NIGERIAN JOURNAL OF PAEDIATRICS

VOLUME 53 | NUMBER 2 | APRIL - JUNE 2026

https://www.njpaediatrics.com

PRINT: ISSN 0302-4660

ONLINE: ISSN 2814-2985

OFFICIAL JOURNAL OF THE PAEDIATRIC ASSOCIATION OF NIGERIA

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ORIGINAL RESEARCH

Nigerian Journal of Paediatrics 2026 (June); Volume 53(2):189-193.
https://dx.doi.org/10.63270/njp.v53i2.2000063.

Effect of COVID-19 Pandemic on Immunisation Programmes in Ibadan Metropolis, Southwest Nigeria

Ogunbosi Babatunde O, Alao Michael A, Alejoh Joy N, Adebayo Bosede E, Lagunju IkeOluwa A

Department of Paediatrics, University of Ibadan/University College Hospital, Ibadan, Nigeria.

Correspondence

Dr Ogunbosi Babatunde O. Department of Paediatrics, University of Ibadan/University College Hospital, Ibadan, Nigeria. E-mail: tundeogunbois@yahoo.com ; ORCID – https://orcid.org/0000-0002-7576-7367.

Abstract

Background: The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) pandemic disrupted routine immunisation (RI) services. Reports from low- and middle-income countries remain inconsistent and under-represented.

Objective: To evaluate the impact of the COVID-19 pandemic on RI, assess the perspectives of caregivers on service provision and pandemic preparedness in a Nigerian city.

Methods: This cross-sectional study was conducted between December 2020 and February 2021 among consecutive mother-child pairs attending four high-volume immunisation clinics: a public primary, a secondary, a tertiary, and a private healthcare facility. Vaccine uptake and caregivers' experiences were determined, while multivariable logistic regression models were used to predict missed immunisations.

Results: A total of 416 mother-child pairs were enrolled. Males were 223 (53.6%), while children aged 7-12 months were 59.6% (248/416). Uptake of Expanded Programme on Immunisation vaccines were as follows: Bacillus Calmette-Guérin (BCG) - 98.8%, DPT3 - 95.9%, first dose of measles-containing vaccine - 93.4%, and meningococcal vaccine - 72.8%. RI appointments were missed by 9.6% of caregivers, and 43.0% reported RI clinic closure. Communication gaps observed were as follows: 67.3% of caregivers lacked service providers' contact details, and 87.7% did not have guidance on RI services. Accessing care at a private hospital was an independent predictor of missed RI schedule (AOR 6.2, 95% CI 2.2, 16.1, $p < 0.05$).

Conclusion: Routine immunisation coverage remained high despite service disruptions and communication gaps. Future pandemic preparedness should prioritise emergency protocols, with particular attention to private healthcare facilities.

Keywords: Health system, Immunisation coverage, Measles vaccine, Routine Immunisation, SARS-CoV-2.

Introduction

Childhood immunisation has remained one of the most effective health interventions in human history, especially in resource-poor settings where healthcare services and primary preventive measures are at an abysmally poor levels. [1-5] Since the launch of the Expanded Programme on Immunisation in the year 1974, globally, an estimated 146 million lives have been saved among children aged less than 5 years, of whom 101 million were infants less than 1 year old. [6] Effective childhood vaccination programmes are hinged on routine immunisation (RI) delivered through existing healthcare infrastructure. Disease outbreaks and erosion of confidence in the efficacy of the vaccination programme result

when there is an interruption in the chain of events involved in the RI programmes. [7]

The Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2) infection outbreak was first reported in December 2019 and had a significant negative impact on healthcare systems worldwide. [8-11] Most affected was the RI programme, where the worst drop in global immunisation coverage was seen in 30 years during the COVID-19 years of 2020 and 2021. [12] The COVID-19 pandemic disrupted RI in several ways, especially as most governments instituted total or partial lockdowns. Both health workers and consumers of routine immunisation services were unable to reach the immigration centres, access funds, or avoided health facilities due to fear of contagion. [13, 14] In some instances, vaccine supply chains and cold chain infrastructure were disrupted. [14] Due to the significant disruption by the COVID-19 pandemic, in some cases, RI resources- human, material, and infrastructural- were repurposed and deployed for pandemic containment efforts. [15]

Significantly, globally, there was a 40% increase in zero-dose children, those who had not received the first dose of the diphtheria, tetanus, and pertussis-containing vaccine, from 13.3 million in 2019 to 18.2 million in 2021. [12] Reports on the effect of the COVID-19 pandemic on vaccine coverage utilising data from around the globe documented varying levels of reduction in the amounts of vaccine delivered during the pandemic compared to the pre-pandemic era. [16, 17] However, some of the reports also detail heterogeneity and disparities within countries and communities, with traditionally poorer and disadvantaged communities bearing a bigger brunt of the problem. [16]

The magnitude to which the SARS-CoV-2 pandemic impacted the RI programme in LMICs, including Nigeria, remains inconsistently documented and largely under-reported. A review of RI records in Oyo State, southwestern Nigeria, suggested a general decline in coverage, with a wave pattern suggesting variations across the state, while another report from the same state observed lower vaccine coverage in rural communities compared to urban settings. [18, 19] This study, therefore, sought to determine the impact of the SARS-CoV-2 pandemic on the routine immunisation programme, the perspective of mothers on RI service provision, factors affecting RI uptake, and pandemic preparedness during the pandemic.

Methods

Study design

The study was cross-sectional in design, conducted between December 2020 and February 2021.

Study area

Ibadan is the capital of Oyo State in Southwest Nigeria, and the fourth largest city in Nigeria. The projected population in 2020, using the 2006 population figure as the baseline and an annual growth rate of 3.4%, was 8.9 million for Oyo State, and 4.07 million for the Ibadan metropolis. [20]

Study population

It involved child-mother pairs at four high-volume immunisation clinics in Ibadan metropolis, Oyo State, southwest Nigeria viz - i) Idi-Ogungun Primary Healthcare Centre, Gate – a public facility; ii) Adeoyo Maternity Teaching Hospital, Yemetu - a state government-owned tertiary healthcare facility; iii) The University College Hospital, Ibadan, - a federal government-owned tertiary healthcare facility; and iv) Vine Branch Hospital, Yemetu, - a private secondary health care facility.

Sample size

The sample size of 416 was determined using Cochran's formula for estimating a single proportion to achieve a confidence level of 95% and 5% precision using a 39.1% prevalence of missed opportunity for immunisation from a previous study by Anah and colleagues. [5]

Sampling technique

A two-staged purposive, proportionate, random sampling technique was used to select consecutive mother-child pairs presenting at the study site.

Stage 1: Utilising the data from the State National Programme on Immunisation, a purposive selection of the largest high-volume immunisation clinics at public primary, secondary and tertiary health centres, and a private secondary health facility was carried out.

Stage 2: Proportional allocation of sample size and selection of participants. Based on the average monthly attendance at the immunisation centres in the previous year, proportionate numbers of children were enrolled from the four immunisation centres. Children aged 18 months and below who had been receiving immunisation services at the selected health facilities from January 2020 and not later than August 2020 were eligible for the study. This period was chosen to capture the build-up to and peak of the COVID-19 pandemic at the study locations.

Participant recruitment: Consecutive mothers presenting for scheduled RI at the immunisation clinic at the study sites were enrolled. Those who consented were enrolled, and the data collection tool was administered until the sample size for each study site was attained.

Data collection instrument and validation

Data on mother-child pairs were collected using a validated semi-structured questionnaire by a research assistant using Google Forms. The demographic information on parents/caregivers included the age and sex of caregivers and child, occupation and level of education of the caregiver. Also, information on vaccines received and antigens missed were obtained. These were verified with the immunisation card/record, where available, or by recall. The caregivers' attitude and challenges to accessing vaccination services at the peak of the pandemic, as well as measures deployed by the immunisation centres to sustain the utilisation of services during and after the pandemic, were recorded.

Data analysis

Completed Google forms were extracted into a Microsoft Excel spreadsheet, exported to and analysed using the IBM Statistical Package for Social Sciences (SPSS) version 23. Categorical data were reported as proportions and frequencies, while continuous variables were presented as means and standard deviation for normally distributed data. The Chi-Square or Fisher's Exact test, as appropriate, was used to compare independent categorical variables for statistical significance. Logistic regression was used to predict factors associated with the primary outcome of missed vaccination episodes. The level of statistical significance was set at $p<0.05$.

Results

A total of 416 children were enrolled across the four facilities over the 10 weeks. A total of 149 (35.8%) from the public secondary health facility, 131 (31.5%) were from the public tertiary health facility, 82 (19.7%) from the private secondary health facility and 54 (13.0%) from the public primary health facility. Males constituted 223 (53.6%), and those aged 7-12months (representing deliveries during the outbreak of the COVID-19 pandemic through the peak of the first wave in Nigeria) constituted 59.6% (248/416). Among caregivers, 59.6% (248/416) were aged 30-45years, 98.3% (409/416) had been married once, 70.7% (294/416) belonged to the upper socioeconomic class and those residing in

urban settings formed 82.0% (341/416) of the total population (Table I).

Table I: Sociodemographic characteristics of study population

Variable	Frequency	Percentage
Child's age (months)		
Birth – 6	13	3.1
7-12	248	59.6
13-18	155	37.3
Sex		
Male	223	53.6
Female	193	46.4
Primary caregiver's age in years		
15-30	149	42.8
31-45	248	59.6
46-60	5	1.4
Parent's social class		
Upper	294	70.7
Middle	80	19.2
Lower	42	10.1
Primary caregiver		
Both Parent	221	53.1
Mother	195	46.9
Caregiver's Domicile		
Rural	75	18
Urban	341	82
Caregiver's Marital Status		
Married	409	98.3
Divorced	1	0.2
Separated	4	1
Single	2	0.5
Type of health facility		
Primary public	54	13
Secondary public	149	35.8
Secondary private	82	19.7
Tertiary public	131	31.5

Concerning the uptake of vaccines in the National Programme on Immunisation schedule, the uptake of Bacillus Calmette-Guérin (BCG) vaccine was 98.8%, 95.9% for DPT3, 93.4% for the first dose of measles-containing vaccine (MCV1), and the 72.8% for the first dose of meningococcal vaccine (Table II). Most of the missed vaccines occurred from the 14-week doses (Table II).

Regarding perspectives and attitudes of caregivers to RI during the pandemic, 98.1% (408/416) believed the non-pharmaceutical measures were effective in preventing the

transmission of COVID-19, and 404/416 (97.1%) would still keep clinic appointments. While 46/416 (11.1%) experienced challenges taking their children for immunisation, 40/416 (9.6%) missed a scheduled RI appointment. Concerning communication during the pandemic, a third 32.7% (136/416) did not have a phone contact of personnel at the vaccination centres, 24.5% (102/416) received reminders on due vaccinations in the form of text messages or phone calls from the health facility, and 12.3% (51/416) received communication about what to expect with regards to vaccination services in the early phases and the peak of the pandemic (Table IIIa)

Table II: The Immunisation Status of Children Accessing Immunisation Services at Selected Public Health Centres

Immunization	Events	Immunisation Uptake	Lower limit	Upper limit	Z-Value
BCG	411	0.988	0.971	0.994	9.799
Penta 3	399	0.959	0.935	0.974	12.74
Measles	389	0.935	0.907	0.955	13.4
Pooled vaccine uptake		0.954	0.939	0.965	20.619
Missed vaccines	49	0.039	0.030	0.052	-21.938
OPV0	408	0.981	0.962	0.990	11.01
HBV	407	0.978	0.959	0.988	11.31
Penta 1	410	0.986	0.968	0.993	10.27
OPV 1	409	0.983	0.965	0.991	10.67
PCV 1	407	0.978	0.959	0.988	11.31
Penta 2	407	0.978	0.959	0.988	11.31
OPV 2	408	0.981	0.962	0.990	11.01
PCV 2	407	0.978	0.959	0.988	11.31
IPV	400	0.962	0.938	0.976	12.62
OPV 3	401	0.964	0.941	0.978	12.49
PCV 3	401	0.964	0.941	0.978	12.49
Vitamin A	395	0.950	0.924	0.966	13.1
Pooled vaccine uptake		0.972	0.966	0.976	39.96
Missed vaccines	133	0.028	0.024	0.034	-40.878
Rota 1	260	0.625	0.577	0.67	5.043
Rota 2	267	0.642	0.595	0.686	5.704
Meningococcal 1	303	0.728	0.684	0.768	8.948
Meningococcal 2	370	0.889	0.856	0.916	13.33
Pooled vaccine uptake		0.703	0.679	0.725	15.297
Missed vaccines	464	0.279	0.258	0.301	-17.381

BCG - Bacillus Calmette–Guérin vaccine; HBV - Hepatitis B virus vaccine; OPV - Oral polio virus; IPV - Inactivated polio virus; Rota - Rotavirus Vaccine

The attitudes of caregivers to RI are presented in Table IIIb, where 303 (72.8%) strongly felt their child must be immunised irrespective of COVID-19, and 96 (23.1%) strongly disagreed it was unsafe to immunise their child at that time.

Some of the factors associated with a missed scheduled immunisation included older age of child, 13-18months of age, both parents serving as the caregivers, difficulty accessing vaccines,

and possession of misconceptions or neutral beliefs. Others are presented in Table IV.

Table IIIa: The knowledge and perspectives of mothers accessing immunisation services during and after the peak of the COVID-19 pandemic

Variable	Yes	No
Do you think hand washing, face masks, and social distancing protect you from contracting COVID-19 infection while at the immunisation clinic?	408 (98.08)	8 (0.02)
Will you be willing to keep an appointment at the peak of the pandemic?	404 (97.1)	12 (2.9)
Did you experience challenges while taking your child/children for immunisation?	46 (11.1)	372 (89.4)
If yes to the above, did your child/children miss any immunisation?	40 (9.6)	
Were the vaccine centres closed during the peak outbreak of COVID-19	179 (43.0)	237(57.0)
Were you notified of the pending closure and suspension of immunisation services?	5 (1.2)	179 (43.0)
Do you have the official contact details of your service provider for your child/ children's immunisation?	136 (32.7)	280 (67.3)
Did you receive a reminder in the form of calls or text messages from the service provider during the COVID outbreak?	102 (24.5)	314 (75.5)
Did you receive specific communication on what to expect concerning your child's immunisation schedule in the event of suspension of immunisation services?	51 (12.3)	365 (87.7)

Table IIIb: The knowledge and perspectives of mothers accessing immunisation services during and after the peak of the COVID-19 pandemic

Variable	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
I felt my child must get immunised on time, irrespective of the COVID outbreak	303 (72.8)	98 (23.6)	8 (1.9)	4 (1.0)	3 (0.7)
I felt it was not safe to get immunised at the peak of the COVID outbreak	5 (1.2)	51 (12.3)	43 (10.3)	221 (53.1)	96 (23.1)
I felt there were too many bottlenecks to get immunisation at the peak of the COVID outbreak	37 (8.9)	2 (2.5)	16 (3.8)	267 (64.2)	94 (22.6)
I feel the complete lockdown made getting my child/children immunised during the peak of the COVID outbreak impossible	19 (4.6)	3 (0.7)	17 (4.1)	258 (62.0)	119 (28.6)
Do you think there is a good prospect of an effective vaccine?	117 (28.1)	225 (54.1)	60 (14.4)	3 (0.7)	11 (2.6)

On bivariate analysis, children from non-traditional family structures (households of single or divorced parent, and separated parents) had about four times higher odds of missing immunisation compared to those from stable married households (p = 0.019; OR = 4.2; 95% CI: 1.3–14.1).

Table IV: Factors associated with a missed immunisation consequent on the COVID-19 pandemic.

Variable	Accessed immunization	Missed Immunization	X^2	*P*
Primary Caregiver				
Both Parent	32 (61.5)	20 (38.5)	12.746	<0.001
Mother	151 (84.4)	28 (15.6)		
Gender				
Male	92 (78.0)	26 (22.0)	0.231	0 .631
Female	91 (80.5)	22 (19.5)		
Age of vaccine recipient				
0-6months	6 (66.7)	3(33.3)	8.223	0.013
7-12 months	110 (85.9)	18(14.1)		
13-18months	67 (71.3)	28(28.7)		
Address of Primary Caregiver				
Rural	12 (80.0)	3 (20.0)	0.006	1.000
Urban	171 (79.2)	45 (20.8)		
Type of Health Facility				
Primary Public	1 (25%)	3 (75%)	16.135	0.001
Secondary Public	107 (87.7)	15 (12.3)		
Secondary Private	21 (65.6)	11 (34.4)		
Tertiary Public	54 (74.0)	19 (26.0)		
Social Class				
Upper Social Class	134 (80.4)	33 (19.6)	0.631	0.729
Middle Social Class	25 (78.1)	7 (21.9))		
Lower Social Class	23 (74.8)	8 (25.8)		
Family Marital Status				
Married	182 (80.2)	45 (19.8)	7.805	0.029
Divorced	00 (0.0)	1 (100.0)		
Separated	1 (50.0)	1 (50.0)		
Single	0 (0.0)	1 (100.0)		
Misconception of COVID and immunization				
Neutral	27 (71.1)	11 (28.9)	6.694	0.035
Yes	22 (66.7)	11(33.3)		
No	134 (83.8)	26(16.3)		
Difficulty accessing the vaccine				
No	154 (82.8)	32 (17.2)	7.413	0.006
Yes	29 (64.4)	16 (35.6)		

A total of 185 were not valid for missing data analysis, either because the vaccine schedules were not yet due as at the time of peak incidence of the pandemic, or they had other reasons not to take the vaccine besides the SARCoV-2 pandemic.

Table V: Factors Associated with missed Immunization

Variable	Beta	Wald	Sig.	Exp(B)	95% C.I. for EXP(B)	
		Unadjusted Odds				
					Lower	Upper
Family Status	1.445	5.537	0.019	4.2	1.3	14.1
Health Facility	0.462	5.126	0.024	1.6	1.1	2.4
Primary caregiver	0.81	4.181	0.041	2.2	1.5	4.9
Child's Age	0.805	5.009	0.025	2.2	1.1	4.5
		Adjusted Odds				
Other facilities besides the public secondary health facility	1.782	12.095	0.001	6.2	2.2	16.1

A total of 185 were not valid for missing data analysis, either because the vaccine schedules were not yet due as at the time of peak incidence of the pandemic, or they had other reasons not to take the vaccine besides the SARCoV-2 pandemic.

Also, children cared for by caregivers other than the mother had more than twice the odds of missing immunisation (p = 0.041; OR = 2.2; 95% CI: 1.5–4.9). Other factors associated with higher odds of missing immunisation included advanced child age and the type of health facility (Table IV). After adjusting for other variables on logistic regression analysis, only health facility type remained a strong independent predictor of missed immunisation, with children receiving care in facilities other than public secondary health facilities having 6.2 times higher odds of missing immunisation (p = 0.001; AOR = 6.2; 95% CI: 2.2–16.1) (Table V).

Discussion

This study provides insights into immunisation uptake, caregivers' perceptions, and factors impacting missed vaccinations during health service disruption in crises. While uptake of RI remained high, challenges with communication and temporary service suspension exposed vulnerabilities of health services during emergencies.

Most of the caregivers in this study were married, urban dwellers, and belonged to the upper socioeconomic class, thus reflecting the urban setting and hospital-based nature of the study. The majority of the children enrolled were aged $^{7–12}$ months, representing the birth cohort at the onset and peak of the first wave of the SARS-CoV-2 pandemic in Nigeria. This is important and helps to capture the experiences of caregivers at the early stages and peak of the pandemic when there were service disruptions, fear of healthcare facilities and contagion, and movement restrictions.

The uptake of scheduled immunisations was not severely affected in the population studied, with coverage rates for BCG, DPT3 and MCV1 in this study remaining above the estimated national and global average for 2020. In contrast, Chandir et al. in Karachi, Pakistan, observed a steep decline in daily immunisation visits of 52.8% during the lockdown. [21] This is in concert with observations from other parts of the world and the state where this study was conducted. [17-19] Early in the course

of the COVID-19 pandemic, the WHO also warned that about 80 million children were at risk of vaccine-preventable diseases due to disruptions to vaccination programmes by the COVID-19 pandemic.[22]

A modelling study estimated that compared to gaps in immunisation coverage in 2020, an additional 8.5 million children would miss routine DPT3 vaccination and 8.9 million would miss routine MCV1 due to the COVID-19 pandemic. [23] Most of these were estimated to occur outside the sub-Saharan region, where the lockdown was more strictly implemented. The immunisation coverage observed in this study may be because a total lockdown was not implemented in the city where this study was conducted. In addition, the caregivers in this study belonged to the higher socioeconomic classes, who traditionally have high vaccine uptake rates for their children. Moreover, most of them maintained a good attitude towards RI and strongly felt their children should get immunised despite the COVID-19 pandemic. Observations from Karachi, Pakistan, also observed that, despite a decline in vaccine uptake in general, the more affluent neighbourhoods were spared. [21] Previous studies in Nigeria have reported children from affluent families being more likely to complete immunisation schedules. [24] This further highlights the inequities that poverty and inadequate resource allocation and provision bring to the immunisation landscape.

As with the modelling study by Causey *et al.*, [23] most of the missed vaccinations occurred early in the COVID-19 pandemic. A similar pattern was observed from Karachi, Pakistan, by Chandir *et al.*, with a steeper decline in total immunisations occurring during the first six weeks of the lockdown early in the COVID-19 pandemic. [21] This steep decline was probably associated with the initial suspension of vaccination programmes amidst uncertainties on how best to handle the closures of health services, redistribution of health personnel to address the pandemic and fears of contracting COVID-19 in health facilities. Indeed, a survey by the WHO to assess the continuity of essential health services in the wake of the COVID-19 pandemic revealed that immunisation services were the most affected. [25] A subsequent WHO Guidance paper was released, which advised against suspension of RI programmes, and the modelling work by Abbas et al. showed that the benefits of maintaining RI services far outweighed the risk to health posed by the COVID-19 pandemic in Africa. [26, 27] Maintaining immunisation services in a safe manner is key during pandemics to preserve the gains made in vaccination uptake in the most affected communities.

Evidence-based interventions to reduce missed opportunities for vaccination and improve vaccination coverage include provider education, patient education, provider prompts in the form of specific communication, including phone calls, patient tracking and outreaches. [28] Only 1.2% were informed of the impending closure of immunisation services in the wake of the pandemic. A third had contact of their vaccination service provider, and just a quarter received reminders on scheduled immunisations. An abysmal 12.3% received specific information on what to expect with regard to their child's immunisation in the event of suspension of immunisation services. Approximately one in ten caregivers reported difficulty accessing immunisation services, and nearly 10% missed scheduled appointments. In addition, 43% reported temporary closure of immunisation clinics during the peak of the pandemic. These findings demonstrate that disruptions were driven less by caregiver hesitancy and more by health system limitations and service interruptions.

Epidemic preparedness is often not factored into the planning of essential health services. An

interim report by WHO on disruption of essential services in 105 member countries reported disruptions in all established essential services for: communicable and non-communicable diseases, mental, reproductive, maternal, newborn, child and adolescent health, nutritional and emergency services. [26] Immunisation service was the most disrupted, especially mobile immunisation services. The majority of respondents in the study did not receive specific messages in preparation for a possible suspension of immunisation services in the wake of the COVID-19 pandemic. Following the suspension of immunisation services, most did not receive communication on the resumption of services or on how to prepare to access immunisation services in the face of the ongoing pandemic.

While patient tracking and provider prompts are not routinely provided in immunisation services, especially in public health facilities, contingency planning and emergency preparedness for health crises need to prioritise effective communication. In the study context, non-traditional methods such as the use of WhatsApp messaging and social media platforms to disseminate information to consumers of RI services could have been considered. Learning from RI programmes in Nepal, Senegal and Liberia reports, some innovative mechanisms were put in place to mitigate the effect of disruptions on the COVID-19 pandemic. [29] These innovations included providing tailored communication to support RI, providing immunisation at off-hours and weekends, tracking patients who missed schedules, and catch-up immunisation programmes where feasible.

Caregivers in this study remained motivated and committed to accessing immunisation services for their children in the face of challenges caused by the COVID-19 pandemic. In a systematic review of determinants of effective vaccine coverage in low and middle-income countries, intent to vaccinate was identified as one of the determining factors. [30] Other factors identified were community access and the readiness of the health facility. [30] These, unfortunately, were found to be suboptimal in some immunisation centres in this study. Successful immunisation programmes are premised on strong, resilient health services, always ensuring the availability of vaccines and a population ready to receive the vaccines. COVID-19 presented a situation where the supply end was ill-prepared, and this calls for a need for pandemic preparedness planning along the whole vaccine supply chain. Other factors associated with increased odds of a missed schedule include accessing immunisation at a public primary or non-public healthcare facility. At the peak of the COVID-19 pandemic, most health services were contracted, and staff were re-distributed for the COVID-19 response. This again speaks to the need for pandemic preparedness in health institutions.

Strength and limitation

A strength of this study includes the inclusion of multiple facility types across different levels of healthcare delivery, providing a broader understanding of immunisation experiences during the pandemic. The study is not without limitations. The affluent study population and hospital-based design might have affected our findings, and so the results are not generalizable and may underestimate the true impact of the pandemic on more vulnerable populations. Though some immunisation cards were examined to ascertain the caregiver's claim, most of the responses were based on recall, which might have introduced some bias. A complete lockdown due to the COVID-19 pandemic was not implemented in the study setting; the findings may differ from other areas where partial or total lockdowns were implemented.

Conclusion

During the COVID-19 pandemic, vaccine uptake remained high, possibly due to the population studied, highlighting again the disparities in immunisation programming tied to resources. The findings of this study are important for policymaking, service planning, prioritising and building resilient health systems in low- and middle-income countries during crises. Strengthening emergency preparedness plans for RI services, improving caregiver communication systems, and ensuring continuity of vaccination activities during crises are essential to prevent secondary outbreaks of vaccine-preventable diseases.

Acknowledgement: The mothers, healthcare workers, and management of the facilities hoisting the immunisation clinics where the study was conducted are acknowledged and appreciated.

Authors' Contributions: OBO contributed to concept, design, definition of intellectual content, literature search, data analysis, and interpretation, manuscript preparation, manuscript revision, and serves as the guarantor of the article. AAM contributed to concept, design, definition of intellectual content, literature search, data analysis, interpretation, and manuscript revision. AJN, ABE, and LIA contributed to concept, design, literature search, data interpretation, and manuscript revision.

Conflicts of Interest: None declared.

Financial support: The authors did not receive any financial support for this research or for the preparation of the manuscript.

Accepted for publication: 18th June 2026.

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