

Spatial Distribution and Surveillance Performance of Acute Flaccid Paralysis Cases in Rivers State, Nigeria, 2023: A Retrospective Surveillance Data Analysis

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Abstract

➤ Background:

Geographic variation in acute flaccid paralysis (AFP) detection and investigation can reveal local surveillance gaps that are obscured by statewide averages. The study assessed the distribution of AFP cases and surveillance performance across local government areas (LGAs) in Rivers State, Nigeria, in 2023.

➤ Methods:

The study conducted a retrospective analysis of routinely collected AFP surveillance line-list data. LGA-level case counts and proportions meeting notification, investigation, stool-timing, and recorded specimen-adequacy indicators were described. Wilson 95% confidence intervals (CIs) were calculated for statewide proportions. LGAs were compared with the programme target of at least 80%. Because population denominators and final non-polio AFP classifications were unavailable, the analysis described case distribution rather than incidence or non-polio AFP rates.

➤ Results:

A total of 423 AFP cases were reported from all 23 LGAs. The median number per LGA was 17 (interquartile range 15–23; range 7–27). Bonny and Omuma reported 27 cases each, followed by Tai (25) and Ikwerre (24); the five highest-count LGAs contributed 126 cases (29.8%). Overall, 411/423 cases (97.2%, 95% CI 95.1–98.4) were notified within seven days and 411/423 (97.2%, 95% CI 95.1–98.4) within 48 hours. Second stool specimens were collected within 14 days for 421/423 cases (99.5%), and 422/423 (99.8%) were recorded as having adequate specimens. Twenty-one LGAs met the 80% notification target. Ogba/Egbema/Ndoni (14/20; 70.0%) and Ahoada East (5/7; 71.4%) did not; Ogba/Egbema/Ndoni accounted for 6 of the 12 delayed notifications statewide. All LGAs met the 80% investigation target.

➤ Conclusions:

AFP surveillance performance in Rivers State was high in 2023, but delayed notification was concentrated in a small number of LGAs. Statewide averages should therefore be complemented by routine LGA-level review, targeted supportive supervision, and investigation of local barriers in Ogba/Egbema/Ndoni and Ahoada East. Population-linked data and final case classifications are needed for assessment of surveillance sensitivity and true spatial risk.

Keywords: Acute Flaccid Paralysis; Poliomyelitis; Surveillance Performance; Spatial Distribution; Timeliness; Local Government Area; Nigeria.

I. INTRODUCTION

➤ Background

Acute flaccid paralysis surveillance is the principal strategy for detecting poliovirus circulation. It requires

sensitive identification of children with sudden flaccid weakness, prompt notification, investigation within 48 hours, collection of two stool specimens at least 24 hours apart and within 14 days of onset, and maintenance of specimens in good condition through laboratory receipt

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[1–3]. High-performing AFP surveillance remains essential after interruption of indigenous wild poliovirus transmission because imported and vaccine-derived polioviruses can circulate in populations with immunity gaps [2–4,5,6]. National and state averages may conceal subnational weaknesses [7–13]. AFP detection depends on access, health-seeking behaviour, health-worker awareness, community informants, active surveillance, transport, and supervision [7–10,14]. These conditions vary geographically, particularly in settings with urban, rural, and riverine communities [7–13]. LGA-level analyses can therefore identify places with few detected cases or recurring delays and direct programme attention to the appropriate operational unit [7–13,14]. Previous AFP surveillance evaluations in Nigeria and other African countries have documented strong overall performance alongside important geographic heterogeneity in notification, investigation, documentation, and stool adequacy [7–13]. However, recent LGA-specific evidence from Rivers State is limited. The 2023 routine surveillance data were analysed to describe the distribution of detected AFP cases across the 23 LGAs, measure surveillance performance, and identify localised performance gaps. In addition, because AFP platforms are increasingly proposed as vehicles for integrated surveillance under the Integrated Disease Surveillance and Response (IDSR) framework [15] and for systematic screening approaches [16], a recent Rivers State pilot integrated stool GeneXpert TB screening into AFP surveillance and identified *M. tuberculosis* DNA in 4.2% of polio-negative AFP cases [17], illustrating the broader programmatic value of detailed AFP performance monitoring [15–17].

II. METHODS

➤ Study Design and Setting

This was a retrospective descriptive analysis of AFP surveillance records from Rivers State between 1 January and 31 December 2023 [18]. Rivers State, in Nigeria’s Niger Delta, comprises 23 LGAs and includes densely populated urban centres, inland rural communities, and riverine settlements. AFP surveillance is implemented through the national integrated disease surveillance structure, supported by health facilities, disease surveillance and notification officers, community informants, active case searches, and laboratory referral [2,3,14,15].

➤ Data Source and Study Population

The 2023 records in the state AFP line list were used. All 423 records with an assigned LGA were included. Variables comprised age, sex, LGA, dates of paralysis onset, notification, investigation and stool collection, interval between stool specimens, and programme-recorded specimen adequacy. LGA spellings were

harmonised before analysis, yielding all 23 recognised LGAs. Records were de-identified before analysis.

➤ Surveillance Indicators

Performance indicators were defined as notification within seven days of paralysis onset, investigation within 48 hours of notification, first and second stool specimens collected within 14 days of onset, two specimens collected one to two calendar days apart, and specimen adequacy as recorded in the line list. The global operational benchmark of at least 80% was used for LGA-level notification, investigation, and stool indicators [2,3,14]. Recorded adequacy was reported because stool-condition information was missing for 120 cases and independent reconstruction of the complete adequacy definition was therefore not possible.

➤ Statistical and Spatial Analysis

Frequencies, percentages, medians, interquartile ranges (IQRs), and Wilson 95% CIs were all calculated [18]. Geographic distribution was summarised by LGA case counts and each LGA’s share of statewide detected cases. LGA performance was displayed in a matrix of indicator percentages, and LGAs below 80% were identified. Spearman correlation assessed the relationship between LGA case count and notification performance. The term spatial refers to LGA-level geographic distribution; adjacency-based clustering or spatial autocorrelation was not assessed. Population denominators, final case classifications, and expected non-polio AFP counts were not available, so incidence and non-polio AFP rates were not calculated. Analyses were performed using Python 3.12.

➤ Ethical Considerations

Approval for secondary analysis of de-identified routine surveillance data was obtained from Rivers State Ministry of Health Ethics Research Committee. Administrative permission was obtained from the various Heads of the Facilities.

III. RESULTS

➤ Case Characteristics and Statewide Performance

A total of 423 AFP cases were reported in 2023. Median age was 25 months (IQR 16–68), 305 (72.1%) were younger than five years, and 206 (48.7%) were male. Notification and investigation targets were met for 411 cases each (97.2%). Second stool collection occurred within 14 days for 421 (99.5%), specimens were collected one to two calendar days apart for 421 of 422 records with valid intervals (99.8%), and 422 (99.8%) were recorded as adequate (Table 1). Median onset-to-notification time was two days (IQR 1–3), median notification-to-investigation time was one day (IQR 0–1), and median onset-to-second-stool time was seven days (IQR 6–9).

Table 1 Characteristics and Statewide AFP Surveillance Performance, Rivers State, 2023

Measure	Result	95% CI
AFP cases	423	-
LGAs represented	23/23	-
Age, median (IQR), months	25 (16-68)	-

Age <5 years	305/423 (72.1%)	-
Male sex	206/423 (48.7%)	-
Notification within 7 days	411/423 (97.2%)	95.1-98.4
Investigation within 48 hours	411/423 (97.2%)	95.1-98.4
First stool within 14 days	421/423 (99.5%)	98.3-99.9
Second stool within 14 days	421/423 (99.5%)	98.3-99.9
Specimens 1-2 days apart	421/422 (99.8%)	98.7-100.0
Recorded adequate specimens	422/423 (99.8%)	98.7-100.0

CI, confidence interval; IQR, interquartile range; LGA, local government area. CIs are Wilson intervals for proportions.

➤ Geographic Distribution of Reported Cases

Cases were reported from every LGA. The median count was 17 per LGA (IQR 15–23; range 7–27). Bonny and Omuma reported the highest counts (27 each), followed by Tai (25), Ikwerre (24), and four LGAs with 23 cases each. The five highest-count LGAs contributed

126 cases (29.8%) of the statewide total. Ahoada East reported the fewest cases (7), followed by Akuku-Toru and Ogu/Bolo (12 each) and Eleme (13) (Figure 1). These are unadjusted counts and do not represent incidence or surveillance sensitivity.

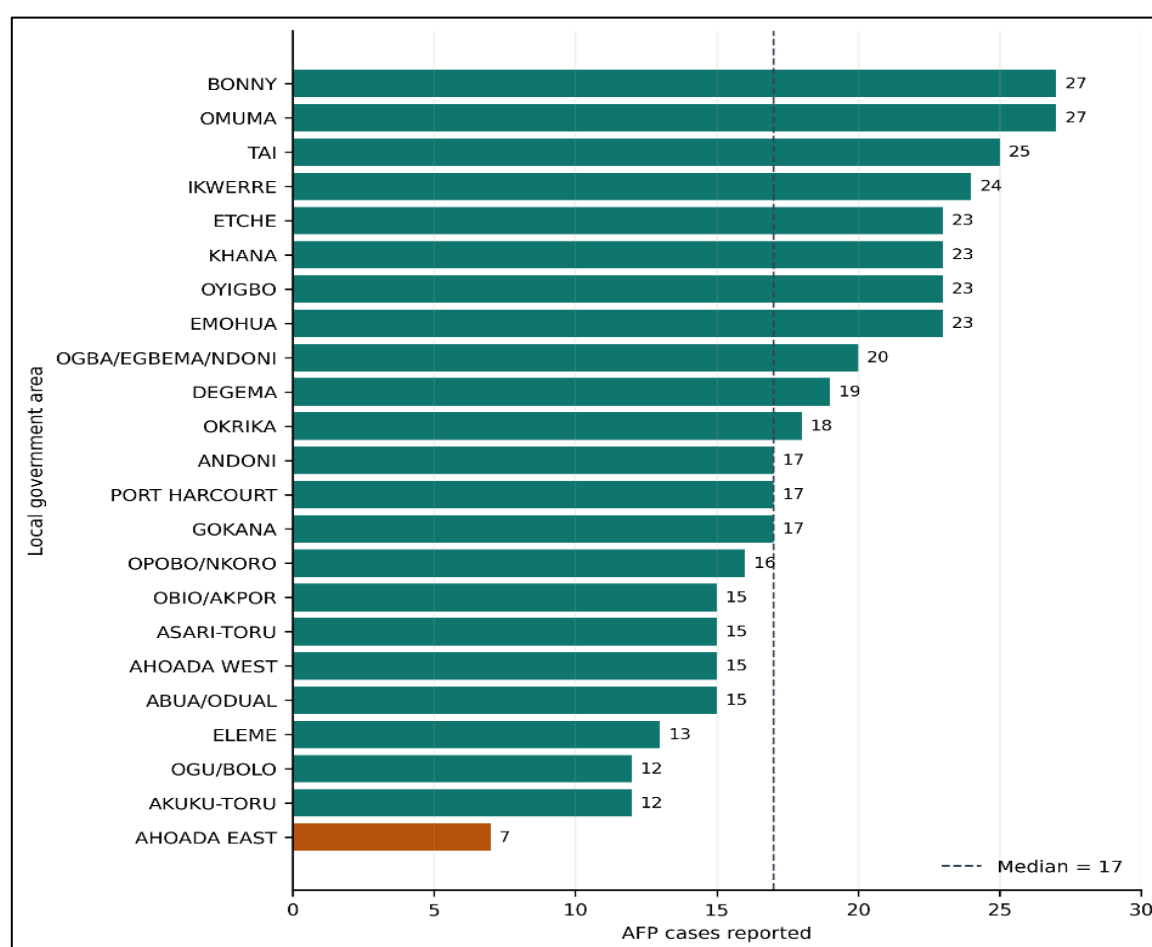


Fig 1 Distribution of reported AFP cases by LGA, Rivers State, 2023

Bars show counts of detected AFP cases. The dashed line indicates the median LGA count. Population denominators were unavailable.

➤ LGA-Level Surveillance Performance

Notification within seven days ranged from 70.0% to 100.0% across LGAs. Twenty-one of 23 LGAs met the 80% target; Ogba/Egbema/Ndoni (14/20; 70.0%) and Ahoada East (5/7; 71.4%) did not. Ahoada West achieved 86.7%, and the remaining 20 LGAs achieved at least 95.8%. Six of the 12 delayed notifications statewide occurred in Ogba/Egbema/Ndoni; two each occurred in Ahoada East and Ahoada West, and one each in Ikwerre

and Omuma. LGA case count was not correlated with notification performance (Spearman rho = -0.03; p = 0.883).

Investigation within 48 hours ranged from 88.2% to 100%, and all LGAs met the 80% target. The 12 delayed investigations were distributed across 10 LGAs; Etche and Gokana each accounted for two. Second stool collection within 14 days was below 100% only in Ahoada East (85.7%) and Omuma (96.3%). Recorded specimen adequacy was below 100% only in Ahoada East (85.7%). All LGAs nevertheless met the 80% benchmark for these indicators (Figure 2; Tables 2 and 3).

Table 2 Statewide Performance and LGA Attainment of the 80% Programme Target

Indicator	Statewide Performance	LGA Range, %	LGAs Meeting Target
Notification within 7 days	411/423 (97.2%)	70.0-100.0	21/23 (91.3%)
Investigation within 48 hours	411/423 (97.2%)	88.2-100.0	23/23 (100.0%)
Second stool within 14 days	421/423 (99.5%)	85.7-100.0	23/23 (100.0%)
Recorded adequate specimens	422/423 (99.8%)	85.7-100.0	23/23 (100.0%)

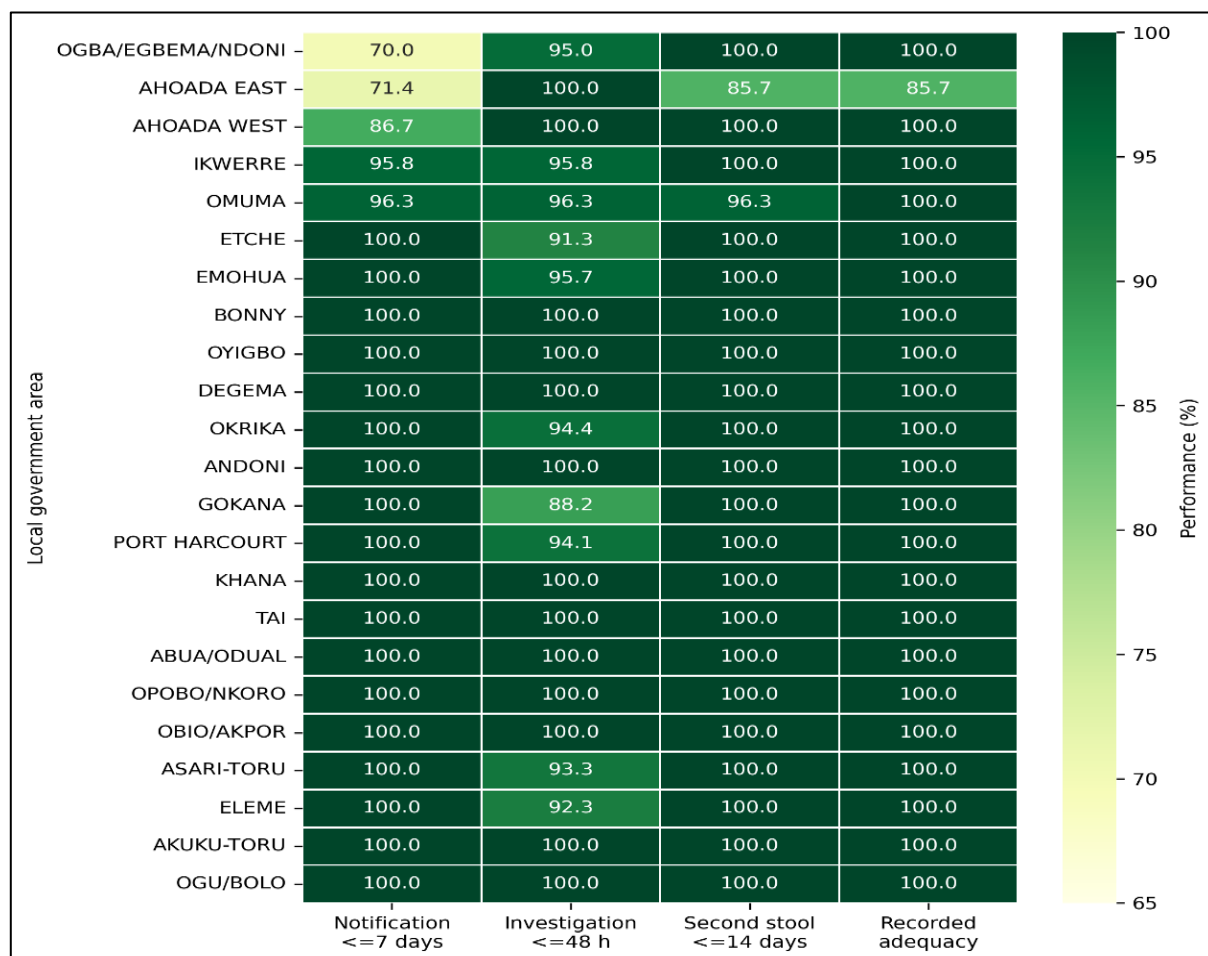


Fig 2 LGA-Level AFP Surveillance Performance, Rivers State, 2023

Cells show the percentage meeting each indicator. Recorded adequacy is the programme classification in the line list.

Table 3 Reported AFP Cases and Surveillance Performance by LGA, Rivers State, 2023

LGA	Cases	Share, %	Notification <=7 d	Investigation <=48 h	Second stool <=14 d	Recorded adequate
BONNY	27	6.4	27/27 (100.0)	27/27 (100.0)	27/27 (100.0)	27/27 (100.0)
OMUMA	27	6.4	26/27 (96.3)	26/27 (96.3)	26/27 (96.3)	27/27 (100.0)
TAI	25	5.9	25/25 (100.0)	25/25 (100.0)	25/25 (100.0)	25/25 (100.0)
IKWERRE	24	5.7	23/24 (95.8)	23/24 (95.8)	24/24 (100.0)	24/24 (100.0)
EMOHUA	23	5.4	23/23 (100.0)	22/23 (95.7)	23/23 (100.0)	23/23 (100.0)
ETCHE	23	5.4	23/23 (100.0)	21/23 (91.3)	23/23 (100.0)	23/23 (100.0)
KHANA	23	5.4	23/23 (100.0)	23/23 (100.0)	23/23 (100.0)	23/23 (100.0)
OYIGBO	23	5.4	23/23 (100.0)	23/23 (100.0)	23/23 (100.0)	23/23 (100.0)
OGBA/EGBEMA/NDONI	20	4.7	14/20 (70.0)	19/20 (95.0)	20/20 (100.0)	20/20 (100.0)
DEGEMA	19	4.5	19/19 (100.0)	19/19 (100.0)	19/19 (100.0)	19/19 (100.0)
OKRIKA	18	4.3	18/18 (100.0)	17/18 (94.4)	18/18 (100.0)	18/18 (100.0)
ANDONI	17	4.0	17/17 (100.0)	17/17 (100.0)	17/17 (100.0)	17/17 (100.0)
GOKANA	17	4.0	17/17 (100.0)	15/17 (88.2)	17/17 (100.0)	17/17 (100.0)
PORT HARCOURT	17	4.0	17/17 (100.0)	16/17 (94.1)	17/17 (100.0)	17/17 (100.0)
OPOBO/NKORO	16	3.8	16/16 (100.0)	16/16 (100.0)	16/16 (100.0)	16/16 (100.0)
ABUA/ODUAL	15	3.5	15/15 (100.0)	15/15 (100.0)	15/15 (100.0)	15/15 (100.0)

AHOADA WEST	15	3.5	13/15 (86.7)	15/15 (100.0)	15/15 (100.0)	15/15 (100.0)
ASARI-TORU	15	3.5	15/15 (100.0)	14/15 (93.3)	15/15 (100.0)	15/15 (100.0)
OBIO/AKPOR	15	3.5	15/15 (100.0)	15/15 (100.0)	15/15 (100.0)	15/15 (100.0)
ELEME	13	3.1	13/13 (100.0)	12/13 (92.3)	13/13 (100.0)	13/13 (100.0)
AKUKU-TORU	12	2.8	12/12 (100.0)	12/12 (100.0)	12/12 (100.0)	12/12 (100.0)
OGU/BOLO	12	2.8	12/12 (100.0)	12/12 (100.0)	12/12 (100.0)	12/12 (100.0)
AHOADA EAST	7	1.7	5/7 (71.4)	7/7 (100.0)	6/7 (85.7)	6/7 (85.7)

Values are n/N (%), except Cases and Share. LGA, local government area. Recorded adequacy reflects the line-list classification.

IV. DISCUSSION

Rivers State's AFP surveillance system achieved high statewide performance in 2023 [2,3,7–13]. All 23 LGAs reported cases, more than 97% were notified and investigated within the recommended timeframes, and stool-timing and recorded-adequacy indicators exceeded 99%. However, the LGA-level analysis revealed a concentrated notification gap that was not apparent from the statewide average. Ogba/Egbema/Ndoni and Ahoada East fell below the 80% notification target, and half of all delayed notifications occurred in Ogba/Egbema/Ndoni.

The presence of reported cases in every LGA indicates broad geographic reach, but case counts alone cannot establish surveillance sensitivity [7–13,14]. Higher counts may reflect larger populations, true differences in AFP occurrence, better detection, more active surveillance, or a combination of these factors. Conversely, Ahoada East's low count may reflect its population size or random annual variation rather than under-detection. Interpretation requires age-specific population denominators and final classification of non-polio AFP cases so that the standard non-polio AFP rate can be calculated [2,3]. Notification was the most geographically variable indicator. Once cases entered the surveillance system, investigation and stool collection were consistently strong across LGAs. This pattern suggests that the principal operational weakness in the priority LGAs may occur before formal notification rather than after the surveillance team is alerted. Potential contributors include caregiver delay, first contact with providers outside the reporting network, incomplete community-informant coverage, transport or communication barriers, and inconsistent active case searching [7–10,14]. These mechanisms were not measured and should be investigated locally.

The results align with Nigerian and regional evaluations showing that aggregate AFP indicators may coexist with subnational variation [7–13]. Intensified active surveillance, improved documentation, community informants, and feedback to reporting sites have strengthened AFP surveillance in other Nigerian settings [8–10]. Rivers State could apply these approaches selectively: conduct record review and supportive supervision in Ogba/Egbema/Ndoni and Ahoada East; map silent or low-reporting facilities and community contacts; review each delayed case to identify the point of delay; and monitor LGA-level run charts monthly rather than relying only on annual statewide summaries [7–10,15]. In addition, integrated surveillance is feasible: a

recent Rivers State pilot integrated stool GeneXpert TB screening into AFP surveillance and found a 4.2% positivity yield among polio-negative AFP cases, with all positive children referred to the National TB Programme [17]. Similar integration of TB screening into polio campaigns has been feasible in Nigeria [19], and stool Xpert is endorsed for paediatric TB diagnosis when respiratory specimens are difficult to obtain [20–23]. These findings reinforce the IDSR principle of sharing surveillance infrastructure across diseases [15] and are relevant in Rivers State, where childhood TB remains under-detected [24–26].

V. STRENGTHS AND LIMITATIONS

This study included all reported AFP cases in 2023, represented every LGA, and used operationally relevant surveillance indicators [18,14]. Presenting LGA-specific numerators and denominators makes performance gaps visible and supports targeted action. The study also has important limitations. First, population denominators and final non-polio AFP classifications were unavailable; therefore, detected case counts could not be converted to incidence or the non-polio AFP rate and should not be interpreted as disease risk [2,3]. Second, one year of data yields small LGA denominators and unstable percentages; for example, two delays reduced Ahoada East's notification performance to 71.4%. Third, the analysis did not assess adjacency, spatial autocorrelation, or clusters of statistically elevated risk. Fourth, programme-recorded adequacy could not be independently reconstructed because stool-condition information was missing for 120 cases. Fifth, routine dates and classifications may contain recording error, and the dataset did not measure active-surveillance intensity, accessibility, staffing, caregiver pathways, or reasons for delay [7–10,14]. Finally, undetected cases are absent by definition, so the geographic distribution reflects the surveillance system's observed output.

VI. CONCLUSIONS

AFP surveillance in Rivers State performed strongly in 2023 and detected cases in all 23 LGAs. Nevertheless, notification delays were concentrated in Ogba/Egbema/Ndoni and Ahoada East, demonstrating the value of LGA-level review alongside statewide indicators. Targeted supportive supervision and case-by-case delay audits should focus on these LGAs. Future analyses should link surveillance records to age-specific population denominators and final case classifications and should pool multiple years to permit robust spatial-rate analysis

[18,14]. The AFP platform may also support integrated screening, as shown by a recent Rivers State pilot [17].

➤ Abbreviations

AFP: acute flaccid paralysis; CI: confidence interval; GPEI: Global Polio Eradication Initiative; IDSR: Integrated Disease Surveillance and Response; IQR: interquartile range; LGA: local government area; TB: tuberculosis; WHO: World Health Organization.

➤ Authors' Contributions

Ifeoma C.N conceptualised the study, curated and analysed the data, interpreted the findings, and drafted and critically revised the manuscript.

Ositadinma M.P also conceptualized, planned the study, interpreted results and proofread the manuscript.

All the authors' read and approved the final version of the manuscript.

➤ Competing interests

The authors declare that they have no competing interests.

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