.004$). Kano had a higher mean Penta dropout rate (9.91% versus 7.68%; $p<0.001$). Kano also recorded higher supplementary-immunisation independent-monitoring coverage (91.81% versus 89.91%; $p<0.001$) and a lower missed-child proportion (8.19% versus 10.09%; $p<0.001$) (Table 5).

In the linear mixed-effects model, the adjusted difference in Penta3 coverage between Kano and Katsina was not statistically significant ($\beta=-6.300$ percentage points; 95% CI: -14.277 to 1.678; $p=0.122$). Penta3 coverage increased significantly by 4.136 percentage points for each successive year (95% CI: 3.721–4.551; $p<0.001$) (Table 5).

Table 5. State comparison and temporal model of immunisation performance

Indicator	Katsina mean	Kano mean	Mean difference (Kano-Katsina)	p-value
OPV3 coverage (%)	96.70	91.85	-4.84	0.029
IPV1 coverage (%)	103.35	88.25	-15.10	<0.001
Penta3 coverage (%)	97.41	91.11	-6.30	0.004
Penta dropout rate (%)	7.68	9.91	2.22	<0.001

Indicator	Katsina mean	Kano mean	Mean difference (Kano-Katsina)	p-value
SIA independent-monitoring coverage (%)	89.91	91.81	1.90	<0.001
SIA missed-child proportion (%)	10.09	8.19	-1.90	<0.001

Panel A: Welch's independent-samples t tests.

Outcome	Predictor	Effect measure	Estimate	95% CI lower	95% CI upper	p-value
Penta3 administrative coverage	Kano versus Katsina	β percentage points	-6.300	-14.277	1.678	0.122
Penta3 administrative coverage	Year, per one-year increase	β percentage points	4.136	3.721	4.551	<0.001

Panel B: linear mixed-effects regression with a local-government random intercept. β values are percentage points. CI, confidence interval

Discussion

This study demonstrated broad improvement in routine and supplementary poliovirus immunisation performance in Kano and Katsina States between 2020 and 2024. Vaccine coverage increased, dropout and stock-out rates declined, reporting completeness improved, independent-monitoring coverage increased and the proportion of missed children decreased. However, the favourable trends coexisted with marked local-government inequalities, administrative coverage above 100%, persistent zero-dose and under-immunised populations, a sharp decline in outreach implementation in Katsina, suboptimal lot quality assurance sampling outcomes and delays in selected outbreak-response rounds.

The increases in OPV3, IPV1 and Penta3 coverage and the reduction in dropout were consistent with Nigerian programme experience showing that strengthened fixed services, mobile teams, community mobilisation, supportive supervision and linkages between high-risk settlements and routine services can improve childhood vaccination [4]. Similar evidence from conflict-affected settings has shown that integrated community engagement and vaccination delivery can raise uptake where conventional facility-based services are insufficient [5]. The significant annual increase in Penta3 coverage indicates that the improvement extended across the study period rather than reflecting a single-year fluctuation.

Coverage estimates above 100% were nevertheless common and became more frequent in the later years. Such values do not demonstrate that every eligible child was protected. They more plausibly indicate weaknesses in projected denominators, vaccination of children from neighbouring areas, movement between service locations, duplicate reporting or incomplete reconciliation of dose data. Household-based microplanning in Kano previously identified settlements and households omitted from existing plans despite apparently strong programme performance [8]. Studies of the interaction between campaigns and routine services have also cautioned that administrative data may overstate population protection when denominators and reporting systems are weak [7].

The local-government findings confirmed that state averages concealed substantial geographical variation. Zango and Daura in Katsina and Bichi and other Kano local government areas recorded comparatively low coverage, while several local government areas reported implausibly high coverage. High zero-dose prevalence in Daura, Ingawa, Zango, Sandamu and Bichi showed that children without initial access to routine immunisation remained concentrated in specific locations. Reviews of zero-dose children in Nigeria have linked these gaps to distance, service availability, caregiver knowledge, socioeconomic disadvantage, health-worker constraints and broader community conditions [2,3]. Corrective action should therefore be targeted geographically rather than applied uniformly across each state.

The decline in Katsina outreach-session implementation to 59% in 2024 was particularly important. Fixed sessions are most accessible to populations living near health facilities, whereas remote, nomadic, border and insecure communities rely more heavily on outreach and mobile delivery. A state can record rising administrative coverage while geographical equity deteriorates if outreach services become less reliable. Nigerian experience with dedicated mobile teams and volunteer community mobilisers has shown that active outreach can identify newborns and connect children in high-risk settlements to routine immunisation [4]. Restoration of regular outreach should therefore be prioritised in local government areas with high zero-dose prevalence or limited access to fixed services.

Supplementary-immunisation performance improved, especially in Kano, where independent-monitoring coverage increased and missed-child proportions fell substantially. This was consistent with evidence that revised microplans, household revisits, community dialogue and differentiated responses to non-compliance can improve campaign reach [8–11]. However, non-compliance continued to account for approximately one-third of missed children. This persistence suggests that technical planning alone is insufficient. Engagement with traditional and religious leaders, rapid response to misinformation and provision of services valued by communities remain important for reducing refusal and campaign fatigue [10,11,20].

The improvement in independent-monitoring coverage did not eliminate poor lot quality assurance sampling results. The two indicators answer different questions: independent monitoring estimates coverage among sampled children, whereas LQAS identifies local areas that are unlikely to have reached a predefined quality threshold. The continued presence of warning and failed lots therefore indicated that programme gains were uneven. Nigeria's polio programme has used monitoring, LQAS and preparedness data together to identify low-performing areas and implement corrective action [12]. The present findings support continued use of both state averages and lot-level results rather than substituting one for the other.

Outbreak-response timeliness was mixed. Delayed rapid-response or first large-scale rounds occurred in both states in selected years, while the second large-scale rounds were consistently timely. Delays during the initial response period may permit continued transmission before population immunity is raised. Modelling and multicountry analyses have shown that earlier, sufficiently broad and high-quality outbreak responses shorten transmission and reduce geographical spread [16,17]. Monitoring should therefore focus on each interval from Day 0, not merely whether all planned rounds were eventually implemented.

The state comparisons showed that neither state performed better across every component. Katsina had higher mean administrative vaccine coverage and lower Penta dropout, while Kano had stronger independent-monitoring coverage and fewer missed children. The adjusted state effect for Penta3 was not significant after repeated local-government observations and year were considered, indicating that within-state heterogeneity and temporal improvement were more important than a simple state label. State-specific strategies should consequently be based on the indicators and local government areas requiring correction rather than a single overall ranking.

The findings have practical implications. Routine immunisation review should combine coverage with dropout, zero-dose prevalence, session implementation, stock availability and data-quality checks. Coverage values above 100% and negative dropout should trigger denominator and numerator reconciliation. Outreach restoration should be prioritised in underserved areas. SIA review should integrate independent monitoring, LQAS, reasons for missed children and settlement accessibility. Finally, rapid-response intervals should be tracked in real time so that delays are identified before they compromise outbreak control.

Strengths and limitations

The study included programme records from all 78 local government areas over five consecutive years and assessed routine immunisation, supplementary immunisation and outbreak-response performance using multiple indicators. The longitudinal analysis distinguished annual change from state differences, while local-government summaries exposed inequalities concealed by state averages. The study was limited by reliance on administrative programme records, which are vulnerable to denominator error, duplicate reporting and incomplete documentation. Administrative coverage could not be independently validated against household survey estimates. Averaging annual local-government indicators may also conceal within-year or ward-level variation, and the ecological design does not permit individual-level causal conclusions.

Conclusion

Routine and supplementary poliovirus immunisation performance improved in Kano and Katsina States from 2020 to 2024. OPV3, IPV1 and Penta3 coverage increased, Penta dropout and stock-out rates declined, independent-monitoring coverage improved and the proportion of missed children decreased. These gains were not uniform. Administrative coverage above 100%, substantial local-government variation, persistent zero-dose and under-immunised populations, reduced outreach implementation in Katsina, poor LQAS outcomes and delays in selected outbreak-response rounds remained. Programme management should therefore prioritise subnational performance review, restoration of outreach services, reconciliation of coverage denominators and dose records, targeted reduction of missed children and real-time monitoring of outbreak-response timeliness.

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Author contributions

Conceptualization; SAI, AIA methodology; SAI, UMI, EOE, AAD data curation; SAI, EOE, JHR, AAD formal analysis; SAI, EOE, UMI, JYR investigation; SAI, AIA, JYR, AAD supervision; SAI, AIA, JYR, UMI. Writing-original draft; SAI, EEE, JYR writing-review and editing; SAI, EOE, JYR. AIA. All authors should approve the final manuscript

Conflict of interest

The authors declare that they have no conflicts of interest.

Data availability

The analytical data were derived from programme immunisation records and are subject to institutional, ethical and programme restrictions. De-identified data may be made available by the corresponding author upon reasonable request and with permission from the relevant health authorities.

Ethics approval

Ethical approval was granted by the Research Ethics Committee of Nasarawa State University, Keffi. The requirement for individual informed consent was waived because the study involved retrospective review of existing aggregate programme records.

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