

Strengthening the Identification and Enumeration of Pregnant Women, Under-five Children and Adolescent Girls to Improve Immunisation, Maternal Health and Other PHC Services: Lessons from Sokoto State, Nigeria

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Abstract

Background

Gaps in household enumeration, weak microplanning, and sociocultural barriers contribute to poor immunisation outcomes and inequity in Nigeria. Accurate identification of children under five years, adolescent girls and pregnant women is essential for planning maternal health services and routine immunisation. Between April and July 2025, the Identify, Enumerate and Vaccinate (IEV) exercise was implemented across all 23 Local Government Areas of Sokoto State to establish a digital register of eligible populations. This study examined the implementation processes, operational challenges and perceived use of the IEV-generated line list across eight purposively selected LGAs.

Methods

A qualitative descriptive design was employed, complemented by descriptive operational outputs from the IEV exercise. Eight (8) LGAs were selected to capture diverse operational contexts. Data were collected through key informant interviews, focus group discussions, and direct observations, triangulated with settlement and household counts from statewide enumeration. Reflexive thematic analysis, guided by implementation science frameworks, identified barriers, enablers, and lessons learned.

Results

Findings revealed operational heterogeneity across LGAs: Tambuwal and Wurno recorded the highest proportions of unreached settlements, while Bodinga and Rabah exhibited integrity issues with the line list. Strong associations between locations with as well as the absolute numbers of zero-dose and partially immunised children in the registers confirmed identification and enumeration gaps as an important contributor to poor immunisation outcomes. Antenatal Care (ANC) coverage exceeded 50% in most LGAs, and HPV coverage among girls aged 9–14 was low (median < 30%). Qualitative data highlighted the critical roles of LGA health authorities, traditional and religious leaders, mid-managers who conduct supportive supervision, and offline-first digital tools in improving immunisation outcomes. Key challenges included network failures, security constraints, and compressed timelines.

Conclusion

In Sokoto's complex sociocultural and geographic context, IEV proved feasible and equity-oriented, strengthening population identification for microplanning for RI and ANC services. Enumeration gaps are both technical and social, requiring culturally adapted strategies and reliable digital infrastructure. Future implementation should extend timelines, institutionalise offline digital systems, embed subnational leadership, and link enumeration line lists to supply readiness in Logistics Management Information Systems and Vaccine Direct Delivery platforms.

1. Introduction

Improving immunisation coverage and reducing maternal mortality in Nigeria requires ensuring that all eligible children and pregnant women are accurately identified, tracked, and provided with the services they need [1–3]. Immunisation remains one of the most effective and cost-efficient public health interventions globally, with the capacity to prevent vaccine-preventable diseases and strengthen population health [4]. Nigeria has made notable progress through campaigns, routine immunisation strengthening, and surveillance, yet persistent inequities remain, particularly in northern states, where large numbers of children remain unvaccinated or under-vaccinated [5].

Accurate enumeration of eligible populations, children under five, pregnant women, and adolescent girls, forms the backbone of microplanning for both vaccination campaigns and routine immunisation [6]. Without reliable household lists, health workers struggle to allocate resources, identify service delivery points, and monitor performance, leaving many households unreached [6]. These gaps are particularly pronounced in Sokoto State, where population mobility, dispersed settlements, and limited health infrastructure complicate the enumeration process [7].

Reviews of programs implemented in Sokoto State have consistently highlighted enumeration and household listing as critical challenges [8–11]. For example, the USAID/TSHIP Routine Immunisation Review in Bauchi and Sokoto States reported persistent under-counting of eligible children due to incomplete settlement lists, weak microplanning, and limited community participation in enumeration [11]. Similarly, the 2018 Lot Quality Assurance Survey (LQAS) in Sokoto State found that only about half of children were fully immunised, attributing missed opportunities partly to poor identification of target households [10]. Qualitative assessments conducted in 2017 further revealed that cultural barriers, mistrust, and inadequate engagement of community leaders undermined household listing and tracking of caregivers [9]. These findings demonstrate that enumeration gaps are not merely technical but also social, requiring both better tools and stronger community engagement. Nonetheless, targeted initiatives demonstrate that progress is possible; during the 2022 Vaccine Direct Delivery program, over 800,000 children in Sokoto State were vaccinated, and vaccines were delivered to more than 350 health facilities to improve timeliness and reduce stockouts, leading to an estimated 18% increase in uptake within six months [8].

Similarly, state investments expanded routine immunisation service points from about 205 in 2014 to over 560 by 2018, with reported coverage rising from 3% to nearly 59% in some quarters [12]. Despite these gains, large inequities remain. A 2024 catch-up campaign revealed that nearly two-thirds of children vaccinated in targeted LGAs had never received any vaccine, while surveys in rural communities in Sokoto State found that only 7% of children were fully immunised and almost one in five had received none, particularly among families where mothers lacked formal education [13]. More recent estimates from the Zero-Dose Learning Hub identified more than 120,000 zero-dose children across 13 Local Government Areas (LGAs), underscoring the scale of unmet need [14][15]. These experiences underscore both the need for innovative enumeration approaches and the potential of combining

community engagement with digital tools to close persistent gaps. At the national level, the National Primary Health Care Development Agency (NPHCDA) and its partners have recognised these systemic challenges and are aligning with the Sustainable Development Goals (SDGs) digitisation agenda to strengthen population registers for health service delivery. Lessons from other African countries reinforce this direction [16–19].

Sokoto State represents a critical opportunity to demonstrate innovative solutions for persistent enumeration challenges. Implementing a digital line list adapted to local sociocultural contexts and informed by global best practices offers a practical pathway to close identification gaps and accelerate progress toward universal immunisation coverage. This study aimed to evaluate the implementation of the Identify, Enumerate and Verify (IEV) strategy in Sokoto State by documenting the enumeration process, exploring operational enablers and barriers across selected LGAs, and assessing the contribution of the digital line list to improved microplanning for routine immunisation and antenatal care services.

2. Intervention Processes

The intervention, which was implemented between April and July 2025 across all 23 local government areas in Sokoto State, had an estimated population of 3.7 million people [20]. It aimed to generate a comprehensive digital register of all children under five years of age, adolescent girls aged 9–14, and all pregnant women to support future planning and monitoring of maternal and child health services.

2.1 Intervention Strategy

A digital line list was developed to be continuously updated, serving as the foundation for planning and service delivery to the target populations. The intervention was structured into five stages.

1. Stakeholder Engagement and Participation

Stakeholder engagement was conducted at multiple levels to ensure coordination and ownership of the intervention. At the national and state levels, health authorities and partners provided oversight, technical guidance, and resource mobilisation. At the local government level, health teams coordinated implementation and supervised field activities. Community structures, including traditional and religious leaders, supported social mobilisation, facilitated access to households, and addressed non-compliance. At the ward and settlement levels, supervisors, community volunteers, and enumerators implemented the daily field activities and provided feedback for continuous quality improvement.

2. Microplanning and Resource Mobilisation

Settlement validation was carried out at the ward level using a structured four-step process (Fig. 1). Tools and templates were prepared, and ward-level meetings with key stakeholders were convened to

review and harmonise settlement lists. Each settlement was verified for habitation status, population characteristics, and terrain, after which the lists were finalised and shared with local authorities and partners. This process generated a comprehensive and harmonised list of settlements with the essential data points required for microplanning.

3. Recruitment and Engagement of Personnel

For the exercise, three categories of personnel were engaged: local guides, data clerks, and ward supervisors. Local guides facilitated community entry and household identification; data clerks managed data entry, collation, and cleaning; while ward supervisors oversaw field teams, validated data, and ensured protocol adherence. Selection was based on local knowledge, technical skills, and supervisory experience, with personnel drawn from community structures, health facilities, and LGA teams. Training sessions covered technical skills in digital data entry, use of standardised data tools, household engagement, and approaches to address concerns or misconceptions raised during enumeration.

4. Identification and enumeration

Enumeration teams conducted settlement walk-throughs and line-listed all eligible household members. Supervisors monitored implementation, while daily review meetings ensured consistency and accuracy of the data collected.

5. Monitoring and Evaluation Plan

Data from the household enumeration exercise was used to develop daily implementation plans, following a revalidation process that confirmed physical walk-throughs had been conducted and improved confidence in the revised microplans. To ensure reliability, external senior supervisors further reviewed the enumeration of data and catchment area maps, using Geographical Information System (GIS) maps for validation.

2.2 The Enumeration Process

The enumeration exercise included all children under five years of age, pregnant women (including pregnant adolescents), and primary respondents such as heads of households (male or female), caregivers, guardians, and emancipated minors who could provide reliable information and other aged female that are present in the household. Individuals were excluded if they were temporary residents or visitors, minors not recognised as emancipated, non-household members, or persons who were mentally incapacitated and unable to provide informed responses (Fig. 1).

3. Methodology for Implementation Evaluation

3.1 Study Setting

This study purposively selected eight focal LGAs, Bodinga, Dange Shuni, Rabah, Sokoto South, Tambuwal, Tureta, Wurno, and Yabo within Sokoto State to capture a spectrum of operational realities. These LGAs were chosen for their representation of diverse geographic and sociocultural contexts, including accessible rural communities, hard-to-reach settlements, and semi-nomadic populations. This diversity provided an ideal platform to assess enumeration challenges and stakeholder experiences in a typical northern Nigerian setting. The selected LGAs are predominantly rural, characterised by dispersed settlements and limited infrastructure, which complicate health service delivery. The population is largely Hausa and Fulani with deeply rooted traditional and religious leadership structures that exert significant influence on community mobilisation and health-seeking behaviours. These sociocultural dynamics shape acceptance of health interventions, making community engagement a critical determinant of success. Additionally, seasonal factors such as flooding and mobility patterns among pastoralist groups further underscore the need for adaptive microplanning strategies tailored to local realities.

3.2 Study Design

This study was a qualitative descriptive implementation evaluation supported by descriptive operational data. The qualitative component examined stakeholder experiences, implementation processes and contextual influences across eight purposively selected Local Government Areas. Operational data were used to describe the scale of the enumeration exercise, variations in programme outputs and operational exceptions across the focal LGAs. The operational data were not used to estimate causal effects or changes attributable to the intervention.

3.3 Sample Size

A total of 18 KIIs were conducted with operational stakeholders directly involved in implementing the April–July 2025 IEV strategy. Participants were purposively selected based on their active engagement in planning, supervising, or executing the campaign. The sample included 8 LGA Consultants, 8 LGA Immunisation Officers (LIOs), and 2 state-level officials: the Director of Disease Control and Immunisation (DDCI) and the State Immunisation Officer (SIO). To complement and validate insights from the KIIs, two (2) Focus Group Discussions (FGDs) were conducted, one with LGA Consultants and another with LIOs. These FGDs enabled collective reflection on operational experiences across implementation variations, teamwork dynamics, and shared bottlenecks that individual interviews might not fully capture.

The operational dataset for the eight focal LGAs includes 3,547 settlements and 192,732 households, with 111 unreachable and 64 misplaced settlements recorded as operational exceptions (from Table 1). It was specified that these are descriptive operational outputs generated during the statewide April–July 2025 IEV line listing and used for triangulation with qualitative findings.

3.4 Sampling rationale and FGD composition

Participants were selected based on their direct involvement in planning, supervising or implementing the IEV exercise. The sampling strategy aimed to achieve role-based and geographic representation across the eight focal LGAs rather than statistical representativeness. Eighteen key informant interviews were conducted with eight LGA consultants, eight LGA Immunisation Officers and two state-level officials: the Director of Disease Control and Immunisation and the State Immunisation Officer.

Two focus group discussions were also conducted. One included LGA consultants, while the second included LGA Immunisation Officers. Eligible participants were identified from the official IEV implementation team lists and invited based on the specific roles they performed during the exercise.

Data collection concluded after the predefined stakeholder categories and all eight focal LGAs had been represented. The stopping criterion was therefore completion of the planned role-based sample rather than statistical representativeness.

3.5 Data Collection Procedures

Operational data was collected electronically using mobile devices preloaded with the digital line list tool. Field teams visited all settlements, households, and eligible individuals in the selected areas. Supervisors validated the completeness of the records daily, and inconsistencies were corrected through re-visits and cross-checking with community participants. The verified settlement and household data were compiled into a digital register, which serves as a harmonised record of all under-five children, adolescents and pregnant women in Sokoto State. The register was designed for use in future planning and delivery of maternal and child health services. Two FGDs were also conducted, one with LGA Consultants and another with LIOs to capture collective experiences and operational insights. FGDs were moderated by trained facilitators using a discussion guide and lasted about 60 minutes.

Both the semi-structured key informant interview (KII) guide and the focus group discussion (FGD) guide were developed specifically for this implementation evaluation by the study team and have not been published previously. The guides were informed by the study objectives and covered participants' roles in the IEV exercise, stakeholder and community engagement, team selection and training, use of digital tools, supervision and real-time monitoring, operational reach and access, the perceived utility of the digital line list, implementation challenges, and recommendations for future implementation. English-language versions of both guides are provided in Supplementary File 1.

4. Data Management and Analysis

All data generated through KIIs, FGDs, field observations, and operational enumeration records were managed and analysed following the Consolidated Criteria for Reporting Qualitative Research (COREQ) aligned qualitative reporting principles. Audio recordings from interviews were transcribed verbatim, checked for accuracy, anonymised, and stored securely on encrypted, access-restricted servers. Observation notes and operational datasets (settlements, households, U5, pregnant women, and adolescent girls) were similarly de-identified before use.

Qualitative data were analysed using a reflexive thematic analysis approach. Two independent analysts reviewed transcripts line-by-line and collaboratively developed an initial codebook combining deductive codes (based on study objectives such as supervision, digital tools, community engagement, and operational barriers) and inductive codes emerging from the data. NVivo 12 software was used to support transcript management, coding, and categorisation. Coding discrepancies were resolved through discussion until consensus was achieved. Themes were refined through iterative comparison across respondent groups (LGA Consultants, LIOs, and state-level officials).

Operational data generated from the IEV exercise, including settlement counts, household enumeration totals, and demographic distributions, were analysed. These descriptive summaries helped characterise microplanning fidelity, coverage variations, and enumeration exceptions (unreached and misplaced settlements) across the 8 focal LGAs. Stata outputs were used solely for descriptive analysis and not for inferential statistics, consistent with the qualitative descriptive design.

Qualitative themes were triangulated with operational enumeration outputs to enhance analytic credibility and provide a comprehensive understanding of implementation fidelity, contextual enablers and barriers, and operational realities shaping the effectiveness of the IEV strategy in Sokoto State. This multi-source triangulation strengthened the robustness and interpretive depth of the findings.

4.1 Data quality assurance

Operational data quality was maintained through independent monitoring, daily data reviews and supportive supervision throughout the IEV implementation. Independent monitors observed enumerators to verify adherence to the campaign methodology and data-collection procedures. Daily reviews assessed completeness, consistency, accuracy, timeliness, GPS coordinates and duplicate submissions, with identified issues communicated promptly for correction. State- and LGA-level supervisors also provided on-the-job mentoring and immediate feedback to field teams.

Qualitative rigour was strengthened through standardised interview and focus group guides, audio recording, verbatim transcription, accuracy checks and de-identification. Data from different respondent groups and operational records were triangulated, while two analysts used a documented codebook and discussed differences in coding and interpretation. Credibility, dependability, confirmability, transferability and reflexivity were further supported by retaining divergent accounts, distinguishing participants' perceptions from operational findings, documenting the study context and using representative quotations to demonstrate how themes were derived from the data.

5. Result

5.1 Settlement and households

Across the eight focal LGAs, settlement counts ranged from 251 (Tureta) to 585 (Bodinga), while household counts ranged from 13,255 (Tureta) to 41,342 (Sokoto South) as indicated in Table 1.

Table 1
Settlements, households, and operational exceptions in the eight focal LGAs
(IEV line listing)

LGA	Settlements	Households	Unreached	Misplaced
Bodinga	585	28,756	18	17
Dange Shuni	568	25,704	18	4
Rabah	326	20,873	6	17
Sokoto South	434	41,342	2	3
Tambuwal	578	23,823	25	4
Tureta	251	13,255	3	10
Wurno	399	17,363	34	6
Yabo	406	21,616	5	3

5.2 Enumeration of eligible populations

The IEV generated a harmonised register of under-five children, pregnant women, and adolescent girls (9–14 years). Enumeration output varied by LGA, reflecting population density and settlement size, as shown in Fig. 2.

5.3 Immunisation indicators

Analysis of routine immunisation line-list indicators across the eight LGAs (Table 2) showed variation in: Proportion of under-five children not vaccinated (NV%), Routine immunisation zero-dose counts and NV% ranged from 46.8% (Tureta) to 74.0% (Tambuwal). Several LGAs demonstrated close alignment between zero-dose counts and NV%.

Table 2

Routine immunisation status among enumerated under-five children in the eight focal LGAs (IEV digital register)

LGA	U5 total	Fully Vaccinated	Partial (Not RI ZD)	Partial (RI ZD)	Not Vaccinated	Total RI ZD	RI-ZD Rate %
Bodinga	35609	1035	3024	6887	24148	30294	67.8%
Dange Shuni	36038	794	2040	9423	23458	32278	65.1%
Rabah	31591	630	3714	10396	16404	26485	51.9%
Sokoto South	29216	4491	5112	4133	13858	17714	47.4%
Tambuwal	41782	397	2078	8233	30918	37674	74.0%
Tureta	25926	1170	3830	7976	12127	19742	46.8%
Wurno	30662	375	1414	8836	19967	27731	65.1%
Yabo	26731	513	2905	3679	19315	22598	72.3%

5.4 Human Papillomavirus Vaccination and Antenatal Care Service Indicators

Across Sokoto State, HPV vaccination coverage for adolescent girls was generally low, with wide variation between LGAs. Most LGAs recorded coverage below 30%, with Shagari notably higher. ANC coverage among pregnant women was comparatively higher across most LGAs, with several LGAs recording coverage above 70%. As shown in Table 3, ANC coverage exceeded 50% in most focal LGAs, whereas HPV vaccination coverage for girls aged 9–14 years remained below 30% in the majority of LGAs

Table 3

Antenatal care (ANC) attendance among enumerated pregnant women and HPV vaccination coverage among girls aged 9–14 years across the eight focal LGAs (IEV digital register)

LGA	Pregnant Women	ANC Attendees	Girls 9–14	HPV Vaccinated	ANC Coverage %	HPV Coverage %
Bodinga	5856	3432	18806	8245	58.6%	19.3%
Dange Shuni	4545	2169	10892	4426	47.7%	14.1%
Rabah	6991	4506	17852	10127	64.5%	26.4%
Sokoto South	3041	2045	14517	4222	67.2%	17.2%
Tambuwal	6774	3803	17341	6424	56.1%	18.0%
Tureta	5448	3591	9656	6848	65.9%	27.6%
Wurno	4185	2357	13240	6770	56.3%	15.1%
Yabo	3653	2315	8014	3659	63.4%	16.2%

5.5 Qualitative findings

The qualitative evaluation explored the experiences of LGA consultants, immunisation officers, and state-level supervisors involved in the IEV campaign. Participants described broad experience in routine immunisation and microplanning, often spanning multiple years and wards. Analysis identified several key findings.

5.5.1. Community Mobilisation and Engagement

The participants emphasised community engagement as a critical facilitator of enumeration success. Participants consistently highlighted the decisive role of traditional leaders, religious figures, and district heads in mobilising households and reducing resistance.

Community mobilisation emerged as a foundational enabler of the IEV implementation across the LGAs. Participants consistently described Community mobilization and engagement with traditional leaders, religious authorities, and district heads as decisive for securing household access, minimising resistance, and legitimising the enumeration process within communities. Rather than functioning as passive endorsers, these actors acted as *implementation gatekeepers*, translating the purpose of the IEV exercise into locally meaningful narratives tied to health service benefits. Several respondents emphasised that early and visible leadership endorsement created an enabling environment for household participation. One immunisation officer noted that community authority structures were instrumental in resolving hesitation and ensuring compliance:

Community leaders (traditional, religious, district heads) were decisive in mobilising households and resolving resistance to the IEV exercise” (FGD LGA Immunisation Officer, Participant -01)

Similarly, frontline health workers highlighted that trust in leaders extended to trust in the intervention itself:

Community leaders were essential in spreading the word about the IEV exercise. Without their support, it would have been much harder to get the community on board.” (KII LGA consultant, Participant-04)

Religious leaders were repeatedly cited as key intermediaries who refrained from enumerating away from fears of taxation or surveillance and toward tangible health benefits. Their explanations were particularly influential in reassuring caregivers:

Religious leaders explained that the list will help us plan vaccinations and ANC days, which made people more comfortable.” (KII LGA consultant, Participant – 07)

Religious leaders also reinforced trust by explaining the purpose of the line list.

Community leaders were instrumental in informing the public. Their involvement was key in reducing resistance and increasing participation in enumeration. (FGD LGA consultant, Participant – 05)

Participants also described how community sensitisation was operationalised through routine religious and social platforms. Announcements after Friday prayers and district-level meetings provided both reach and legitimacy:

The district head called a meeting; after Friday prayers, they announced dates and told people to support the enumerators. (FGD LGA Immunisation Officer, Participant – 02)

Collectively, these findings demonstrate that community engagement functioned as implementation infrastructure rather than an auxiliary activity. Anchoring the IEV exercise within trusted leadership structures, implementers were able to reduce resistance, facilitate household entry, and promote sustained cooperation throughout the enumeration period.

5.5.2 Team selection and accountability

Participants described the composition of enumeration teams as largely community-driven, with enumerators and local guides selected from within the communities they served. This approach was widely perceived to enhance trust, improve performance, and strengthen adherence to protocols. The presence of individuals who were socially recognised within the community increased acceptance and reduced suspicion toward data collection activities.

One respondent summarised the combined effect of local team selection and strengthened supervision:

Community-driven selection of enumerators/local guides increased trust and performance; independent and LGA supervisors improved accountability in the field. (KII LGA Immunisation Officer, Participant-05)

Others emphasised that this approach improved technical competence and data quality by prioritising ability and familiarity with local contexts:

The community-driven team selection was a major improvement. It ensured that only competent individuals were selected to perform the enumeration. (KII LGA Immunisation Officer, Participant-03)

Independent supervisors strengthened accountability through daily oversight and data verification.

The value of this process was reinforced in FGDs, where participants linked careful selection directly to better implementation outcomes:

The community-driven selection process ensured that only competent and trusted individuals were selected for enumeration, which improved the quality of the work. (FGD LGA Consultant, Participant-05)

Independent supervisors and LGA-level oversight introduced an additional accountability layer, enabling daily verification of activities and rapid correction of errors. Together, locally grounded team selection and multi-tier supervision created a structure that supported implementation fidelity while maintaining community trust.

5.5.3 Training and digital tools

Training was broadly described as well-structured and comprehensive, equipping teams with an initial understanding of IEV procedures and digital tools. However, participants consistently highlighted a gap between classroom training and effective field application, particularly in relation to the use of digital data-collection platforms.

Several respondents stressed that while training content was adequate, enumerators required additional hands-on experience once deployed:

The training was thorough, but some enumerators had difficulty using digital tools. This was a challenge at first, but we resolved it through continuous support."(KII LGA Consultant, Participant-04)

This statement highlights the way digital readiness evolved during implementation rather than being fully achieved at the training stage. It shows that technical difficulties were not simply a matter of inadequate training content but were part of a broader process of adapting to new tools under real operational pressures. Continuous support rather than one-off instruction was what ultimately enabled teams to progress.

The FGD participants reinforced this interpretation; they described how challenges with device synchronisation emerged primarily in the field, especially in areas with poor connectivity. This contextual dimension is reflected in another respondent's account.

Training was essential, but some enumerators faced difficulties using digital tools, which caused delays in data synchronisation. (KII LGA Consultant, Participant-03)

However, the explanation brings attention to the operational environment; even well-trained personnel may struggle with the technological systems interacting with fragile network infrastructure. Synchronisation delays were not merely a skill problem; they were tied to the realities of rural Sokoto, where connectivity can be inconsistent or absent. This reinforces the need for digital tools that are more tolerant of low connectivity settings and for supervisors to provide ongoing on-site troubleshooting.

Also, a participant deepened this theme by noting that offline use, intended to solve connectivity issues, became an additional challenge. Some enumerators were unsure how to manage unsent forms, handle error messages, or initiate manual synchronisation.

Training was positively received, but some enumerators struggled with the electronic tools, synchronisation, and offline use, all of which caused delays. (KII SIOI, Participant-02)

This demonstrates that the challenges were not limited to synchronisation alone; they extended to the broader functionality of the CommCare application. It underscores that digital literacy varies across field teams, and that “offline first” solutions may require deeper explanation and practical demonstration than was provided within the training timeframe.

Taken together, these Findings illustrate a coherent narrative, training equipped teams with basic knowledge, but effective digital tool use required continuous reinforcement, real-time mentoring, and problem-solving in context. This pattern is widely documented in digital-health implementations in low-resource settings, where adaptation to technology is an iterative process rather than an outcome of a single training event. In the Sokoto IEV campaign, this meant that supervisors’ ability to provide daily support and teams’ opportunities to learn by doing were just as critical as the initial instructional sessions.

5.5.4 Supervision and real-time monitoring

Enhanced supervision and near-real-time monitoring were widely regarded as major improvements over previous enumeration or campaign experiences. Participants described supervision as enabling both quality assurance and operational problem-solving.

One experienced supervisor noted a shift toward more systematic validation practices.

I have supervised ward teams for several years; the IEV exercise was the first time we systematically verified settlements before assigning routes. (KII DDCI, Participant-01)

Dedicated LGA supervision and near-real-time monitoring enabled timely troubleshooting and kept operations on track.

Independent supervisors were critical to the success of the IEV exercise. They ensured that any issues were resolved immediately, which kept the process on track. (KII LGA Consultant, Participant-03)

Moreover, Real-time monitoring tools facilitated timely correction of errors and daily performance review.

Independent supervisors were key in maintaining accountability. They tracked the teams' progress in real time and ensured that everything was on track (KII LGA Immunisation, Participant-04)

5.5.5 Reach and operational access

Most respondents described high settlement coverage during the initial sweep, supported by the presence of local guides and structured community entry. However, coverage was not uniform, and implementation reach was systematically constrained by three interacting barriers: insecurity, flood-prone terrain, and connectivity limitations, which together reduced the feasibility of reaching the most remote hamlets within the available timeline.

Participants highlighted that insecurity created “no-go” spaces where enumeration teams could not safely operate, necessitating mop-up scheduling and, in some cases, leaving residual gaps:

We managed to cover most areas, but some hard-to-reach settlements were missed due to security concerns. Mop-up rounds were scheduled to address this.” (KII LGA Immunisation, Participant-03)

Within accessible areas, local guides were described as operational enablers who improved navigation and household entry, supporting a narrative of intensive coverage efforts. Another participant stated that:

Local guides took us settlement by settlement; we knocked on every door. (KII LGA Consultant, Participant-01)

Beyond access, respondents emphasised that community entry protocols were important for cooperation and sustaining trust, particularly in settings where outsiders are treated with suspicion. Formal introductions and authorisation were described as essential elements of field etiquette and legitimacy:

They introduced themselves, showed authorisation, and explained they were compiling a list to plan services. (FGD LGA Consultant, Participant-02)

Nevertheless, physical terrain, especially flooding, created practical barriers that mop-ups did not always overcome. Respondents stressed that certain settlements remained partially enumerated despite attempts to revisit:

In remote settlements, the paths were flooded; we planned mop-ups, but some houses remained. (KII DDCI, Participant-01)

As noted by some participants, mop-up activities were required but not always sufficient to reach all missed settlements, as stated by the participants.

Mop-up rounds helped, but security and network problems meant we couldn't reach every household on time. Some areas were just too difficult to access.” (FGD LGA Consultant, Participant-04)

These accounts suggest that “coverage” is best understood as a function of feasibility rather than effort alone. Importantly, the settlements most likely to be missed were those facing layered vulnerability (insecurity + terrain + poor connectivity), which raises equity concerns because these contexts often overlap with weak service access and a higher risk of missed children.

5.5.6. Perceived value of the line list

Participants strongly endorsed the updated digital line list as a high-utility planning instrument, emphasising its value for reducing missed children, improving microplanning precision, and strengthening integration across routine immunisation, ANC, and HPV delivery platforms. The line list was repeatedly described as shifting microplanning from approximation to evidence-based scheduling, enabling teams to plan sessions with clearer denominators and better anticipate demand.

One respondent articulated the line list’s operational value as improving microplans and reducing missed children in subsequent rounds. A participant stated that

The updated line list (eligible children and pregnant women) streamlined subsequent vaccination microplans and reduced missed children in later rounds. (FGD LGA Immunisation Officer, Participant-04)

Participants also noted improved linkage of RI sessions with ANC and school-based HPV mobilisation.

Similarly, participants emphasised that having updated household-level denominators made planning more actionable and reduced uncertainty.

Several accounts linked improved planning to perceived reductions in missed children, implying a mechanism through which better denominators translate into more complete outreach and follow-up:

Having an updated line list made it much easier to plan for vaccinations. We saw a noticeable reduction in missed children during the next campaign. (FGD LGA Consultant, Participant-05)

The data we collected made it much easier to plan for vaccinations, and the number of missed children was significantly reduced. (KII LGA Consultant, Participant-05)

Participants emphasised that the updated digital line list significantly improved the accuracy of microplanning across the focal LGAs. With clearer household-level information on eligible populations, teams were better able to allocate resources, plan session days, and anticipate demand for routine immunisation and maternal health services.

As one participant explained,

Now we know how many children under five and pregnant women live here; planning is easier. (FGD LGA Consultant, Participant-03).

The improved accuracy also strengthened coordination with schools during HPV vaccination activities. Respondents noted that once the number of eligible girls and their locations were clearly documented, it

became easier to schedule and communicate HPV vaccination days. This clarity improved attendance and reduced missed opportunities.

Schools helped HPV girls attend when the dates were clear. (FGD LGA Consultant, Participant-01)

Pairing RI with ANC days made mothers more likely to come. (FGD LGA Consultant, Participant-02)

The line list generated value when it was translated into decisions and schedules, not merely stored. The accounts imply that the register improved microplanning accuracy, strengthened integration (RI-ANC-HPV), and supported practical coordination across community structures, facilities, and schools, suggesting a pathway from enumeration to service delivery reliability.

5.5.7 Challenges encountered

Key challenges reported by participants included network failures, security risks, time pressure in large or hard-to-reach wards, and difficulties synchronising digital forms. These issues were further compounded in remote settlements, where poor connectivity and limited device familiarity slowed data submission. Some respondents also noted occasional political interference in personnel selection, which affected team efficiency in a few locations.

The network issues delayed our progress, and the time allocated for the exercise was not enough to cover all households. (Participant 5 FGD, health worker)

Also, some participants highlighted that some LGAs have Security-restricted settlements.

We faced significant technical challenges with the app, and some areas were inaccessible due to security concerns. (KII LGA Immunisation Officer, Participant-03)

After two cancelled sessions, they stopped trusting us. (FGD LGA Consultant, Participant-04)

Some enumerators struggled with syncing; offline forms helped. (FGD LGA Immunisation Officer, Participant-07).

We had training, but more practice on the device would help. (FGD LGA Consultant, Participant-02).

5.5.8 Recommendations

Participants provided actionable suggestions to strengthen future enumeration exercises and immunisation microplanning in Sokoto State. These recommendations reflect operational realities and lessons learned during the IEV campaign. Participants consistently emphasised the need for a longer field time to ensure complete coverage, particularly in remote areas.

As one health worker noted,

Next time, we need more time to carry out the enumeration properly, especially in remote areas where network issues are common (KII LGA Consultant, Participant-03) Another added, *Extend enumeration*

timelines, strengthen refresher on-the-job digital support, ensure tools function fully offline, and engage traditional/community leaders earlier and throughout to sustain accountability (FGD LGA Consultant, Participant-05)

Connectivity challenges delay data synchronisation, underscoring the need for robust offline-first systems. Implementers recommended pre-testing devices and maintaining offline backups.

Next time, we should ensure more time for the enumeration, especially in remote areas, and improve our data collection tools so that they can work offline" (FGD LGA Immunisation Officer, Participant-05)

While initial training was helpful, participants called for refresher sessions and practical troubleshooting.

Train enumerators again on devices; have offline backups (FGD LGA Consultant, Participant-02)

Continuous digital support during fieldwork was viewed as essential for addressing synchronisation issues and improving confidence in device use.

Early and sustained involvement of traditional and religious leaders was highlighted as critical for mobilisation and trust-building. One participant advised that the date should be announced in mosques and schools. Others suggested providing small convenience support for families in distant settlements to encourage participation.

Geographic and security barriers limited coverage in some settlements. Implementers recommended verifying routes with local guides and using maps for planning.

Verify settlements with maps and local guides before planning routes (FGD LGA Consultant, Participant-01).

Pre-positioning transport resources and adapting wet-season route cards were also suggested to overcome terrain challenges.

6. Discussion

This study has demonstrated that the IEV strategy strengthened population enumeration and microplanning across diverse contexts in Sokoto State. Variation in settlements and household counts shaped the operational complexity, with high-density LGAs that required larger teams and stronger supervision for coverage, and riverine or flood-prone LGAs that needed adapted wet-season routes and equipment. Likewise, urban LGAs also require block-based listing and institutional outreach due to transient populations. There was a high number of unreachable settlements in Wurno and Tambuwal, highlighting persistent access challenges in these LGAs. In contrast, the large number of misplaced settlements in Bodinga and Rabah pointed to settlement list integrity problems that required harmonisation and verification using GIS tools. The observed alignment between RI zero-dose and NV proportions suggests that zero-dose children remain the dominant component of the non-vaccinated burden, reinforcing the value of IEV methods for locating and revisiting missed households.

Programmatically, LGAs with significant hard-to-reach settlement barriers require longer enumeration timelines and paired field teams to ensure adequate coverage. Conversely, high-performing LGAs such as Sokoto South and Tureta can serve as peer learning sites, providing practical examples of effective coordination and field implementation.

HPV vaccination coverage showed wide inequities, with most LGAs that show below 30% contrasting with relatively higher ANC coverage. Shagari LGA has consistently outperformed other LGAs for both indicators, while low-coverage LGAs for HPV likely reflect school attendance gaps, consent challenges, or logistical constraints. Moreover, persistent ANC variation was found across LGAs that mirror known service access determinants, including geography, staffing, and sociocultural norms [21]. Together, these patterns underscore the need for targeted adolescent-focused outreach and sustained maternal-health investment.

Community engagement emerged as a critical enabler as the traditional and religious leaders facilitated acceptance, entry, and mobilisation that aligned with Nigerian evidence showing leadership and engagement improve RI uptake [22] and broader literature on culturally adapted strategies in northern Nigeria [23–26]. Their involvement functioned as a mobilisation infrastructure for the campaign.

In addition, the participants indicated that microplanning effectiveness improved through updated line lists (enumerated), which reduced missed children and improved RI session and planning that aligned with consistent findings from Kaduna State and other Nigerian settings [27, 28], this aligns with Reaching Every District/Reaching Every Community (RED/REC) principles and Gavi's emphasis on microplanning as an equity tool, particularly when combined with GIS and community participation [23, 29–32].

Supervision quality, enabled by state supervisors and LGA supervisors, aligns with Consolidated Framework for Implementation Research constructs on feedback loops, communication, and champion engagement. Real-time monitoring through Open Data Kit improved accountability and rapid issue resolution, consistent with implementation-science recommendations for IA2030 immunisation systems strengthening [33–37].

Despite comprehensive training, digital tool challenges persisted, as stated in, especially around offline use and synchronisation issues, as widely documented in CommCare, which aligned with literature for low-resource environments (38). Finally, insecurity and access constraints limited reach in some LGAs, echoing evidence that conflict reduces vaccination uptake in Nigeria [39, 40]. Implementers' insights reinforced the need for context-specific strategies, mobile outreach, and flexible routing in fragile settings [41].

7. Study Limitations

This study has several limitations that should be acknowledged. First, the evaluation relied on a qualitative descriptive design aimed at capturing stakeholder experiences and contextual insights; as such, it does not allow for causal inference, quantification of operational gaps, or statistical assessment

of implementation fidelity. Second, data were drawn from eight purposively selected LGAs chosen for operational diversity rather than representativeness, limiting the generalizability of findings across all LGAs in Sokoto State. Third, the study relied on self-reported accounts from LGA Consultants, Immunisation Officers, and state-level officials, which may be subject to recall bias or social desirability. Fourth, field observations captured only selected phases of the IEV campaign, meaning day-to-day variations in field practice may not have been fully observed. Finally, the study did not include perspectives from community members, enumerators, or frontline mobilizers, whose views could have enriched the understanding of on-the-ground implementation dynamics. Despite these limitations, the consistency of narratives across respondent groups strengthens confidence in the credibility and contextual relevance of the findings.

8. Conclusion

In Sokoto, where survey data reveal a substantial zero-dose burden and persistent inequities, the IEV approach has proven both feasible and necessary. By blending community engagement, settlement validation, and a live digital register, IEV enabled differentiated strategies such as border-aware scheduling, flood season routing, urban block listing, and security-sensitive deployment to reach every household across all 23 LGAs. This exercise strengthened identification and enumeration, allowing teams to locate RI zero-dose and not-vaccinated clusters. and to understand why gaps persist, including demand-side norms and supply-side reliability issues.

The convergence of operational data with FGD and KII narratives aligns with Nigeria-specific geospatial and qualitative evidence, making this package generalizable to similar northern contexts. The Sokoto IEV campaign successfully improved immunisation coverage and data accuracy through the active involvement of community leaders and independent supervisors. However, challenges such as technical issues, security concerns, and time limitations highlighted areas for improvement. Extending the duration, enhancing training, and deploying more reliable tools will further strengthen future IEV campaigns.

In Sokoto's mixed geography and sociocultural landscape, IEV provides a pragmatic, equity-oriented approach to reach pregnant women, children under five, and adolescent girls. The context only helps right-sized teams and routes, while KII and FGD specify how to implement and engage traditional and religious leaders, institutionalise supportive supervision, and ensure offline-first digital reliability. With Digital Adaptation (DAK)-aligned data standards, although not part of the IEV implementation itself, emerging national systems such as the WHO DAK for immunisation, Nigeria's Logistics Management Information System/Vaccine Direct Delivery (LoMIS/VDD) platform, and the Basic Health Care Provision Fund (BHCPF) provide pathways for integrating the Sokoto digital line list into routine service delivery. Aligning the IEV line list with DAK data standards would ensure interoperability with national digital health systems, while linking the updated population registers to LoMIS/VDD could strengthen vaccine stock visibility and session readiness. Similarly, BHCPF-supported primary healthcare financing offers a mechanism to fund last-mile service delivery based on accurate microplans. These linkages illustrate

how the improved line lists produced through the IEV exercise could meaningfully inform routine immunisation and maternal health planning beyond the enumeration period (42).

Finally, the Sokoto experience demonstrates that IEV is an effective strategy for improving immunisation coverage and health data planning. Sustained community involvement, robust supervision, and technology-enabled processes remain critical for success.

9. Recommendations

To strengthen immunisation equity and operational efficiency in Sokoto State, several priority actions are essential. First, access-focused planning should be prioritised for hard-to-reach LGAs by extending mop-up timelines. Qualitative findings identified terrain-related access barriers, particularly flooding and difficult-to-reach riverine settlements, as a recurring operational challenge in several LGAs. Participants explained that flooded paths, washed-out footbridges, and water-logged routes delayed teams and prevented full coverage during the initial sweep and using wet-season route cards to guide deployment. Paired teams with daily check-ins can further improve coverage in these challenging terrains. Second, improving list integrity in areas with high misplacement rates requires harmonising settlement lists at the ward level, verifying routes with local guides and GIS overlays, and reprinting corrected route cards before redeployment. Third, institutionalising offline-first digital systems is critical; this includes adopting WHO Immunisation DAK standards, ensuring devices function reliably without internet connectivity, and providing refresher training with in-field troubleshooting for enumerators. Fourth, supportive supervision and leadership engagement should be embedded throughout the process by sustaining independent and LGA-level supervision with real-time feedback and formally involving traditional and religious leaders during planning and mop-up activities. Finally, linking household line lists to supply readiness is vital to ensure that identified children translate into stocked immunisation sessions. This can be achieved by integrating LoMIS/VDD for stock visibility and monitoring defaulter closure every week. Collectively, these measures will enhance operational efficiency, reduce missed children, and advance maternal and child health outcomes across Sokoto State.

Statewide Priorities:

1. Strengthen Microplanning Accuracy by Institutionalising the geospatial verification in every microplanning cycle using GRID3 layers and closure dashboards, and by improving the enumeration quality through extended timelines, better training, and more reliable offline data tools.
2. Improve Service Delivery Reliability by Stabilising session delivery by enforcing published immunisation calendars, preventing stockouts, and ensuring backup staffing for hard-to-reach days.
3. Integrate Services for Greater Reach through co-delivering routine immunisation with ANC/postnatal services and routinising HPV vaccination through schools and community platforms.
4. Enhance Community Engagement by implementing norms-responsive Social Behavioural Change Communication using co-created messages with traditional/religious gatekeepers, supported by

local radio and mosque announcements and strengthen early engagement with community leaders before field deployment.

5. Reinforce Accountability and Performance Monitoring by Expanding the use of scorecard-driven accountability with quarterly public reviews tracking budget execution, service reliability, and stock performance.

Abbreviations

ANC

Antenatal Care

BHCPF

Basic Health Care Provision Fund

CMS

Corona Management System

COREQ

Consolidated Criteria for Reporting Qualitative Research

DDCI

Director of Disease Control and Immunisation

FGDs

Focus Group Discussions

GIS

Geographical Information System

HF

Health Facility

HPV

Human Papillomavirus

IA2030

Immunisation Agenda 2030

IEV

Identify, Enumerate, and Vaccinate

KIIs

Key Informant Interviews

LGA

Local Government Area

LIOs

LGA Immunisation Officers

LoMIS/VDD

Logistics Management Information System/Vaccine Direct Delivery

LQAS

Lot Quality Assurance Survey

NPHCDA
National Primary Health Care Development Agency
NV
Not vaccinated
PEOC
Polio Emergency Operation Centre
RED/REC
Reaching Every District/Reaching Every Community
RI
Routine Immunisation
SDG
Sustainable Development Goals
SIO
State Immunisation Officer
SMOH
State Ministry of Health
SPHCDA
State Primary Health Care Development Agency
U5
Under-5
USAID/TSHIP
United States of America International Development/ Targeted States High Impact Project
ZD
Zero Dose

Declarations

Clinical trial number

Clinical trial number: not applicable.

Ethics approval and consent to participate

Human ethics and consent to participate declarations, Ethical approval for this study was obtained from the Sokoto State Ministry of Health Institutional Review Board (Reference: **SMH/IRB/2025/023**). All participants provided written informed consent before participation. Participation was voluntary, and participants retained the right to withdraw at any stage without penalty. All methods were conducted in accordance with relevant ethical guidelines and regulations. Qualitative data were de-identified and stored securely on encrypted, password-protected systems accessible only to the core research team.

Consent for publication

Not applicable. This manuscript does not contain any information that could identify individual participants. All data have been fully anonymised, and any quotations presented are devoid of personal identifiers to ensure participants' privacy and confidentiality.

Competing interests

The authors declare no competing interests.

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Author Contribution

M.A. conceived and designed the study. U.L.M. led the drafting of the manuscript and contributed to data interpretation. O.O., O.A., and G.M. coordinated data collection and supervised field activities in Sokoto State. S.U.O., C.O., and S.A. contributed to the development of data collection instruments and supported the conduct of qualitative interviews and focus group discussions. A.O. and A.S. led data transcription, coding, and thematic analysis. F.O., D.A., and A.O. critically reviewed the manuscript for intellectual content. F.U.A., L.A.T., B.S., H.Y., and B.G.I., reviewed and provided programmatic support. C.K., provided supervisory leadership of project design, supervision of project delivery, and supervisory authorship of the manuscript. All authors read and approved the manuscript.

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Data Availability

The datasets generated and analysed during the current study are not publicly available due to ethical considerations and confidentiality agreements established with study participants. However, de-identified data that supports the findings of this study may be made available by the corresponding author upon reasonable request, subject to approval by the appropriate ethics and State immunisation committees.

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Figures

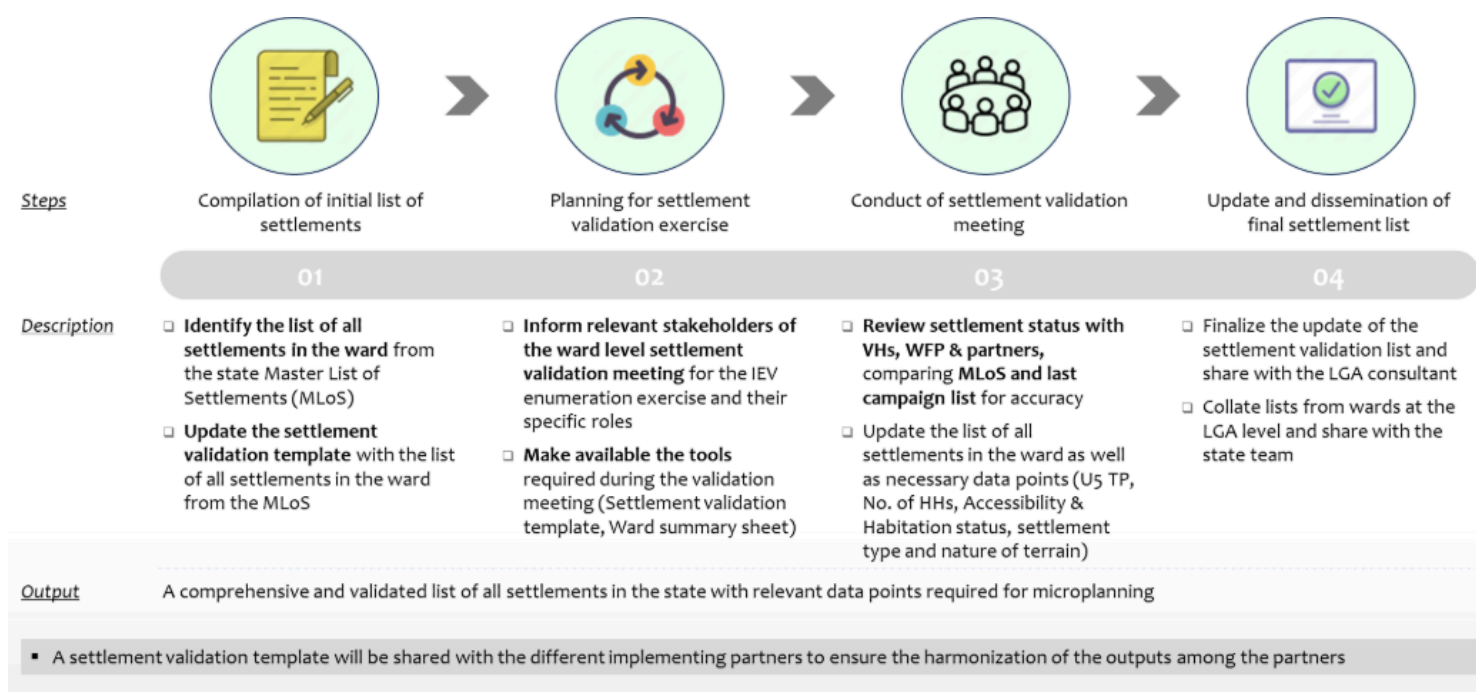


Figure 1

Settlement enumeration and Validation process.

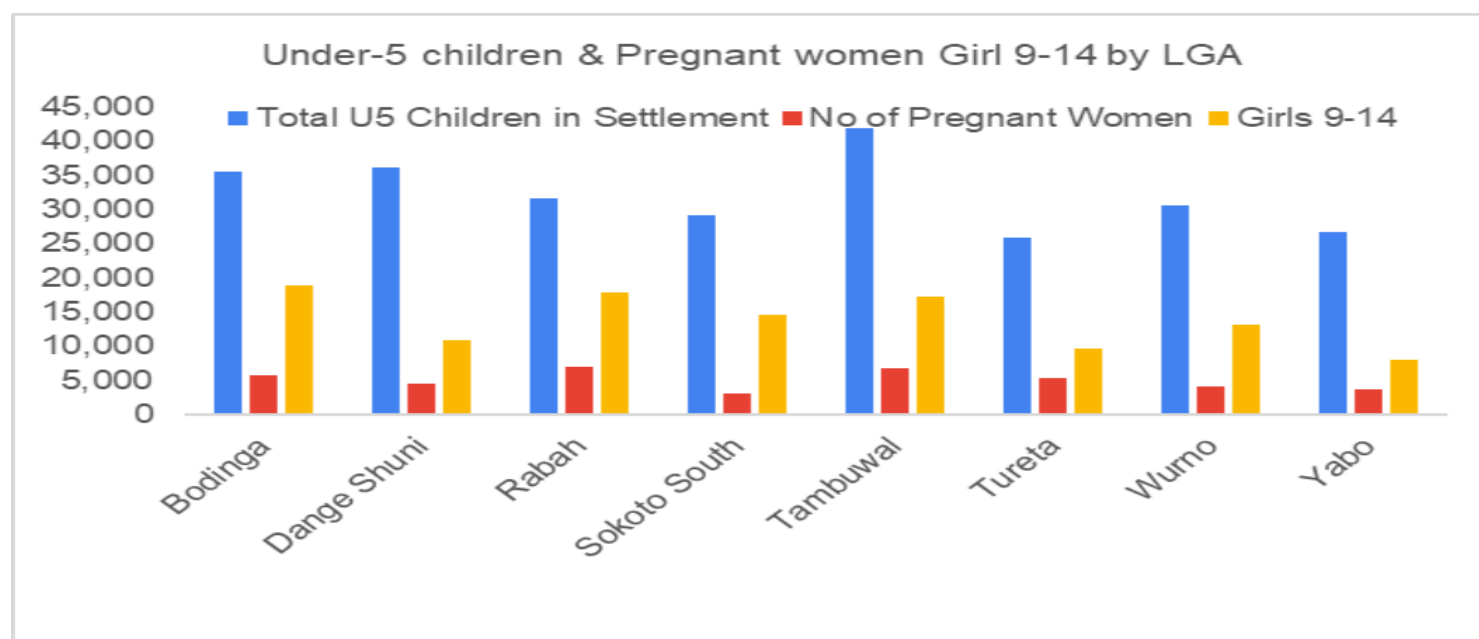


Figure 2

Enumeration output by Local Government Area (LGA): total under-five children, pregnant women, and adolescent girls aged 9–14 years recorded in the digital line list during the Sokoto IEV exercise across the eight focal LGAs.

Supplementary Files

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- [SupplementaryFile1.docx](#)