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Post-Mass Vaccination Epidemiology of Suspected and Laboratory-Confirmed Yellow Fever in Rivers State, Nigeria (2020-2025)

Nduye Christie Tobin Briggs and Ifeoma Christiana Nwadiuto*

Department of Community Medicine, Rivers State University, Port Harcourt, Nigeria

ABSTRACT

Background: Yellow Fever (YF) is a re-emerging, vaccine-preventable arboviral disease of major public health importance in Nigeria. Rivers State conducted a preventive mass vaccination campaign in early 2020. Sustained surveillance is essential to detect outbreaks and identify residual immunity gaps in the post-campaign period.

Objective: To describe the epidemiology of suspected and confirmed Yellow Fever cases in Rivers State from January 2020 to August 2025.

Methods: A retrospective descriptive analysis of state-integrated disease surveillance and laboratory data was conducted. Suspected cases were defined using national guidelines. Laboratory confirmation was based on Yellow Fever IgM ELISA at a regional reference laboratory, with confirmatory plaque reduction neutralization testing (PRNT) at a WHO reference laboratory. Demographic, geographic, and vaccination characteristics were analyzed.

Results: No suspected cases were reported in 2020. From August 2021 to August 2025, 181 suspected cases were recorded, of which 9 (5.0%) were laboratory-confirmed. Confirmed cases occurred in late 2021 and mid-2025. Males accounted for 88.9% of confirmed cases, and 44.4% were infants under one year. None of the confirmed cases had documented YF vaccination. Confirmed infections occurred in only 5 of 23 LGAs, indicating focal transmission.

Conclusion: Rivers State experienced sporadic, geographically focal Yellow Fever activity following the 2020 mass vaccination campaign. Confirmed infections occurred exclusively among unvaccinated individuals, highlighting both vaccine effectiveness and persistent immunity gaps. Strengthening routine immunization, targeted supplementary campaigns, and timely laboratory feedback remain essential to prevent future outbreaks.

*Corresponding author

Ifeoma Christiana Nwadiuto, Department of Community Medicine, Rivers State University, Port Harcourt, Nigeria.

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Introduction

Yellow Fever (YF) is an acute viral haemorrhagic disease caused by a flavivirus and transmitted primarily through infected *Aedes* mosquitoes, with sylvatic transmission cycles involving non-human primates and forest vectors [1,2]. Despite the availability of a safe and highly effective live-attenuated vaccine, YF remains a persistent public health threat across sub-Saharan Africa and parts of South America [1,3]. The World Health Organization (WHO) estimates that the majority of global YF burden continues to occur in Africa, driven by ecological suitability, rapid urbanization, population mobility, and heterogeneous vaccine coverage [4,5].

Nigeria is classified as a high-risk country for YF epidemics due to favourable climatic conditions for vector proliferation, large susceptible populations, and historically suboptimal immunization coverage in some regions [6,7]. Following decades of relative control, Nigeria experienced a resurgence of YF outbreaks beginning in 2017, with thousands of suspected cases and hundreds of laboratory-confirmed infections reported nationally between

2017 and 2019 [8,9]. Similar re-emergence patterns have been documented across West and Central Africa, raising concerns about epidemic potential in urban settings [10-12].

In response, Nigeria implemented phased preventive mass vaccination campaigns under the global Eliminate Yellow Fever Epidemics (EYE) strategy, launched in 2017 to reduce outbreak risk through vaccination, strengthened surveillance, and rapid response capacity [13,14]. Modelling studies indicate that mass campaigns achieving $\geq 80\%$ coverage can substantially reduce the risk of transmission and mortality [15,16]. Rivers State, located in the Niger Delta region, conducted a statewide preventive campaign in early 2020, targeting individuals aged 9 months to 44 years, with reported coverage of approximately 82% [17].

Rivers State's ecological context including dense urban settlements, extensive riverine communities, and high population mobility creates conditions conducive to arboviral transmission and potential sylvatic spillover [18,19]. Post-campaign surveillance is therefore critical for monitoring residual transmission, identifying immunity gaps, and ensuring timely outbreak detection [20,21]. Laboratory confirmation remains essential, although challenges

persist with cross-reactivity in flavivirus serology and delays in confirmatory testing [22,23].

This study analyses suspected and laboratory-confirmed Yellow Fever cases reported in Rivers State from 2020 through August 2025. We describe temporal trends, demographic and geographic distribution, and vaccination status of cases in the post-mass vaccination period. Findings will support ongoing immunization strategies and strengthen outbreak preparedness in alignment with national and global YF elimination goals [13-24].

Methods

Study Design and Setting: A retrospective descriptive analysis of YF surveillance data for Rivers State, Nigeria, from 1 January 2020 through 31 August 2025 was conducted. The state has 23 Local Government Areas (LGAs) with urban, peri-urban, and riverine communities.

Data Sources: Data were obtained from the Rivers State integrated disease surveillance system line-list (MeaslesLab dataset), filtered for “Yellow fever/Fievre Jaune.” The dataset included demographic information (age, sex, LGA), clinical data, laboratory results, and vaccination history for all suspected YF cases reported from any health facility in the state.

Case Definitions and Laboratory Testing

Suspected YF Case: Defined per Nigeria Centre for Disease Control (NCDC) guidelines as any person with acute fever and jaundice within 14 days of onset, with no other obvious cause, or any person with fever and hemorrhagic symptoms [7].

Laboratory-Confirmed Case: A suspected case with laboratory evidence of YF infection. Blood samples were tested for YF IgM antibodies via ELISA at the regional reference laboratory (University of Benin Teaching Hospital). Presumptive positives and select samples were forwarded to the WHO Regional Reference Laboratory (Institute Pasteur Dakar) for confirmatory plaque reduction neutralization test (PRNT) [8]. In this analysis, “confirmed cases” include IgM-positive cases and those with confirmatory PRNT results.

The laboratory confirmation (positivity) rate was calculated as the proportion of tested suspects that were IgM-positive.

Vaccination and Outcome Data: Vaccination status was captured via the recorded date of last YF vaccination. A case was categorized as “vaccinated” if a valid date was provided; cases with no date were considered “not documented.” Clinical outcome (survival/death) was not systematically recorded.

Data Analysis: Data cleaning and analysis were performed using Python/Pandas. Descriptive statistics were used for demographic variables. Temporal trends were assessed by year and month of onset. Geographic distribution was summarized by LGA. Proportions were compared using per cent differences; given the small number of confirmed cases, formal statistical testing was not employed.

Suspected case definitions followed the Nigeria Centre for Disease Control (NCDC) guidelines [25]. Laboratory testing utilized IgM ELISA with confirmatory PRNT testing at WHO reference laboratories [22-26]. Surveillance strengthening is consistent with WHO recommendations for endemic countries [1-21].

Results

Temporal Trends in Suspected and Confirmed Cases

No suspected YF cases were reported in Rivers State in 2020. The first cases appeared in mid-2021. From 2021 to August 2025, a total of 181 suspected YF cases were recorded, of which 9 (5.0%) were laboratory-confirmed (Table 1).

Transmission was sporadic. A small surge in July-September 2021 included 4 confirmed cases. In 2022, 41 suspects were tested with 1 confirmation (2.4% positivity). No confirmed cases were detected in 2023 or 2024 despite 34 and 42 suspects being tested, respectively. A distinct cluster emerged in May-June 2025, with a spike in suspected cases and 2 initial IgM-positive confirmations; additional samples from this cluster were sent for confirmatory testing. By August 2025, suspected cases had declined.

Table 1: Annual Summary of Yellow Fever Cases and Laboratory Results in Rivers State, 2020-2025

Year	Suspected Cases	Tested in Lab	IgM-Positive Cases	Positivity Rate (%) [*]
2020	0	0	0	--
2021	31	31	4	12.9%
2022	41	41	1	2.4%
2023	34	34	0	0.0%
2024	42	42	0	0.0%
2025†	33	7	2	28.6%
Total	181	155	9	5.8%

^{*}Positivity rate is the percentage of tested cases that were IgM-positive.

[†]Data for 2025 are through August 2025. The low “Tested” count for 2025 reflects samples sent directly for confirmatory testing, with results pending at the data cutoff.

Demographic Characteristics of Cases

Among 181 suspected cases, sex was recorded for 180: 96 male (53.3%) and 84 female (46.7%). Among the 9 confirmed cases, 8 were male (88.9%) and 1 female (11.1%).

Age was available for 142 (78.5%) suspects. The age distribution was broad (median age 17 years), with 20.4% infants <1 year. Among 8 confirmed cases with known age, 4 (50.0%) were infants <1 year, 2 (25.0%) were aged 10–19 years, one was 30–39, and one was ≥50 years. No confirmed cases occurred in the 1-9 year age group (Table 2).

Table 2: Demographic Distribution of Suspected and Confirmed Yellow Fever Cases - Rivers State, 2020-2025

Demographic Category Sex	Suspected Cases (N=181)	Lab-Confirmed Cases (N=9)
Male	96 (53.3%)‡	8 (88.9%)
Female	84 (46.7%)‡	1 (11.1%)
Age group (years) (% of those with known age)		
<1 (infants)	29 (20.4%)	4 (50.0%)
1-9	30 (21.1%)	0 (0%)
10-19	26 (18.3%)	2 (25.0%)
20-29	15 (10.6%)	0 (0%)
30-39	23 (16.2%)	1 (12.5%)
40-49	11 (7.7%)	0 (0%)
≥50	8 (5.6%)	1 (12.5%)
Median age (years)	17 (range 0-79)	11 (range 0.7-65)

‡Sex was not recorded for 1 suspected case.

Geographic Distribution of Cases

Suspected YF cases were reported from all 23 LGAs in Rivers State. The LGAs with the highest number of suspected cases were Khana (19), Abua/Odual (17), Ikwerre (15), and Omuma (14). However, confirmed cases occurred in only 5 LGAs: Port Harcourt (3), Omuma (2), Ogu/Bolo (2), Ahoada West (1), and Khana (1). The remaining 18 LGAs had zero confirmed cases (Table 3).

Table 3: Yellow Fever Cases by Local Government Area (Rivers State, 2020-2025)

LGA	Suspected Cases (N)	Lab-Confirmed Cases (N)
Abua/Odual	17	0
Ahoada West	5	1
Ikwerre	15lab-confirmed	0
Khana	19	1
Ogu/Bolo	8	2
Omuma	14	2
Port Harcourt	11	3
Other 16 LGAs	*92*	*0*
Total	181	9

Vaccination Status and Outcomes

YF vaccination status was documented for only 41 (22.7%) of 181 suspected cases. None of the 9 lab-confirmed YF cases had any record of YF vaccination (0% vaccinated). The surveillance dataset did not systematically capture mortality; no deaths were explicitly recorded among the suspects or confirmed cases.

Discussion

This analysis presents a five-year post-mass-vaccination epidemiologic assessment of Yellow Fever surveillance in Rivers State, Nigeria. The findings indicate that the state largely avoided major epidemics after the 2020 preventive campaign, experiencing only small, focal clusters of confirmed infections in 2021 and again in 2025. Such sporadic patterns are consistent with high but incomplete population immunity, where viral introductions lead to limited transmission among unvaccinated or susceptible subgroups [15-27].

The exclusive occurrence of confirmed infections among individuals without documented vaccination underscores the protective effectiveness of the YF vaccine, which is known to confer long-lasting immunity in most recipients [3-28]. This aligns with evidence from Angola's 2016 outbreak and subsequent African epidemics, in which vaccine shortages and immunity gaps contributed to the re-emergence despite available preventive tools [11-29]. Sustaining high routine coverage following mass campaigns is therefore essential to prevent accumulation of susceptible cohorts [30,31].

A notable demographic finding was the predominance of confirmed cases among males and infants. Male overrepresentation has been observed in other Nigerian outbreak investigations, potentially reflecting differential exposure risks, occupational mobility, or healthcare-seeking behaviours [9-32]. The high proportion of infant cases is particularly important, as infants may be too young for vaccination or may represent missed opportunities in routine immunization services [31-33]. This highlights the importance of achieving and sustaining >90% routine immunization coverage at 9 months, as recommended by WHO [1-21].

Geographically, confirmed infections were restricted to five LGAs, suggesting focal transmission rather than widespread urban outbreaks. This may reflect multiple independent sylvatic spillover events rather than sustained human-to-human transmission [2,18]. However, the occurrence of confirmed cases in Port Harcourt, a densely populated urban centre, reinforces the continuing risk of urban YF epidemics if vaccination coverage declines [10-34].

Surveillance and laboratory system challenges were evident, particularly in 2025, when many samples were pending confirmatory results. Delays in specimen transport and laboratory turnaround have been widely documented as barriers to timely outbreak response in endemic settings [20-35]. Strengthening integrated laboratory networks and rapid diagnostic feedback remain critical to Nigeria's progress toward YF elimination [14-24].

Conclusion and Recommendations

Rivers State reported relatively few confirmed Yellow Fever cases between 2020 and 2025, with outbreaks being focal, brief, and confined to unvaccinated individuals. This provides field evidence supporting the effectiveness of the 2020 preventive mass vaccination campaign. To prevent future outbreaks, sustained routine immunization, targeted supplementary campaigns, improved surveillance timeliness, and strengthened laboratory confirmation systems are essential.

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Conflict of Interest

The authors have declared no competing interests.

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Data Availability Statement

Data are available at reasonable request from the rivers State Ministry of Health.

Authors' Contributions

NCTB and ICN contributed to the conception and design of the study.

NCTB performed data cleaning and statistical analysis and drafted the initial manuscript.

ICN provided epidemiological supervision, contributed to the interpretation of findings, and critically revised the manuscript for important intellectual content.

Both authors reviewed and approved the final manuscript and accept responsibility for the integrity of the work.

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