A systematic review on the effect of the COVID-19 pandemic on childhood immunisation programmes of West African countries

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Conflict of interest: None declared

SUMMARY

Objectives: To investigate the effects of the COVID-19 pandemic on childhood immunisation programmes in West African Countries.

Design: The study was a systematic review of available evidence of the impact of the COVID-19 pandemic on childhood immunisation programmes in West Africa.

Setting: An online literature search was conducted using PubMed, Embase, Scopus and Web of Science for all peer-reviewed longitudinal, descriptive, observational, prospective and retrospective studies on childhood immunisation programmes in West Africa published between January 2020 and May 2022.

Participants: All West African childhood immunisation programmes.

Interventions: None.

Main Outcome Measures: Change in immunisation volumes during the COVID-19 pandemic.

Results: 353 studies were identified during the literature search, and eight were included in this review. The studies comprised six quantitative studies, one mixed-method (quantitative/qualitative) study and one qualitative study. Changes to immunisation services ranged between 53% and 52% for MCV and Penta3 vaccines in Guinea, lasting longer than August 2020, to 0.3% and 1% in Liberia for BCG and MCV vaccines lasting no longer than May 2020. Factors contributing to the observed disruptions in vaccine coverage during the pandemic included the fear of contracting the virus expressed by caregivers and healthcare workers and general misinformation about the COVID-19 virus.

Conclusion: While the changes were greater than 50% and lasted longer in some countries, they were brief and short-lived in others, emphasising that the COVID-19 pandemic’s effect in each country differed.

Keywords: COVID-19, immunization, vaccination

INTRODUCTION

The expanded programme on immunisation (EPI) was birthed on the heels of the success of the smallpox vaccination programme,¹ and integrated into routine maternal and childhood services, offering mobile and facility-based immunisation services. The EPI provides the Bacille Calmette-Guerin vaccine (BCG), the Oral polio vaccine (OPV), the Diphtheria-Pertussis-Tetanus Vaccine (DPT), the Measles Vaccine (MCV), and the tetanus vaccine.²-⁵ Furthermore, the EPI allowed the domestication of the vaccines provided in the scheme based on local and prevailing epidemiologic factors, which has led to the introduction of the Hepatitis, Yellow fever, Meningococcal and Pneumococcal vaccines.⁶,⁷ The EPI also allowed for the conduct of National immunisation days (NIDs), Supplemental immunisation activities (SIAs) and catch-up immunisation campaigns to supplement routine immunisation services.⁸,⁹ Monitoring and evaluation of immunisation programmes use selected indicators, such as Vaccination coverage, disease incidence and surveillance, vaccine quality control, cold chain and vaccine management, and immunisation safety, retrieved from the UNICEF Multiple Indicators Cluster Survey, Demographic health surveys, and the EPI cluster surveys.¹⁰-¹² DPT vaccination is routinely used to estimate vaccine utilisation, coverage and access.¹³,¹⁴ DPT1 vaccine coverage indicates entry points into the EPI programme, while DPT3 measures the programme’s ability to retain the children. DPT dropout rates of > 10% denote poor utilisation of vaccine services.¹⁵

Vaccines have become one of the most cost-effective public health interventions.¹⁶ Over 116 million children are vaccinated annually (86% of all children born), and the use of vaccines has expanded to cover over 20 diseases and is being used to control epidemics or pandemics.¹⁷
African regional DPT3 coverage was 52% in 2010, which increased to 76% by 2015, with 34% of African countries achieving greater than 90% national coverage18, and by 2019, global DPT3 coverage averaged 81.6 %19. Similarly, African regional MCV1 coverage increased from 53% in 2000 to 74% in 2015, with Twelve African countries (26%) achieving more than 90% national coverage. BCG vaccines currently have the highest coverage, and the Oral Polio vaccine has the lowest coverage, according to a study among 25 sub-Saharan countries20.

However, vaccine access globally is still inequitable, adversely affecting marginalised and poor populations. Over 13 million children are currently classed as "zero-dose children" because they have not had a single dose of a potentially life-saving vaccine16, 75% of whom live in 14 Low to Middle-income countries(LMICs).19 Another 30 million children in these areas also do not receive the full complement of vaccination even when available16. Due to the poor distribution or access to vaccines, diseases that may have been on a downward trend have been resurgent. For example, vaccine-derived poliovirus is becoming a problem in many African countries,21 and the incidence of measles has doubled in the last three years (2019-2021).21

Initial reports of the effects of the COVID-19 pandemic indicated disruption to immunisation programmes in over half of the countries participating in a global WHO pulse survey.22-24 Furthermore, 13.5 million children missed doses of their vaccines in thirteen of the world's poorest countries25-28 amidst reports of fresh outbreaks of the wild poliovirus in Afghanistan and Pakistan.27 Vaccine shipment was reduced by 80%, and lockdown regulations disrupted the production of vaccines.28-29 Most countries repurposed pre-existing health systems to provide health care for COVID-19 patients, providing COVID-19 vaccinations to the most vulnerable.22-24 At the same time, some non-emergency healthcare services, like immunisations that relied on physical contact and movement, were deprioritised.22-24 For example, the WHO initially recommended suspending immunisations in the first few months of the COVID-19 pandemic because it feared the virus would spread during routine immunisations.30 Furthermore, the misinformation about COVID-19 and its treatment may have affected many caregivers' and mothers' desire to use vaccination services.22-24 Combined with vaccine hesitancy in some communities, the desire for immunisation services may have dropped further.31-34

Given the fragility of health systems in West Africa and the struggle to achieve good childhood immunisation coverage, the risk of severe disruption to childhood immunisation programmes due to the COVID-19 pandemic exists. This review aims to quantify the COVID-19 pandemic's effects on West African immunisation programmes and conceptually synthesise why the pandemic had such an effect.

This review aims to determine how the COVID-19 Pandemic in 2020/21 affected childhood immunisation programmes in West Africa.

Specific objectives include:
1. To analyse the volume and trends of immunisation in the West African region pre-COVID-19 and compare these results with those obtained during the COVID-19 pandemic in 2020.
2. To explore why the COVID-19 pandemic may or may not have affected immunisation programmes in West African countries.

METHODS
The study was a systematic review without meta-analysis(SwIM) of all peer-reviewed longitudinal, descriptive, observational, prospective and retrospective studies on childhood immunisation programmes in West Africa published between January 2020 and May 2022. The COVID-19 pandemic had its most disruptive impact on healthcare in 2020, and this period was selected to enable the review to capture as many reports/studies on the subject as possible, taking into account the varying length of time for peer review and publishing. The protocol for this study was based on the Preferred Reporting Items for Systematic Reviews and Meta-analysis Protocols-PRISMA-P.35 A preliminary search was conducted using the PubMed database to validate the premise and availability of peer-reviewed articles covering the subject. Subsequently, a defined search strategy was designed(Figure 1).

Figure 1 Search Strategy showing key search words and combinations

(Covid -19 OR COVID OR CORONAVIRUS OR SARS CoV2 OR PANDEMIC OR 2019-nCoV OR MERS CoV OR CORONA) AND (Child* OR infant OR Paediatrics OR Pediatrics)) AND (Immuniz* OR Immunis* OR Vaccin* OR MCV OR OPV OR DPT OR NPI OR "National Immunization program" OR "Measles Vaccine" OR "Oral Polio Vaccine" OR "Diphtheria -pertussis vaccine" OR "Polioviruses vaccine" OR "Expanded Programme on Immunisation" OR Immunization program OR Measles OR Polio OR Diphtheria OR Pertussis) AND (Benin OR Burkina Faso OR Cape Verde OR Côte D'Ivoire OR Côte d'Ivoire OR Côte d'Ivoire OR Guinea OR Ghana OR Guinea-Bissau OR Liberia OR Mali OR Mauritania OR Niger OR Nigeria OR Senegal OR Sierra Leone OR Togo or "West Africa"))
Inclusion criteria
All peer-reviewed longitudinal, descriptive, observational, prospective, and retrospective studies published between 2020 and May 2022 that studied or described the effects of the COVID-19 pandemic on childhood immunization programmes in West Africa were deemed eligible.

Also included were studies that described or studied the effects of the COVID-19 pandemic on vaccination coverage and the utilisation of these services directly via vaccination numbers and trends by comparing pre and post-COVID-19 values and allowing for analysis of vaccine coverage and factors affecting coverage.

The review also included all modelling studies that used pre-COVID-19 data to estimate the impacts of the COVID-19 pandemic on immunisation programmes. In addition, Qualitative studies that explored the effect of the COVID-19 pandemic on the experiences of caregivers or parents accessing childhood vaccination services and healthcare workers providing childhood vaccination services were included.

An article was deemed to have studied the correct population (Childhood immunisation programmes in West Africa) and included in the review if it showed results on at least one of the BCG, Measles, Polio, Diphtheria-pertussis, Pentavalent, Meningococcal or Yellow Fever vaccines in at least one West African country. For this review, only the results from the West African country were included for analysis. There were no language restrictions, and studies not in English were run through the Google translator AI (Google Translate) and then analysed.

Exclusion criteria
This study excluded systematic reviews, modelling studies that excluded pre-COVID-19 vaccination data, and papers that did not estimate the impact of the COVID-19 pandemic on childhood vaccine coverage.

Information sources and search strategy
OCO and VAO conducted a literature search in the PubMed, Embase, Scopus, and Web of Science databases and filtered it to allow only papers published between January 2020 and May 2022. The search strategy explored alternate search words for the main question items and used British and American spellings where necessary. Truncation and quotes were used to broaden the search parameters. Boolean commands "AND" and "OR" were used to combine search groups ( ).

Study records/screening
Search results from the respective databases were saved, downloaded, and imported into the Rayyan (www.rayyan.ai) web-based data management software. Articles were deduplicated in Rayyan and manually reviewed by OCO and VAO. Titles and abstracts were screened based on the inclusion criteria. After that, a full-text screening of the remaining articles on Rayyan was performed. Agreement on article inclusion between OCO and VAO was required before being included for further analysis. The included articles had their references screened to determine if any relevant citations were suitable for inclusion.

Data management
Following full-text screening and review, relevant data were extracted using a form created in Excel by one reviewer- OCO. For quantitative data, the data extracted included author, title, year of publication, study design, study population, length of study, inclusion criteria met by the paper, study aim, vaccine and vaccine characteristics studied, and data collection mode. The form also extracted the included studies’ results, statistical methods, conclusions, and recommendations. For Qualitative data, the data extracted included author, title, year of publication, study population, length of study, study aim, vaccine and vaccine characteristics studied, data collection mode (KIs, FGD), major themes that emerged from the paper, conclusions, and recommendations by the article. Data analysis was based on the framework of Phillips et al. on factors determining vaccine coverage and contributing to inequalities in vaccine access (Figure 2). For quantitative studies, proportions and differences in vaccination numbers were extracted from the studies and analysed by country. In contrast, qualitative studies were analysed along thematic lines identified by the authors. All forms of studies were analysed following the conceptual framework for vaccination coverage (Figure 2).

Quality for quantitative studies was assessed at the study design level to determine the presence or absence of bias during data collection, reporting, and management, including missing data handling, appropriate use of relevant statistical tests and methods, and data interpretation. Quality assessment for the qualitative studies was carried out using the four criteria described by Lincoln et al. These criteria include credibility, dependability, confirmability, and transferability.

Figure 2 Conceptual framework for vaccine coverage.

Quality assessment

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These quality assessment criteria were used because they allowed for a more flexible quality assessment in the dynamic context of the COVID-19 Pandemic.

RESULTS

Three hundred fifty-three (353) publications from four databases were retrieved. Retrieved results included 233, 8, 104 and 0 from PubMed, Scopus, Web of Science and Embase, respectively, on 22/02/2022. Eight results were retrieved from PubMed on 11/03/2022, while the other databases returned no additional results. The databases returned no other results at the last search session on 09/05/2022. Following deduplication, 259 studies were screened, and 230 publications were excluded due to a wrong publication type/irrelevant study. The full texts of 29 studies were retrieved and screened for inclusion. On full-text screening, twenty-one articles were excluded based on a wrong study population, study design or being a background article, e.g., editorials or letters to the editor. Eight studies were finally included in this review, and a search of the references in the selected articles did not reveal any paper relevant to this review (Figure 3).

Study characteristics

The review included six quantitative studies on vaccination coverage trends before and during the COVID-19 pandemic,\textsuperscript{40,45} one qualitative study on the utilisation of immunisation services during the COVID-19 pandemic,\textsuperscript{46} and one mixed method-quantitative and qualitative study- on vaccination coverage and the utilisation of immunisation services.\textsuperscript{47} Data from eight of 17 West African countries were included in this review: Ghana,\textsuperscript{42,47} Guinea,\textsuperscript{42} Liberia,\textsuperscript{44,45} Mali,\textsuperscript{45} Nigeria,\textsuperscript{42,45,46} Senegal,\textsuperscript{42,43} Sierra Leone.\textsuperscript{41,45}

Quantitative Studies

The tables below summarise quantitative data extracted along individual vaccine lines from the eligible studies.

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![Figure 3 PRISMA flowchart of the systematic search process](image-url)
Table 1 Summary of quantitative studies

<table>
<thead>
<tr>
<th>1st Author/Year</th>
<th>Type Of Study</th>
<th>Country Studied</th>
<th>Vaccine Studied</th>
<th>Period Of Study</th>
<th>Sample Size</th>
<th>Data Source</th>
<th>Type Of Analysis</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow A. 2020</td>
<td>Retrospective quantitative analysis</td>
<td>Senegal</td>
<td>Bcg, oral polio 1,2,3, pentavalent 1,2,3, measles, yellow fever</td>
<td>Mar 2018-Aug 2020</td>
<td>&gt;5000</td>
<td>Local hospital vaccination records</td>
<td>Simple proportions</td>
<td>23% reduction in vaccines given at birth</td>
</tr>
<tr>
<td>Bimpong K. 2021</td>
<td>Mixed methods study-retrospective quantitative data analysis, thematic qualitative analysis</td>
<td>Ghana</td>
<td>Bcg, pentavalent 1,2, measles</td>
<td>Apr 2019-May 2020</td>
<td>8000</td>
<td>Local hospital vaccination records, HCWS and caregivers</td>
<td>Simple proportions</td>
<td>BCG: -(47%) Penta1: -(42%) Penta2: -(40.3%) Penta3: -(39%) Mcv1: -(10.5%) Mcv2: -(0.9%)</td>
</tr>
<tr>
<td>Mairama Baissa 2020</td>
<td>Retrospective quantitative data analysis of aggregated health data on utilisation of healthcare services</td>
<td>Niger</td>
<td>Penta 1, 3, var1</td>
<td>Jan 2019-Jun 2020</td>
<td>Na</td>
<td>NHIS, OPD registers, MOH data sources</td>
<td>Simple proportions, Wilcoxon signed-rank tests.</td>
<td></td>
</tr>
<tr>
<td>Buonsenso 2020</td>
<td>Retrospective data analysis of vaccination rates using hospital records</td>
<td>Sierra leone</td>
<td>Bcg, oral polio 1,2,3, pentavalent 1,2,3, measles, yellow fever</td>
<td>Mar 2019-Apr 2020</td>
<td>Na</td>
<td>Local hospital records</td>
<td>Wilcoxon ranked tests.</td>
<td>ERROR! REFERENCE SOURCE NOT FOUND.</td>
</tr>
<tr>
<td>Balcha Maresha 2021</td>
<td>Retrospective data analysis of immunisation volumes</td>
<td>Guinea, Ghana, Nigeria, Senegal</td>
<td>Dpt, mcv1 and 2</td>
<td>Jan 2019-Jun 2020</td>
<td>Na</td>
<td>Administrative data records</td>
<td>Simple proportions</td>
<td></td>
</tr>
<tr>
<td>Emilia Connolly 2022</td>
<td>Retrospective mixed methods study (quantitative and modelling)</td>
<td>Liberia</td>
<td>Bcg, oral polio 0,1,2,3, pentavalent 1,2,3 measles</td>
<td>Jan 2016-Aug 2021</td>
<td>Na</td>
<td>Health information records</td>
<td>Negative binomial regression</td>
<td></td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>Ghana</th>
<th>Guinea</th>
<th>Liberia</th>
<th>Mali</th>
<th>Niger</th>
<th>Nigeria</th>
<th>Senegal</th>
<th>Sierra Leone</th>
</tr>
</thead>
</table>

VACCINE
BCG
OPV0
OPV1
PENTA1
OPV2

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Shapira Gil 2021 C19 disruptions to matches in sub-Saharan Africa COUNTRY | BCG | OPV0 | OPV1 | PENTA1/DPT1 | OPV2 | PENTA2/DPT2 | OPV3 | PENTA3/DPT3 | MEASLES | YELLOW FEVER
---|---|---|---|---|---|---|---|---|---|---
Ghana# | -47 | -42 | -40 | | | | | | | |
Ghana | | | | | | | | | | |
Guinea | | | | | | | | | | |
Liberia | -11.8 (+15.4, -8.2) | -11 | -33 | -16 | -38 | -24 | -39 | -7.8 (-13.1, -2.5) | -1 |
Mali | -0.3 | -11 | -14 | -0.1 | -11.8 | -3.4 | -5.2 | -17.4 (-22.6, 12.3) |
Niger | -0.1 | -20 | -30 | -8.3 | -0.2 | -1.3 | -1.4 | -1.6 |
Senegal | -14 | -20 | -30 | -8.3 | -0.2 | -1.3 | -1.4 | -1.6 |
Sierra Leone# | -53 | -53 | -71 | -71 | -79 | -79 | -78 | -78 | -66 | -66 |
Sierra Leone | -7.4 | | | | | | | | -12.6 (-19.1, -6.1) | -7.4 (-11.9, -2.9) |

#Data From Subnational Data, E.G., Regional/State Hospital Records
*Blank Cells- No Reported Data From The Literature Reviewed
*Bcg-Bacille Calmette Guerin, Opv- Oral Polio Vaccine, Pent- Pentavalent, Dpt-Diphtheria Pertussis Tetanus
*95% Cis Provided Where Available

Table 1 Summary table of reductions in immunisation volumes in percentages from March 2020 – August 2021 showing national and subnational figures

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>JAN-MAR 2020</th>
<th>APRIL-JUN 2020</th>
<th>% CHANGE IN THE TWO QUARTERS</th>
<th>JAN-MAR 2020</th>
<th>APRIL-JUN 2020</th>
<th>% CHANGE IN THE TWO QUARTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana</td>
<td>95358</td>
<td>919678</td>
<td>-4</td>
<td>93035</td>
<td>89443</td>
<td>-4</td>
</tr>
<tr>
<td>Guinea</td>
<td>35352</td>
<td>16850</td>
<td>-52</td>
<td>35605</td>
<td>16788</td>
<td>-53</td>
</tr>
<tr>
<td>Nigeria</td>
<td>560428</td>
<td>492483</td>
<td>-12</td>
<td>523869</td>
<td>455412</td>
<td>-13</td>
</tr>
<tr>
<td>Senegal</td>
<td>51663</td>
<td>44539</td>
<td>-14</td>
<td>41719</td>
<td>39486</td>
<td>-5</td>
</tr>
</tbody>
</table>

Table 2 2019 National infant childhood immunisation coverage estimates in percentages before the pandemic. WHO-UNICEF estimates.48

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>BCG</th>
<th>DPT1</th>
<th>DPT3</th>
<th>MCV1</th>
<th>OPV3</th>
<th>YELLOW FEVER</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana</td>
<td>96</td>
<td>97</td>
<td>97</td>
<td>92</td>
<td>97</td>
<td>92</td>
</tr>
<tr>
<td>Guinea</td>
<td>85</td>
<td>85</td>
<td>47</td>
<td>47</td>
<td>82</td>
<td>80</td>
</tr>
<tr>
<td>Liberia</td>
<td>84</td>
<td>94</td>
<td>87</td>
<td>85</td>
<td>87</td>
<td>79</td>
</tr>
<tr>
<td>Mali</td>
<td>83</td>
<td>82</td>
<td>71</td>
<td>70</td>
<td>54</td>
<td>66</td>
</tr>
<tr>
<td>Niger</td>
<td>70</td>
<td>92</td>
<td>81</td>
<td>79</td>
<td>81</td>
<td>83</td>
</tr>
<tr>
<td>Nigeria</td>
<td>67</td>
<td>65</td>
<td>57</td>
<td>54</td>
<td>57</td>
<td>-</td>
</tr>
<tr>
<td>Senegal</td>
<td>103</td>
<td>106</td>
<td>100</td>
<td>96</td>
<td>100</td>
<td>89</td>
</tr>
<tr>
<td>Sierra Leone</td>
<td>75</td>
<td>95</td>
<td>95</td>
<td>87</td>
<td>95</td>
<td>90</td>
</tr>
</tbody>
</table>

Table 3 Routine DPT3 And MCV immunisation performance In West African countries during the pandemic.42

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>JAN-MAR 2020</th>
<th>APRIL-JUN 2020</th>
<th>% CHANGE IN THE TWO QUARTERS</th>
<th>JAN-MAR 2020</th>
<th>APRIL-JUN 2020</th>
<th>% CHANGE IN THE TWO QUARTERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ghana</td>
<td>95358</td>
<td>919678</td>
<td>-4</td>
<td>93035</td>
<td>89443</td>
<td>-4</td>
</tr>
<tr>
<td>Guinea</td>
<td>35352</td>
<td>16850</td>
<td>-52</td>
<td>35605</td>
<td>16788</td>
<td>-53</td>
</tr>
<tr>
<td>Nigeria</td>
<td>560428</td>
<td>492483</td>
<td>-12</td>
<td>523869</td>
<td>455412</td>
<td>-13</td>
</tr>
<tr>
<td>Senegal</td>
<td>51663</td>
<td>44539</td>
<td>-14</td>
<td>41719</td>
<td>39486</td>
<td>-5</td>
</tr>
</tbody>
</table>

Table 4 Disruptions In BCG and PENTA3 vaccine coverage in West African countries during COVID-19.45

<table>
<thead>
<tr>
<th>COUNTRY</th>
<th>TOTAL % SHORTFALL IN BCG VACCINATIONS APR-JUN 2020</th>
<th>TOTAL % SHORTFALL IN PENTA 3 VACCINATIONS APR-JUN 2020</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liberia</td>
<td>0.3</td>
<td>-7.8</td>
</tr>
<tr>
<td>Mali</td>
<td>-11.8</td>
<td>-17.4</td>
</tr>
</tbody>
</table>
**Table 5** Childhood immunization during The COVID-19 pandemic In Liberia. (Adapted from Connoly et al. 44)

<table>
<thead>
<tr>
<th>VACCINE</th>
<th>MAR-AUG 2020 (A)</th>
<th>SEPT 2020-FEB 2021 (B)</th>
<th>% TOTAL CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EXPECTED</td>
<td>OBSERVED</td>
<td>% DIFF (95% PI)</td>
</tr>
<tr>
<td>BCG</td>
<td>1220</td>
<td>1123</td>
<td>-8 (-24.5-10.7)</td>
</tr>
<tr>
<td>OPV0</td>
<td>1016</td>
<td>927</td>
<td>-8.8 (-23.7-4)</td>
</tr>
<tr>
<td>OPV1</td>
<td>1369</td>
<td>1198</td>
<td>-12.5 (-25.1-4)</td>
</tr>
<tr>
<td>OPV2</td>
<td>1274</td>
<td>1062</td>
<td>-16.6 (-34.9-0.3)</td>
</tr>
<tr>
<td>OPV3</td>
<td>1333</td>
<td>1041</td>
<td>-21.9 (-35.4-7.9)</td>
</tr>
<tr>
<td>PENTA1</td>
<td>1360</td>
<td>1190</td>
<td>-12.5 (-25.5-1)</td>
</tr>
<tr>
<td>PENTA2</td>
<td>1287</td>
<td>1063</td>
<td>-17.4 (-31.5-2.5)</td>
</tr>
<tr>
<td>PENTA3</td>
<td>1348</td>
<td>1035</td>
<td>-23.2 (-36.5-9.2)</td>
</tr>
</tbody>
</table>

**Table 6** Child healthcare and immunisations in Sierra Leone during the pandemic (Adapted from Buonsenso et al. 41)

<table>
<thead>
<tr>
<th>VACCINE</th>
<th>MAR-APR 2019</th>
<th>MAR-APR 2020</th>
<th>% CHANGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>BCG</td>
<td>36</td>
<td>17</td>
<td>-52.7</td>
</tr>
<tr>
<td>OPV0</td>
<td>58</td>
<td>17</td>
<td>-70.7</td>
</tr>
<tr>
<td>OPV1</td>
<td>58</td>
<td>17</td>
<td>-70.7</td>
</tr>
<tr>
<td>PENT A1</td>
<td>71</td>
<td>15</td>
<td>-78.9</td>
</tr>
<tr>
<td>OPV2</td>
<td>71</td>
<td>15</td>
<td>-78.9</td>
</tr>
<tr>
<td>PENTA2</td>
<td>67</td>
<td>15</td>
<td>-77.6</td>
</tr>
<tr>
<td>PENTA 3</td>
<td>67</td>
<td>15</td>
<td>-77.6</td>
</tr>
<tr>
<td>MCV1</td>
<td>64</td>
<td>22</td>
<td>-65.6</td>
</tr>
<tr>
<td>MCV2</td>
<td>49</td>
<td>8</td>
<td>-83.7</td>
</tr>
</tbody>
</table>

**Qualitative studies**

Two qualitative studies were included in this study. 62, 63 and were analysed along thematic lines based on Phillips et al.'s framework for the determinants of vaccination coverage 62.

**Table 7** Summary of qualitative studies

<table>
<thead>
<tr>
<th>AUTHOR/ YEAR</th>
<th>TYPE OF STUDY</th>
<th>COUNTRY</th>
<th>COMMON THEMES</th>
<th>PERIOD OF INTEREST</th>
<th>POPULATION/SAMPLE SIZE</th>
<th>DATA SOURCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ahmed T. 2021</td>
<td>Contextual narrative synthesis of the utilisation of basic and advanced MNCHC services</td>
<td>NIGERIA</td>
<td>Fear of infection and disruption of COVID-19 routine activities and livelihoods A lack of safety protection and logistical support for healthcare workers</td>
<td>April/May 2019 and April/May 2020</td>
<td>NA</td>
<td>Hospital Records of a Nigerian Tertiary Hospital</td>
</tr>
<tr>
<td>Bimpong K. 2021</td>
<td>Mixed methods study- Retrospective Quantitative data analysis, Thematic qualitative analysis</td>
<td>GHANA</td>
<td>HEALTH CARE WORKERS: Fear Misinformation CLIENTS Fear Side effects</td>
<td>Apr 19-May 2020</td>
<td>8000</td>
<td>Hospital vaccination records, HCWs and Caregivers</td>
</tr>
</tbody>
</table>

**Quality analysis**

At the study design level, all quantitative studies relied on data collected via registries of data reports from various national registries. Only two studies 44, 45 Explicitly stated how missing data were managed. One study 47 Mentioned missing data but did not state how this was handled. Other studies were silent about missing data. Sample sizes were not explicitly stated for all studies. However, one study 41 had a sample representative of a
county or locality, three studies\textsuperscript{40,43,46} had state or regionally representative samples, and four studies\textsuperscript{40,42,44,45} had nationally representative samples. Seven studies provided adequate data reports, while one study\textsuperscript{43} did not provide individual data for the reported vaccine.

Table 8 Quality analysis

<table>
<thead>
<tr>
<th>AUTHOR</th>
<th>DATA COLLECTION</th>
<th>Was the sample representative</th>
<th>DATA REPORTING</th>
<th>DATA MANAGEMENT</th>
<th>TEMPORAL TRENDS</th>
<th>STATISTICAL METHODS USED</th>
<th>RESULT REPORTING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sow A. 2020</td>
<td>Probable reporting bias</td>
<td>State representative sample</td>
<td>Inadequate. It does not provide individual data for individual vaccines</td>
<td>No mention of handling missing data</td>
<td>Moderately adequate. Compared to 2 years of data</td>
<td>No tests of significance</td>
<td>Appropriate</td>
</tr>
<tr>
<td>Bimpong K. 2021</td>
<td>Probable reporting bias</td>
<td>State representative sample</td>
<td>Adequate</td>
<td>Mentioned missing data but did not say how it was accounted for in the analysis</td>
<td>Poor. Compared to one year</td>
<td>Wilcoxon signed-rank test</td>
<td>Appropriate</td>
</tr>
<tr>
<td>Mairama Baisa 2020</td>
<td>Probable reporting bias</td>
<td>State representative sample</td>
<td>Adequate</td>
<td>No mention of handling missing data</td>
<td>Poor. Compared to one year of data</td>
<td>T-test, Chi square, Anova, Bonferroni</td>
<td>Appropriate</td>
</tr>
<tr>
<td>Ahmed T. 2021</td>
<td>Probable reporting bias</td>
<td>State representative sample</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
</tr>
<tr>
<td>Business 2020</td>
<td>Probable reporting bias</td>
<td>Local county representative sample</td>
<td>Adequate</td>
<td>No mention of handling missing data</td>
<td>Poor. Compared to one year of data</td>
<td>Wilcoxon signed-rank test</td>
<td>Appropriate</td>
</tr>
<tr>
<td>Balcha Maresha 2021</td>
<td>Probable reporting bias</td>
<td>Nationally representative sample</td>
<td>Adequate</td>
<td>No mention of handling missing data</td>
<td>Moderately adequate. Compared to 2 years of data</td>
<td>No tests of significance</td>
<td>Appropriate</td>
</tr>
<tr>
<td>Emilia Connolly 2022</td>
<td>Probable reporting bias</td>
<td>Nationally representative sample</td>
<td>Adequate</td>
<td>Managed missing data appropriately. Missing data was treated as &quot;missing at random.&quot;</td>
<td>Highly adequate. Compared to 6 years of data</td>
<td>Binomial regression</td>
<td>Appropriate</td>
</tr>
<tr>
<td>Shapira Gil 2021</td>
<td>Probable reporting bias</td>
<td>Nationally representative sample</td>
<td>Adequate</td>
<td>Managed missing data appropriately. Missing data was treated as &quot;missing at random.&quot;</td>
<td>Moderately adequate. Compared to 2 years of data</td>
<td>ITS, OLS</td>
<td>Appropriate</td>
</tr>
</tbody>
</table>

Both qualitative studies showed some quality as the papers used appropriate research processes/procedures to answer the questions. However, while Bimpong\textsuperscript{47} detailed the sampling procedure and process, Ahmed\textsuperscript{46} did not provide any information about the sampling process or procedure, so the representability of his sample could not be determined. Furthermore, neither study was explicit on the methodology or framework used for their chosen approaches, nor were their methods fully justified. Bimpong provided some information about the qualitative process to replicate their study if necessary and utilised quotes to aid descriptions and findings compared to Ahmed.\textsuperscript{46}

DISCUSSION

The impact of the COVID-19 pandemic on West African countries’ immunisation programmes can be described along three major themes (Figure 4). The most significant changes in vaccination volumes (>50%) occurred in April 2020 across the eight countries in this review. However, these changes in April may not have been solely due to the direct effects of the COVID-19 pandemic because this period coincided with the WHO directive recommending the suspension of mass immunisation programmes and the reduction of routine immunisation programmes due to concerns about the transmission of the Covid-19 virus.\textsuperscript{30} However, the continued changes to immunisation coverage noted in this review may be attributed directly to the pandemic alongside other factors like the strength of the health system before COVID-19 and the successes of the childhood immunisation programme before the pandemic. All of these contributed to the varying impact of the COVID-19 pandemic on childhood immunisation programmes in West African countries by impacting critical components of the vaccination cycle and determinants of vaccination coverage.\textsuperscript{37,49}

Countries with high pre-pandemic vaccination coverage, like Ghana, Senegal and Liberia, experienced minimal (<20%) and short-lived changes to vaccination volumes during the COVID-19 pandemic. However, measles outbreaks were still common in these countries, pointing to local contextual factors that may have pre-existed and
still exist despite the high coverage reported.\textsuperscript{42,50–53} Countries like Niger and Sierra Leone reported high vaccine coverage before the COVID-19 pandemic but witnessed reductions in immunisation during the COVID-19 pandemic lasting longer than August 2020.

However, these pre-pandemic gains may have been lost during the COVID-19 pandemic due to pre-existing high levels of insecurity, political unrest, poor vaccine storage and distribution, and a lack of a sustainable health system resilience plan combined with the effects of the COVID-19 pandemic. Other countries in this review—Nigeria, Mali, and Guinea—have poor pre-pandemic vaccine coverage and have demonstrated reduced vaccination coverage throughout the COVID-19 pandemic. The reported reductions in coverage were possibly due to the amplification of already existing inequalities in vaccine distribution and utilisation, pre-existing security challenges and political instability.

Five of the eight countries (Guinea, Mali, Nigeria, Niger, Sierra-Leone) in this review had significant reductions (>50\%) in childhood vaccination coverage during the COVID-19 pandemic. When these reductions are viewed in light of the pre-existing challenges in these countries, the potential national and regional impacts on childhood health become enormous. While these disruptions’ medium to long-term effects may not be known, the short-term effects are currently being reported. The WHO says that a resurgence in vaccine-preventable diseases is rising in Africa.\textsuperscript{54} In 2022, between January and March, 17,500 cases (400\% increase) of measles were reported from 20 African countries, eight more countries compared to the same period in 2021.\textsuperscript{54}

The West African region contributed about 44\% of measles cases (Nigeria 5,613, Cote d’Ivoire 1,075, Mali 946 contributing the most cases).\textsuperscript{55} Twenty African countries reported a variant of polio in 2020, which increased to Twenty-four in 2021.\textsuperscript{54} While all African countries except Malawi have been certified wild polio virus-free, the continent still has vaccine-derived poliovirus to contend with.\textsuperscript{55} Ten countries in West Africa have circulating vaccine-derived poliovirus infections. Only Togo and Ghana are polio-free in the region. The reduction of vaccinations caused by the COVID-19 pandemic is capable of causing the cross-border spread of vaccine-derived poliovirus, leading to a regional poliovirus crisis and worsening the poliovirus epidemics within West African Countries.

Hence, it is imperative that in the short term, catch-up immunisation programmes to provide the missed doses of vaccines be done in countries that experienced severe disruptions. These countries may also employ more National Immunisation days and Supplemental Immunisation activities to improve vaccine coverage. In the medium to long term, strengthening the facility readiness, improving community access, and increasing the intent to vaccinate while strengthening health system resilience should be pursued. Facility readiness, described as the ability of the existing health system to supply vaccines to meet demand, can be influenced by varying factors.

An Important factor influencing facility readiness is the government’s political will and the provision and management of funding.\textsuperscript{56}
This review showed that programmes with a history of strong political and governmental support and good funding, e.g., Senegal, perform better than programmes with poor funding, poor political will, and government support, e.g., Guinea. Another factor directly affecting facility readiness and funding is the provision of adequate vaccine distribution, supply and storage. Distribution, supply, and storage are essential to prevent stock-outs and ensure that a facility continues offering vaccine services. Proper distribution and storage also ensure that the vaccine provided to children is high-quality. The availability of trained healthcare workers in adequate numbers is also pivotal to a facility’s success in providing vaccine services.

The ability to bridge the facility’s readiness to provide immunisation services and the intent to vaccinate depends on the community’s access to these services. The prevailing social determinants of health, such as socioeconomic status, location, race, sex, and age distribution, the absence or presence of advocacy for the use of immunisation services, the absence of poor community partnerships, the attitude of the community towards health-seeking, and the perceived quality of care in the health facility, determine this access. Contextualised bottom-up approaches like the community-driven comprehensive national immunisation programme in Senegal or the community engagement, social mobilisation and communication strategy of Liberia provide room for end-users ownership of the health system and improve community access to vaccines.

**Implications for policy**

Health shocks like the COVID-19 pandemic are on the rise. Therefore, policies that strengthen the available health system are imperative to prevent these shocks’ effects on the health system. Policies that improve facility readiness—improving community access to vaccines, storage and distribution of vaccines—and better government funding and support are essential to withstand the effects of health shocks.

**Limitations of the review**

A limitation of this review is that the currently available evidence is few and heterogeneous. Except for DPT3 and MCV vaccines, not all vaccines were studied for all countries, making estimating the pandemic’s effect on childhood immunisation programmes within and between the countries along respective vaccine lines challenging.

**CONCLUSION**

The pandemic may have amplified pre-existing inequalities in vaccine access and system weakness, which hampered the provision of vaccination services during the pandemic. While the changes in the immunisation programmes were significant and lasted longer in some countries like Nigeria, Guinea, Mali, Sierra-leone and Niger, they were less substantial and short-lived in others.
like Ghana, Senegal and Liberia, emphasising the fact that the effect of the pandemic was unique to each country. Pandemics like the COVID-19 pandemic can damage the existing fragile health systems of LMICs and erode the gains of universal health coverage and immunisation. Improving health system resilience is critical to ensuring that the gains in vaccination and universal healthcare are not eroded by public health shocks, as shown by Niger and Sierra Leone. Therefore, while improving facility readiness, community access and intent to vaccinate, attention must be paid to processes and policies that strengthen health systems and prepare them for future shocks.

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