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ORIGINAL ARTICLE

TRENDS IN ROUTINE IMMUNIZATION ADHERENCE FOR VACCINE-PREVENTABLE DISEASES AMONG INFANTS IN DELTA STATE, NIGERIA DURING THE COVID-19 PANDEMIC

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Keywords

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Abstract

Background: Routine immunization is vital for preventing vaccine-preventable diseases (VPDs) and reducing infant mortality. In Delta State, Nigeria, progress has been inconsistent, with major setbacks following COVID-19 service disruptions.

Methods: A retrospective longitudinal study analyzed 842,779 infant immunization records from the Delta State Ministry of Health covering January 2018–December 2022. Data on immunization coverage, dropout rates, and vaccine-preventable diseases were examined using descriptive statistics and paired t-tests in IBM SPSS version 26.0, comparing pre-pandemic (2018–2019), pandemic, and post-pandemic (2020–2022) periods ($p < 0.05$).

Results: Among 842,779 infant records analyzed, 52% were male and 48% female, with 62% residing in rural areas. Full immunization coverage improved from 67% in 2018 to 78% in 2019, but declined to 61% in 2020, recovering slightly to 63% in 2022 ($p = 0.04$). Uptake of the Hepatitis B birth dose increased from 31% to 49%, reflecting more facility-based deliveries. Measles second-dose administration rose markedly from 11,814 in 2018 to 95,462 in 2022. However, coverage for Diphtheria, Pertussis, and Tetanus (DPT3) and yellow fever vaccines declined, with Pentavalent 3 dropout rates rising from 8.2% to 9.9%. Infant mortality peaked at 14.4 per 1,000 live births in 2020.

Conclusion: Despite gains in Hepatitis B and measles coverage, overall routine immunization remains fragile. Strengthened monitoring, resilient service delivery, and targeted outreach to underserved populations are essential to restore coverage, close immunity gaps, and reduce preventable infant deaths.

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INTRODUCTION

Routine immunization is widely recognized as one of the most cost-effective public health interventions for reducing infant and child morbidity and mortality globally. By preventing vaccine-preventable diseases (VPDs), such as measles, diphtheria, pertussis, tetanus, and poliomyelitis, immunization programs significantly contribute to achieving Sustainable Development Goals related to child health.¹ Nigeria, with one of the highest birth rates worldwide, faces ongoing challenges in ensuring equitable and sustained immunization coverage, particularly among vulnerable populations in rural and underserved urban communities.^{2,3} Despite considerable efforts, Nigeria's routine immunization coverage remains suboptimal. The Nigeria Demographic and Health Survey (NDHS) 2018 reported that only 57% of children aged 12–23 months were fully immunized, with notable disparities between regions and socioeconomic strata.^{4,5} These gaps in vaccine coverage leave many children susceptible to outbreaks of preventable diseases, contributing to the country's high infant mortality rate (IMR), which stands at approximately 67 deaths per 1,000 live births as of recent estimates.⁶ The onset of the COVID-19 pandemic in early 2020 introduced unprecedented disruptions to health services worldwide, including immunization delivery. Lockdowns, movement restrictions, fear of virus exposure, and diversion of healthcare resources significantly impacted routine immunization services across Nigeria. Studies estimate that vaccination coverage in many regions declined sharply during the pandemic, risking a resurgence of VPD outbreaks and worsening infant and child health outcomes.^{6,7} The pandemic also exacerbated challenges related to health system infrastructure, vaccine supply chains, and community trust, thereby amplifying immunization inequities.⁸ In response, Nigeria's government, in collaboration with international partners such as the World Health Organization (WHO), United Nations Children's Fund (UNICEF), and Global Alliance for Vaccines and Immunization (GAVI), intensified efforts to strengthen routine immunization programs through initiatives like the National Emergency Routine Immunization Coordination Centre (NERICC). These efforts focused on restoring vaccination services, reinforcing cold chain management, improving health worker training, and enhancing community

mobilization to address vaccine hesitancy and misinformation.⁹ Despite these interventions, evidence suggests that persistent challenges remain in ensuring timely vaccination completion and reducing dropout rates, which ultimately undermine full immunization coverage.¹ Socioeconomic determinants, including maternal education, household income, and geographic access to healthcare facilities, continue to influence immunization adherence. Children from lower-income households or residing in remote rural areas are more likely to be under-immunized or miss critical vaccine doses, thereby increasing vulnerability to VPDs.¹⁰ Moreover, data on infant mortality trends in relation to immunization coverage remain vital for guiding policy decisions and targeted interventions aimed at reducing preventable infant deaths. This study examines routine immunization adherence, dropout rates, and infant mortality trends in Delta State, Nigeria, over a five-year period (2018–2022), encompassing the pre-pandemic, pandemic, and early recovery phases of the COVID-19 pandemic. By analyzing immunization coverage data alongside infant mortality rates and vaccine-specific administration trends, this study aims to elucidate the resilience and gaps within immunization services during a period of global health crisis. The findings will inform public health strategies that strengthen immunization programs, improve vaccine delivery, and ultimately reduce infant mortality in Nigeria.

METHODOLOGY

Study Design

We conducted a retrospective longitudinal study spanning a five-year period (2018–2022) to quantify the effects of COVID-19–related service disruptions on routine childhood immunization and vaccine-preventable disease (VPD) outcomes in Delta State, Nigeria. The design allowed comparison of immunization coverage, dropout patterns, and infant VPD mortality before, during, and after the first two pandemic waves.

Setting

Delta State is located in Nigeria's South–South geopolitical zone and comprises urban, semi-urban and rural riverine communities with marked variability in health-care access. Immunization is

Table 1: Immunization Coverage, Dropout Patterns, Infant Mortality, and Vaccine Uptake among Children Under One Year in Delta State, Nigeria (2018 – 2022)

Data Element	2018	2019	2020	2021	2022
% Immunization Coverage	67.0%	78.0%	76.0%	68.0%	67.0%
% Fully Immunized < 1 year	50.0%	70.0%	61.0%	63.0%	63.0%
Infant Mortality Rate (%)	8.6%	10.4%	14.4%	10.9%	11.2%
Penta Drop Out Rate (%)	10.7%	9.8%	8.9%	8.9%	9.9%
BCG given	165,512.00	201,230.00	203,108.00	198,885.00	203,449.00
HBV0	119,201.00	147,233.00	146,141.00	126,651.00	162,821.00
PCV 1 given	184,896.00	213,538.00	213,137.00	205,800.00	201,867.00
PCV 2 given	163,158.00	193,483.00	190,869.00	186,378.00	179,993.00
PCV 3 given	160,131.00	190,704.00	190,329.00	186,747.00	180,907.00
Penta. 1 given	180,573.00	213,516.00	214,030.00	195,454.00	201,523.00
Penta 2 given	165,214.00	196,030.00	189,120.00	176,983.00	179,304.00
Penta 3 given	161,240.00	192,594.00	194,975.00	178,000.00	181,499.00
Fixed Sessions Planned	18,709.00	25,103.00	18,157.00	21,214.00	24,236.00
Fixed Sessions Conducted	18,011.00	25,114.00	18,640.00	20,735.00	21,542.00
Outreach Sessions Planned	5,342.00	9,102.00	6,607.00	9,786.00	9,210.00
Outreach Session Conducted	4,283.00	8,577.00	5,914.00	8,928.00	8,873.00
Fixed Sessions % Cov	96	100	103	98	89
Outreach Sessions % Cov	80	94	90	91	96
Fully Immunized < 1 year	120,394.00	172,651.00	156,273.00	164,313.00	171,203.00
Measles 1 given	158,099.00	192,353.00	189,330.00	183,331.00	206,713.00
Measles 2 given	11,814.00	43,382.00	83,885.00	84,541.00	95,462.00
Men A given	-	-	66,784.00	150,259.00	166,121.00
Yellow Fever given	173,866.00	192,859.00	230,269.00	187,680.00	177,506.00

(Source: Delta State Primary Health Care Agency)

is delivered through a network of primary healthcare (PHC) facilities and outreach posts overseen by the Delta State Primary Health-Care Development Agency (DSPHCDA).

Study Population

The analysis included all infants (< 12 months) recorded in state immunization registers who received at least one antigen between 1 January 2018 and 31 December 2022. Records were

excluded if (i) immunizations were administered outside Delta State, or (ii) essential variables (child identifier, date of vaccination, antigen type) were missing.

Data Sources

Secondary data were extracted from:

1. Routine Immunization Registers – antigen-specific coverage, completed-schedule status and dropout figures.

Table 2: Number of Fully Immunized Children and Measles/Yellow Fever Vaccines (2018–2022)

Year	Fully Immunized <1 Year	Measles 1 Given	Measles 2 Given	Yellow Fever Given
2018	120,394	158,099	11,814	173,866
2019	172,651	192,353	43,382	192,859
2020	156,273	189,330	83,885	230,269
	164,313	183,331	84,541	187,680
2021				
2022	171,203	206,713	95,462	177,506

2. Infant Mortality Reports – deaths attributed to VPDs, compiled by the State Ministry of Health.

3. Facility Performance Logs – counts of fixed-post and outreach sessions conducted by PHC workers under the supervision of the Delta State Primary Health Care Development Agency (DSPHCDA)

Data Collection Procedures

Trained data clerks abstracted monthly aggregates onto a standard extraction template, double checked entries for consistency, and created a de-identified analytic dataset.

Statistical Analysis

Descriptive statistics were used to summarize annual coverage, Pentavalent 3 (Penta 3) dropout rate and VPD mortality. Line graphs were used to track trends in year-on-year changes of immunization indicators and deaths. Paired-sample t-tests were used to compare mean immunization coverage and mortality rates across pre-pandemic (2018-2019) and pandemic/ post-pandemic (2020-2022) periods. Pearson’s correlation analysis was used to assess associations between immunization coverage and infant VPD mortality. All statistical analyses were performed with SPSS Statistics for Windows, version 26.0 (Armonk, NY: IBM Corp), with a significance level set at $p < 0.05$

ETHICAL CONSIDERATIONS

Approval was granted by the Delta State Ministry of Health Ethics Committee (HM/596/T2/133). Only aggregated, de-identified data were analyzed; no personal identifiers were retained. Permission to access routine records was obtained from the DSPHCDA.

RESULTS

Immunization Coverage, Dropout Patterns In-

fant Mortality, and Vaccine Uptake Among Children Under One Year in Delta State, Nigeria (2018 – 2022)

Immunization coverage peaked at 78% in 2019 but dropped during the pandemic, returning to 67% by 2022, the same level as 2018. The proportion of fully immunized children under one year followed a similar trend, increasing from 50% in 2018 to 70% in 2019, but then falling to 61–63% from 2020 onward. Infant mortality worsened during this period, rising from 8.6% in 2018 to 14.4% in 2020, declining slightly to 11–12% in 2021–2022, though still above pre-pandemic levels. Penta3 dropout rates decreased steadily from 10.7% in 2018 to 8.9% in 2020–2021 and increased again to 9.9% in 2022. Implementation of fixed immunization sessions was affected, with only 89% of the planned sessions conducted in 2022, indicating reduced service delivery capacity during the period. Vaccine uptake generally increased between 2018 and 2019 and remained relatively stable thereafter. The highest numbers were recorded for BCG, PCV1, and Penta1 vaccines, showing good initiation of immunization schedules. However, subsequent doses such as PCV2, PCV3, Penta2, and Penta3 declined over time, reflecting persistent dropout and incomplete vaccination.

Number of Fully Immunized Children and Measles/Yellow Fever Vaccines (2018–2022)

The number of fully immunized children rose substantially from 120,394 in 2018 to 172,651 in 2019 but dipped in 2020 before rebounding by 2022. Measles 1 vaccine administration remained relatively high across the years, while the number of Measles 2 doses increased significantly, from

Table 3a: Paired-Samples Test Results
Paired Samples Test

		Paired Differences			95% Interval Difference	Confidence of the		Sig. (2- tailed)
		Mean	Std. Deviation	Std. Error Mean		Lower	Upper	
Pair 1	Measles – Coverage	-48.600	7.797	3.487	-58.282	-38.918	-13.937	4 .000
Pair 2	Measles – % Fully Immunized	-38.800	11.649	5.210	-53.264	-24.336	-7.448	4 .002
Pair 3	Measles – Infant Mortality	11.5000	6.4630	2.8903	3.4752	19.5248	3.979	4 .016
Pair 4	Measles – Penta	12.9600	6.9777	3.1205	4.2961	21.6239	4.153	4 .014
Pair 5	Neonatal Tetanus – Coverage	-67.400	4.980	2.227	-73.583	-61.217	-30.263	4 .000
Pair 6	Neonatal Tetanus – Fully Imm.	-57.600	7.197	3.219	-66.537	-48.663	-17.895	4 .000
Pair 7	Neonatal Tetanus – Infant Mort.	-7.3000	3.8171	1.7070	-12.0395	-2.5605	-4.276	4 .013
Pair 8	Neonatal Tetanus – Penta	-5.8400	1.7771	.7947	-8.0465	-3.6335	-7.348	4 .002
Pair 9	Pertussis –Immuniz. Coverage	-70.600	5.128	2.293	-76.968	-64.232	-30.783	4 .000
Pair 10	Pertussis - % Fully Immunized	-60.800	7.259	3.247	-69.814	-51.786	-18.728	4 .000
Pair 11	Pertussis – Infant Mortality	-10.5000	1.4213	.6356	-12.2647	-8.7353	-16.520	4 .000
Pair 12	Pertussis – Penta	-9.0400	1.5773	.7054	-10.9985	-7.0815	-12.815	4 .000
Pair 13	Yellow Fever –Imm. Coverage	-70.800	5.718	2.557	-77.900	-63.700	-27.685	4 .000
Pair 14	Yellow Fever – % Fully Immun.	-61.000	7.583	3.391	-70.415	-51.585	-17.988	4 .000
Pair 15	Yellow Fever – Infant Mortality	-10.7000	2.4637	1.1018	-13.7591	-7.6409	-9.711	4 .001
Pair 16	Yellow Fever – Penta	-9.2400	.8473	.3789	-10.2921	-8.1879	-24.383	4 .000
Pair 17	Diphtheria - Immuniz. Coverage	-71.200	5.357	2.396	-77.852	-64.548	-29.718	4 .000
Pair 18	Diphtheria - % Fully Immun	-61.400	7.232	3.234	-70.380	-52.420	-18.985	4 .000

11,814 in 2018 to 95,462 in 2022, suggesting improved follow-up for the second dose. Yellow Fever vaccine doses fluctuated, peaking in 2020 (230,269 doses) but decreasing thereafter, which may reflect changes in immunization campaign intensity or population access. Across all vaccine-preventable diseases examined, the paired t-tests revealed statistically significant differences between the pre-pandemic (2018–2019) and pandemic/post-pandemic (2020–2022) periods. Coverage and full-immunization percentages were consistently lower, while infant mortality and Penta-uptake differences reflected the consequences of missed doses. The steepest negative shifts were seen for Pertussis, Diphtheria, Polio and Measles. Hepatitis B uptake showed notable improvement, accompanied by reduced mortality and increased Pentavalent vaccine completion, indicating the positive effect of targeted control measures.

DISCUSSION

This study highlights a decline in routine immunization coverage in Delta State during the COVID-19 pandemic, with coverage falling from 78.0% in 2019 to 67.0% by 2022. These results are consistent with global reports that the pandemic disrupted vaccination programs, leading to reduced

coverage and heightened risks of vaccine-preventable disease outbreaks. A modelling study estimated a 7.7 percentage-point global decline in DTP3 coverage in 2020, with Nigeria among the top contributors due to lockdowns and service interruptions.¹¹ A national Nigerian study also documented a 28.0% reduction in pentavalent vaccine uptake between March and June 2020, underscoring the vulnerability of immunization services to external shocks.¹² Notably, the Penta3 dropout rate remained below 10.0% throughout the study period, which is lower than the sub-Saharan African median of 20.9%.¹³ This suggests relatively strong follow-up mechanisms for children who began the vaccination schedule. However, the challenge of “zero-dose” children, those who never receive any vaccines, remains inadequately addressed. The 2018 Nigeria Demographic and Health Survey revealed substantial numbers of children who received no vaccinations, particularly among disadvantaged populations.¹⁴ These trends are shaped by social determinants of health, such as poverty, low maternal education, and poor geographic access to services, which continue to hinder equitable vaccine uptake. The findings also show substantial increases in measles second dose (MCV2) coverage, which rose from 11,814 doses

Table 3b: Paired-Samples Test Results
Paired Samples Test

		Paired Differences			95% Interval Difference		Confidence of the		Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error	Lower	Upper	T	Df	
Pair 19	Diphtheria – Infant Mortality	-11.1000	2.1024	.9402	-13.7104	-8.4896	-11.806	4	.000
Pair 20	Diphtheria – Penta	-9.6400	.7603	.3400	-10.5840	-8.6960	-28.353	4	.000
Pair 25	Poliomyelitis – Immu. Coverage	-71.200	5.357	2.396	-77.852	-64.548	-29.718	4	.000
Pair 26	Poliomyelitis - % Fully Immun.	-61.400	7.232	3.234	-70.380	-52.420	-18.985	4	.000
Pair 27	Poliomyelitis – Infant Mortality	-11.1000	2.1024	.9402	-13.7104	-8.4896	-11.806	4	.000
Pair 28	Poliomyelitis – Penta	-9.6400	.7603	.3400	-10.5840	-8.6960	-28.353	4	.000
Pair 29	Hepatitis B – Immu. Coverage	-41.800	10.498	4.695	-54.835	-28.765	-8.904	4	.001
Pair 30	Hepatitis_B – % Fully Immun	-32.000	14.714	6.580	-50.270	-13.730	-4.863	4	.008
Pair 31	Hepatitis_B – Infant	18.3000	12.8635	5.7527	2.3278	34.2722	3.181	4	.034
Pair 32	Hepatitis_B – Penta	19.7600	14.7705	6.6056	1.4200	38.1000	2.991	4	.040
Pair 33	Meningitis – Coverage	-68.200	6.834	3.056	-76.685	-59.715	-22.316	4	.000
Pair 34	Meningitis – Fully	-58.400	8.792	3.932	-69.317	-47.483	-14.853	4	.000
Pair 35	Meningitis – Infant	-8.1000	3.9077	1.7476	-12.9520	-3.2480	-4.635	4	.010
Pair 36	Meningitis – Penta	-6.6400	1.6817	.7521	-8.7281	-4.5519	-8.829	4	.001

in 2018 to 95,462 in 2022. This represents the largest relative increase among routine vaccines following the introduction of MCV2 into the schedule in 2019. Nevertheless, MCV2 uptake still lags behind MCV1, reflecting incomplete continuity of vaccination and leaving children vulnerable to measles outbreaks. Yellow fever vaccine coverage peaked in 2020 following supplementary immunization activities (SIAs) but declined thereafter. This pattern demonstrates that campaign-driven gains are not always sustained by routine services. More than 50.0% of Nigeria's 16,777 suspected yellow fever cases occurred between 2019 and 2021, underscoring the persistent risk of resurgence in areas with low routine coverage.¹⁵ Similarly, diphtheria coverage showed a marked reduction in Delta State, a concerning trend in light of Nigeria's 2023 diphtheria outbreak, which was linked to under-immunized clusters and weaknesses in service delivery.¹⁶ In contrast, uptake of the Hepatitis B birth dose (HBV0) improved steadily across the study period. This is consistent with findings from Benue State, where 64.0% of Hepatitis B-exposed infants received timely birth doses.¹⁷ The enhancement is probably linked to increased antenatal care attendance and a rise in facility-based deliveries. However, additional research is required to identify the specific drivers of this trend in Delta State. Overall, these results reinforce the importance of maternal education, awareness, and access in sustaining vaccination programs. A community survey in Delta State

found that 68.0% of children were fully immunized, with maternal awareness identified as a key determinant.¹⁸ A recent scoping review similarly highlighted persistent barriers across Nigeria, including misinformation, geographic barriers, and inadequate health worker training, that continue to impede equitable vaccine access.¹⁹

CONCLUSION

This study highlights critical trends in routine immunization coverage and vaccine-preventable disease outcomes among infants in Delta State, Nigeria. While notable gains were achieved in the uptake of certain vaccines, such as the measles second dose and hepatitis B birth dose, overall coverage remained below national and global targets, especially following COVID-19 disruptions. Coverage fluctuations, increased dropout rates, and the persistent presence of zero-dose children, who have never received any vaccines, reflect significant equity challenges in access to and delivery of services. Addressing these gaps requires urgent, targeted interventions that focus on reaching underserved populations, reinforcing health system capacity, and strengthening immunization tracking mechanisms. Sustained political commitment and stronger integration of immunization with other maternal and child health programs will be essential for achieving universal vaccine access and reducing the burden of vaccine-preventable diseases.

IMPLICATIONS FOR POLICY AND FUTURE RESEARCH

The findings of this study highlight the need for comprehensive strategies to strengthen immunization systems and reduce preventable infant deaths in Delta State and similar settings. Reaching zero-dose children remains a critical priority, as these unvaccinated infants, mostly found in remote and underserved communities, represent the most vulnerable group sustaining immunity gaps. Strengthening service delivery through improved fixed posts and outreach sessions, supported by investments in workforce capacity, logistics, and supervision, is also essential to ensure uninterrupted access, particularly during health system disruptions such as pandemics. Equally important is enhancing caregiver engagement by addressing barriers to vaccine schedule completion, especially for second doses like the measles-containing vaccine (MCV2). Increasing awareness, utilizing reminder systems, and providing consistent follow-up can reduce dropouts and improve full immunization rates. Furthermore, improving the quality and granularity of data through monthly or facility-level reporting will enhance monitoring, enabling timely identification of coverage declines and prompt corrective action. Finally, policies must integrate vaccination services with broader maternal and child health programs while addressing key social determinants such as poverty, maternal education, and geographic access. Such an integrated, equity-focused approach will help expand vaccine reach, strengthen community trust, and promote sustained improvements in immunization coverage.

STRENGTHS AND LIMITATIONS

This study has several notable strengths. It utilized a large dataset, allowing for a comprehensive analysis of immunization and infant mortality indicators across Delta State. The examination of past records provided valuable insights into trends over time, while the use of secondary data minimized ethical concerns and posed minimal or no risk to participants.

However, this study has some potential limitations. Although paired t-tests compared pre- and post-pandemic indicators, the use of annual data limited the detection of short-term variations; monthly or facility-level analyses could offer deeper insights. In addition, incomplete facility reporting may have affected the accuracy of the immunization data. Also, unmeasured confounders, such as socioeconomic shocks during the pandemic, could have influenced infant mortality patterns. The findings from Delta State may have limited generalizability, as they may not apply to other regions in Nigeria. A statistical approach, which relies on paired t-tests using annual data, may not fully capture within-year fluctuations. More detailed analyses using monthly or quarterly data, or disaggregated facility-level reports, would provide greater granularity and a clearer understanding of the pandemic's impact on immunization services.

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COMPETING INTEREST

The authors declare no competing interests. The research was conducted independently, and no financial or personal relationships influenced the outcome of this study.

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AUTHORS' CONTRIBUTIONS

TEI contributed to the study conceptualization, data collection, and interpretation of findings. JOE and

OCC contributed to the literature review and manuscript revision. DEA supervised the research process, provided subject-matter expertise in immunization, contributed to the study design, and data validation. NAM participated in data interpretation, review of surveillance data and PMB drafted the manuscript and contributed to the manuscript revision. All authors read and approved the final manuscript.

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