Countdown to 2030
Women's Children's & Adolescent's Health

African Population and Health Research Center

Childhood Immunization Coverage and Inequalities in Sub-Saharan Africa

Strengthening Evidence Through Integrated Routine Health Information and Survey Data

Multicounty Analysis

Technical report

2025

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Abstract

Monitoring immunization coverage and equity is essential for assessing progress toward global immunization targets and identifying populations that remain un- or under-immunized. While household surveys such as the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS) provide important population-based coverage estimates, they are conducted infrequently and often depend on external funding, limiting their ability to provide timely insights for program management. Routine health information system (RHIS) data reported through national platforms such as DHIS2 offer a continuous and geographically detailed source of information that can complement survey data when data quality is adequately assessed. This study leverages the Countdown to 2030 (CD2030) collaborative framework to strengthen the analysis of routine immunization data across 26 countries in sub-Saharan Africa and to generate comparable estimates of immunization coverage and equity at national and subnational levels. Routine immunization data were extracted from national DHIS2 systems using a harmonized extraction module linked to the CD2030 standardized template. Data quality was assessed through indicators of reporting completeness, missingness, and composite data quality scores. Coverage estimates were generated for key antigens including Penta-1, Penta-3, BCG, OPV1, and Measles-1, and comparisons were made between RHIS-based estimates and household survey estimates where available. The analytical workflow was implemented through the CD2030 DataSuite, a zero-coding analytical platform designed to facilitate country-led analysis of routine immunization data.

Reporting completeness remained relatively high across the study period, with median levels close to 95% and approximately 97% by 2024. Overall data quality scores remained broadly stable, although variability across countries persisted. As of 2024, the median immunization coverage was about 90% for Penta-1 and 85–86% for Penta-3 and Measles-1. Furthermore, our analysis revealed substantial disparities across countries and regions. Several countries maintained high coverage levels, while others continued to experience persistent gaps in access and completion of vaccination schedules. The number of zero-dose children was high between 2020 and 2023 before declining slightly by 2024, while dropout between Penta-1 and Penta-3 remained a significant challenge. Comparisons between RHIS-derived coverage and household survey estimates showed moderate agreement, with most differences within 10 points difference.

These findings demonstrate that RHIS data, when systematically assessed and harmonized, can provide valuable and timely insights into immunization program performance and equity. The CD2030 collaborative model, supported by standardized analytical approaches, automated DHIS2 data extraction, and accessible analytical tools, enables country-led analysis while facilitating cross-country comparisons. Strengthening routine data systems and analytical capacity will be critical for improving immunization monitoring, identifying underserved populations, and accelerating progress toward global immunization goals.

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List of Acronyms and Abbreviations

UNICEF	United Nations Children's International Emergency Fund
GAVI	Global Alliance for Vaccines and Immunization
WHO	World Health Organization
APHRC	African Population Health and Research Center
CD2030	Countdown to 2030
DHIS2	District Health Information Software
DHS	Demography and Health Survey
MICS	Multiple Indicator Cluster Surveys
EPI	Expanded Program on Immunization
RMNCAH+N	Reproductive, Maternal, Newborn, Child, Adolescent Health and Nutrition

Background

Immunization remains one of the most effective public health interventions for improving child survival and supporting healthy development. Sustaining high and equitable immunization coverage is central to achieving global immunization goals, including those outlined in the Immunization Agenda 2030 (IA2030), which emphasizes reaching zero-dose children, reducing inequalities, and strengthening the use of data for program monitoring and decision-making. Regular, high-quality estimates of immunization coverage are therefore essential for assessing progress toward global targets, monitoring program performance, and identifying populations that remain un- or under-immunized.

National immunization programs have historically monitored vaccination coverage across districts, regions, and countries using a combination of population-based surveys, routine health facility data, and program reports. Household surveys, most conducted through the Demographic and Health Surveys (DHS) or Multiple Indicator Cluster Surveys (MICS), provide population-based estimates that can be disaggregated by socioeconomic characteristics, place of residence, geographic location, age, and sex. However, these surveys are typically conducted at intervals of approximately five years, which limits their ability to provide timely information on program performance. In addition, survey implementation in many countries depends substantially on external donor funding. Recent disruptions in donor financing have led to delays or cancellations of planned survey rounds in several settings, further constraining the availability of up-to-date coverage data needed for program monitoring and strategic planning. Routine health facility data reported through national routine health information systems (RHIS), most implemented through platforms such as DHIS2, provide a continuous source of information on vaccine doses administered. When appropriately assessed and adjusted for data quality, RHIS data offers important opportunities to generate more timely and geographically granular estimates of immunization coverage. Unlike periodic surveys, routine reporting systems capture monthly service delivery data and can support analyses not only at national and subnational levels but also at lower administrative levels or facility catchment areas. This level of granularity enables programs to identify localized pockets of under-immunization, monitor drop-out between vaccine doses, and detect short-term fluctuations that may signal operational challenges such as vaccine stockouts, service disruptions, or population movements.

Over the past decade, many countries have integrated immunization reporting into broader national health management systems, replacing previously separate reporting structures for immunization programs. This integration has strengthened the availability and accessibility of routine immunization data within national health information architectures. At the same time, there is increasing national ownership and domestic investment in RHIS platforms, reflecting their growing role in health system monitoring and program management. Strengthening the quality, analysis, and interpretation of RHIS data therefore presents an important opportunity to complement survey-based estimates, address gaps created by delayed or infrequent surveys, and support more responsive program management. At the global level, the World Health Organization (WHO) and the United Nations Children's Fund (UNICEF) coordinate an extensive reporting system for immunization coverage and related indicators. Through an annual review process that synthesizes administrative data, survey findings, and country-reported information, WHO and UNICEF produce the WHO and UNICEF Estimates of National Immunization Coverage (WUENIC), which serve as the primary global reference for immunization coverage trends. Considerable investments have been made to strengthen the country's capacity for immunization data analysis through technical tools, collaborative initiatives, and capacity-building workshops aimed at improving the quality and use of both survey and routine data.

Despite these investments, further strengthening of national analytical capacity remains necessary, particularly for generating reliable subnational and local-level estimates and for better understanding inequalities in immunization coverage. Strengthening country-led analysis is critical for monitoring progress toward global immunization targets, guiding program improvements, and ensuring that underserved populations are reached. In response to this need, the present project supports ministries of health and national public health institutions in 26 sub-Saharan African countries to strengthen analyses of immunization coverage and equity at national and subnational levels through Countdown to 2030 country collaborations. In addition, the development of harmonized data extraction tools and standardized analytical approaches enables consistent processing and interpretation of routine health information system data

across countries. This harmonization allows for comparable analyses of immunization coverage, service utilization patterns, and equity indicators across multiple settings, while preserving country-specific indicator definitions and data system structures. As a result, the initiative not only strengthens national analytical capacity but also facilitates cross-country comparative analyses that can identify regional trends, shared challenges, and opportunities for programmatic learning. By enhancing the capacity of country teams to assess data quality, integrate multiple data sources, and produce robust coverage estimates, the initiative aims to improve evidence-based decision-making at national and subnational levels. At the same time, the harmonized analytical framework supports the generation of comparable evidence across countries, thereby contributing to regional learning and strengthening global monitoring frameworks aligned with international immunization goals.

In this report, we describe how the project leverages the Countdown to 2030 collaboration, including harmonized data extraction tools and standardized analytical approaches, to generate multicounty estimates of immunization coverage. The analyses incorporate both national and subnational assessments, as well as equity analyses aimed at identifying disparities in coverage and populations that remain un- or under-immunized. Using consistent methodologies across participating countries, the project enables comparative analyses and supports a deeper understanding of immunization coverage patterns and inequalities across settings.

Project Implementation Setting

The project was implemented in 26 countries in sub-Saharan Africa, most of which are part of the Countdown to 2030 initiative. Participating countries included Burkina Faso, Cameroon, Central African Republic, Chad, Côte d'Ivoire, Democratic Republic of Congo, Ethiopia, Ghana, Guinea, Kenya, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, Somalia, Tanzania, Uganda, Zimbabwe, and Zambia. These countries represent diverse health system contexts and face varying challenges related to immunization coverage, equity, and data quality, providing an important setting for strengthening analytical capacity and improving the use of routine health information for decision-making.

Figure 1: CD2030 / Immunization Project countries

This multi-country project on immunization coverage and equity was designed to strengthen national analytical capacity, support the generation of robust estimates of immunization coverage at national and subnational levels, and produce in-depth analyses to better understand progress and identify un- and under-immunized populations, including zero-dose children. The project utilized multiple data sources, including routine health facility data and nationally representative household surveys such as the Demographic and Health Surveys (DHS) and the Multiple Indicator Cluster Surveys (MICS). Integrating these complementary data sources enabled the production of more reliable and contextually relevant estimates of immunization coverage.

The initiative specifically supports ministries of health and national public health institutions in strengthening data quality assessment and analytical approaches for estimating immunization coverage and equity. Emphasis is placed on enhancing the use of routine health information system data to generate coverage estimates at both national and subnational levels, thereby supporting evidence-based program planning and performance monitoring. Strengthening the quality and use of these data is particularly important in Gavi-supported countries, where reliable information is essential for tracking progress, informing resource allocation, and contributing to national, regional, and global reporting mechanisms such as the WHO and UNICEF Estimates of National Immunization Coverage (WUENIC).

A major emphasis of the project is addressing immunization inequities by identifying populations that remain un- or under-immunized. These groups often include zero-dose children and communities located in hard-to-reach, remote, or marginalized settings. By equipping country teams with analytical tools and technical support to conduct detailed, disaggregated analyses, the project aims to strengthen the understanding of geographic and population-level disparities in immunization coverage and support targeted strategies to reach underserved populations.

Implementation Approach

The implementation leverages the CD2030 methodological framework for estimating health service coverage using routine district-level facility data following six sequential steps (Figure 2). The process begins with the compilation and standardization of monthly data, followed by data quality assessments that evaluate reporting completeness, internal consistency, and the presence of outliers or missing values. Identified issues are addressed through systematic corrections, including adjustments for incomplete reporting and the treatment of outliers and missing data. These procedures ensure that routine health information system data are sufficiently reliable for subsequent analysis and coverage estimation.

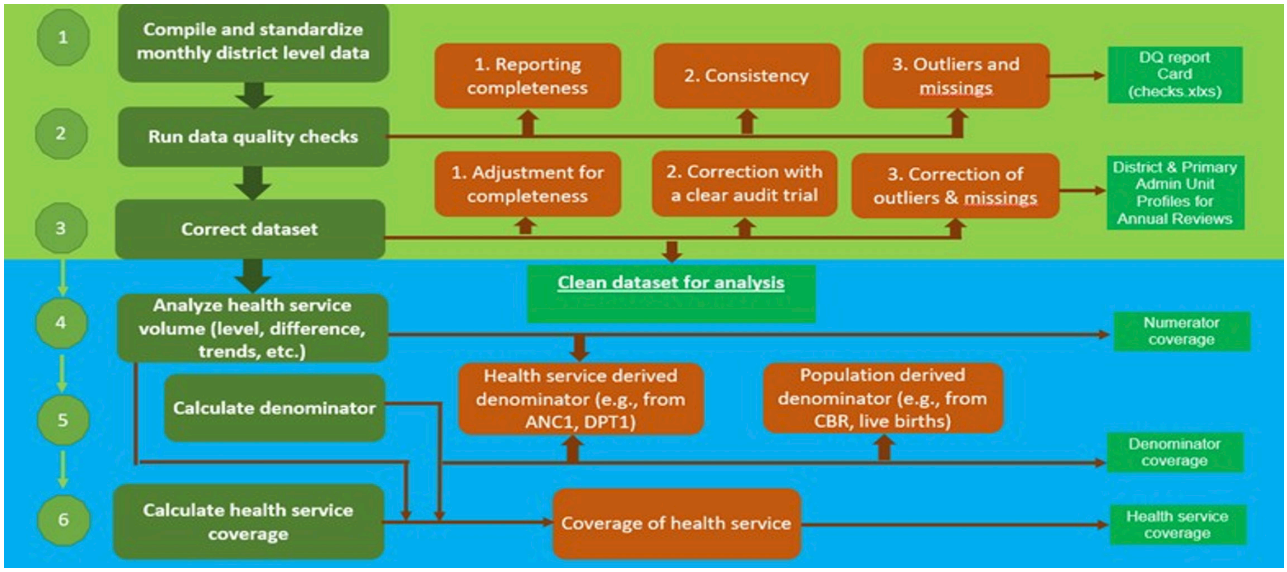

Figure 2: CD2030 analysis steps for RHIS

As part of the global CD2030 initiative, a harmonized data extraction system was developed to standardize the collection and analysis of maternal, newborn, and child health indicators. The system is built around a standardized template designed to capture key service delivery and health system performance indicators. With support from Gavi, this analytical application implemented using R Shiny automates data retrieval, harmonization, and output generation from national DHIS-2 systems using secure credentials. Countries map their indicators to the standardized template to accommodate variations in national data system architecture. Once configured, the application retrieves the relevant data and generates outputs aligned with the CD2030 format, reducing reliance on manual exports and improving the consistency and comparability of routine data. The core of the analytical work was supported by a dedicated R Shiny application designed specifically for immunization data analysis. This tool enables country teams to assess and clean their datasets, apply necessary adjustments, and generate national and subnational coverage statistics.

Following data compilation, the CD2030 analysis application conducts automated data quality assessments and numerator adjustments. Data quality checks evaluate reporting completeness, internal consistency between related indicators such as ANC-1 visits relative to Penta-1 doses and Penta-1 relative to Penta-3 doses, and the presence of extreme outliers or missing values. Implausible observations are identified using the Hampel identifier based on the median absolute deviation from historical values. Outliers are corrected using median imputation, while missing data are imputed when sufficient information is available to generate stable estimates. Adjustments are also applied for incomplete facility reporting using context-specific assumptions about service provision in non-reporting facilities.

Denominators are then selected, and coverage is estimated using both facility-based and population-based approaches. Facility-derived denominators are generated by applying demographic assumptions along the continuum of care, for example converting ANC-1 visits into estimates of live births and surviving infants while accounting for pregnancy loss, stillbirths, twinning, and infant mortality. Coverage estimates derived from these denominators are compared with nationally representative survey estimates, such as those from DHS or MICS, to identify the most plausible denominator. The final stage involves planning for country-level dissemination and action. This includes in-country workshops with ministries of health and key partners to review results, develop policy briefs, and identify priority actions. Countries are encouraged to share their findings with broader national stakeholders, strengthening the use of routine data for decision-making and fostering a culture of data-driven health planning while promoting local capacity, sustainability, and ownership of the analytical process.

Country Collaborations and Capacity Building

The project is implemented through country collaborations involving public health institutions, ministries of health, and CD2030 technical partners. These collaborations are co-led by a national public health institution, analysts from the Ministry of Health, and global or regional CD2030 partners. The active participation of Ministry of Health analysts is essential to ensure that the analytical work aligns with national priorities and that the resulting evidence informs policy formulation and program implementation. Country collaborations operate through regular virtual and in-person engagements, including technical meetings and annual country team meetings. These interactions provide structured opportunities for capacity building, knowledge exchange, and peer learning across participating countries. Embedding the collaborations within national systems and institutions strengthens ownership of the analytical processes and promotes the uptake of findings for planning and monitoring activities.

Capacity building is a central component of the project and focuses on strengthening the skills of country teams in data analysis, interpretation, and the use of evidence for decision-making. This is implemented through a combination of virtual and in-person workshops, targeted technical assistance, and peer learning mechanisms. Virtual workshops provide hands-on training on running analytical tools, troubleshooting technical issues, and interpreting outputs. These activities are complemented by in-person workshops that allow for more intensive training and collaborative problem solving. In addition, in-country meetings and stakeholder consultations serve as an important step for validating analytical findings before broader dissemination. These engagements allow national stakeholders to review results, assess their plausibility in light of programmatic realities, and refine interpretations where necessary. This process helps ensure that the final outputs are contextually appropriate and credible, while strengthening the use of routine data for decision-making at national and subnational levels.

Countries' Annual Meetings

As part of the validation and analytical process, a regional workshop was organized as a key milestone of the project, bringing together country teams from all 26 participating sub-Saharan African countries. Each country team included analysts from ministries of health or national public health institutions, along with representatives from national Expanded Program on Immunization (EPI) units. The workshop was facilitated by technical experts from the African Population and Health Research Center (APHRC), Johns Hopkins University, the University of Pelotas, and the University of Southampton. Representatives from the World Health Organization (WHO), the United Nations Children's Fund (UNICEF), and Gavi also participated, highlighting the importance of coordinated global and regional support for strengthening immunization monitoring and analysis.

The workshop aimed to strengthen country-level analytical capacity, validate analytical outputs, and support the finalization of national and subnational immunization coverage estimates. Country teams reviewed and synthesized findings from multiple analytical components, including routine health facility data and household survey analyses. Through collaborative review and discussion, participants assessed the plausibility of results and ensured that interpretations reflected national program realities. This process formed an important step in validating analytical outputs prior to broader dissemination and policy engagement.
In addition, the workshop provided a platform for country teams to develop country reports and generate strategic recommendations to accelerate routine immunization coverage. Particular emphasis was placed on documenting immunization inequalities and identifying populations that remain un- or under-immunized, including zero-dose children. The findings and recommendations generated during the workshop were intended to inform national strategic discussions and support targeted actions to improve coverage and equity within countries and across the region.

Results

Data Quality

Completeness of Reporting in DHIS2

Median reporting completeness for routine immunization indicators remained high and relatively stable between 2020 and 2024. Across the countries analyzed, median completeness consistently remained above 95 % for tracer antigens. 2024 had the highest median for reporting for completeness at 97% while 2020 and 2021 had the lowest reporting for completeness at 95%.

Country	2020	2021	2022	2023	2024
DRC	97	97	99	100	100
Guinea	98	95	99	99	100
Niger	98	99	99	100	100
Cote d'Ivoire	100	99	100	99	99
Liberia	98	97	98	97	99
Madagascar	83	94	96	94	99
Rwanda	99	99	100	99	99
Zambia	96	98	99	99	99
Cameroon	90	93	94	95	98
Ghana	93	94	95	97	98
Malawi	83	91	96	96	98
Kenya	96	96	97	97	97
Mozambique	92	92	93	96	97
Sierra Leone	94	95	92	93	97
Zimbabwe	95	93	96	97	97
Tanzania	94	87	90	95	95
Somalia	-	-	73	95	94
Chad	98	99	84	94	91
Ethiopia	91	88	87	90	91
Nigeria	87	87	86	87	86
CAR	-	-	56	75	85
Burkina Faso	94	94	89	89	82
Senegal	98	98	76	54	76
Uganda	98	99	99	99	71
Median	96	95	96	96	97
Q1	92	93	89	94	91
Q3	98	98	99	99	99

Figure 3: Reporting completeness

Countries such as DRC, Rwanda, and Cote d'Ivoire emerged as regional benchmarks with high reporting for completeness, whereas CAR and Somalia face persistent gaps in reporting for completeness. This is in contrast to the missingness, which identifies specific districts that fail to provide essential data elements despite the report. While some districts may achieve high reporting completeness, significant missingness revealed a bigger gap where forms were submitted without usable data. There were notable countries that have maintained low missingness, such as Liberia, which exhibits a missing tracer vaccine in recent years.

Overall Data Quality Score

The median value across countries remained relatively stable over the period, increasing slightly from 81% in 2020 to 82% in 2021 and 2022, before declining to 78% in 2023 and recovering modestly to 79% in 2024. While most countries cluster around the 80–90% range, the spread of points indicates variability in performance across countries, with a few countries reporting substantially lower levels in certain years. Overall, the trend suggests generally stable but uneven performance, with some deterioration after 2022.

Country	2020	2021	2022	2023	2024
DRC	97	97	99	100	100
Guinea	98	95	99	99	100
Niger	98	99	99	100	100
Cote d'Ivoire	100	99	100	99	99
Liberia	98	97	98	97	99
Madagascar	83	94	96	94	99
Rwanda	99	99	100	99	99
Zambia	96	98	99	99	99
Cameroon	90	93	94	95	98
Ghana	93	94	95	97	98
Malawi	83	91	96	96	98
Kenya	96	96	97	97	97
Mozambique	92	92	93	96	97
Sierra Leone	94	95	92	93	97
Zimbabwe	95	93	96	97	97
Tanzania	94	87	90	95	95
Somalia	-	-	73	95	94
Chad	98	99	84	94	91
Ethiopia	91	88	87	90	91
Nigeria	87	87	86	87	86
CAR	-	-	56	75	85
Burkina Faso	94	94	89	89	82
Senegal	98	98	76	54	76
Uganda	98	99	99	99	71
Median	96	95	96	96	97
Q1	92	93	89	94	91
Q3	98	98	99	99	99

Figure 4: Annual Overall DQA score

Comparison between Coverage from the Household Survey and DHIS2

The scatter plots compare immunization coverage estimates from the survey that are within the RHIS reporting period household surveys with those reported through the DHIS2 routine health information system for Penta-3. Each point represents a country, and the dashed 1:1 line indicates perfect agreement between the two data sources.

Overall, the results show moderate agreement between survey-based and administrative coverage estimates, with most countries clustering near the 1:1 reference line. This suggests that in many settings, routine administrative data provide coverage estimates broadly consistent with those obtained from population-based surveys. The pattern indicates that routine data are directionally consistent with survey findings but still exhibit notable variability, underscoring the importance of triangulating multiple data sources when assessing immunization performance.

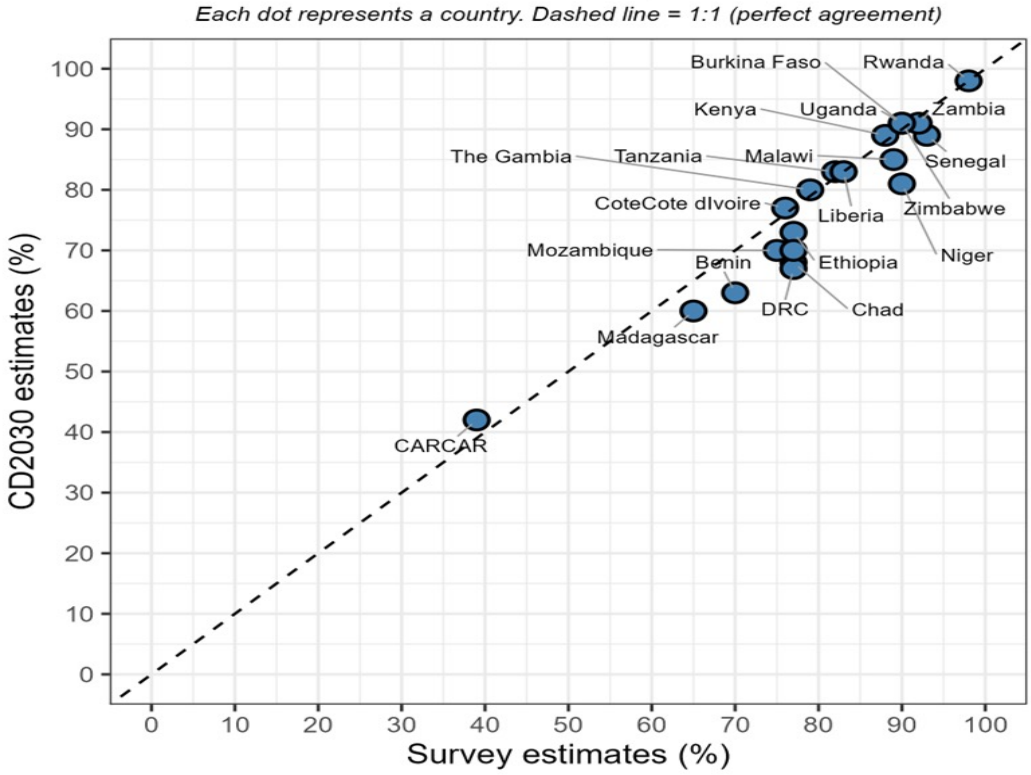

Figure 5: Comparison of Penta 3 coverage

However, some countries deviate from the line, indicating discrepancies between the two data sources. In some cases, DHIS2 coverage is higher than survey estimates, which may reflect issues such as over-reporting of vaccinations, inaccurate target population denominators, or reporting completeness biases in routine systems. In other cases, survey estimates exceed DHIS2 coverage, suggesting possible under-reporting within routine systems or improvements in service delivery not fully captured by administrative data. A few countries show substantial divergence, highlighting potential data quality concerns. For example, some countries with low survey coverage but relatively higher DHIS2 estimates may indicate challenges with denominator accuracy or reporting practices. Conversely, countries located above the line suggest situations where administrative data may underestimate true coverage. Nonetheless, the deviation is at most 10 points (Table 1).

Table 1: Comparison of penta-3 estimates derived from DHIS-2 and survey conducted within the same period

Country	2020	2021	2022	2023	2024
Niger	95	96	94	97	97
Rwanda	91	97	96	87	93
Kenya	92	96	95	96	90
Zambia	92	94	93	92	89
Liberia	93	93	84	74	87
Mozambique	89	83	83	88	87
Ethiopia	85	83	84	81	87
DRC	85	86	88	88	87
Cote d'Ivoire	88	86	89	84	84
Burkina Faso	90	91	88	87	84
Tanzania	88	81	85	85	84
Mali	84	84	72	85	80
Cameroon	78	82	80	82	80
Madagascar	77	87	82	75	80
Zimbabwe	95	91	89	91	77
Sierra Leone	80	80	75	71	76
Somalia	-	-	56	81	76
Guinea	93	89	93	87	76
Ghana	77	75	74	72	75
Chad	85	87	76	80	75
Malawi	62	75	81	82	74
Nigeria	75	77	75	76	73
CAR	-	-	65	67	72
Senegal	85	88	67	59	70
Uganda	91	93	92	91	69
Median	**88**	**87**	**84**	**84**	**80**
Q1	**82**	**83**	**75**	**76**	**75**
Q3	**91**	**92**	**89**	**88**	**87**

Sub-Saharan Africa Immunization Coverage

Median immunization coverage remained relatively stable between 2020 and 2024 across the countries analyzed. By 2024, median coverage reached 90% for Penta-1, 89% for BCG, 86% for Penta-3 and OPV1, and 85% for Measles-1. Coverage for first-dose vaccines remained consistently high, indicating relatively strong access to initial immunization services.

However, the slightly lower coverage observed for Penta-3 and Measles-1 suggests persistent challenges in ensuring completion of the vaccination schedule and maintaining coverage for later doses. Some fluctuations were observed during the period, particularly around 2021 and 2023, which may reflect temporary disruptions in service delivery or program recovery efforts.

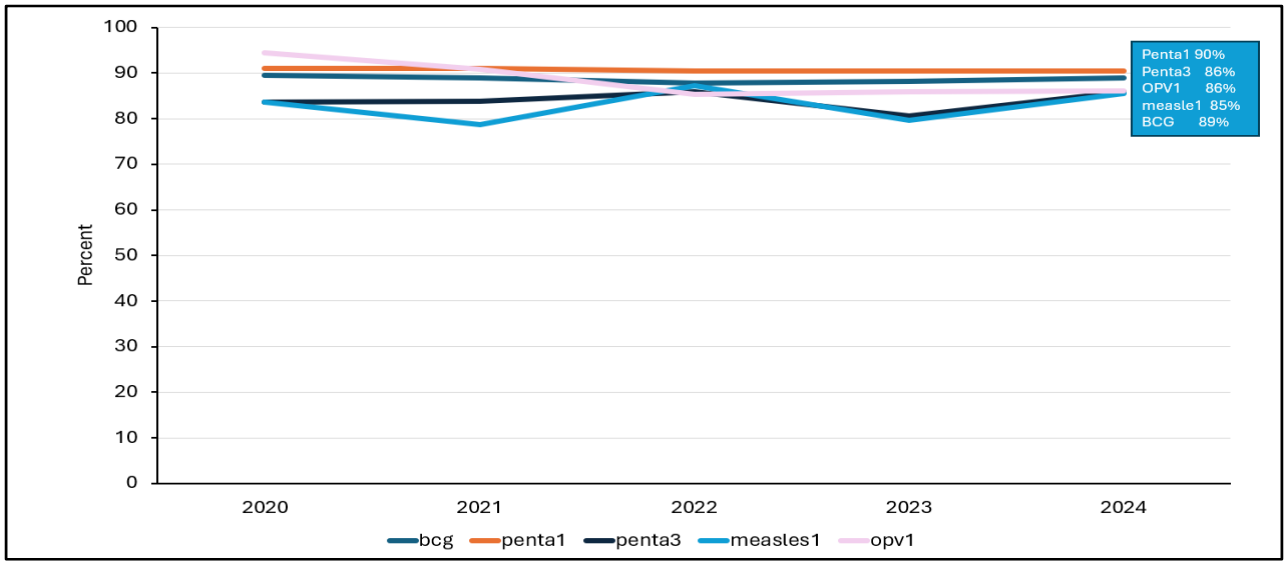

Figure 6: Median coverage for SSA region

Immunization Coverage by Region and Countries

The data reveals coverage performances across the regions. In West Africa, there is significant polarization; countries like Sierra Leone and Ghana consistently perform at the top end (near or above 90%), while Nigeria and Guinea lag significantly behind, often reporting coverage below 60%. Similarly, East Africa shows a wide disparity, with Rwanda and Tanzania serving as high performers, contrasting sharply with Somalia and Ethiopia, which struggle to reach comparable levels. Central Africa remains the most challenged region, with the CAR consistently recording the lowest median coverage, highlighting a critical gap in the region.

The Pentavalent third dose largely mirrors the Measles 1 coverage. Rwanda and Ghana again emerge as benchmarks with high, tightly clustered coverage, indicating a robust system capable of retaining children through the 14-week schedule. Somalia and CAR sit at the bottom of the distribution, with median coverage frequently dropping below 50%. Notably, Southern Africa sits at the middle performance of countries like Mozambique and Madagascar, which show moderate coverage but exhibit wider variations, suggesting that while the national average is stable.

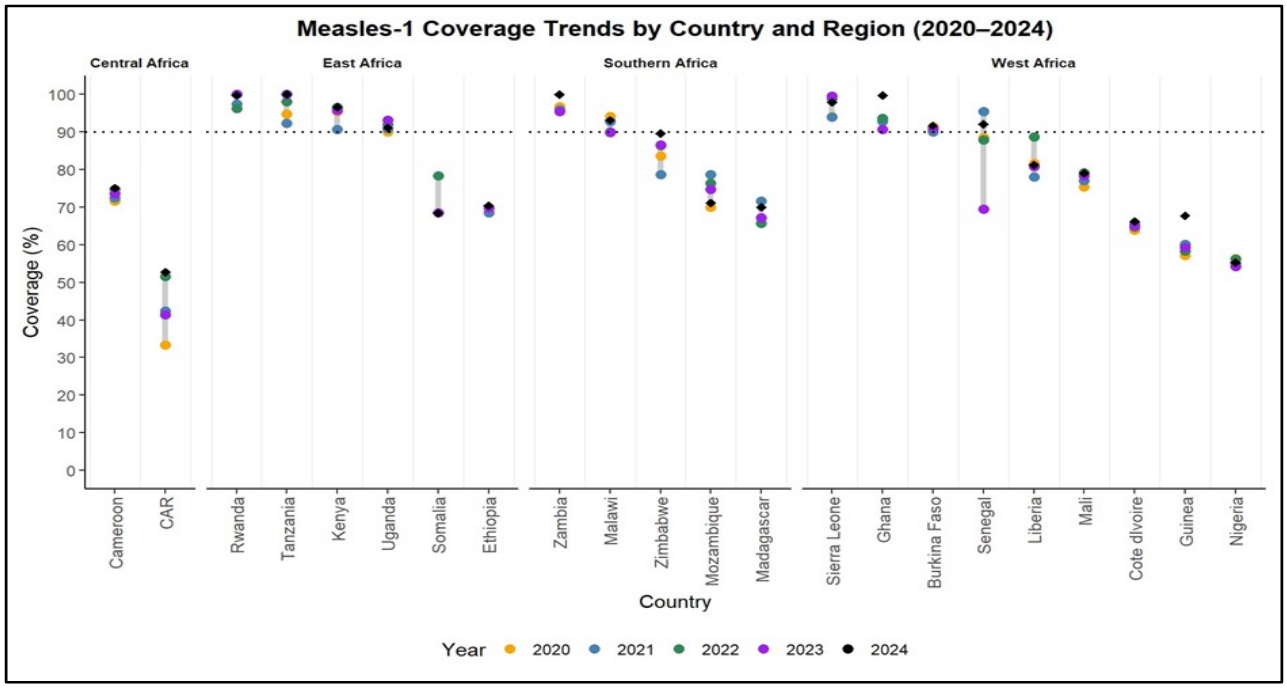

Figure 7: Measles 1 coverage by region

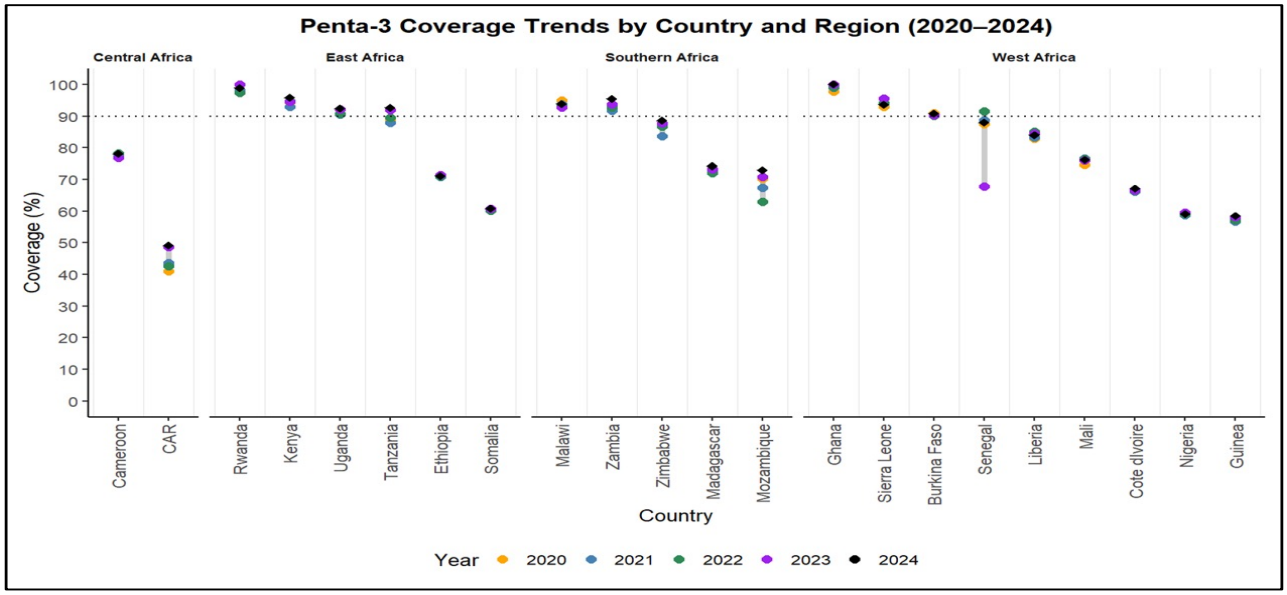

Figure 8: Penta3 Coverage by region

Overall SSA Trends in Pentavalent Coverage, Zero Dose, and Pentavalent Vaccine Dropout

Between 2020 and 2024, median Penta-1 coverage remained relatively stable and close to the 95% target, while Penta-3 coverage fluctuated slightly but generally remained above 90%, indicating that most countries maintained relatively high first-dose access but experienced some variation in completing the full schedule. Despite these relatively stable coverage levels, the number of zero-dose children increased over the period, rising from 1.5 million in 2020 to 1.7 million in 2022, before declining slightly to 1.4 million in 2024. This pattern suggests that access gaps initially widened during the early years of the period but showed modest improvement toward 2024.

At the same time, Penta-1 to Penta-3 dropout increased steadily, from 7.7 million children in 2020 to 9.5 million in 2024. This indicates growing challenges in ensuring children who start the immunization schedule complete subsequent doses.

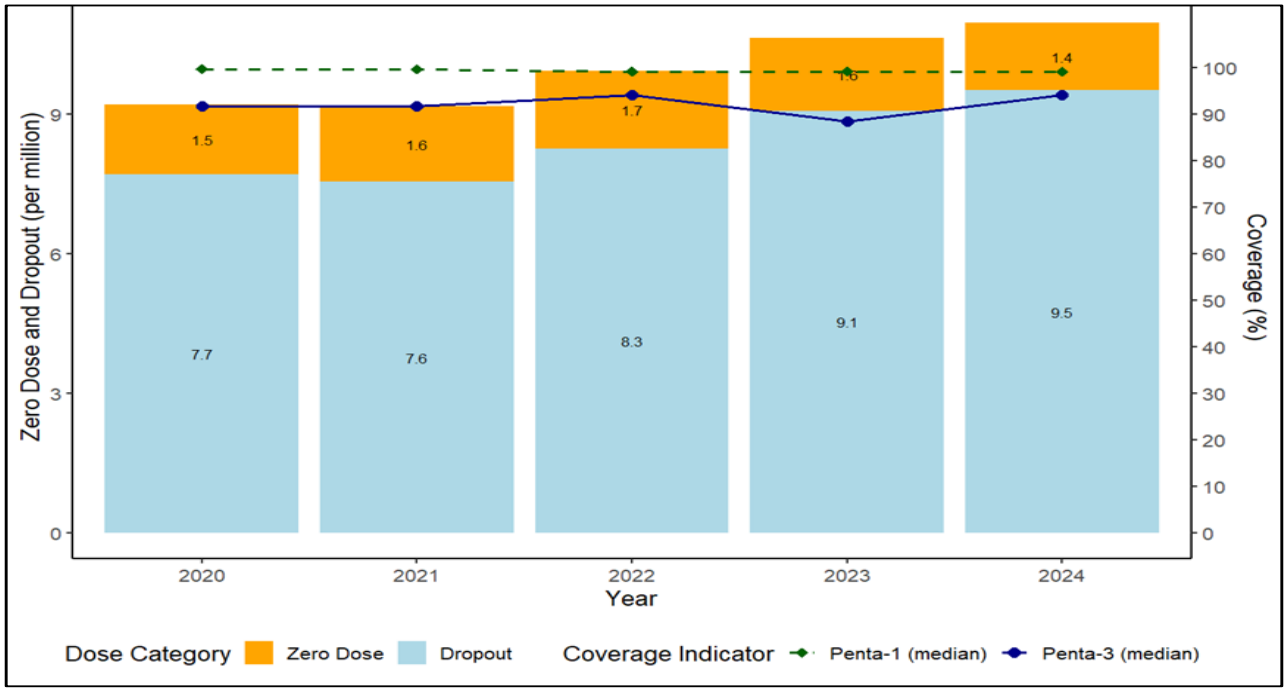

Figure 9: Trends in Penta3, Zero dose, Penta vaccine dropout

The analysis of zero-dose and dropout rates per 100,000 population reveals substantial variation across countries over the 2020–2024 period. A small number of countries consistently account for the highest zero-dose burdens. Nigeria shows by far the largest levels, with zero-dose rates exceeding 40 per 100,000 throughout the period and increasing to over 50 per 100,000 by 2024. Ethiopia also exhibits relatively high levels, with rates remaining around 11–13 per 100,000. Other countries with moderate but persistent zero-dose burdens include Mozambique, Côte d'Ivoire, and Guinea, where rates generally range between 3 and 5 per 100,000.

Several countries demonstrate moderate but gradually increasing levels, such as Somalia and Madagascar, indicating potential emerging access gaps. In contrast, many countries maintain relatively low zero-dose rates, including Kenya, Senegal, Burkina Faso, Uganda, Zambia, Zimbabwe, Malawi, Liberia, Sierra Leone, Ghana, and Rwanda, where levels remain below one per 100,000 or only slightly above this threshold.

Dropout patterns generally follow a similar geographic distribution. Countries with higher zero-dose levels, particularly Nigeria and Ethiopia, also experience relatively elevated dropout rates, suggesting that challenges occur both in reaching children with the first dose and in ensuring completion of the immunization schedule. In several other countries, dropout remains present but at lower levels, indicating that although access to the first dose may be relatively strong, continuity of care across subsequent doses still requires strengthening.

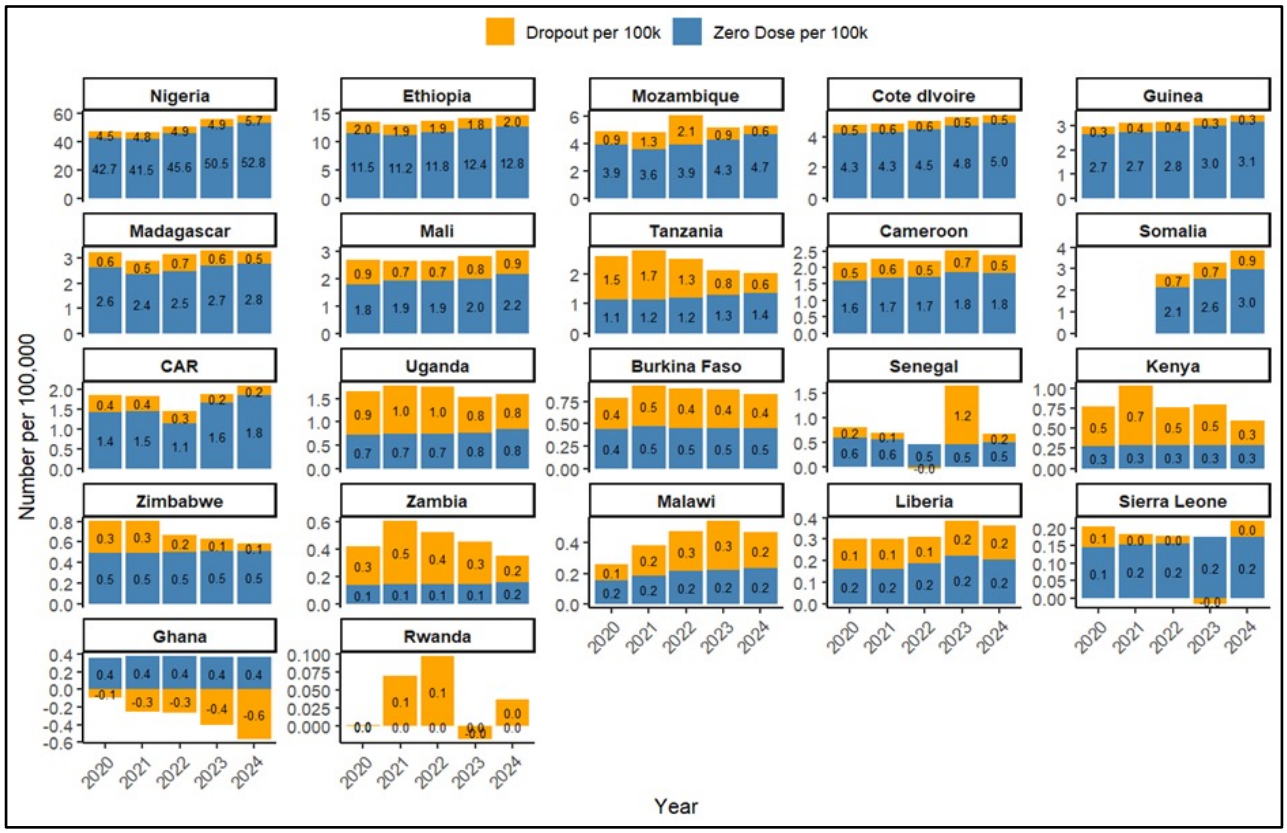

Figure 10: Zero dose & Pentavalent vaccine dropout by country and year

The regional analysis of zero-dose and incomplete pentavalent doses from 2020 to 2024 reveals persistent immunization gaps across sub-Saharan Africa, with the total number of under-immunized children remaining high. In Central Africa, the Central African Republic (CAR) faces a severe crisis, with zero-dose rates consistently exceeding 50%. East Africa displays a sharp contrast between Rwanda, which maintains near-zero rates, and Somalia and Ethiopia, which struggle with high numbers of incomplete doses. Southern Africa generally performs better, although Mozambique shows a notably higher burden of incomplete doses compared to its neighbors. In West Africa, a performance divide is evident: Ghana and Sierra Leone have successfully kept both zero-dose and dropout rates below 10%, while Guinea and Nigeria grapple with zero-dose rates frequently surpassing 40%.

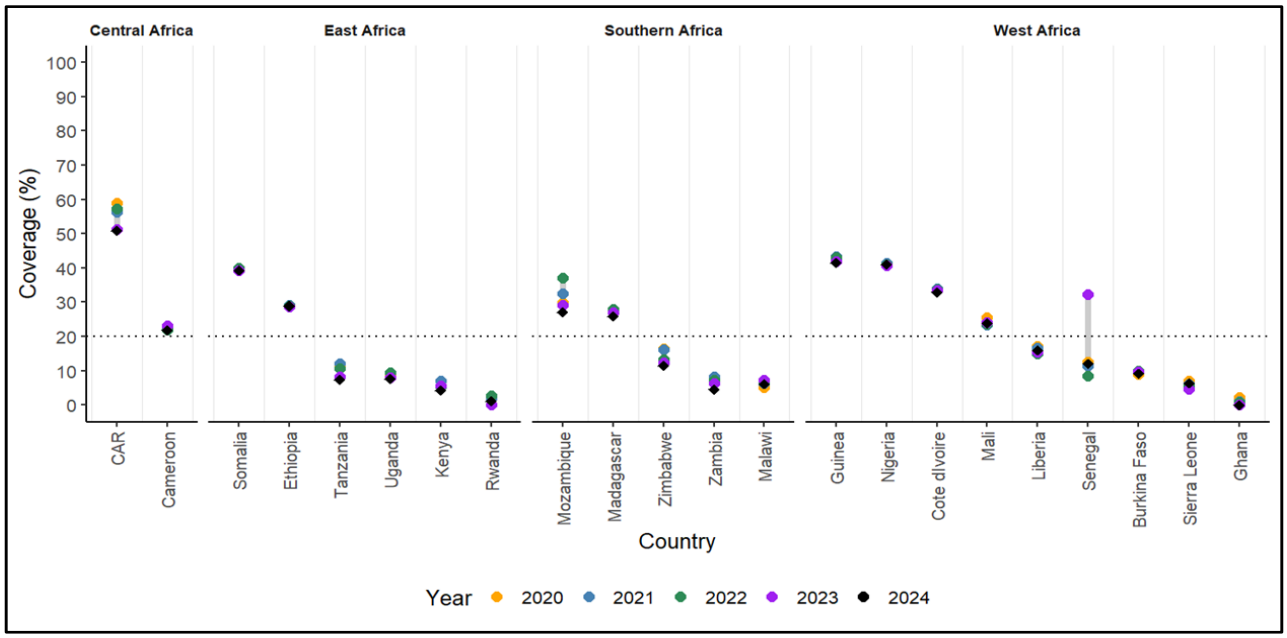

Figure 11: Zero and incomplete penta dose trends by region and countries

Subnational Immunization Coverage

Percentage of the regions and districts with target coverage of greater than 90%

At least 80% of regions (administrative level 1) and 70% of districts (administrative level 2) are expected to achieve vaccination coverage of at least 90%. However, only 35% of countries met this benchmark at the administrative level 1 for Penta-3, and 22% for Measles-1. At the district level, just 26% of countries had at least 70% of their districts reaching the 90% coverage target for both Penta-3 and Measles-1, highlighting persistent subnational gaps in immunization coverage.

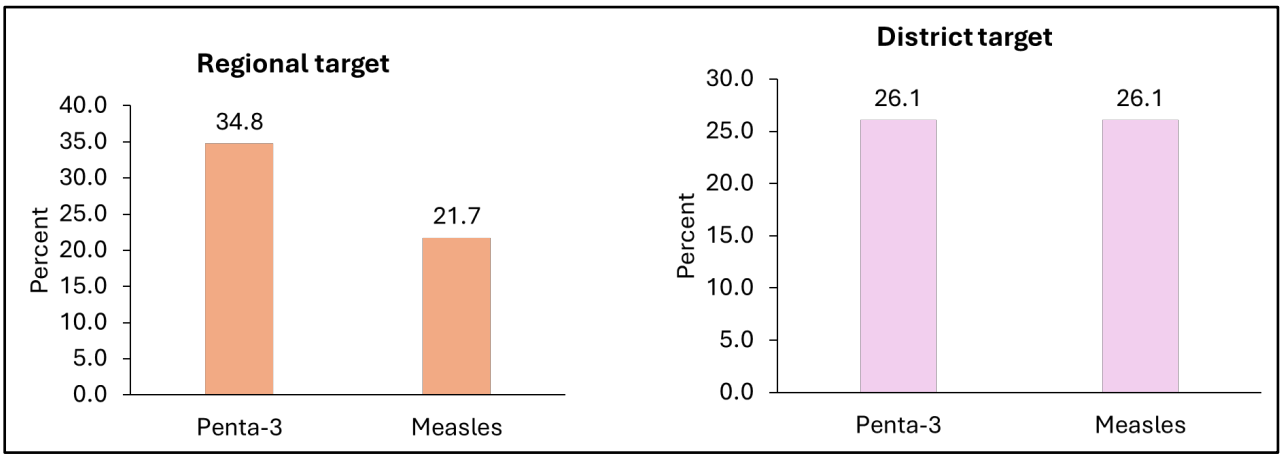

Figure 12: Regional and district coverage targets

Admin1 data indicate that while some health systems are moving toward greater uniformity, wide variations in coverage persist between regions, provinces, and counties. The analysis of Admin-1 Level Penta-3 and Measles-1 Coverage highlights a sharp performance divide; for instance, high-performing countries like Ghana and Kenya still exhibit internal disparities where certain subnational exceed 90% while others lag, whereas fragile contexts like the CAR show consistently low performance across nearly all borders.

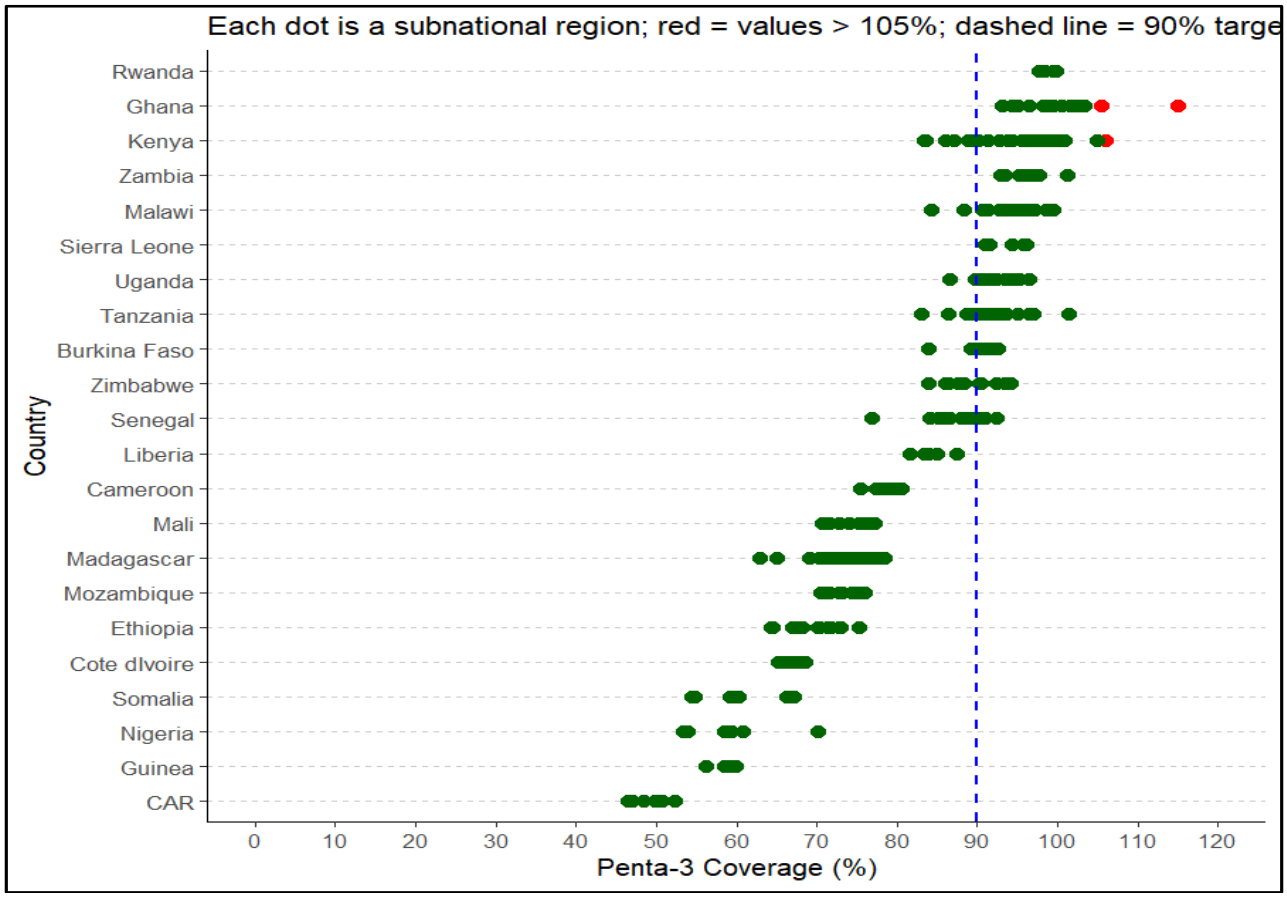

Figure 13: Admin level penta3 coverage by countries (2024)

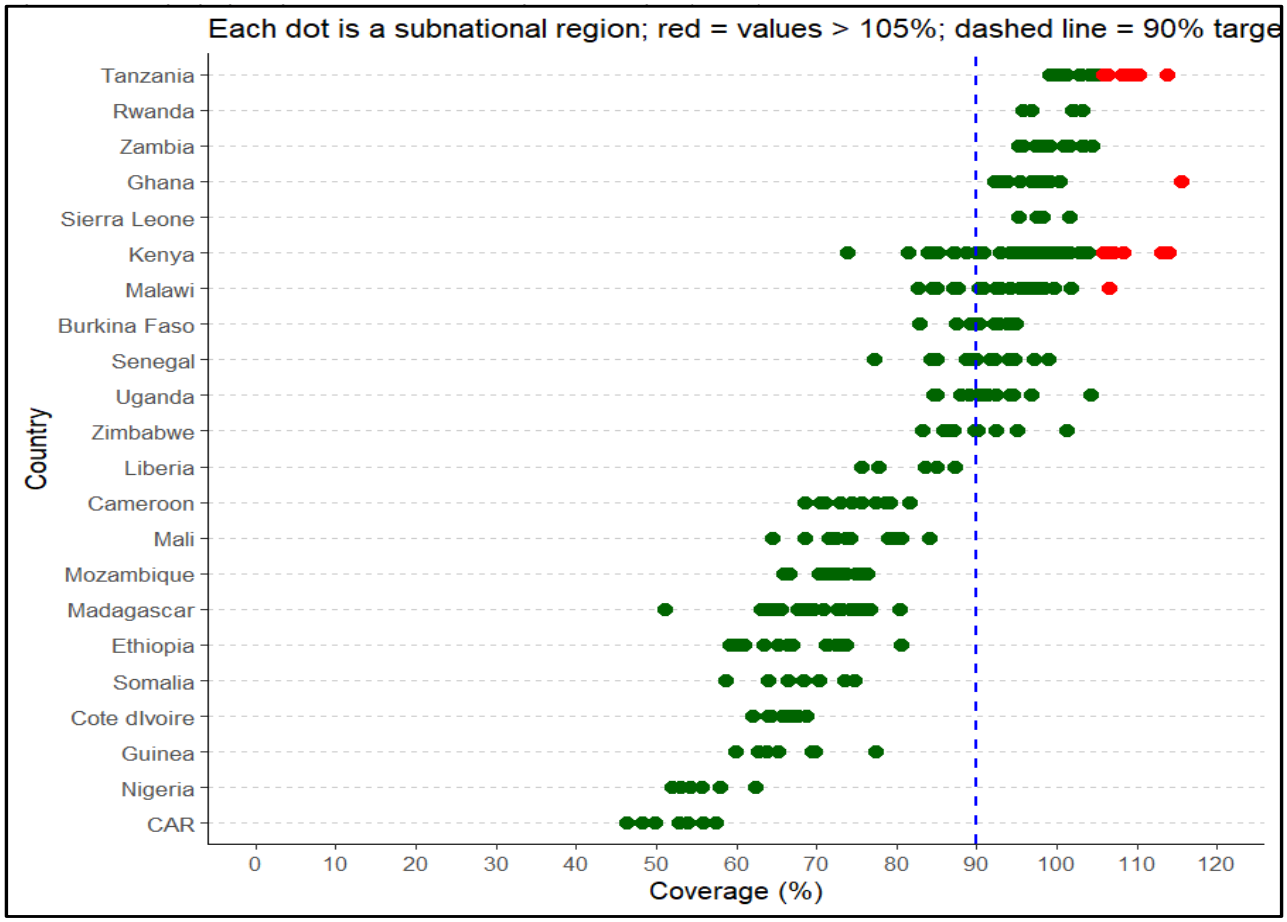

Figure 14: Admin1 level measles vaccine by countries (2024)

Immunization Inequality

Inequality by vaccine using the latest surveys from all countries

First dose of Pentavalent Vaccine

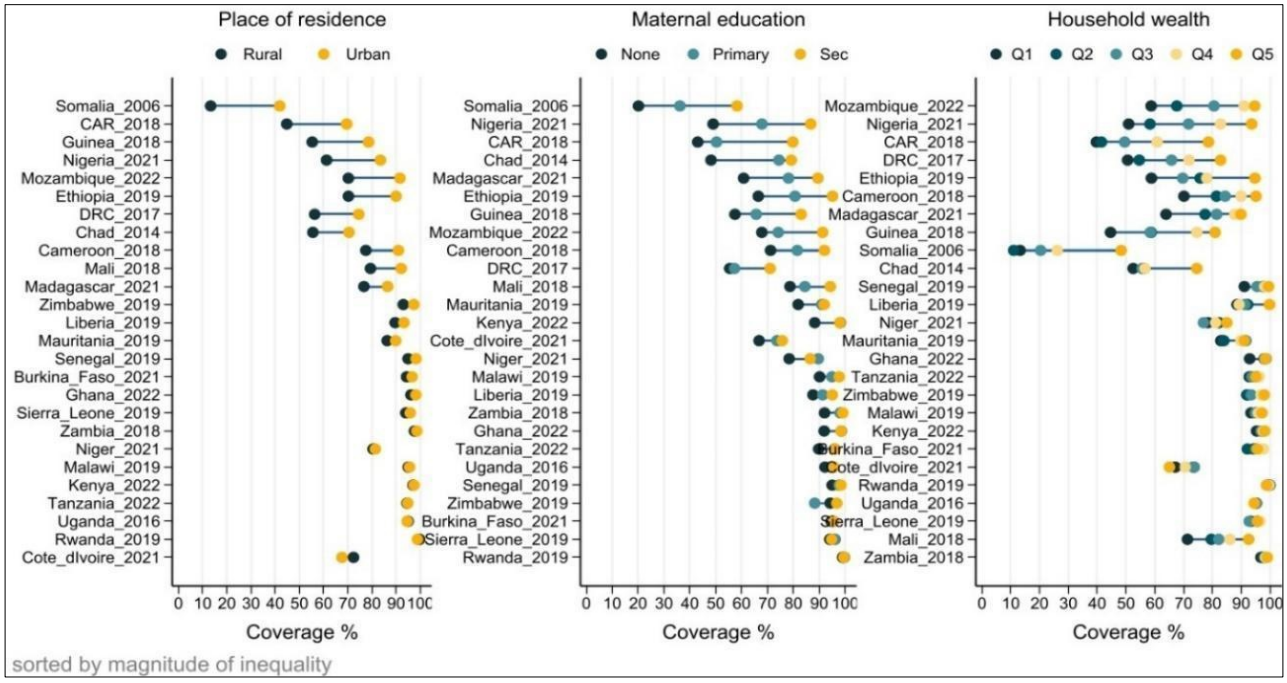

Figure 15: Coverage for the first dose of pentavalent vaccine by place of residence, maternal education and household wealth.

Third Dose of Pentavalent Vaccine

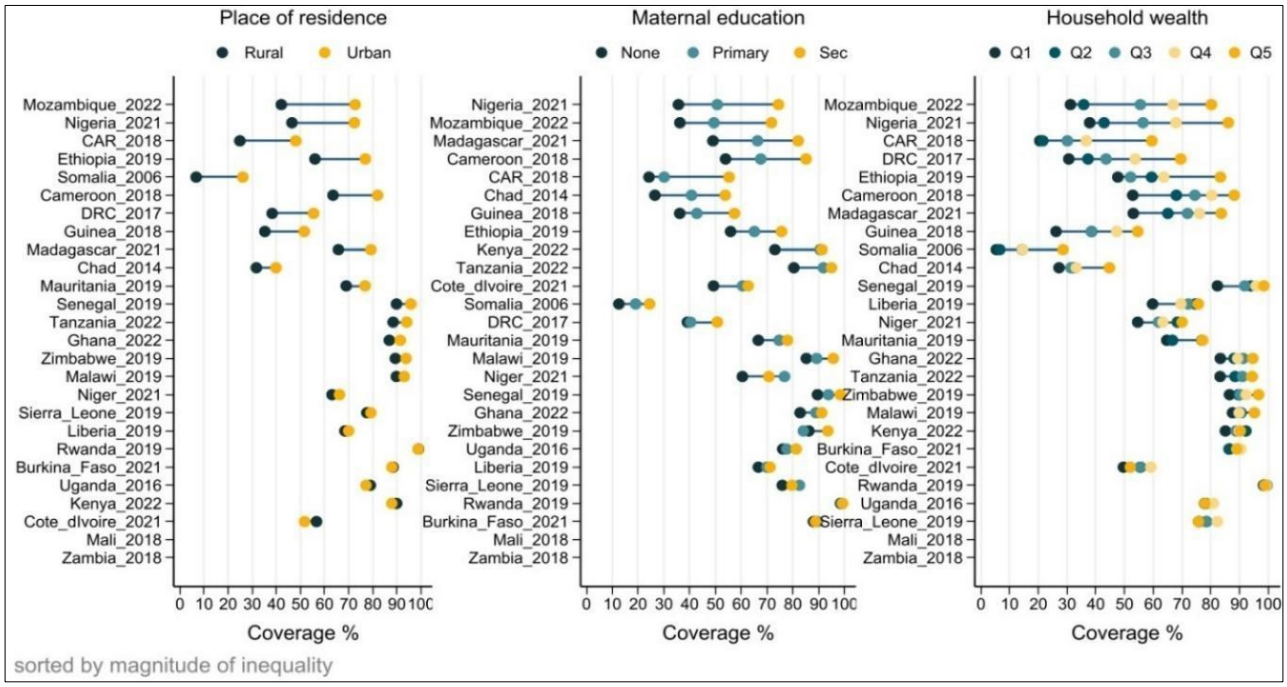

Figure 16: Coverage of the third dose of pentavalent vaccine by place of residence, maternal education and household wealth status.

First Dose of Measles Vaccine

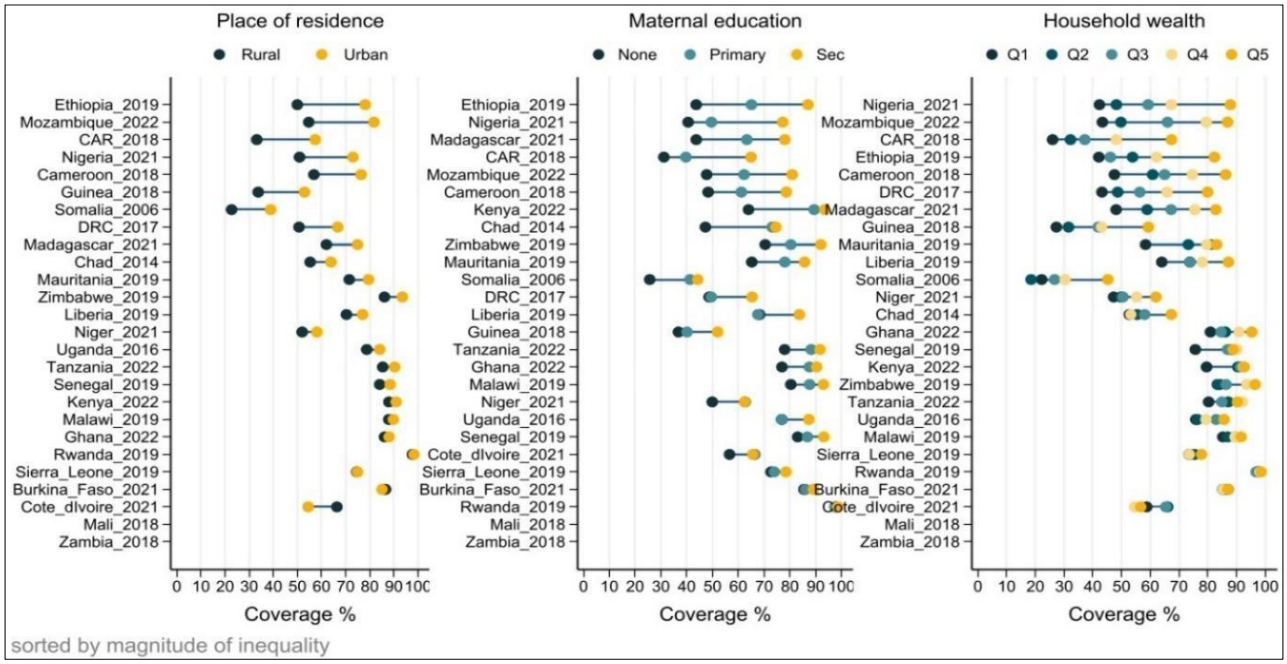

Figure 17: Coverage of the first dose of measles vaccine by place of residence, maternal education and household wealth status.

Pentavalent 1 to 3 Dropout Rate

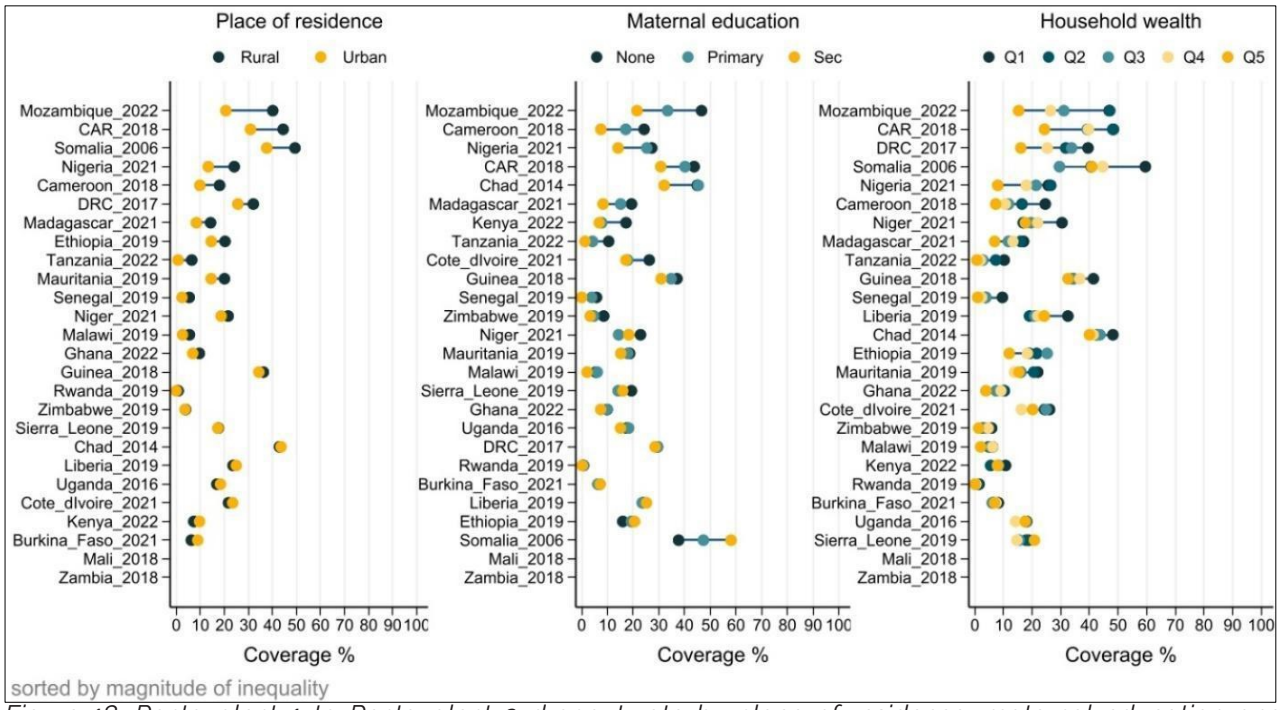

Figure 18: Pentavalent 1 to Pentavalent 3 dropout rate by place of residence, maternal education and household wealth status.

Real Zero Dose Rate

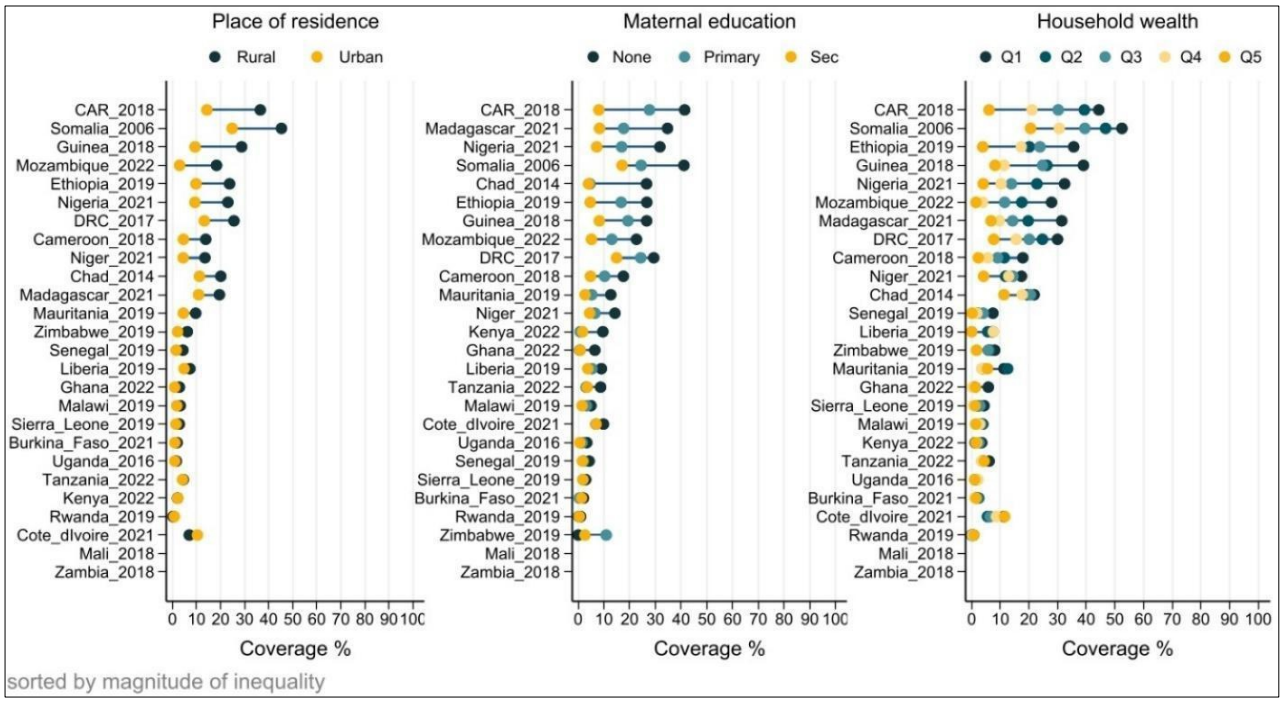

Figure 19: Zero dose rate by place of residence, maternal education and household wealth status

Proxy Zero Dose

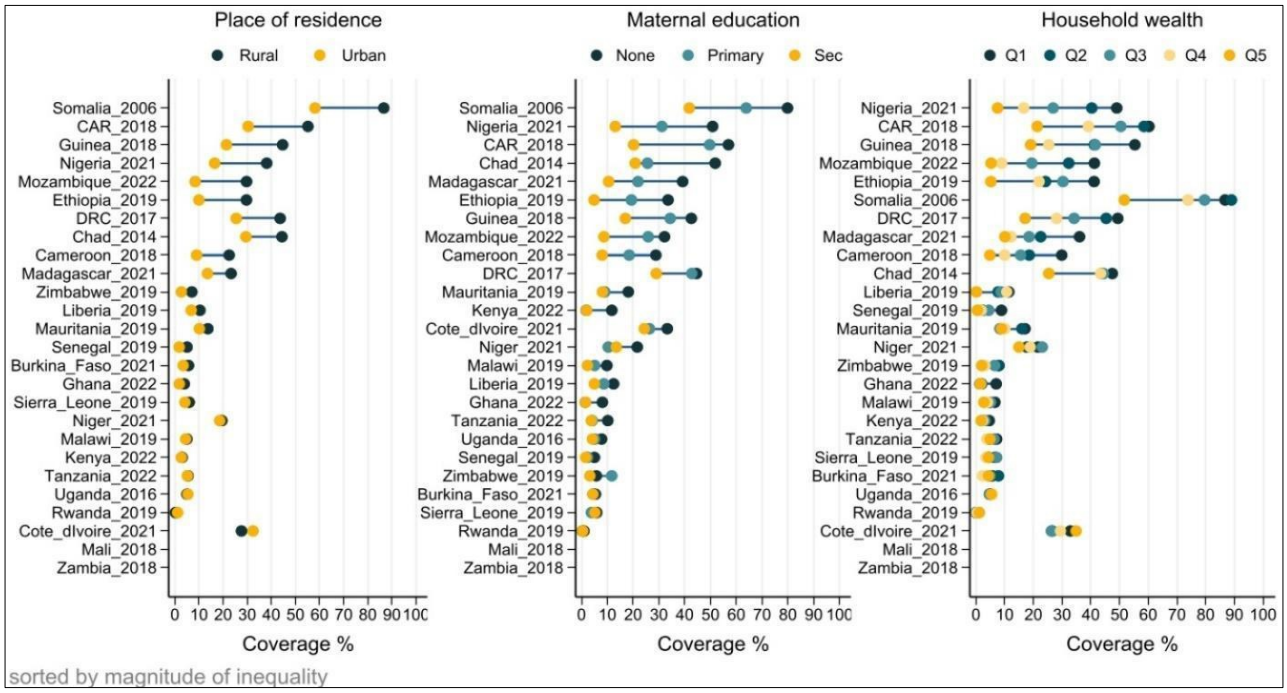

Figure 20: Zero dose (proxy) rate by place of residence, maternal education and household wealth status.

Discussion

This multi-country analysis provides important insights into the performance of RHIS and immunization programs across sub-Saharan Africa. Overall, the findings indicate that RHIS reporting completeness remained relatively high and stable between 2020 and 2024. Median reporting completeness consistently exceeded 95%, reaching approximately 97% by 2024. These findings suggest that routine reporting systems across many countries are sufficiently functional to support program monitoring and decision-making. However, the temporary declines observed around 2021 and 2023 may reflect disruptions in reporting systems or operational challenges affecting health services during those periods. Such fluctuations may relate to broader health system pressures, including resource constraints, competing health priorities, or operational disruptions.

While several countries such as the Democratic Republic of Congo, Rwanda, and Côte d'Ivoire have demonstrated strong reporting performance and may serve as regional benchmarks, other countries including the Central African Republic and Somalia continue to experience persistent gaps. Furthermore, the presence of missing values for vaccine tracer antigens within submitted reports highlights a critical data quality issue that is not captured by reporting completeness alone.

The overall data quality score further illustrates that while performance remained broadly stable across the study period, it was uneven across countries. Median scores increased slightly between 2020 and 2022 but declined in 2023 before partially recovering in 2024. Although most countries clustered within the 80–90% range, the spread of values indicates substantial variation in performance. These findings suggest that improvements in RHIS data quality may have plateaued in several settings and that continued investments in data quality assurance, facility-level reporting capacity, and routine data audits remain essential.

In terms of program performance, the analysis revealed that immunization coverage for key antigens remained relatively stable during the study period. Median coverage in 2024 reached 90% for Penta-1 and 89% for BCG, while coverage for Penta-3, OPV1, and Measles-1 remained slightly lower, ranging between 85% and 86%. The consistently high coverage for first-dose vaccines suggests relatively strong access to initial immunization services across many countries. However, the lower coverage observed for later doses highlights persistent challenges in ensuring completion of the immunization schedule. This gap between first-dose access and full schedule completion has been widely recognized as an important indicator of program performance and reflects challenges in follow-up, service continuity, and caregiver engagement.

At the regional level, substantial disparities in coverage remain evident across countries and regions. West Africa shows pronounced polarization, with countries such as Sierra Leone and Ghana consistently achieving high coverage levels while Nigeria and Guinea continue to lag significantly behind. East Africa demonstrates a similar contrast between high-performing countries such as Rwanda and Tanzania and lower-performing settings including Somalia and Ethiopia. Central Africa remains the most challenged region, with the Central African Republic consistently reporting the lowest coverage levels. These patterns highlight variation in broader health system capacity, including political stability, and service delivery infrastructure shape immunization program performance.

The analysis of zero-dose children and dropout between Penta-1 and Penta-3 provides further evidence of persistent immunization gaps. Although median Penta-1 coverage remained close to the 95% target during the study period, the number of zero-dose children increased from 1.5 million in 2020 to 1.7 million in 2022 before declining slightly to 1.4 million in 2024. At the same time, the number of children failing to complete the vaccination schedule increased steadily, indicating growing challenges in ensuring continuity of immunization services after the first dose. Countries such as Nigeria and Ethiopia accounted for a large proportion of the regional zero-dose burden, while several other countries including Mozambique, Côte d'Ivoire, and Guinea showed moderate but persistent access gaps. These findings underscore the importance of addressing both access and retention challenges within routine immunization systems.

Subnational analyses further reveal that national averages often mask substantial geographic

inequalities in immunization coverage. Only about one-third of countries achieved the benchmark that at least 80% of regions reach 90% Penta-3 coverage, and fewer than one-quarter met the corresponding target for Measles-1 coverage. At the district level, only about one-quarter of countries had at least 70% of districts reaching the 90% coverage target. Even in relatively high-performing countries such as Ghana and Kenya, internal disparities persist between high- and low-performing regions. In contrast, fragile contexts such as the Central African Republic exhibit consistently low coverage across nearly all administrative areas. These findings highlight the importance of subnational monitoring and targeted strategies to address localized coverage gaps.

Finally, the comparison between administrative coverage estimates derived from DHIS2 and those obtained from household surveys demonstrated moderate agreement across countries. In many cases, routine administrative data produced estimates broadly consistent with survey-based coverage levels, suggesting that RHIS data can provide useful approximations of immunization coverage when reporting completeness is high and denominators are reasonably accurate. However, deviations observed in some countries highlight the need for continued triangulation of multiple data sources. Instances where administrative estimates exceed survey estimates may reflect over-reporting or denominator inaccuracies, while the opposite pattern may indicate under-reporting in routine systems or improvements in service delivery not fully captured by administrative data. Although the discrepancies were generally modest, they underscore the importance of ongoing efforts to strengthen data quality and improve the accuracy of population denominators.

Implementation Experience and Learning

The findings from this multi-country analysis highlight the value of the Countdown to 2030 (CD2030) collaborative model for strengthening the use of routine health information system (RHIS) data in immunization monitoring. The initiative combined harmonized analytical methods, shared technical tools, and collaborative capacity building to support country-led analyses of immunization coverage and equity. Through this approach, participating countries were able to systematically assess data quality, generate national and subnational coverage estimates, and identify persistent immunization gaps, including zero-dose children and areas with high dropout between vaccine doses. These results demonstrate that routine administrative data, when carefully assessed and standardized, can provide meaningful insight into program performance and complement traditional survey-based monitoring approaches.

A key innovation of the CD2030 model has been the development of digital analytical platforms that enable countries to engage directly with their routine data. The analytical process initially relied on R-based scripts and an interactive R Shiny application that automated core analytical steps, including data quality assessment, numerator adjustment, denominator estimation, and coverage calculation. While this approach improved reproducibility and transparency, implementation experience revealed substantial variation in country analysts' familiarity with statistical programming, which limited the accessibility of the platform for some users.

To address this challenge and expand accessibility, the initiative has developed a zero-coding analytical platform, the CD2030 Data Suite, which allows users to conduct the full analytical workflow without interacting directly with programming code. The Data Suite is installed as a standalone software application that integrates backend analytical processes within a user-friendly graphical interface. Country teams can upload standardized datasets, perform data quality assessments, generate coverage estimates, and produce graphical outputs without running scripts or managing backend code. This transition significantly reduces technical barriers and enables a broader range of analysts within ministries of health and public health institutions to engage directly with routine immunization data.

In parallel, improvements have been introduced to strengthen the standardization and efficiency of data extraction. Early implementation revealed that country datasets often required extensive cleaning and reformatting due to differences in DHIS2 configurations, indicator naming conventions, and reporting structures. To address these challenges, the project developed a dedicated DHIS2 data extraction module linked to the CD2030 harmonized extraction template, enabling countries to retrieve routine immunization data directly from their national DHIS2

systems and automatically map indicators to the standardized CD2030 format. This approach reduces manual data manipulation and improves consistency across countries.

The technical infrastructure supporting the extraction process has also been migrated from an R-based backend to a Java-based architecture, which significantly improved system performance and scalability. The transition to Java increased the speed and stability of data downloads, particularly when extracting large datasets from national DHIS2 platforms. These improvements streamlined the analytical workflow and made the platform more robust for large-scale multi-country analyses.

Beyond the technical innovations, the CD2030 collaboration demonstrated the importance of sustained technical engagement and knowledge exchange among countries and partners. Through workshops, technical meetings, and joint analytical exercises, country teams were able to validate findings, interpret results within programmatic contexts, and generate actionable recommendations for improving immunization coverage. The collaborative model also facilitated shared learning across countries facing similar challenges and enabled cross-country analyses that highlight regional patterns in immunization performance and equity.

Conclusion

This multi-country analysis demonstrates the growing potential of routine health information system (RHIS) data to support monitoring of immunization coverage and equity across sub-Saharan Africa. When systematically assessed and standardized, routine administrative data can provide timely and geographically detailed insights into program performance, complementing periodic household surveys that are often conducted at long intervals. The findings highlight both the strengths and limitations of RHIS data: while reporting completeness and overall data quality remain relatively strong in many countries, important challenges persist, including inconsistencies in data completeness, disparities in coverage across countries and subnational areas, and gaps in vaccination completion reflected by dropout between doses.

The analysis also reveals that regional immunization coverage has remained largely stable over the past five years, with median coverage for key vaccines approaching but often not consistently reaching global targets. While access to first-dose vaccines remains relatively strong in many settings, persistent gaps in completion of vaccination schedules and the continued presence of zero-dose children indicate that significant barriers to equitable immunization coverage remain. Subnational analyses further demonstrate that national averages frequently mask substantial geographic inequalities, underscoring the importance of more granular monitoring to identify underserved populations and target program interventions effectively.

The experience of implementing the Countdown to 2030 (CD2030) analytical framework illustrates the value of harmonized methodologies, collaborative learning, and digital analytical tools in strengthening the use of routine data. Innovations such as the CD2030 Data Suite zero-coding analytical platform and the automated DHIS2 data extraction module have reduced technical barriers for country analysts, improved data standardization, and enabled more efficient multi-country analyses. These tools, combined with sustained technical collaboration and capacity building, support greater country ownership of data analysis and interpretation.

Strengthening RHIS data systems and analytical capacity will be essential for accelerating progress toward global immunization goals, including those outlined in Immunization Agenda 2030. Continued investments in data quality improvement, standardized analytical approaches, and country-led data use will help ensure that routine data systems can play an increasingly central role in monitoring immunization programs, identifying underserved populations, and guiding evidence-based strategies to improve coverage and equity.

Annex

Country Profiles

We accompany this report with countries' output pro iles that were generated using the R Shiny app. Access them **here**.

Parameters Used for Denominator Analysis

Country	Stillbirth Rate	Neonatal Mortality Rate	Post-neonatal Mortality Rate	Penta1	Anc-1
Uganda	0.150	0.022	0.014	0.99	0.96
Nigeria	0.043	0.033	0.037	0.69	0.70
Tanzania	0.018	0.024	0.009	0.89	0.95
Zambia	0.012	0.027	0.014	0.96	0.97
Somali	0.028	0.036	0.040	0.31	0.21
Chad	0.024	0.024	0.034	0.90	0.90
Sierra Leone	0.023	0.030	0.045	0.98	0.95
Madagascar	0.010	0.026	0.047	0.67	0.81
Rwanda	0.013	0.018	0.013	0.99	1.00
Mauritania	0.032	0.022	0.010	0.88	0.88
Senegal	0.015	0.030	0.008	0.97	0.90
Niger	0.020	0.029	0.043	0.81	0.81
DRC	0.027	0.030	0.035	0.82	0.81
Cameroon	0.019	0.026	0.021	0.83	0.87
Kenya	0.021	0.016	0.011	0.97	0.97
Ethiopia	0.020	0.027	0.019	0.74	0.74
CIV	0.020	0.030	0.020	0.70	0.95
CAR	0.026	0.042	0.055	0.54	0.52
Burkina Faso	0.010	0.018	0.012	0.98	0.95
Liberia	0.020	0.240	0.320	0.98	0.91
Mozambique	0.017	0.024	0.049	0.87	0.76
Guinea	0.020	0.032	0.034	0.62	0.81
Zimbabwe	0.019	0.029	0.022	0.94	0.93
Ghana	0.021	0.017	0.011	0.97	0.98
Mali	0.023	0.032	0.029	0.80	0.82
Malawi	0.020	0.024	0.022	0.97	0.95