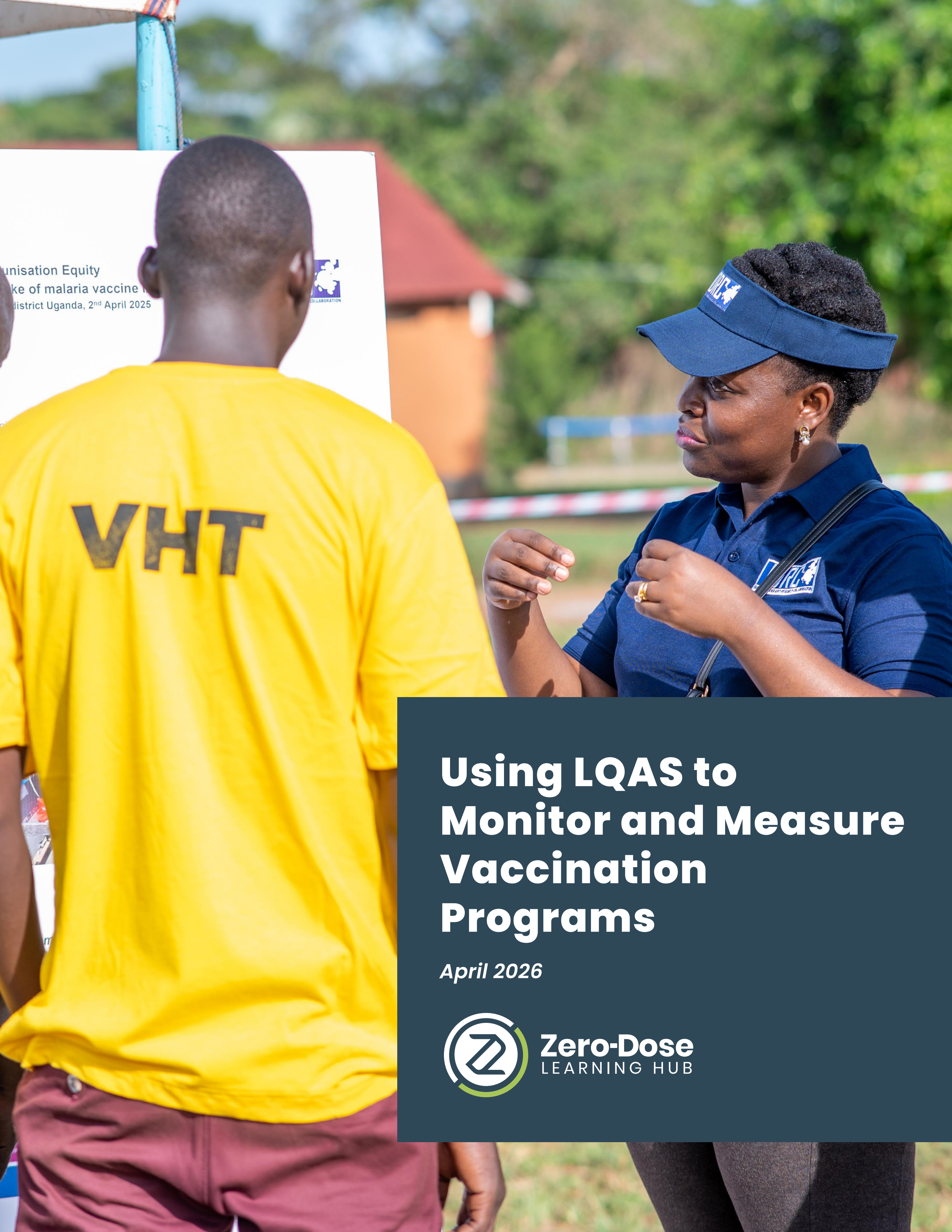

Using LQAS to Monitor and Measure Vaccination Programs

April 2026

Zero-Dose
LEARNING HUB

Gavi Zero-Dose Learning Hub (ZDLH)

Funded by Gavi, the Zero-Dose Learning Hub (ZDLH) serves as the global learning partner and is led by JSI Research & Training Institute, Inc. (JSI) with two consortium partners, The Geneva Learning Foundation (TGLF) and the International Institute of Health Management Research (IIHMR). Together, the consortium enables sharing and learning across four Country Learning Hubs (CLHs) in Bangladesh, Mali, Nigeria, and Uganda to advance the uptake of evidence by synthesizing and disseminating key learnings. The ZDLH also focuses on improving immunization equity and reducing the number of zero-dose (ZD) and under-immunized children globally by facilitating high-quality evidence generation and uptake.

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This manual was created in response to the need for plain-language guidance on planning and using lot quality assurance sampling (LQAS) for immunization monitoring and implementation research. As this document is not intended to be a training manual, it aligns with previous LQAS training materials and aims to standardize terminology and the application of LQAS principles to ultimately improve decision-making in immunization programs.

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Acronyms

BCG	Bacillus Calmette–Guérin (vaccine)
BeSD	behavioral and social drivers
CA	catchment area
CAPI	computer-assisted personal interviewing
CI	confidence interval
CLH	country learning hub
DIM	decentralized immunization monitoring
DTP	diphtheria-tetanus-pertussis containing vaccine
EPI	Expanded Programme on Immunization
KAP	knowledge, attitudes, and practices
LGA	Local Government Area
LMIC	low- and middle-income country
LQAS	Lot Quality Assurance Sampling
MEL	monitoring, evaluation, and learning
MICS	Multi-Indicator Cluster Survey
MOH	Ministry of Health
NGO	nongovernmental organization
OCC	operating characteristic curve
PPES	probability proportional to estimated size
pL	lower threshold
pU	upper threshold
RCS	rapid convenience sampling
RCM	rapid convenience monitoring
RI	routine immunization
SA	supervision area
SE	standard error
UI	under-immunized
WHO	World Health Organization
ZD	zero-dose

I. Overview of LQAS

1.1 Introduction

Timely, reliable, and objective data are essential for ensuring childhood immunization programs deliver high-quality services and address community needs. This information should focus on whether priority vaccinations are delivered effectively and whether the target population receives them at the appropriate age. For the Expanded Program on Immunization (EPI), this means verifying that children receive all required vaccinations during their first year of life. Additionally, a critical component of program success is identifying and addressing the barriers that hinder vaccination uptake among caregivers.

Lot Quality Assurance Sampling (LQAS) is an established survey methodology that can generate actionable data for vaccination programs in targeted subnational areas. It is designed to classify service coverage at the most decentralized administrative levels—such as the district, subdistrict, or community—to enable the efficient and precise allocation of resources. Its core purpose is to furnish actionable data at these local levels, empowering decision-makers to target interventions more effectively. Over the past four decades, LQAS has been widely used to assess various health care services including immunization, family planning, antenatal care, oral rehydration therapy for childhood diarrhea, HIV/AIDS, disease incidence, nutrition, growth monitoring and health worker performance (Valadez, 1986; Robertson and Valadez, 2006). The method has been used in diverse contexts such as rural and peri-urban areas, refugee and displaced persons settlements, conflict zones, urban slums, and at regional or national scales. These assessments have included multiple countries in sub-Saharan and the Horn of Africa; Central, South, and South East Asia; and Latin America and the Caribbean. Depending on the context, the units of analysis (also known as lots) have been defined as districts, subdistricts, townships, parishes, villages, health center catchment areas, and zones or neighborhoods within cities or urban areas. LQAS can be used for both internal evaluations and independent assessments. However, a critical gap remains: program managers and research teams lack practical, step-by-step guidelines to effectively plan, design, and implement LQAS surveys for routine immunization.

This *Operational Guidance* aims to outline the steps for planning and conducting an LQAS survey for monitoring immunization programs. It is intended for program managers and monitoring, evaluation, and learning (MEL) specialists working in Gavi-supported countries, but it can be used by any EPI team in any setting. This guidance provides tools and guidance to design, implement, and manage LQAS surveys effectively, enabling strategic decision-making to improve vaccination coverage. While this document focuses on immunization service delivery, LQAS is versatile and can be used to monitor and evaluate almost any health service, even in remote areas (Sprague et al., 2016; Valadez et al., 2020). Its purpose is to offer actionable insights on service delivery coverage and related indicators, empowering program managers to address gaps and barriers and improve health outcomes.

1.2 LQAS: Core Principles and Common Misconceptions

1.2.1. What it is

LQAS is a classification technique for decision-making that uses probability-based sampling methods specifically designed to work with small sample sizes in geographic subunits, often referred to as lots. LQAS uses probability-based random sampling and statistically defined decision rules to classify each lot according to a coverage target. If rigorously implemented, the individual lots can be combined, weighted by their population size, to provide reliable point estimates and confidence intervals (CIs) for vaccination coverage as well as a range of socioeconomic and behavioral indicators linked to vaccination uptake.Originally introduced by Dodge and Romig in 1929 (Dodge and Romig, 1944; Dodge and Romig, 1929), LQAS is a statistical tool based on frequentist notions of misclassification error. LQAS evolved from early work in Statistical Quality Control, including contributions by Shewhart (1931). Dodge and Romig developed the approach to assess the quality of items on a factory production line without inspecting every item. In the early 1980s, LQAS was adapted for use in the health sciences (Valadez, 1986; Valadez, 1991) where it gained considerable traction as a versatile tool for measurement and evaluation (Robertson and Valadez, 2006). In 1991, a World Health Organization (WHO) consultation on epidemiological and statistical methods for rapid health assessments recommended its use for health program monitoring in low- and middle-income countries (LMICs) (Anker, 1991; Lemeshow and Taber, 1991; Lanata and Black, 1991). Since then, significant advances have improved the methodology, including the development of statistical reference tables, a textbook, and software which have simplified the use of LQAS by eliminating the need for manual calculations. Additionally, training materials have been developed to facilitate the use of LQAS in field settings by public health practitioners (Valadez et al., 2007a, 2007b). These advancements have empowered local program managers with a rapid and easy-to-use method for monitoring and evaluating programs and making data-driven decisions.

The WHO guidance produced in 1996 (WHO, 1996) and Valadez and Weiss's manual (Valadez et al., 2007a, 2007b) provide foundational concepts for health workers using LQAS, including its use for immunization coverage surveys and program monitoring. The WHO guidance contrasts the recommended use of LQAS relative to the 30 Cluster EPI Survey method. The recommended (classical) LQAS designs are used to classify the individual lots in relation to two thresholds, an upper and lower threshold where the upper threshold is a coverage target and the lower threshold is an unacceptably low level of coverage. Results provide a pass/fail classification for each lot, which allows programs to rapidly identify low-performing areas that need targeted action or additional resources. Classical LQAS designs always have two thresholds. See Section 2.6 for a detailed explanation of the thresholds.

1.2.2. What it is not

The classical LQAS methodology described in this guidance should not be confused with Cluster-LQAS (C-LQAS) or Rapid Convenience Sampling (RCS), both of which are used to monitor the quality of supplemental immunization activities (SIA), in particular in polio-endemic countries. It is important to note that C-LQAS and RCS have different sampling approaches and purposes compared to LQAS.

- C-LQAS is used to classify areas based on multiple predetermined thresholds but cannot provide precise point estimates of prevalence or coverage due to the limitations of cluster sampling (Global Polio Eradication Initiative, 2012). Oversimplified guidelines and a lack of transparent interpretation methods may cause program managers to misinterpret results, especially when coverage falls within intermediate ranges between thresholds. Additionally, C-LQAS designs may have higher rates of misclassification errors which further limits the reliability of its classifications (Pezzoli et al., 2010).
- RCS is a quick assessment method commonly used in immunization programs to identify unvaccinated children and guide immediate actions, such as targeted outreach or mop-up activities, after a campaign or in low-coverage areas. RCS uses a non-probability convenience sample of caregivers living near health facilities or other easily accessible sites. The sample is small (often 6–12 caregivers per site, 3–5 sites per area) and not random; therefore, findings can highlight potential gaps but cannot be used to calculate valid coverage estimates.
- Rapid Convenience Monitoring (RCM) is sometimes used interchangeably with RCS, particularly in polio and measles programs. RCM refers to the ongoing use of convenience surveys for real-time monitoring during or immediately after campaigns, whereas RCS can be a single rapid assessment. The methods are the same; the distinction lies in the timing and purpose. In both cases, RCS and RCM provide anecdotal or rapid insights and are only intended for operational feedback rather than statistically representative results. For more details, please see the WHO guidance on Rapid Convenience Monitoring.

Another classification approach that is sometimes confused with classical LQAS is the classification procedure for the probability-based WHO vaccination coverage cluster survey (WHO, 2018). The WHO Vaccination Coverage Survey Manual presents sample size calculations for classification. While results from the coverage cluster survey can be classified against coverage targets, this classification is derived from statistically valid coverage estimates and their CIs, not from pass/fail decision rules as in LQAS. Unlike LQAS, which is optimized for small samples and rapid operational decision-making, the WHO approach typically requires larger samples to achieve precise estimates and is intended for formal coverage measurement rather than immediate field action.

Box 1: Statistical Framing of this Guidance

This guidance is tailored for the program manager or supervisor responsible for monitoring the performance of vaccination services and zero-dose interventions at the subnational level. It focuses on LQAS as a practical statistical tool that provides actionable information for resource allocation and program management. The guidance follows a frequentist framework, as originally intended by the quality control statistics of Dodge and Romig (1929). This perspective evaluates the probability of an outcome given a set of known parameters, which is how LQAS operates to classify areas as "acceptable" or "unacceptable." A frequentist framework is used because it provides a clear, objective measure of the misclassification risks (alpha and beta) regardless of prior beliefs about a population's performance. This approach is well-suited for a public health context where consistent, standardized classifications are needed across multiple subnational areas

It is important to note that this guidance does not employ a Bayesian framework (Olives and Pagano, 2013; Hund, 2014), which can introduce complexity that is not necessary for the primary purpose of this tool. The Bayesian framework is a statistical method that estimates the probability of an outcome by combining survey data with existing information (e.g., prior knowledge or historical data on actual coverage levels). Unlike the frequentist approach, which looks at the current survey data in isolation, a Bayesian model starts with a "prior distribution." This is a mathematical representation of what is already believed about an area's performance based on past surveys, expert opinions, or historical trends. When new LQAS data is collected, the model updates this prior belief to produce a "posterior probability," which reflects the likelihood of a lot being acceptable given both the new evidence and the historical context. While this allows for a more nuanced interpretation of small samples, it introduces complexity and potential bias, as the final classification can be heavily influenced by the initial "prior" assumptions rather than the new data alone.

Additionally, this guidance does not focus on using LQAS for hypothesis testing because LQAS is fundamentally a quality control tool for classification, not a method for statistical inference. Hypothesis testing is designed to determine if there is enough statistical evidence to support a claim about a population. However, prior experience (Lanata, 1991) has shown that the lot samples are too small for meaningful hypothesis testing. Furthermore, the purpose of LQAS is to classify an area (lot) as either "acceptable" or "unacceptable" based on a predefined standard. The goal is not to make a statistical claim but to make a practical decision for resource allocation. For example, a supervisor needs to know, "Does this subdistrict meet the performance standard, or does it require an immediate intervention?" LQAS is designed to be accurate at classifying areas that fall into the "acceptable" or "unacceptable" categories. The two-threshold structure plays a key role in LQAS and does not fit into the single-hypothesis framework of traditional statistical testing.

1.3 Key Concepts of LQAS

The first task in organizing a targeted survey using LQAS is to establish the sampling parameters. For any LQAS sampling design, five questions should be addressed:

1. What is the supervision area (SA) (also known as the lot) and the catchment area (the larger area comprising all supervision areas)? When using LQAS, the SA/lot refers to an area that is under responsibility of an entity of the health system. The entity can be a health facility, a community health worker, an outreach team, etc. This area is referred to as a supervision area because it is the area where the LQAS result is being used for decision-making.

2. What indicators will be assessed?

3. What is the coverage target for each indicator? This is the threshold that should be reached in the SA to be classified as having acceptable coverage.

4. What coverage level is unacceptably low and indicative of a serious performance issue in the SA?

5. What are the acceptable classification errors (i.e., risk of misclassification of the SA)?

Once the survey indicators have been identified, program managers must establish two thresholds for each survey indicator. Using the first dose of diphtheria-tetanus-pertussis containing vaccine (DTP1) as an example, the upper threshold is often set to match the national or regional coverage target (e.g., 80%), which is the proportion of children 12–23 months who should be vaccinated with the first dose of the DTP vaccination during a predetermined period, such as one year.[1] The lower threshold is usually 30 percentage points below the upper threshold. The lower threshold indicates an unacceptably low coverage level (e.g., 50%) that signals failed service delivery and highlights the SAs that should be prioritized for improvement. Different threshold levels can be set depending on the targets of the particular immunization program.

A statistically determined decision rule is selected to optimize the accurate classification of the SAs. For immunization, the **LQAS decision rule** is the **minimum number of vaccinated children** required for an SA to be classified as acceptable (at or above the desired coverage threshold). Classification of the SA is made by comparing the number of vaccinated children with the LQAS decision rule. If the number of vaccinated children is below this decision rule, the SA is classified as unacceptable (below the threshold).

The decision rule is designed to prevent the misclassification of an area as failing when it is actually passing (the alpha error, see explanation under Classification Errors). Because the risk of a false positive is low, any area classified as ‘failing’ is highly likely to have true coverage that is below the **lower threshold (50%)**. This design allows managers to prioritize interventions where they are most needed. However, there is a trade-off: areas with true coverage slightly below the target may be misclassified as “passing.” This risk decreases as coverage drops further; the lower the actual coverage is below the target, the more likely the tool will correctly classify the area as “failing.” When true coverage is below the lower threshold, the probability of it being wrongly classified as “passing” becomes very low (the beta error). This ensures the most underserved areas are almost always caught.

The decision rule ensures that SAs reaching the coverage target (for example, 80%) have a high probability of being correctly classified. Likewise, the rule ensures that SAs at or below the lower coverage threshold are accurately classified with minimal error. In general terms, LQAS is designed to identify high- and low- performing areas based on these two thresholds. However, there can be SAs with vaccination coverage between the two thresholds where conclusions are not straightforward. In practice, SAs with coverage closer to the upper threshold are more likely to be classified as passing/acceptable, while SAs with coverage closer to the lower threshold are more likely to be classified as

1 Please note: While 80% coverage may seem low as an upper threshold for many antigens, it is simply used as an example throughout this guidance to explain the principles of LQAS.

failing/unacceptable. Section 2 describes how to mitigate the error that an SA is classified as high performing when it is not (and vice versa).

In summary, the recommended steps for classical LQAS include the following:

- Use the program target as the upper threshold.
- Set the lower threshold 30% below the upper threshold to define an unacceptably low performance that needs focused attention.
- Select the statistically determined decision rule using the LQAS table or the LQAS sampling calculator app (see Annex 1).
- Determine the acceptable classification errors.

These guidelines explain each of these principles using pragmatic language. Please see Annex 1 for a detailed statistical explanation of the method. See Annex 4 for a list of Frequently Asked Questions related to LQAS.

Box 2: Meaning of Pass/Fail in LQAS

In classical LQAS, "pass" and "fail" are binary classifications for an SA/lot. The pass/fail determination is defined by a decision rule based on the number of "successes" (e.g., vaccinated children) within a small, randomly selected sample from the SA/lot. The purpose of the tool is to quickly classify and prioritize areas that need attention, rather than to precisely estimate the true coverage in every area.

In the example where the Lot sample n = 19, Upper threshold = 80%, Lower threshold = 50% and the Decision rule *d* = 13:

	PASS	FAIL
Classification	Pass ≥ 13 vaccinated children. The lot passes when the number of vaccinated children (e.g., successes) in the lot sample is greater than or equal to the decision rule value (*d*).	Fail < 13 vaccinated children. The lot fails when the number of vaccinated children in the lot sample is less than the decision rule value (*d*).
Interpretation	A PASS classification means coverage levels are considered adequate and the lot is not a priority for quality improvement. A PASS means the lot is classified in the high coverage category (e.g., 80%). This event will happen 90% of the time when true coverage is at or above 80%. Tracking repeated LQAS rounds is useful for monitoring performance over time because a program success in one round is not a predictor for the next round.	A FAIL classification means coverage levels are considered inadequate and the lot is a high priority for resources and program improvement initiatives. A FAIL means the lot is classified in the low-coverage category (e.g., 50%). This event will happen more than 90% of the time when true coverage is at or below 50%. Tracking repeated LQAS rounds is useful to monitor if the quality improvement program worked and if funding and support are still needed to improve performance.
Recommended Action	The program is likely on track in this lot for the specific indicator and no additional action is needed at this time. Lots with consistent PASS results can be selected for learning and understanding best practices.	The program is likely not meeting its objectives in this lot and should take immediate corrective action, such as re-training health workers, mobilizing resources, or conducting a more in-depth assessment or root cause analysis.

1.4 Use Case for Zero-Dose Programs

In the context of immunization and the Gavi Zero-Dose Learning Hub (ZDLH), LQAS has been used as an effective tool to identify and target areas with likely high concentrations of zero-dose (ZD) or under-immunized (UI) children. For operational and measurement purposes, a ZD child is defined as a child aged 12-23 months who has not received DTP1 during their first year of life. A UI child is defined as a child aged 12-23 months who has not received the third dose of DTP (DTP3) during their first year of life. Instead of conducting a large, expensive survey to estimate overall coverage, LQAS enables a program manager to classify a district, subdistrict, or community as either "acceptable" or "unacceptable" based on pre-set coverage thresholds for DTP1 and DTP3. Lots classified as unacceptable for DTP1 or DTP3 coverage are likely to have higher proportions of ZD or UI children, respectively. This information provides a clear map of which lots require urgent attention. LQAS results can be used to direct resources, such as additional vaccinators, outreach programs, and improved cold chain logistics, to the specific lots most in need. This targeted approach is more efficient than a blanket strategy, as it focuses limited resources on the communities with higher concentrations of ZD and UI children. As a result, LQAS provides a practical, actionable approach for identifying and addressing inequities in immunization coverage. Annex 5 provides language that can be adapted when developing a protocol for an LQAS survey for monitoring immunization coverage in targeted subnational areas.

Box 3: Key LQAS Terms and Definitions

Catchment Area (CA): The overall study area where coverage is calculated. Typically, a large geographic area in the health system comprising numerous service delivery units or health centers that are responsible for routine immunization services.

Supervision Area (SA): The SA is a subunit of the CA, often referred to as the "Lot." Typically the SA is a lower-level health center and the population it serves; it can also be defined as a subdistrict area or an urban neighborhood. In this guidance, the terms SA and lot are used interchangeably.

Sampling Frame: A list of villages in the SAs and their population sizes. The sampling frame is used to randomly select the villages where the survey interviews will take place.

Interview Location: Randomly selected villages from the sampling frame of each SA where the interviews of eligible participants will take place. The number of interview locations equals the sample size in each SA.

Upper Threshold (pU): The upper benchmark or vaccination coverage target for a particular antigen or the expected/desired proportion for a given indicator. This upper threshold is used to classify SAs (lots) with acceptable performance.

Lower Threshold (pL): The lower benchmark below which coverage or indicator proportions are considered unacceptable; it identifies the SAs (lots) with poor performance. The lower threshold must have a low risk of misclassification.

Decision Rule: The minimal number of children in the sample vaccinated with a given antigen (e.g., DTP1) in order for the SA to be classified as reaching the upper threshold or coverage target. If the minimum number of vaccinated children is not found in the sample, coverage in the 'lot' is classified as unacceptable.

Classification Errors: LQAS classification errors occur when determining whether an SA meets the vaccination coverage target or not. Two types of error are important to understand: Alpha (α) error is the probability of misclassifying an area with coverage above the upper threshold as failing/unacceptable. Beta (β) error is the probability of misclassifying an area with coverage below the lower threshold as passing/acceptable. These definitions are reversed when the LQAS analyses are used to count vaccination failures rather than successes. See the subsection on Classification Errors and Annex 1 for a brief discussion.

Box 4. Steps in Applying LQAS for Monitoring Routine Immunization

Implementing an LQAS survey follows a series of basic steps:

- Define the SAs. Typically, the SA is a lower-level health center and the population it serves; it can also be defined as a subdistrict area or an urban neighborhood.
- Identify the vaccination indicators to be assessed.
- Define the upper and lower thresholds of performance. A difference of 30% is recommended between the two thresholds to maintain a small, cost-efficient sample size. These thresholds are based on coverage targets or expected indicator proportions, management decisions, and prior information about the expected performance of health workers. The upper threshold is the coverage target that the SA/lot should reach. The lower threshold is unacceptably low coverage.
- Determine acceptable alpha and beta errors.
- Use the LQAS Table of Decision Rules or LQAS Sample Size Calculator to determine the sample size and decision rule.
- Using the decision rules and data from the individual SAs, classify each SA as reaching or not reaching (pass/fail) the coverage target for each indicator.
- For the overall catchment area, aggregate the results from each SA to calculate the weighted coverage estimate or indicator proportion and confidence interval, using the SA population sizes as the weights.

1.5 Should I Use LQAS to Monitor and Manage an Immunization Program?

Immunization program managers typically monitor vaccination coverage by using administrative data captured in the health management information system, such as DHIS2. However, administrative data has been shown to be inaccurate and often overestimates the coverage of service delivery (Jeffery et al., 2018; Jeffery et al., 2022; Scobie et al., 2020). Surveys are often used for measuring program coverage because they are designed to produce results that are representative of the target population and include a measure of their own error, called a standard error (SE). The SE (Olives and Pagano, 2013) is an estimate of deviation of the sample mean from the actual mean of a population. The SE is also used in calculating a 95% CI, which indicates the precision of the estimate. Macro surveys, such as the Demographic Health Survey (DHS), serve a useful purpose of measuring coverage in large geographical areas, such as a region of a country or the country as a whole. However, macro surveys rarely can be used to monitor changes in coverage at subnational levels, where programmatic decisions need to be made. This is why targeted surveys are needed. LQAS is a targeted survey approach that is designed to classify coverage at the level where services are delivered, such as the district, subdistrict, or community levels. It can be used for focused assessments to provide information for identifying ZD and UI children and to monitor the reach of interventions targeting ZD populations (M-RITE, 2022). It is also useful for understanding social, economic, and behavioral barriers to vaccination in specific communities. For example, in Nigeria, a subdistrict monitoring system using LQAS was established in eight Local Government Areas (LGAs) to assess vaccination coverage and the socioeconomic factors influencing uptake (Attahiru et al., 2025).

Box 5. Advantages of LQAS for Targeted Surveys

- LQAS sampling procedures and analyses are relatively simple and the findings can be used immediately by local managers and health workers.
- Only a small sample is needed to classify an SA (or lot) as having reached (or not) a predetermined coverage target for each indicator.
- The data from individual SAs can be weighted and aggregated into an estimate of coverage for the entire program catchment area (e.g., district).
- Small sample sizes are useful for sampling in targeted subnational areas relevant to ZD and allows more frequent implementation than standard probability surveys.

1.5.1. Use case for LQAS in immunization

LQAS was adapted from industrial production to the public health setting to measure the performance of facility- and community-based health services, such as childhood vaccinations. It is designed to produce information at the local level that is useful to program managers, such as district health management teams. For example, LQAS typically subdivides a CA into smaller subunits called SAs where health services are delivered. Small samples are used to classify each SA as having acceptable or unacceptable coverage based on a predetermined threshold or target for each indicator in the survey. After all samples are completed for all SAs, the data can be combined and weighted by the estimated population sizes of the SAs to calculate a population estimate of vaccination coverage for the overall catchment area. This gives managers two levels of information: performance of vaccination service delivery in a SA and overall vaccination coverage in the CA. Once aggregated, the LQAS survey is similar to a vaccination coverage survey that is powered for measuring coverage at the overall CA level.

When used in immunization programs, LQAS traditionally has been utilized to measure coverage of vaccine antigens. However, other domains can be included in the survey questionnaire. Examples relevant to immunization include questions about vaccine hesitancy; behavioral and social drivers (BeSD) of vaccination; social capital; use of antenatal care and other primary health care services linked to vaccination uptake; and caregivers' knowledge, attitudes, and practices. Use of these additional indicators related to socioeconomic barriers and other demand-side factors might substantially increase the utility of the LQAS survey in areas of relatively high vaccination coverage.

1.5.2. Advantages of LQAS

The small sample sizes allow more frequent sampling than standard probability surveys powered for estimation, making LQAS a practical choice for program managers who intend to regularly monitor the progress of vaccination services. LQAS can be a cost-efficient approach, especially if data collection is integrated into the service delivery tasks of local health workers or integrated into the task of a supervisor who regularly visits the field to monitor programs. In either case, planning is needed to ensure they have appropriate training and can balance data collection tasks within their workload (Valadez and Devkota, 2002). They often need minimal per diem since they return to their homes each night rather than lodging in hotels (Valadez and Devkota, 2002; Anoke et al., 2015). Also, they tend to know the locations of communities and may not need guides or translators, and sometimes not even drivers.

LQAS can be used by managers to evaluate performance of vaccination services at a micro level, such as subdistrict or even lower levels, while also providing overall coverage estimates for the larger program or CA. An SA can also be defined as a specific geographic target area, such as mountainous areas, valleys, health facility CAs, or market areas to determine if coverage varies based on geographic characteristics. For example, this approach to LQAS has been used following a vaccination campaign where field teams may need to verify whether specific areas—such as slums or mountainous communities—were adequately reached with vaccination services (Weiss, Newberry and Dias, 2002; Weiss and Bhui, 2004). This targeted disaggregation allows for more precise identification of gaps in service delivery and makes it more likely that even hard-to-reach populations, such as ZD children, are included in coverage assessments. It is important to note that monitoring data at targeted subnational levels also can be collected using rapid convenience sampling as described above; however, this approach uses a convenience sample in small subunits and does not provide probability-based estimates of coverage. LQAS does not provide a precise coverage estimate at the subunit level either; rather, it gives a statistically defined classification of having reached a coverage threshold or not.

1.5.3. Trade-offs of using LQAS

While LQAS is an effective monitoring tool for tracking the performance of vaccination strategies over time, it is not designed to detect small incremental changes within a supervision area. Instead, it is optimized to identify substantial shifts in performance, providing a clear "order of magnitude" regarding coverage levels. This makes the method particularly useful in contexts of perceived low performance or high heterogeneity, where identifying pockets of low coverage is critical.

Tracking repeated LQAS rounds allows for robust performance monitoring over time; consistent "fail" classifications provide strong evidence of sustained low coverage, while consistent "passes" reinforce confidence in high performance. Conversely, a single round of LQAS is not sensitive enough to detect small shifts in coverage in areas that already have very high or very low baseline performance. Ultimately, successful implementation depends on proper training for data collectors and careful determination of the thresholds, decision rules, and sample sizes to ensure accurate classification.

1.5.4. Costs

A study by Brenzel et al. (2019) comparing survey methods used to measure immunization coverage showed that LQAS surveys were less costly than traditional EPI 30x7 coverage surveys using cluster sampling. However, it is important to remember these surveys provide different types of information and are intended to fulfill different use cases for managing immunization programs at national, regional, and decentralized levels. For example, EPI cluster surveys are typically not powered to provide coverage estimates at decentralized levels (e.g., district) and any cost comparisons between the methods can be misleading. Additional cost studies are needed to explore the cost differentials to get robust estimates at district level, recognizing that different sampling approaches exist and each has a different use case.

LQAS is most cost-efficient in heterogeneous settings where immunization coverage varies across supervision areas, allowing programs to target resources and corrective actions only to low-performing lots. However, in uniformly low-coverage, homogeneous areas, almost all lots will fail the decision rule, providing little actionable differentiation because all areas need support to improve their quality. Furthermore, data collection costs increase when the upper threshold is set low for low coverage areas, as larger sample sizes are required to maintain classification accuracy. As Brenzel et al. (2025) noted, the cost advantage of LQAS diminishes in homogeneous contexts where vaccination services are uniformly poor and blanket interventions are needed regardless of the LQAS classification.

2. How to Plan an LQAS Survey

2.1. Defining the Aims and Objectives of an LQAS Survey

The aims and objectives are two very important concepts in research and program monitoring and evaluation. They guide the survey design and define the tasks needed to prepare for it. The aim tends to be a broad statement indicating the purpose of the survey. For example, the survey aim might be to identify areas with high ZD burden in the program catchment area (i.e., you are looking for pockets of ZD children not individual children). The aim states why you are carrying out the survey. Objectives are focused statements indicating how you will achieve the aim. The following example objectives are relevant to the ZD context. You need to ensure that your aims and objectives are adapted to your specific context and research questions.

Example Objectives:

- **Objective 1:** to determine the number/proportion of children 12–23 months of age who have received all required vaccinations by their first birthday. This data tells you the current effectiveness of the vaccination system for infants in your CA. This objective will require identifying which antigens and doses will be evaluated in the survey and creating an indicator table (see Annex 7).
- **Objective 2:** to measure up-to-date vaccination status among children 0–11 months of age. This information can be used to learn if caregivers are accessing vaccinations on time or if there are delays specific to certain months during infancy.
- **Objective 3:** to classify the SAs according to the established thresholds (targets) for the LQAS survey in order to identify high and low-performing SAs.
- **Objective 4:** to determine which socioeconomic and behavioral factors are associated with vaccination coverage levels, specifically at the CA. This objective will likely draw on indicators from the WHO Behavioral and Social Drivers (BeSD) of vaccination (WHO, 2022).

2.2. What are the Target Groups for the LQAS Survey?

The target groups define who will be sampled and who will be interviewed. In the objectives, we listed the two most common age groups for monitoring and evaluating routine immunization (RI) programs: children aged 0–11 months and 12–23 months. The 12-23-month age group is typically sampled to measure coverage of all routine immunizations required in the first year. Some countries may use additional age cohorts for immunization monitoring. For example, in 2023, the partners involved in the Gavi-funded ZDLH agreed to use the age cohort of 18 weeks to 11 months for targeted surveys aimed at measuring timeliness of DTP1 and DTP3 vaccines that, in many countries, are recommended at 6 and 14 weeks, respectively (Corrêa et al., 2024). If there is interest in monitoring vaccine doses recommended in the second year of life, for example measles-rubella second dose, DTP first booster, or malaria vaccines, a target age of 24–35 months may be appropriate. You should discuss the selection of the survey target groups with the health authorities responsible for childhood immunizations to ensure that they are relevant for local immunization schedules.

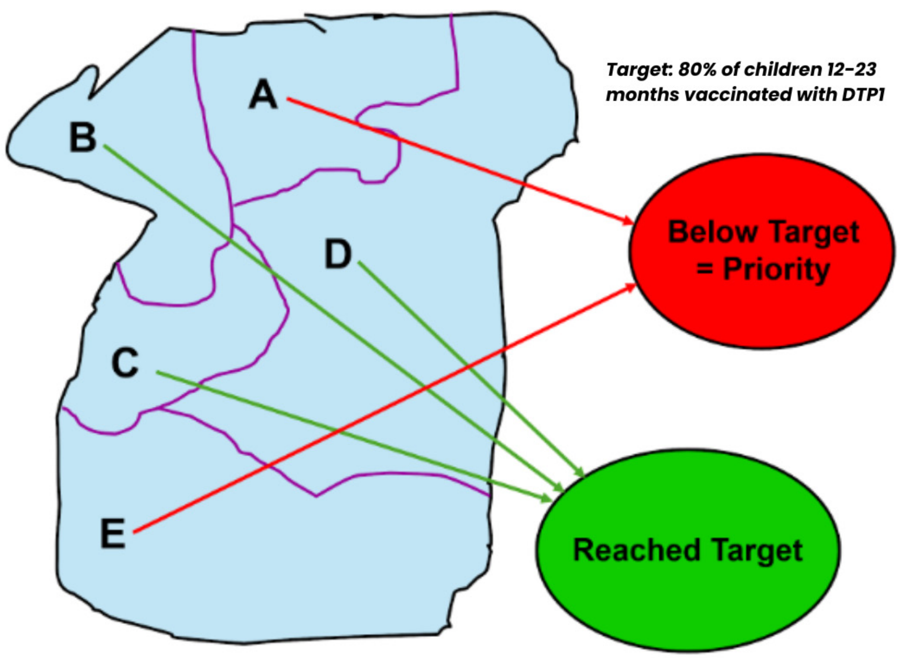
It is equally important to define who will be interviewed. The interview respondent should be the caregiver who is most familiar with the child's health care and who manages the child's vaccination card. Typically, the caregiver is the child's mother. The mother's sister, grandmother, or husband may be lacking the critical information needed for the survey and are not appropriate substitutes for an interview. Identifying the appropriate respondent for the survey should be based on clear selection criteria and can be determined through simple questions: "Are you responsible for immunizing this child? If not, who is?"

2.3. How to Define the Catchment Area and Supervision Area for LQAS?

Each country has its own management system for vaccinating children. Program managers at district or subdistrict levels can use LQAS to manage vaccination services in the areas they supervise to ensure children are vaccinated according to the schedule for routine immunization. When using LQAS, these local areas are called **SAs** (often referred to as "lots"). Each SA (or lot) is meant to represent the smallest programmatic unit where decisions will be made (e.g., health facility catchment, ward, or county). For example, in Uganda, the district teams manage vaccination service delivery at a county or parish level. In this case, the district is the overall **CA** and the county or parish is the SA for an LQAS assessment (Sprague et al., 2016).

In Nigeria, program managers at the LGA level manage vaccination teams operating at the ward level, who are responsible for RI services delivered through health facilities and outreach efforts to settlements within each ward. In this case, the LGA could serve as the overall CA, while the ward serves as the SA for the LQAS assessment.

Figure 1. One District in Nepal with Five Health Facility CAs Defined as the SAs



Vaccination programs are typically designed to serve large administrative areas in a timely manner. In Figure 1, the large blue area represents Rautahat District in southern Nepal (Valadez and Devkota, 2002). The villages and the population in Rautahat District form the program's overall CA. The district EPI program is responsible for vaccination service delivery in this area. The CA, being quite large, was subdivided into five smaller subunits that corresponded to the location of the health facilities in the district. The villages in the health facility catchment areas determined the boundaries of each of the SAs. These five subunits served as the SAs for LQAS monitoring because they were being managed by the district. In summary, subunits A through E represent the SAs, which together form the overall CA for the district's vaccination program.

LQAS provides information at the local level using small samples to classify whether coverage in the SA is adequate or not relative to a particular threshold. However, it does not provide an estimate of coverage at this local level. In other words, managers should not use LQAS to estimate the coverage within an SA because the sample size is too small to calculate a precise coverage estimate. The SA level data only should be used to classify the area as "pass/acceptable" or "fail/ unacceptable" with respect to a coverage threshold for a given vaccination indicator. Vaccination thresholds (or coverage targets) are often established by the ministry of health (MOH) or a government authority or they can be based on the specific project targets or information on existing coverage levels.

LQAS requires that each lot is sampled using a simple, stratified or systematic random sample. The number of children sampled is the denominator and the number of children in the sample having received the vaccination of interest forms the numerator. If the number of vaccinated children in the lot sample reaches or exceeds the decision rule (*d*), the lot is classified in the high coverage category (pU); otherwise, it is classified in the low-coverage category (pL). What does this mean? An SA is classified as passing/acceptable when there is insufficient evidence that true coverage is below the target (80%, the upper threshold, or pU, in this example). Likewise, an SA is classified as passing/acceptable because there is evidence that true coverage is not below the lower threshold pL (or 50% in this example).

This information is useful for identifying lots with UI and ZD children as the largest proportion of them are likely in the lots that have been classified as unacceptable and in the low level of coverage (pL). Once the data are reviewed and SAs are classified as high or low-performing areas, the data from all of the SAs in the CA are aggregated and treated as a stratified random sample and weighted by the population size of each community in each SA (see explanation in Section 2.4). This calculation produces a weighted coverage proportion for the CA with a 95% confidence interval. Each of these steps is possible once the SA is correctly defined.

2.4. How Many Supervision Areas Should be Sampled?

For most LQAS study designs, at least five lots/SAs are identified in each CA, with a lot sample of n = 19 each. This gives a total sample of 5 x 19 = 95 with an expected precision of ±10%. It is important to note that more (n = 6) or less (n = 4) SAs do not considerably affect the precision (±9% versus ±11%) of the coverage estimate.

For the estimation of overall coverage in the catchment area, this example shows how the precision levels of the estimates vary only slightly depending on the number of SAs:

- 4 SAs (4 x 19 = total sample size 76): 95% confidence interval = ±11%
- 5 SAs (5 x 19 = total sample size 95): 95% confidence interval = ±10%
- 6 SAs (6 x 19 = total sample size 114): 95% confidence interval = ±9%

This classical LQAS design reflects a balance between statistical rigor and operational feasibility, with n = 19 per lot representing the minimum sample size that provides a high probability of classifying a lot correctly (keeping alpha and beta errors low) while remaining logistically feasible for a single data collector or small team to complete in one or two days.

Using five lots with n = 19 per lot allows for both the classification of each lot (pass/fail) and the estimation of overall coverage across the catchment area. The combined sample of 95 (19 x 5) produces an aggregate coverage estimate with a precision of about ±10% at a 95% confidence level. Programs with different numbers of subunits can adapt by subdividing the CA into more or fewer lots, provided each lot still represents a meaningful decision-making unit.

Ideally all subunits in a CA are included in the overall sample. If there are more than five subunits in the overall CA, the recommended approach is the following:

- **Do not artificially combine subunits just to create five lots**, as this masks local variation and undermines the purpose of LQAS, which is to identify specific areas that are underperforming.
- **Do not select only five units and ignore the rest** unless program decisions are only needed for those selected areas (rare in coverage assessments).

- **Best practice:**
  - Include all subunits as individual lots whenever feasible. This ensures that every unit can be classified and targeted for action.
  - If resources are limited, group only those subunits that are managed together (e.g., two very small adjacent wards under one facility), and treat that group as a single lot.
  - If only a subset of lots is included (e.g., sentinel lots), clearly document the rationale and recognize that classification will not apply to excluded units.

Example: If a district or LGA has 10 wards, the ideal approach is to sample all 10 wards individually (i.e., a sample of 19 respondents per ward). If resources only allow sampling of five wards, the program may combine pairs of wards that share services, or select five sentinel wards but must document this choice and understand that results will not represent all wards if the ward-level data are combined to estimate coverage. Another way to address this issue is using a design called Large Country LQAS (LC-LQAS), which is an adaptation of classical LQAS designed for countries with many subnational units (e.g., dozens or hundreds of districts). LC-LQAS combines LQAS for local level classification with multistage cluster sampling to obtain precise regional or national coverage estimates. Instead of collecting data in every lot (district or supervision area), LC-LQAS uses a smaller number of lots per region or zone to provide representative, actionable information at a higher administrative level. The same principles can be applied at the LGA level to select a representative number of wards if there are too many to sample all wards in a given LGA. While this is beyond the scope of this guidance, detailed information is presented in Hedt et al. (2008) LC-LQAS manual (Hedt et al., 2008; Biedron et al., 2010; Hund et al., 2013). For readers interested in other LQAS adaptations such as multiple classification LQAS and LQAS for acute malnutrition, please see Olives et al., 2012 and Deitchler et al., 2007.

The following case examples describe how the Gavi-funded ZDLH Country Learning Hubs (CLHs) in Nigeria and Mali used LQAS for immunization assessments and defined the SAs/lots at different levels of the health system based on the information needs of the project. See the ZDLH website for additional LQAS resources produced by the Nigeria and Mali Learning Hubs.[2]

2 Classification reliability refers to the likelihood of observing the same outcome (pass or fail) upon repeated sampling. We expect high reliability when true coverage is at the extremes—above the upper threshold or below the lower threshold. Reliability decreases if true coverage falls within the "gray area" between the upper and lower thresholds.

Case Study 1: Nigeria – Using All Wards as Supervision Areas/Lots

In 2024–2025, the Nigeria CLH developed a Decentralized Immunization Monitoring (DIM) approach in eight LGAs across four states targeted by the CLH. The DIM used LQAS to assess RI coverage and identify low-performing areas for adaptive learning and to develop localized strategies to reach ZD and UI children. The CLH initially piloted the DIM in Kumbotso LGA in Kano State, which is the focus of this case example.

Sampling Design

For the purposes of the LQAS pilot, the entire LGA of Kumbotso was designated as the CA and each of its 11 wards served as an SA, or lot. In this design, the ward itself was the operational unit for service delivery and therefore the logical choice for defining the lot boundaries. Within each ward, 19 interview locations (villages) were selected using probability proportional to estimated size (PPES) from a master list of settlements (the sampling frame). The 19 selected locations were then segmented using sketch maps, and one segment was chosen at random. From there, a

starting household was randomly selected using randomizing principles, and interviews proceeded systematically until the required sample was reached for the two age groups of interest—children aged 4.5–11 months and children aged 12–23 months. This approach ensured that the sample reflected the distribution of the population across all wards while maintaining the comparability and reliability of results at the ward level. In this case, reliability refers to the reproducibility of the LQAS classifications based on where true coverage falls relative to the thresholds in the survey (see Footnote 2).

Indicators

The DIM used LQAS to measure both coverage and drivers of immunization uptake, including:

- **Vaccination status for key antigens:** BCG; DTP1/DTP3; IPV1/IPV2; PCV1/PCV3; Measles 1.
- **Timeliness of DTP1 vaccination:** in children aged 4.5–11 months.
- **ZD prevalence:** proportion of children aged 12–23 months with no DTP1.
- **DTP dropout rates:** between early and later doses (e.g., DTP1–DTP3).
- **BeSD indicators:** perceptions of vaccine importance and safety; trust in health workers; intent to vaccinate; social norms; service satisfaction.

Data use

Ward-level coverage estimates were compared against decision rules using an 80% target threshold for all antigens based on national vaccination targets. Wards not meeting the threshold were classified as *low-performing* and targeted for follow-up interventions. This approach allowed program managers to identify specific wards needing intensified outreach and to address social and systemic barriers. This design simplifies logistics, supports local decision-making, and still produces actionable, disaggregated results.

Case Study 2: Mali – Using Subsections of Health Facility Catchment Areas as Supervision Areas

In 2024, the Mali Country Learning Hub—Centre d'Apprentissage pour l'Équité en Vaccination (CAPEV)—piloted two interventions to improve immunization delivery across four districts in Mali: Coaching de Performance (C2P) and MEDEXIS. As part of this pilot, an LQAS survey was conducted to assess baseline vaccination coverage and identify operational barriers.

Sampling Design

The survey was designed to measure performance at a highly localized level. The geographic units were defined as follows:

- **Catchment Areas (CAs):** These were defined as the official health facility catchment areas (aires de santé). Two CAs per district were selected based on having a large target population (at least 1,000 children under 23 months) and low Penta[3] coverage.
- **Supervision Areas (SAs) / Lots:** Instead of treating an entire health facility catchment as one area, the SAs were defined as smaller subsections within each CA. These subdivisions directly aligned with the specific geographic zones assigned to the Community Health Workers (agents de santé communautaire). Mapping lots to these micro-zones allowed the project team to pinpoint pockets of low coverage within a single facility's reach.

Four CAs were divided into 5 lots, while two CAs contained 4 lots due to geographic constraints. Interviews were split evenly between two target age cohorts: children aged 18 weeks–11 months and children aged 12–23 months. For CAs with five lots, the LQAS sample size was n = 19 per SA per age cohort. For CAs with four lots, the team increased the lot sample to n=24 to achieve a total N=96 (nearly the same as n=95 for the CAs with five lots).

Interview sites within each SA were selected using Probability Proportional to Estimated Size (PPES) from updated settlement lists. Households were selected using segmentation sampling and a random-start method. Security challenges in the Yorosso district ultimately required the removal of its CAs from the final sample. Data collection successfully proceeded across the remaining 6 CAs (comprising 28 total SAs), yielding a final sample of 1,144 interviews.

Indicators

The LQAS survey in Mali measured the following:

- **Vaccination Coverage:** Coverage for BCG, Penta1, Penta3, Measles (VAR1, VAR2), and other routine antigens.
- **Zero-Dose (ZD) Prevalence:** The proportion of children aged 12–23 months who had not received Penta1.
- **Dropout Rates:** Penta/DTP dropout between early and later doses (e.g., Penta1 to Penta3).
- **Timeliness:** On-time delivery of early infant vaccinations.
- **Barriers to Service:** Reasons for non-vaccination, including perceived stock-outs, physical access, and financial costs.
- **Behavioral Determinants:** Sociodemographic factors, caregiver perceptions, trust in health services, and female decision-making autonomy.

Data Use

Subdividing a single health facility's catchment area into multiple community health worker lots allowed local teams to identify micro-level performance gaps and inequities. These localized disparities would have been otherwise masked if multiple facilities had been grouped into a single catchment area.

The classification of each lot against LQAS decision rules helped managers prioritize targeted interventions, such as mobile outreach or adjusted service hours, for specific underperforming subsections of the facility's area. This approach is particularly useful where catchment populations are large, geographically diverse or face heterogenous barriers to vaccination.

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3 The Pentavalent (Penta) vaccine combines DTP with hepatitis B and Haemophilus influenzae type b (Hib) in a single injection, reducing the number of shots for the child and improving compliance. In many countries (e.g., Mali, Nigeria, India), the Penta vaccine has officially replaced the DTP series in the national immunization schedule. Three doses of Penta are required at the same ages as DTP.

2.5. Classification Errors

An important consideration when using LQAS is to decide the amount of sampling error that is acceptable. All sampling methodologies have some level of error. LQAS has two types of error, alpha (α) and beta (β) errors. The design of LQAS aims to minimize both alpha and beta errors. In classical LQAS, these errors, or risks, are defined in a frequentist framework, meaning alpha is usually measured at the **upper threshold** and beta is measured at the **lower threshold**.

An **alpha error** occurs when a lot that has true coverage at or above the upper threshold (e.g., 80%) is incorrectly classified as failing. Also known as Type I Error, the alpha error is the probability of misclassifying a truly high-performing area as failing, suggesting an intervention is needed when the standard is already being met, potentially wasting valuable resources.

A **beta error** occurs when a lot with true coverage at or below the lower threshold (e.g., 50%) is incorrectly classified as passing. Also known as Type II Error, the beta error is the probability of misclassifying a truly low-performing area as passing, declaring an area as acceptable when it is actually substandard, which results in a missed opportunity to intervene.

Because immunization programs typically focus on improving vaccination coverage, it is important to avoid misclassifying poor performing areas as having reached a target. In these guidelines, we prioritize keeping the beta error low (e.g., beta < 0.10) because the social cost of missing an underserved (failing) area is higher than the cost of accidentally intervening in a passing one.

Keep in mind that the study team and stakeholders will not learn the true coverage from the study data; they will only learn the number of vaccinated children in the sample (i.e., 0–19) and the classification outcome (adequate or inadequate).

The alpha and beta errors are the maximum allowable risks of misclassification at the upper threshold and lower threshold, respectively. The consequences of both types of errors should be considered when determining the LQAS sample size.[4] LQAS performs well when classifying lots with coverage that is either extremely high or extremely low, but classification is less precise when true coverage levels are moderate (i.e., between the two thresholds). The closer true coverage is to either threshold increases the likelihood the lot will be correctly classified as acceptable or not acceptable. The probability of misclassification increases for smaller sample sizes. The key is to select a sample size and decision rule that minimize both types of error. Decision rules are selected where the sum of alpha and beta are lowest for a given upper and lower threshold. In general, a sample size of 19 children (with a decision rule of 13 vaccinated children) permits both alpha and beta errors of ≤10%, which is typically sufficient confidence for making decisions related to routine immunization.

2.6. How to Select the Threshold Values

2.6.1. Vaccine antigens

If you have prior coverage estimates for each antigen at the catchment level (e.g., from DHS, prior LQAS rounds, or high-quality administrative data), you can use them to set realistic upper and lower coverage thresholds. You can also use current national vaccination coverage levels or national annual targets to set the thresholds. Another way to determine the threshold is to calculate average coverage for your catchment area using the LQAS data you have just collected. To do this, first collect the data in all SAs. Next, aggregate the data across all SAs in each CA and calculate the current average coverage for each antigen in each CA. Use these coverage estimates to set the threshold values for the lots in each CA in the LQAS Decision Rule Table and then go back and classify each SA using the data you have just collected. This approach classifies the SAs that are below average.

4 Alpha and beta errors are often kept approximately equal to each other. If a program decides to prioritize reducing beta error, the result will be to increase alpha error and vice versa.

- **Upper threshold (pU):** minimum acceptable program coverage level based on current national vaccine coverage levels, current national annual targets, or current average coverage estimates for the catchment area (e.g., 80%).
- **Lower threshold (pL):** 30 percentage points below the upper threshold (e.g., 80% - 30% = 50%).

2.6.1.1. Antigen-specific thresholds

It is often advisable to set different threshold (or target) levels for each antigen rather than using the same threshold to classify all antigens. This is particularly true in cases where the existing baseline coverage varies widely (e.g., BCG 95% vs. DTP1 65%). In these cases, you can use the average coverage per antigen to define realistic pU and pL bounds rather than applying a uniform threshold across all antigens. This approach prevents overly strict thresholds for already high-coverage antigens or overly lenient thresholds for low-coverage ones. See Case Study 3 Example 3.

Upper threshold (pU) is the current coverage estimate or program target

Lower threshold (pL) is pU - 30%

Case Study 3: Setting Thresholds for Individual Antigens

When designing an LQAS survey, programs may establish coverage thresholds and corresponding decision rules for each antigen or indicator of interest. Thresholds do not need to be the same for all antigens. Indicators with higher baseline coverage—often vaccines given earlier in the immunization schedule, such as BCG—can be assessed against higher thresholds. In contrast, indicators with lower baseline coverage—often vaccines administered later in the vaccination schedule, where dropout is more likely, such DTP3 or MCV1—may be assessed against lower thresholds. Thresholds should be informed by available baseline coverage estimates from administrative data or population surveys (e.g., DHS or MICS). When LQAS is used repeatedly in the same lots to monitor program performance, results from the initial round can also serve as a useful baseline for setting upper and lower thresholds in subsequent rounds.

Steps:

- Identify antigens or indicators of interest (e.g., BCG, Penta/DTP1, Penta/DTP3, MCV1).
- Review recent coverage estimates to understand baseline levels, including past LQAS data if available.
- Set upper coverage thresholds that are both realistic and ambitious. Upper threshold = the current coverage estimate or program target for each antigen; lower threshold = upper threshold - 30%.
- Select a decision rule for each antigen based on the LQAS Decision Rule Table for your sample size (most common is n = 19) where the combined alpha and beta errors are <=10%.

Table 1 shows how different thresholds and decision rules can be used for three childhood vaccination indicators across five SAs/lots using hypothetical data. In this case, the SAs were defined as the wards in one selected district (LGA) and the sample size in each ward was 19 children aged 12–23 months. The selection of upper and lower thresholds was based on available data from previous MICS surveys that showed lower existing coverage of Penta 1 and Penta 3 (70% and 60%, respectively) at the state level.

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Interpretation:

- **Lots that FAIL:** SAs where coverage is ***below*** the stated lower threshold. SA3 in particular performed poorly across all three antigens; a program would likely focus resources in this SA to strengthen services and/or demand. Further investigation is needed to determine the root causes of the poor performance.
- **Lots that PASS:** SAs where coverage is ***at or above*** the stated upper threshold. SA2 and SA5 performed well across all three antigens and may provide lessons learned for SAs that have weaker vaccination performance.

Table 1. Illustrative LQAS Classification of Vaccination Coverage Using Decision Rules and Thresholds

Indicator	SA1	SA2	SA3	SA4	SA5	Upper/ Lower Thresholds	Decision Rule	Lot Classification
Children 12–23 months who received BCG by first birthday	16	18	9	14	17	85% / 55%	14	**Pass:** SA1, SA2, SA4, SA5 **Fail:** SA3
Children 12–23 months who re-ceived Penta1 by first birthday	14	16	6	8	12	70% / 40%	11	**Pass:** SA1, SA2, SA5 **Fail:** SA3, SA4
Children 12–23 months who re-ceived Penta3 by first birthday	7	15	3	2	12	60% / 30%	9	**Pass:** SA2, SA5 **Fail:** SA1, SA3, SA4

2.6.2. BeSD indicators or knowledge, attitude, practice (KAP) variables

Target thresholds typically do not exist for indicators related to vaccination drivers or caregiver knowledge, attitude, practice (KAP) variables. The recommended approach for determining an appropriate target threshold (pU) for such indicators is to use the average proportions of each indicator at the CA level. This approach works similarly to antigen coverage thresholds, but there are important nuances because BeSD and KAP indicators measure attitudes, beliefs, and intent using Likert scales rather than binary categories used for vaccination status.

2.6.2.1. Clarify what you are classifying

Each BeSD indicator (e.g., "confidence in vaccine safety," "perceived convenience of services") is usually measured as a proportion of caregivers agreeing with a statement (e.g., percent answering "agree/strongly agree"). When using LQAS, you want to classify a catchment area as acceptable or problematic for each indicator (e.g., "high vaccine confidence" vs. "low vaccine confidence"). In most cases, it is necessary to recode the BeSD indicators into binary indicators where the Likert responses are assigned a yes or no based on pre-defined categories, as recommended in the WHO BeSD guidelines. For example, "strongly agree" and "agree" responses are recoded as a "yes," while "neutral," "disagree," and "strongly disagree" are recoded as a "no." These binary categories allow LQAS to classify lots based on a simple count of positive responses.

2.6.2.2. Use average proportions to define LQAS thresholds

If you have baseline or previous survey data for each BeSD indicator:

- Upper threshold (pU):
  - Define what you consider to be a "desirable" level for each indicator (e.g., 85% of caregivers have confidence in vaccines) using existing data as a reference.
  - This can be based on the average proportion calculated at the aggregate level using the LQAS data you have just collected or based on existing BeSD surveys from the program area. Or you can just use the average proportion for each indicator as the upper threshold.

- Lower threshold (pL):
  - Define what level you consider "problematic" (e.g., ≤60% caregivers have confidence in vaccines).
  - This can be 20–30% below pU, or aligned with historically low-performing areas.

2.6.2.3. Why average proportions are useful

Average BeSD scores provide a realistic reference point for determining LQAS thresholds instead of arbitrary targets. Different BeSD domains (thinking/feeling, social processes, motivation, practical issues) often have different baseline levels and thresholds should reflect these rather than applying a single cut-off. Thresholds signal where the social or behavioral barriers are high enough to warrant intervention at the catchment level.

2.6.2.4. Important caveats for BeSD indicators

Unlike vaccination coverage (where 80–90% targets are clearly desirable), consensus is lacking on cut-offs for social and behavioral indicators and such thresholds can appear to be subjective. For this reason, thresholds should be co-developed with program teams. Some indicators are positive (e.g., "confidence in vaccines") while others are negative (e.g., "concerns about side effects"). It is important to keep in mind the direction of the indicators to ensure you define the thresholds consistently (e.g., proportion with low concern vs. high concern). Lastly, BeSD indicators tend to fluctuate more than vaccination coverage, so consider using a slightly wider tolerance (pU and pL may be closer together than for vaccine antigens).

Case Study 4: Setting Thresholds for BeSD Indicators

Managers need to understand how to select LQAS thresholds and decision rules for the BeSD indicators. These indicators have been incorporated in the LQAS survey instruments used by the Nigeria and Mali CLHs for the purpose of classifying the drivers of vaccination at the subnational level. While BeSD data are mainly analyzed at the aggregate CA level, we describe how to classify BeSD data at SA level here.

To set thresholds and decision rules for BeSD indicators, you must transition from measuring coverage (a binary yes/no indicator) to measuring sentiment or experience (e.g., "was the parent treated with respect?"). Because BeSD indicators such as intent, confidence, and practical issues often precede the actual vaccination event, the thresholds you choose should reflect your programmatic "tolerance" for these barriers.

Practical Example Using the Respectful Care Indicator

In the Mali and Nigeria CLHs, a critical BeSD driver is the quality of immunization services.

Why BeSD Thresholds Differ from Vaccination Antigens

Unlike immunization coverage, where 80% is a commonly-used benchmark, BeSD thresholds are often context-specific:

- **For "Intent to Vaccinate":** You might set a very high pU (90%) because intent should always be high.
- **For "Practical Issues" (e.g., distance):** You might set a more modest pU (70%) if the geography is known to be difficult, focusing only on identifying the absolute worst-performing areas.

Note: By choosing n = 19 and the relevant threshold levels, you are ensuring that your alpha error (failing an acceptable lot) and beta error (passing an unacceptable lot) remain low, usually below 10%.

2.7. What Sample Size Should be Used in Each SA?

When using LQAS, the sample size is determined by selecting your indicator target (pU) and the lower threshold (pL) and the maximum acceptable classification errors (α and β errors) for pU and pL. For evaluating vaccination coverage relative to a target, the most commonly used sample size is n = 19 per SA (Robertson and Valadez, 2006). This sample size is generally sufficient because for any value of pU (with a 30-percentage point range between pU and pL) the classification errors will not exceed 0.10. Therefore, a sample of 19 provides an acceptable level of error for making management decisions. Sample sizes larger than 19 result in the same classifications with similar error terms, but they can be more expensive to carry out simply because of the larger number of interview locations. See Figure 2 for the LQAS Decision Rule Table. See Annex 1 for more details on the LQAS sample size calculation.

Figure 2. LQAS Decision Rule Table with Decision Rules for Sample Sizes 12–30 Assuming 30 Percentage Points between pU and pL

LQAS Table: Decision Rules for Sample Sizes of 12-30 and Coverage Benchmarks or Average Coverage of 10% to 95%

	Coverage Benchmarks or Average Coverage																	
Sample Sizes	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
12	N/A	N/A	1	1	2	2	3	4	5	5	6	7	7	8	8	9	10	11
13	N/A	N/A	1	1	2	3	3	4	5	6	6	7	8	8	9	10	11	11
14	N/A	N/A	1	1	2	3	4	4	5	6	7	8	8	9	10	11	11	12
15	N/A	N/A	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13
16	N/A	N/A	1	2	2	3	4	5	6	7	8	9	9	10	11	12	13	14
17	N/A	N/A	1	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	N/A	N/A	1	2	2	3	5	6	7	8	9	10	11	11	12	13	14	16
19	N/A	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20	N/A	N/A	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17
21	N/A	N/A	1	2	3	4	5	6	8	9	10	11	12	13	14	16	17	18
22	N/A	N/A	1	2	3	4	5	7	8	9	10	12	13	14	15	16	18	19
23	N/A	N/A	1	2	3	4	6	7	8	10	11	12	13	14	16	17	18	20
24	N/A	N/A	1	2	3	4	6	7	9	10	11	13	14	15	16	18	19	21
25	N/A	1	2	2	4	5	6	8	9	10	12	13	14	16	17	18	20	21
26	N/A	1	2	3	4	5	6	8	9	11	12	14	15	16	18	19	21	22
27	N/A	1	2	3	4	5	7	8	10	11	13	14	15	17	18	20	21	23
28	N/A	1	2	3	4	5	7	8	10	12	13	15	16	18	19	21	22	24
29	N/A	1	2	3	4	5	7	9	10	12	13	15	17	18	20	21	23	25
30	N/A	1	2	3	4	5	7	9	11	12	14	16	17	19	20	22	24	26

For all coverage benchmarks (except where noted) LQAS is at least 92% sensitive and specific

N/A = Not Applicable -- Indicates that LQAS should not be used since coverage is too low for LQAS to detect.

[blue] Alpha and Beta Errors are > 10%

[yellow] Alpha and Beta Errors are > 15%

The LQAS Decision Rule Table shown in Figure 2 facilitates the sample size and decision rule selections for an LQAS coverage assessment in a given population. Different sample sizes are listed in the first column and possible upper thresholds (pU) are listed in the first row. Decision rules relative to sample size and thresholds are found in the body of the table. Different shading of the cells indicates the alpha and beta errors associated with decision rules for different sample sizes at different coverage levels. The table outlines the typical case of a sample of 19 where 80% upper and 50% lower thresholds for coverage and a decision rule of 13 are used. See Annex 3 for a full-size LQAS Table.

To use the LQAS Table, place one finger on the coverage target column of 80% and the other on the sample size row of 19 which is the sample size we have been using in this document. By moving your finger down the 80% column and the other finger across the n = 19 row, they meet at a cell showing 13, which is the decision rule. The LQAS Table assumes a pL of 30% below pU. Notice that the cells are color coded. A white cell means that the total classification errors for pU and pL do not exceed 0.10. A blue cell means one or both errors exceed 0.10. If the cell is yellow, then one or both errors exceed 0.15. The blue and yellow cells reflect the decision rules with larger total errors.

In the LQAS Table, you will notice that 19 is the smallest sample size where both alpha and beta are ≤10% for all benchmarks or targets of 10%–95% in the table. This means that when the decision rule is not met, you have evidence that the target has not been achieved (this will be true 90% or more of the time). Note that if the decision rule is met, you cannot say you have evidence that the target has been achieved. What you can say is that there is "insufficient evidence that it has not been achieved." If you find this language awkward, you can simply say the decision rule has been reached and the SA is classified in the high category, or the decision rule was not reached with the SA classified in the low category.

You will notice in Figure 2 that the cells are color-coded. If both alpha and beta are <10% then the cell is clear. If alpha or beta are greater than 10% or 15% these are coded blue or yellow, respectively. With a sample size of 19, all cells are clear—this is the smallest sample size with low-error terms. Alpha and beta errors vary with the sample size and the decision rule. While it is counter intuitive that sample sizes of 20 and 22 have blue-coded cells, in these cases either alpha or beta slightly exceeds 10%. Decision rules are chosen for each target threshold to minimize the ***sum of alpha and beta***. Reducing one error term can increase the other, so the selection of the decision rule seeks the smallest combined value of alpha + beta. While the error terms for samples of 20 and 22 exceed 10%, they do so by hundredths of percentage points and have little programmatic impact. However, for purposes of transparency, they are still color-coded blue in the table that guides decision rule selection. Please note: you can also use the LQAS app to determine the sample size: bit.ly/LQAS_Sample_Size_Calculator.

2.8. Why is There Only One Decision Rule with Two Thresholds?

A core principle of classical LQAS is the use of a single decision rule to evaluate lots against two predetermined thresholds: an upper threshold (pU) and lower threshold (pL). Data from the lot samples are used to classify the lots as either "acceptable" or "unacceptable" relative to pU and pL. In this guidance, we use 80% and 50% as the example thresholds, but these can be set at higher or lower levels depending on the specific program or vaccination targets. Typically, immunization coverage targets are much higher than 80% (often 90–95%) for several epidemiological, programmatic, and equity reasons. WHO and UNICEF generally recommend ≥90% coverage nationally and ≥80% in every district to meet disease elimination goals (Strategic Advisory Group of Experts on Immunization, 2013).

With this approach, only one decision rule is used which is selected to minimize the misclassification of a lot. The decision rule (d) is the cutoff point for classifying lots based on data from the lot sample. For example, d = 13 vaccinated children for lot sample size n = 19 with upper and lower thresholds of 80% and 50%. Using this decision rule, lots with 13 or more vaccinated children are classified at or above the pU value (80%). Lots with 12 or fewer vaccinated children are classified at or below the pL value (50%).

LQAS focuses on both upper and lower thresholds, not just one. The probability of observing 13 or more vaccinated children in a lot sample of 19 is above 90% for any population coverage that is above 80%. This is why we choose 13 to be our decision rule cutoff.

If we observe 13 or more vaccinated children in our random lot sample of 19, we will declare the population coverage to be better than 80%. With this decision rule, we have the confidence that when the population coverage is 80% or better, the risk of making an error is less than 10%.

Similarly, if the population coverage is 50% or less, the probability, or risk, of making a mistake in our inference about the population coverage (mistakenly saying it is >80%) is less than 10%.

The risk of making an error varies with the true population coverage and the decision rule used.

With any LQAS application, the goal is to classify the population prevalence as above or below the predefined thresholds by comparing the number of "successes" in a random lot sample to a specific decision rule. The choice of sample size and decision rule determine the degree to which we can rely on this classification. LQAS controls the errors at the boundaries pU and pL rather than within the gray zone between them. That is why a single decision rule calibrated at the two thresholds is sufficient.

LQAS classifications are usually most suitable (and classification errors are lowest) when using a sample of 19 and when the spread between the two thresholds is not more than 30%. You can reduce the spread between the thresholds, but this would result in an increased sample size. As a reminder, lots refer to administrative or geographic areas such as districts, subdistricts, or health facility catchment areas, etc.

Example LQAS Parameters

- pU = 80% (high-performing)
- pL = 50% (low-performing)
- alpha error and beta error < 0.10 at pU and pL
- Decision rule = 13 vaccinated children (cut-off point)
- Lot sample size n = 19 children aged 12–23 months

It is important to remember that the "pass" result is a statistical decision, not a measurement. "Pass" does not guarantee that true coverage is at or above 80% in a given lot. Because of the gray zone inherent in small-sample statistics, many lots classified as "pass" will actually have true coverage below the target, and that is acceptable from an LQAS method perspective.

However, if true coverage is above 80%, it is very likely it will be correctly classified as a "pass." The purpose of LQAS is not to correctly categorize every lot, just to classify the extremes. This distinction is important to avoid equating a "pass" with coverage above 80%.

The classical LQAS method is designed to simplify fieldwork by using a single cut-off value (d) for a given set of thresholds and sample size. The decision rule is the cut-off value where the classifications do not exceed the maximum permitted errors for the chosen thresholds. This approach avoids the need for full estimation of coverage in individual lots while still supporting programmatic decisions. For a detailed explanation of this point and example of how a decision rule is selected, please see (Valadez, 1991, Chapter 4).

2.8.1. Selecting a decision rule

As explained in Annex 1, LQAS sample sizes and decision rules are determined using binomial probabilities. The binomial formula calculates the probability of a specific number of vaccinated children being sampled in a population that has the exact coverage of, say, 80% or 50%.

Column 2 in Figure 3 shows the exact probability that exactly 19 children in a sample of 19 will be vaccinated in an SA with 80% coverage. The column shows the remaining probabilities for exactly 18 children through 9 children. The next column over comprises the cumulative probabilities of the previous individual probabilities. The highlighted portion of the example shows 12 vaccinated children with a cumulative probability of 0.997, which is the chance that in a population with 80% coverage, 12 or more children will be vaccinated in a sample of 19. It also shows cumulative probabilities for 14 or more and 13 or more children of 0.837 and 0.932, respectively. The next column shows the error which is 1 minus the cumulative probabilities, which are very low for 13 and 14. So why then choose 13 or more vaccinated children as the decision rule instead of 12, which has the lower error of 0.023 vs 0.068 for a decision rule of 13?

The answer becomes clear in the next half of **Figure 3**, which shows that pL, the populations with 50% coverage, have a 0.180 probability of having 12 or more vaccinated children being sampled when n = 19. The cumulative probability for 13 children declines to 0.084, which maintains an error less than 0.10 for a decision rule of 13. The last column contains the cumulative errors for each decision rule option which sums columns 4 and 7. The cumulative error is lowest for any decision rule option for d = 13. It is 0.152. Any other choice has a higher cumulative error.

The principle is to choose the decision rule option that has the lowest joint error for misclassifying pU and pL. This applies for any value of pU and pL.

Figure 3. Selecting a Decision Rule for a Sample of 19 With a Target of 80% Coverage

Example 1: Selecting a decision rule for a sample 19 with a target of 80% coverage							
Vaccincation Coverage = 80%, n=19				Vaccincation Coverage = 50%, n=19			Cumulative error
Vaccinated children sampled	Probability of occurrence	Cumulative probability	Error	Vaccinated children sampled	Probability of occurrence	Cumulative probability	
19	0.014	0.014	0.986	19	0	0	0.986
18	0.069	0.083	0.917	18	0	0	0.917
17	0.154	0.237	0.763	17	0	0	0.763
16	0.218	0.455	0.545	16	0.002	0.002	0.547
15	0.218	0.673	0.327	15	0.008	0.010	0.337
14	0.164	0.837	0.163	14	0.022	0.032	0.195
13	0.095	0.932	0.068	13	0.052	0.084	0.152
12	0.045	0.977	0.023	12	0.096	0.180	0.203
11	0.016	0.993	0.007	11	0.144	0.324	0.331
10	0.005	0.998	0.002	10	0.176	0.500	0.502
9	0.0020	1	0	9	0.175	0.675	0.675

In classical LQAS, charts like the operating characteristic curve (OCC) and risk curves are used to summarize a survey design. These frequentist tools show the probabilities of making errors (alpha and beta risks) based on the true coverage level.

2.8.2. What is an Operating Characteristic Curve?

The OCC is central to understanding how LQAS uses a single decision rule to classify lots based on two thresholds (i.e., 50% and 80%). The OCC plots the probability of a lot being classified as "acceptable" across a range of true coverage values. At a true coverage of 80% (upper threshold), there is a ≥90% chance that the area will be correctly classified as acceptable. This also means there is a ≤10% risk of making a Type 1 error (alpha risk), which is the risk of incorrectly classifying a high-performing lot as unacceptable. Expressed mathematically, where Pa represents the probability of acceptance, the alpha risk is $1 - P_a \leq 10\%$.

Likewise, at a true coverage of 50% (lower threshold), there is a ≤10% chance that the area will be incorrectly classified as acceptable. This represents the Type II error (beta risk), which is the risk of incorrectly classifying a poor-performing lot as acceptable, written as $P_a \leq 10\%$.

The above discussion of decision rule selection can be extended to show how populations with any level of coverage from 0% to 100% are classified. All communities are classified, not just those with 80% or 50%. Figure 4 shows the OCC for our example of sample size n = 19; decision rule (d) = 13; pU = 80%, pL = 50%. The OCC plots the probability of accepting a lot with any level of coverage.

- **X-axis:** True population coverage (e.g., 0% to 100%).
- **Y-axis:** Probability of accepting the lot or "passing" (i.e., number of vaccinated children ≥ decision rule threshold).

The OCC helps you understand how likely you are to classify a lot as acceptable (or unacceptable) at different levels of actual coverage. With classical LQAS the objective is to:

- Minimize the risk of misclassifying poorly performing lots (<50%) as acceptable.
- Minimize the risk of misclassifying high-performing lots (>80%) as unacceptable.

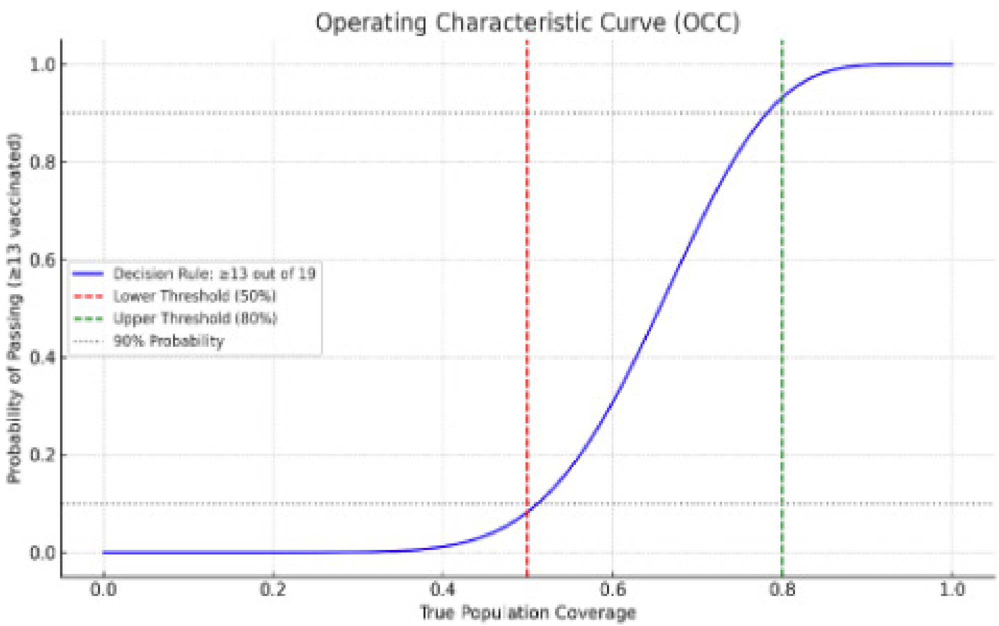
- Accept some uncertainty for coverage levels in between the two thresholds where lots may be classified either way.

To do this, the OCC helps you select a single decision rule (d) where:

- The probability of incorrectly passing a truly low-coverage area (≤50%) is very low (ideally ≤10%)
- The probability of correctly passing a truly high-coverage area (≥80%) is very high (ideally ≥90%)

This means the OCC bends steeply between the lower and upper thresholds, ensuring sharp discrimination between the two thresholds.

Figure 4. LQAS Operating Characteristic Curve for a Lot Sample of 19 and Decision Rule of 13



The OCC shown above is for an LQAS sample of 19 with a decision rule = 13. The curve shows the probability of concluding that a lot meets the performance threshold (i.e., ≥13 vaccinated) at various levels of true coverage from 0–100%. The height of the curve at the lower threshold is beta and the height of the curve at the upper threshold is 1 - alpha.

2.8.3. How to interpret the OCC

- At **50% true coverage**, the probability of observing >13 vaccinated children in the lot sample is very low (~5–10%); this is the chance of acceptance which is very small. Therefore, lots with poor performance are unlikely to pass.
- Notice how the curve slopes steeply left as true coverage declines, showing a diminishing likelihood of accepting (i.e., passing) poorly performing lots as you reach the pL coverage target.
- At **80% true coverage**, the probability of observing >13 vaccinated children in the sample is very high (~90%+). Therefore, most truly high-performing lots will pass. If 13 or more children in the sample are vaccinated, the area is classified as high-performing and is unlikely to need an immediate intervention.
- Notice how the curve slopes steadily right, showing that as coverage increases above 80%, the chance of misclassifying the lot reduces to zero.
- The curve transitions steeply between 50% and 80%, ensuring a clear discernment between low and high performers. The closer true coverage is to either pU or pL, the greater the chance the lot will be classified at that end of the continuum.

- LQAS is sensitive to the high and low ends of the binomial distribution rather than detecting small differences near the middle. That is its purpose: LQAS is a classification tool.

Using the OCC allows us to quantify the risks of error (i.e., false positives and negatives) of misclassifying lots in the wrong category. These features are important for making evidence-based program decisions based on small samples and helps users to understand how all populations are being classified.

2.8.4. Confidence intervals

As explained in this guidance, classical LQAS is designed as a classification method, not an estimation method. The decision rule (e.g., 13 of 19) already incorporates acceptable error rates (i.e., alpha and beta errors, or misclassification risks described above) and is used to classify each lot as meeting or not meeting a predefined coverage threshold. CIs are not required for this classification step.

In some cases, programs may aggregate the data from multiple lots to estimate an overall coverage level for a district or region. When pooled data are used in this way, the data should be weighted (explained below) and CIs always should be calculated to describe the precision of the pooled estimate. It is important for the CI to be calculated with software that accounts for the stratified design of the sample as there will be a design effect. Additionally, because LQAS samples are small and coverage proportions can be very high or very low, typically the Wilson CI formula is preferred. This method provides asymmetric CIs if the coverage is near 0% or 100%, which reflects true uncertainty better than standard symmetric (Wald) intervals, which assume a normal distribution. These issues are fully described in the statistical textbook by Dean and Pagano (2015).

2.9. Developing the Sampling Frame

A sampling frame is needed for each supervision area. For this example, a sampling frame is a list of all communities, villages, or settlements in each SA and their approximate population size. Figure 5 shows an example sampling frame from a hypothetical country. The population size can be an estimate of the number of children under two years of age, an estimate of the total population, or an estimate of the number of households in the SA.

For the purposes of developing the sampling frame, the population sizes do not have to be exact. It is important to know the relative size of one community to the other so you can sample interview locations using probability proportional to size (explained below).

The listing of all communities in an SA is typically available from one of two sources. Frequently, the district health management team has a listing as it is useful for managing their drug supply, including their supply of vaccines. The second source is the Central Bureau of Statistics or the Department of Planning, which may have demographic and population data for planning purposes. Once you have the draft sampling frames, it is a good idea to ask the district staff to review each one, ensuring that all villages are correctly assigned to the appropriate SA and verifying whether recent population changes—such as increases due to refugee movements—are accurately reflected in the recorded population data.

Figure 5. Example of a Sampling Frame for an SA with All Communities Listed

Name of Community	Total Population
Pagai	548
Santai	730
Serina	686
Mulrose	280
Fanta	1256
Bagia	684
Rostam	919
Mt. Sil	1374
Livton	1136
Farry	544
Tunis	193
Pulau	375
Sarasota	333
Pingra	3504
Kanata	336
Sirvish	2115
Balding	258
Rescuut	678
Krista	207
Manalopa	1162
Garafa	408
Spiltar	455
Masraf	978
Abrama	335
Junagadh	541
Singri	725
Kalarata	355
Ichimota	498
Chaplar	347
Sr. Kitt	186
Nevis	1346
TOTAL	**23489**

2.10. LQAS Sampling Procedures

LQAS sampling uses a series of steps to systematically narrow down the selection from a larger subnational area to a specific household.

Step 1: Probability Proportional to Estimated Size (PPES) to select villages: The process begins by selecting the specific villages or communities where the LQAS interviews will take place. Using PPES ensures that larger villages have a higher chance of being selected, which keeps the data representative of the total population.

Step 2: Segmentation sampling to select the index house: Once a village is chosen, it is divided into smaller geographic "segments" of roughly equal population sizes. One segment is randomly selected, and a starting household is identified within it. This eliminates interviewer bias and ensures that every household has an equal chance of being included.

Step 3: Parallel sampling if you need to sample different age cohorts: Finally, if the survey includes indicators for multiple age groups (such as infants for polio and older children for measles), parallel sampling is used. Instead of restarting the entire segmentation process for each age group, the data collector uses the index household for the first cohort and then visits the *next nearest door* to find respondents for the remaining cohorts. Because the first house was randomly selected through segmentation sampling, these subsequent households are also considered part of a random chain, allowing for valid data collection across multiple age cohorts simultaneously.

Detailed instructions are provided below for each step in the sampling cascade.

2.10.1. Step 1: Random sampling of interview locations using PPES

For a typical LQAS survey, 19 interview locations are randomly sampled in each supervision area using Probability Proportional to Estimated Size (PPES) sampling. The interview locations are the villages where you will carry out the interviews. PPES sampling is a sampling procedure where the probability of a village being selected is proportional to its size, giving larger villages a greater probability of selection and smaller villages a lower probability. The location of the LQAS interviews depends on the relative sizes of the villages. Larger villages will have several interview locations while the smaller villages may have none. Using PPES to define your interview locations also accounts for heterogeneity in coverage levels. See Box 6 for a brief explanation of the steps for using PPES. Annex 6 contains instructions and an automated Excel worksheet that you can use to generate a PPES sample for your LQAS survey. The worksheet also provides example village data used by the Nigeria CLH to develop their PPES sample.

Box 6. How to Use Probability Proportional to Size (PPES) Sampling

To conduct PPES sampling, first obtain a list of all villages in the SA from a reliable source. *The village list is the sampling frame for the SA*. Ensure the list includes the up-to-date population size of each village in the SA. It is not necessary for the sampling frame to have the exact population sizes; what is important for PPES is the relative size of the villages. The village list should be reviewed together with the local authorities or health workers to verify the information. For example, areas with high levels of in-migration or out-migration may have different population sizes than listed in the sampling frame and the population estimates should be verified by the local health workers who are delivering services in these areas.

Steps:

- Calculate the cumulative population. To do this, first create a table with five columns. List all villages (in any order) and their respective populations in columns 1 and 2. Record the total population of all villages in column 2. To calculate the cumulative population, record the population of the first village in the third column. Then add this population size to the population of the second village, and record that number in the next row. Continue this process until you reach the last village. See Figure 6 for a completed example. Please note, the total population and total cumulative populations should be the same (e.g., 23,489).
- Calculate a sampling interval by dividing the cumulative population by the sample size, which in our example is n = 19. The result is 23,489 / 19 = **1,236.26** which is the sampling interval.
- Next, identify the 19 interview locations for the SA, as follows. The first interview location is determined by taking a random number between 1 and the sampling interval (in this case 1,236.26) from a random number table. Let's assume the number is 622. That is the first interview location. Record that number in the column labelled "interview location" (see Figure 7). To do this, find the village where the number 622 is greater than the previous village cumulative population and less than or equal to the current population size. For example, the first interview location is 622. This number is greater than the first village Pagai (545), but less than the cumulative population in the second village Santai (1,278).
- The next sampling point is found by adding the sampling interval (1,236.26) to 622 (first interview location) which gives 622 + 1,236.26 = 1,858.26. Record the second interview location in the same "interview location" column. The sampling point (1,858.26) is greater than Santai cumulative population (1,278) and less than the cumulative population of the next village, Serina (1,964). Therefore, Serina gets the second sampling point.
- Following this logic, the third sampling point is found by adding the sampling interval to the previous interview location as follows: 1,858.26 + 1,236.26 = 3,094.52. This process continues until all 19 interview locations have been recorded in the table. It is important to avoid rounding off the decimals to the closest whole number as this could bias against selecting villages at the end of the list, or you could have a last interview location number that is larger than any village population in the sampling frame. By retaining the decimal places, you ensure that your sampling process remains accurate across the entire population.
- Lastly, in the last column, note the number of interviews that should take place in each selected village in the list. See Figure 7 for a complete example.

Figure 6. Example Sampling Frame with Cumulative Population Sizes

Name of Community	Total Population	Cumulative Population
Pagai	548	548
Santai	730	1278
Serina	686	1964
Mulrose	280	2244
Fanta	1256	3500
Bagia	684	4184
Rostam	919	5103
Mt. Sil	1374	6477
Livton	1136	7610
Farry	544	8154
Tunis	193	8347
Pulau	375	8722
Sarasota	333	9055
Pingra	3504	12559
Kanata	336	12895
Sirvish	2115	15010
Balding	258	15268
Rescuut	678	15946
Krista	207	16153
Manalopa	1162	17315
Garafa	408	17723
Spiltar	455	18178
Masraf	978	19156
Abrama	335	19491
Junagadh	541	20032
Singri	725	20757
Kalarata	355	21112
Ichimota	498	21610
Chaplar	347	21957
Sr. Kitt	186	22143
Nevis	1346	23489
TOTAL	**23489**	**---**

Figure 7. Example PPES Sample Using a Sampling Frame

Name of Community	Total Population	Cumulative Population	Interview Location Number	Number of Interviews
Pagai	548	548		
Santai	730	1278	622	1
Serina	686	1964	1858	1
Mulrose	280	2244		
Fanta	1256	3500	3094	1
Bagia	684	4184		
Rostam	919	5103	4330	1
Mt. Sil	1374	6477	5567	1
Livton	1136	7610	6803	1
Farry	544	8154	8039	1
Tunis	193	8347		
Pulau	375	8722		
Sarasota	333	9055		
Pingra	3504	12559	9275, 10512, 11748	3
Kanata	336	12895		
Sirvish	2115	15010	12984, 14220	2
Balding	258	15268		
Rescuut	678	15946	15457	1
Krista	207	16153		
Manalopa	1162	17315	16693	1
Garafa	408	17723		
Spiltar	455	18178	17929	1
Masraf	978	19156		
Abrama	335	19491	19165	1
Junagadh	541	20032		
Singri	725	20757	20402	1
Kalarata	355	21112		
Ichimota	498	21610		
Chaplar	347	21957	21638	1
Sr. Kitt	186	22143		
Nevis	1346	23489	22876	1
TOTAL	**23489**	**---**		**19**

2.10.2. Step 2: Random sampling of respondents using segmentation sampling

The PPES sample is the first step in random sampling and provides the list of villages selected for the LQAS interviews. Once you arrive at each selected village, LQAS surveys typically use **segmentation sampling** (Turner, Magnani, and Shuaib, 1996) to randomly sample the first household. Please note that while this is a practical way to do sampling in larger communities, if a complete, up-to-date household listing is available, this may be used for sampling instead. The disadvantage of the household listing is that it may not reflect all households in a community, especially those who have been systematically missed by primary health care services and are more likely to have ZD or UI children.

The segmentation sampling approach for household selection is preferred because it:

- **Reduces bias:** eliminates the subjectivity of interviewers choosing "convenient" households.
- **Improves probability:** ensures every household in a selected area has a known, equal chance of being selected.
- **Standardizes the process:** divides a primary sampling unit (like a village) into smaller segments of roughly equal population size, one of which is randomly selected for systematic sampling.

2.10.2.1. How to use segmentation sampling

Digital maps (e.g., Google Maps) are useful tools for dividing catchment areas into supervision areas or lots, providing clear boundaries at higher administrative levels. However, digital maps are generally too coarse for segmentation sampling at the community level, where detailed, locally relevant divisions are required. For this purpose, sketch maps developed with input from community informants are essential to accurately identify landmarks and segment smaller areas within a community, including informal settlements or seasonal clusters. While sketch maps may be less precise and harder to replicate than digital maps, they better capture local realities critical for probability-based sampling. They can be developed during community entry with local guides and are flexible for adjusting to informal or rapidly changing communities. For transparency, the segmentation process should be documented and photos or copies of the sketch maps should be kept by the survey team.

Steps for segmentation sampling:

- The data collector should begin by contacting one or more village leaders to work together to sketch a map of the village, which includes paths, roads, and landmarks such as markets, churches, mosques, large stones or trees, or cemeteries.
- Using the sketch map, the local leader then estimates the number of households in the village and marks the approximate number of households in each location on the map.
- The data collector then divides the village into segments of similar size (e.g., similar number of households) and enumerates each segment. The aim is to create segments of approximately 20 households or less.
- Using a random number table, which is a standard part of the data collection kit (see Annex 2), one segment is randomly selected.
- The data collector must then visit the selected segment. If the segment has 20 or fewer houses, the data collector then draws a detailed map showing the location of the households on the back of the questionnaire (if using paper-based questionnaires) or on separate paper.
- If there are more than 20 houses in the segment, the area is further segmented, and one segment is chosen randomly.
- Once the detailed map showing the location of the houses is completed, one house is selected randomly using the random number table. This is called the reference household. Normally, the house closest to the reference household is chosen for the first interview to reduce the chance that houses not included in the map have zero probability of selection.
- Remember to keep copies of your segmentation maps and any photos as documentation of the randomizing process used to select the reference household.

See Photos 1 and 2 for examples of segmentation sampling.

Photo 1. A training map developed in Uganda to demonstrate segmentation sampling.

Photo 2. A segmentation sampling map developed in South Sudan by a data collector with the input of village leaders.

2.10.3. Step 3: Sampling more than one age cohort using parallel sampling

Global guidance for vaccination coverage surveys (i.e., WHO Vaccination Coverage Cluster Surveys) sometimes recommends sampling multiple age cohorts within the same household (e.g., 12–23 months for routine coverage and 24–59 months for campaign coverage) to efficiently assess multiple indicators. While logistically appealing, this approach has some disadvantages when analyzing the age cohorts separately:

- **Potential selection bias from household composition:** Households with multiple eligible cohorts tend to be larger or differ socioeconomically from households with only one eligible cohort. If these household characteristics are correlated with vaccination uptake, failing to adjust for them can bias cohort-specific coverage estimates.

- **Increased respondent burden:** Collecting data for multiple cohorts from the same caregiver prolongs interviews and can contribute to respondent fatigue, which may compromise data quality and increase non-sampling error (Valadez and Devkota, 2002).

Classic LQAS using parallel sampling is a useful alternative when you use survey indicators that require different denominators. The most common in the ZD context are children aged 0–11 months to measure timeliness of vaccination and children aged 12–23 months to calculate coverage of DTP1 or dropout from DTP1 to DTP3. Additional age cohorts may need to be included in the sample if the survey is evaluating other antigens, for example, the second dose of measles-containing vaccine (MCV2), which is usually given between 15–18 months of age. In this case, an additional cohort of children aged 24–36 months is usually included in the survey to ensure there are enough respondents to satisfy the sample size.

Using **parallel sampling** allows a data collection team to efficiently collect information from different sample groups in the same area at the same time. It also ensures that there is an adequate sample size for each indicator from each sample group. Therefore, parallel sampling allows you to select an independent sample of children in each age cohort to maintain the statistical power in each group.

Table 2. Parallel Samples for Three Age Cohorts with Example Indicators Measured

Age Cohort (Parallel Sample)	Common Indicators Measured in Each Age Cohort	Lot Sample (n)	Number of Lots	Total Sample (n)
0–11 months	Timely vaccination with Penta1, Penta2, and MCV1	19	5	95
12–23 months	Vaccination with Penta1, Penta3, MCV1; Dropout Penta1-3; Dropout Penta3-MCV1; complete vaccination	19	5	95
24–36 months	Vaccination with MCV2	19	5	95
				285

With LQAS, data are used to make decisions about whether or not SAs are meeting targets or benchmarks. This same information can be aggregated, using a weighted average, across the supervision areas to obtain accurate coverage estimates for the entire project area. Parallel sampling ensures there is a sample size of at least n = 19 for each indicator for each SA. This provides a sufficient sample size to classify SAs that are meeting program benchmarks or targets and those areas that require special attention. It also helps to ensure there is an adequate sample size at the program or project level when the data from the separate SAs are pooled to measure coverage. A minimum sample size of n = 95 is recommended for each indicator to calculate a mean and a confidence interval for the entire project area.

2.10.3.1. How to use parallel sampling

In the selected household, the data collector lists all eligible children in the target age groups (e.g., children 0–11 months and 12–23 months) and selects one randomly using a random number table. The selected child is the subject of the interview. It is recommended to sample only one respondent from a given household.

The remaining target group is selected in the next closest door of the next closest house (Valadez et al., 2007a; Valadez et al., 2007b). The principle is to make use of the one randomly selected household to sample a target age group. If they are not in one household then the next closest house is used. The order in which a child 0–11 months or 12–23 months is selected is not important. The resultant sample of individuals is random, and thus you can calculate a meaningful coverage estimate with a CI when the data from all SA are aggregated to calculate overall coverage in the CA. Only one member of each target group is selected for each random starting point which was identified with segmentation sampling.

This method is referred to as *parallel sampling* because the same random starting point is used to select respondents from two or more independent age groups. Given that the data from each group are not added together (i.e., each age group is analyzed separately), there is no meaningful design effect to report. LQAS uses a stratified random sampling design (the lots serve as the strata), which is why there is virtually no design effect of the aggregated data at the CA level. The stratified design is effective at reducing variance.

The design effect (*D*) is a coefficient which reflects how a sampling design affects the computation of significance levels compared to simple random sampling. A design effect coefficient of 1.0 means the sampling design is equivalent to simple random sampling. A design effect greater than 1.0 means the sampling design reduces precision of the estimate compared to simple random sampling (cluster sampling, for instance, reduces precision). A design effect less than 1.0 means the sampling design increases precision compared to simple random sampling (stratified sampling, for instance, increases precision).

Box 7. Steps for Parallel Sampling

- Go to each community where there is an LQAS interview location (based on the PPES sampling of your sampling frame).
- Randomly select one household in the community using the steps for segmentation sampling, and go to the selected household.
- If there is an eligible child aged 0–11 months or 12–23 months in the household, then use the corresponding questionnaire to interview the caregiver.
- Once you have completed with the first interview, go to the next nearest house to look for the remaining child in the other age cohort.
- If there are no eligible children in the correct age groups, then go on to the next nearest household to look for a child in either age cohort.
- Continue going to the next closest house until both questionnaires have been completed.
- If there are two eligible children in a given household (i.e., a child 0–11 months and 12–23 months), then select one of them randomly using a random number table. Do not decide to select one or the other children; both must have the same chance of being selected.

Note: You should not sample more than one age cohort in the same household because you are assessing the caregiver's behavior for vaccinating their children. Caregivers who live in the same household may have similar behaviors related to vaccination uptake. Therefore, it is always better to sample respondents from different households to obtain more information.

2.11. Data Collection Tools

2.11.1. What indicators and variables do I include in my survey?

Answering this question will help you develop the survey questionnaire. Survey indicators refer to the health care services that are being assessed. For our purpose, the indicators refer to the specific vaccinations that will be measured through the survey. It is also possible to design a survey with specific components of interest to the EPI, such as the BeSD indicators. The global standard for measuring routine vaccination coverage for infants through survey research is among children aged 12–23 months (WHO, 2018). This cohort ensures that children have had sufficient time, usually by their first birthday, to receive all recommended primary vaccines. Some countries may also want to measure timeliness of vaccination which warrants including a second cohort of children aged 0–11 months (or 18 weeks–11 months, as noted above) or children aged 24–36 months for vaccines given in the second year of life, or children up to five years old for the Big Catch-Up campaigns.

UNICEF measures vaccination coverage using the Multi-Indicator Cluster Surveys (MICS). You may wish to consult a recent one in your country or region. The questionnaire is usually found in the Annex of the MICS report. You can review how they ask mothers about their child's vaccination history, which includes both reviewing the vaccination card and requesting the mother to recall her child's vaccination history. Figure 8 shows the typical recommended ages for each vaccination (note that each country has its own EPI schedule).

Figure 8. Typical EPI Vaccination Schedule and the Recommended Age of Vaccination

Age	Vaccines
At birth	BCG, OPV0, HepB0
6 weeks	Pentavalent 1 (DTP-HepB-Hib), OPV1, PCV1
10 weeks	Pentavalent 2, OPV2, PCV2
14 weeks	Pentavalent 3, OPV3, PCV3, IPV1
9 months	Measles-Rubella 1 (MR1), IPV2
15–18 months	Measles-Rubella 2 (MR2)

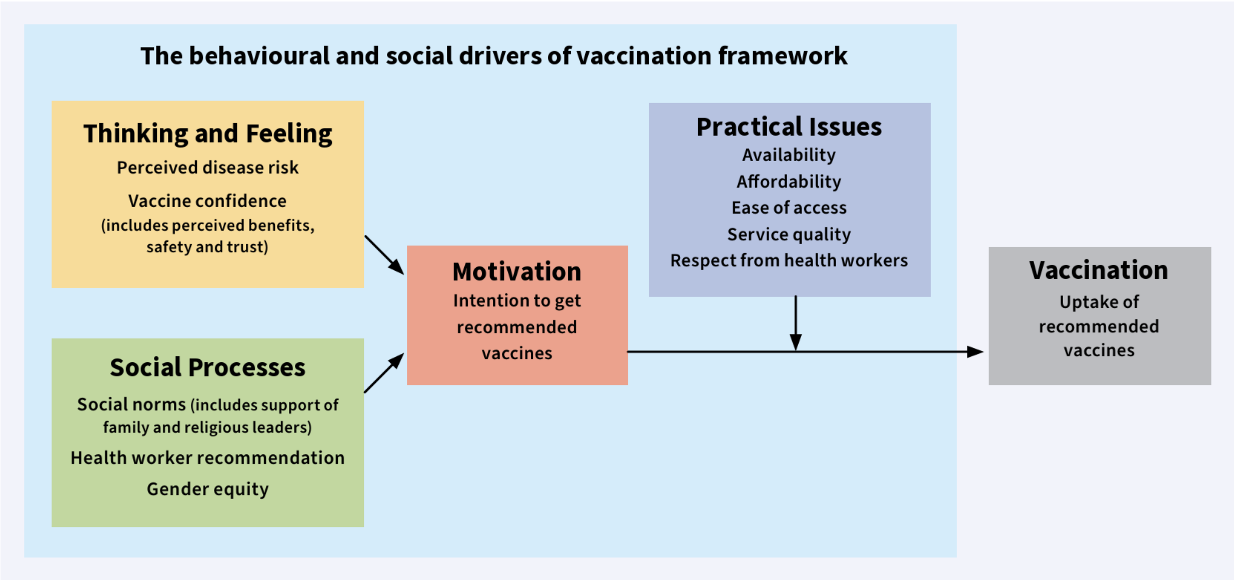
Other variables measure basic information about the child and the sociodemographic characteristics of the caregiver. This information is used to determine whether ZD or UI is associated with certain characteristics that place children at higher risk of being missed by the vaccination program, such as:

- The child's age (in months) and date of birth and sex.
- Whether the child has a vaccination card, and whether the card has complete vaccination dates. Ask for the child's vaccination card and record if it was seen by the interviewer, lost or misplaced, never had a card, or the caregiver does not know. If smart phones or tablets are used for data collection, photos of the vaccination card can be taken for data verification or to highlight issues.
- Caregiver's age recorded in completed years. If she does not know her age, you should also ask for key events that some cultures use to signpost the years and are commonly known in the country or the region of the survey (e.g., the year of a flood, a political event).
- Highest level of school attended by the caregiver: incomplete primary school, primary school completed, secondary completed, university or institutes for higher learning. Ask for the highest grade completed.
- Caregiver's literacy: consider using a very short literary test with a simple sentence written on a card (e.g., When my child has a fever, I always take him/her to the health worker).
- Caregiver's marital status: never married, married, widowed, divorced/separated, co-habitating (living together with someone).
- Number of children living in the household.
- Household or caregiver's wealth using an index of physical assets in the house. We generally recommend using a shortened, reduced wealth index developed by Metrics for Management for most LMICs. This reduced index provides a measure of relative wealth that approximates the larger wealth measure used in the DHS but requires fewer questions.

Other important variables measure selected facilitators and barriers of vaccination uptake. The WHO BeSD of vaccination framework is often used to measure indicators in four categories: thinking and feeling, social processes, motivation, and practical issues.

2.12. Behavioural and Social Drivers of Vaccination

Figure 9. Behavioural and Social Drivers of Vaccination Framework



Source: *The BeSD working group. Based on Brewer et al., 2017.*

This guidance does not go into detail about these indicators other than to give an example for each of the four categories. WHO has developed tools and guidance for measuring the BeSD indicators in a household survey (2022).

- **Thinking and feeling:** How important do you think vaccines are for your child's health?
- **Social processes:** Do you think most of your close family and friends want you to get your child vaccinated?
- **Motivation:** Your country has a schedule of recommended vaccines for children. Do you want your child to get none of these vaccines, some, or all of them?
- **Practical issues:** Do you know where to go to get your child vaccinated?

While the correlation analysis using the BeSD indicators cannot be performed at the SA level, it can be useful to understand barriers in the CA with the aggregate sample. It is possible to design the survey to answer some programmatically priority questions by classifying the BeSD indicators at the SA level as well. For example, assuming affordability of vaccination is very low in a given SA (e.g., lower than the 50% threshold), this finding could prompt providing transport vouchers that community health workers could distribute to households in the SA.

Please see Annex 8 for an example Indicator Matrix and LQAS questionnaire developed by the Nigeria CLH in 2024. The LQAS survey measured vaccination coverage and BeSD indicators to explore sociodemographic factors influencing vaccination behaviors among caregivers of young children in selected districts and subdistricts in Nigeria.

3. Logistics for Carrying Out an LQAS Survey

3.1. Agreement of Subnational MOH and EPI Managers

Your first step is to engage local authorities to secure their buy-in for the assessment. Clearly explain the survey's purpose and show how the data will help them manage the vaccination system in each supervision area. Involving local managers in data collection and analysis builds essential local capacity. Because these managers are ultimately responsible for using the findings to improve vaccination systems, they should ideally integrate the LQAS process into their routine management plans (Valadez et al., 2002, 2014, 2020).

3.2. Who Will Collect the Data?

Early on in your planning, you should decide who will collect the LQAS survey data. You have two basic choices:

1. Select health workers from the district health system or an NGO working in the study area. The benefits and drawbacks of selecting local district health workers are:

- Enlisting local health workers cultivates local ownership of the program monitoring process for strengthening child vaccination.
- Using local health workers can reduce survey costs. Their costs could include a stipend for their participation in the survey and a per diem for travel and lunch. They normally begin the day at their home and return to it at night.
- Local health workers tend to know the location of the villages and speak the local language, which precludes the need for a driver, a guide, and a translator.
- Local health workers may have competing work priorities during the timeframe of the survey data collection.

2. Hire data collectors (or research assistants). This approach has both advantages and disadvantages:

- Using hired research assistants can expedite the survey process if local health workers cannot be recruited or are not available.
- This approach is usually more costly if data collectors do not live in the district. In addition to a full salary, hired data collectors may need a per diem to cover the costs of their hotel, meals, and incidentals.
- Hired data collectors do not necessarily know the location of the villages and may not understand the local language; therefore, guides and translators may need to be hired.

When possible, it is usually preferable to engage local health workers who work in the MOH or an NGO in the area that has a supportive relationship with the MOH. However, recruiting health facility clinical staff is not recommended to serve as data collectors or supervisors in the LQAS survey, unless it is for a very short period of time. It is important that clinical staff remain dedicated to delivering health services to the population. Sometimes, the question is raised whether using local health workers as data collectors might introduce bias if they want to be perceived as producing high quality work. Studies show that local staff produce data that is just as reliable as hired data collectors who have no stake in the outcomes (Beckworth et al. 2015, 2016).

It is advisable to screen and recruit the data collectors and supervisors based on selection criteria. See the following section for a list of suggested criteria.

3.2.1. How many data collectors and supervisors do I need?

There are two approaches to making this decision. As previously discussed, the standard LQAS sample size is 19 respondents from each target group in each SA. Depending on the number of target groups and length of the questionnaires, data collectors should aim to visit at least one sample location in the morning and one in the afternoon. Assuming that two data collectors work concurrently in each SA, with a minimum of four interviews per day, data collection should wrap up in five to six days. In areas where travel is easier, one data collector could collect two interviews in the morning and two in the afternoon. One interviewer, in this context, could finish data collection in one SA within one week.

The choice between one or two interviewers per SA depends on the total number of SAs. If you have many SAs, deploying two data collectors per area may create a team that is too large to train and supervise effectively. In general, it is a good idea to avoid recruiting too many field staff for each SA, as it will be logistically complex and costly to arrange their transport. It is also difficult to train and supervise a large number of data collectors unless you increase the number of trainers and supervisors.

One supervisor per every three SAs should be sufficient depending on the context. The supervisor is responsible for ensuring the interviewers complete all of their assigned interviews correctly, follow correct procedures for sampling households and respondents, and receive timely support for any questions during the data collection process. They also assist with problem-solving and spot check the quality of data collection with a brief reliability study in each SA. Supervisors are ultimately responsible for ensuring a high-quality survey. Table 3 outlines the recommended qualifications for selecting data collectors and supervisors. Keep in mind that gender balance is important when selecting the data collection team and, in some settings, it is necessary to have female data collectors to gain access to the caregiver for administering the survey.

Table 3. Suggested Qualifications for Skilled Data Collectors and Supervisors

Data Collectors	Supervisors
• Dedicated to the LQAS training and survey implementation with full time availability through completion • Good understanding of the EPI RI schedule • Experience working in the health system • Prior experience with surveys and interviewing people about their health or their child's health • Able to enter data into a smartphone accurately on computer-assisted personal interviewing (CAPI) software such as ODK or KoboToolBox • Familiarity with the sample locations (villages or settlements in their district) • Speaks and reads the local language • Able and willing to travel alone in the villages or with the support of a driver	• Good understanding of the EPI RI schedule • Experience working in the health system • Experience problem solving and troubleshooting with household survey logistics (e.g., transportation issues, safety issues) • Experience problem solving and troubleshooting with electronic data collection apps (ODK or Kobo Collect) • Prior experience as a household survey supervisor and with supportive supervision practices • Able to review and ensure all surveys are correctly completed at the end of the day • Able to carry out a reliability spot check/ validation of data quality in each lot following completion of data collection

3.2.2. Finalizing the questionnaire

Once you have prepared the draft version of the questionnaire, consider taking these next steps.

1. Prepare the questionnaire in the official language of the country and review it with relevant stakeholders to ensure clarity and accuracy. Ensure there is only one standardized version. Also, ensure that the questions provide the required information to assess the agreed list of indicators.
2. The questionnaire should include a voluntary consent form that must be confirmed by the respondent (signature, X mark, or through oral consent) before the interview begins. The consenting information covers important ethical aspects, such as the right of the participant to know the purpose of the survey and how the data will be used, the length of the interview, understand that the responses are anonymous, and that they have the right to refuse to participate at any time during the interview. If the LQAS survey includes an adolescent target group for an assessment of the human papillomavirus (HPV) vaccine, then adolescent respondents may be required to give assent to participate in research in addition to adult consent in some countries.
3. Make sure to pre-test the questions in several nearby villages to determine the clarity of the questions and the instructions of the questionnaires. Do not concern yourself with sampling at this stage. Take a convenient sample of as many respondents as possible until you get the same recurring comments. As part of the pre-testing exercise, ask the respondents their opinions, such as, "What is it about this question that is not clear? How can we rephrase it?" Write their comments on the questionnaire to retain a record of their responses.
4. Revise the questionnaire based on the pre-test feedback. It is always a good idea to then pre-test the revised version of the questionnaire to ensure clarity and understanding and to verify the correct SKIP patterns for the questions.
5. When the questionnaire is ready, translate it into local languages if necessary. Use health workers or staff from a local NGO for translation, rather than university linguists who may use formal language not understood by community members.
6. You are now ready to prepare the final hard copy of the questionnaire. It is convenient to produce a small set of hard copies, ensuring at least two copies for every data collector in case of insecurity, loss of internet, or technical problems with their smartphones.
7. As a final stage, program your smartphones using both the national language and the local language if a translation is required. Ensure that the data collected can be understood by non-speakers of the local language when downloaded to the database. CAPI software such as Open Data Kit (ODK) and KoboToolbox are commonly used for this purpose. Other CAPI software can be used as long as it meets the following criteria: ability to work offline, battery life is sufficient, charging stations available to data collectors, compatibility among all users, and ability to pinpoint GPS locations.
8. Lastly, pre-test the smartphones or tablets to ensure no bugs are causing the screen to freeze or prevent progression to the next question. Verify that all SKIP patterns function correctly. This testing can be done in your office, but it's also important to test in a village setting to ensure proper functionality and data upload to a central database when the interview is complete.

3.2.3. Using smartphones or paper-based questionnaires

In recent years, most survey teams have preferred to conduct surveys using smartphones or tablets, as inexpensive smartphones are readily available in most countries. Ensure there are enough smartphones for all data collectors and supervisors, and retain additional phones in reserve in case of loss or damage. Ideally, all phones should have the following features: a removable data storage card; camera for taking photos of each vaccination card; sufficient storage for the survey and photos; and the ability to capture GPS coordinates.

Some countries hire data collectors who use their own smartphones, provided compatibility with the survey questionnaires is verified and the battery life is sufficient. Power packs are often purchased for each data collector to ensure phones can last more than one day before recharging. If using smartphones, a random number table can be generated electronically on the phone. Research teams should ensure that phones are available for those who do not have their own smartphones to ensure a fair selection of data collectors. It is important to be mindful of the digital divide with professional development opportunities, especially for women.

Paper questionnaires can also be used, but with additional logistical considerations. Each data collector will need to carry at least four sets of questionnaires daily: two for required interviews and two additional sets in case they can interview more villages or in case of damaged or missing pages. They will also need a bag or backpack to carry the questionnaires, a random number table, a clipboard, at least two pencils, and an eraser.

If using paper questionnaires, ensure that questionnaires are printed, collated, and stapled at the top. Include a footer at the bottom of each module for questionnaires that involve multiple respondents from the same village (e.g., children aged 0–11 months and 12–23 months) to ensure the interviewers record all information correctly.

3.2.4. Survey checklist

A survey checklist will help you organize the materials you need before the survey begins. Ensure the following tasks have been completed:

- ☐ Review the sampling frame and data collection plan for each SA.
- ☐ Review final pretested questionnaires and any electronic data collection (e.g., ODK, Kobo).
- ☐ Ensure travel logistics and communications are set for all supervision areas.
- ☐ Provide the resources needed to carry out the survey:
    - ✓ Data collection plan for each SA
    - ✓ Pencils
    - ✓ Pencil sharpener
    - ✓ Eraser
    - ✓ Clipboard
    - ✓ 1–2 printed sets of the survey questionnaire
    - ✓ Smartphones/tablets and data card for all data collectors and supervisors*
    - ✓ Chargers for phones or tablets
    - ✓ Battery/power packs for backup charging
    - ✓ Day pack or bag
    - ✓ Random number tables
    - ✓ List of procedures to select respondents in a household
    - ✓ Raincoat
    - ✓ Community maps or paper for making maps

*The survey team should ensure that all data collectors and supervisors have a fully functional smart phone. This may require that the survey team provides the phones to the data collection team. Phone ownership should not be a criterion for selecting data collectors as this is essentially unfair and unequitable and may introduce bias in your selection of data collectors (e.g., in some locations women will have access to smartphones less often).

3.3. Obtaining Ethical Approval

Before conducting a community survey, you need to seek ethical approval from an authorized institution in the country. In many countries, this authority resides with the Ethics Review Board within the MOH, while in others, universities are responsible for ethical review. Seek guidance from the MOH or a local university about the process you need to follow for ethical review of your study design and instruments.

Once you have identified the appropriate institution, obtain their ethics review application form to understand the required information. Typically, this includes providing details such as the purpose of the survey and sample size determination process and attaching the final draft of the survey instrument. Ensure the survey instrument includes a section at the beginning for obtaining informed consent from each respondent, which can be indicated by a written signature, thumbprint, or another recognized mark or orally in specific cases where this is appropriate.

3.4. How to Train Data Collection Teams

This section lists actions to consider for training of data collectors and supervisors in LQAS. It is not a training guide but will refer you to training resources. Above all, having at least one experienced LQAS trainer is crucial. Ideally the trainer will have participated in prior LQAS training and successfully carried out LQAS surveys.

Important points to consider:

- Ideally, we aim for no more than 30 participants per workshop, though this may vary based on the local context. Should the number of participants exceed this threshold, it is advisable to have multiple trainers to effectively manage the group, facilitate small group exercises, and provide necessary support.
- If the training venue is in a local area where attendees can return home at night and the distance is not significant, your training costs will be lower. However, this increases the risk of trainees arriving late. Typically, a percentage of trainees will require hotel accommodation due to distance.
- We recommend two field practice sessions organized in small groups of no more than eight participants, mentored by a trainer or a training assistant. The field practice sessions allow the data collection teams to learn first-hand how to select households and survey respondents at random and administer the questionnaires using effective interviewing techniques. Field practice requires appropriate planning. The selected community for field practice should be located within a reasonable distance from the training venue and have similar characteristics to the sample locations where the actual survey will be undertaken. Avoid conducting the practice in sampled villages, and make available all necessary materials, equipment, and logistics for the successful implementation of this exercise.
- The first field session is designed to practice map-making, segmentation sampling, and identifying the first household and respondent. This session concludes when the group of participants correctly identifies the first randomly selected house and respondent.
- The second session, which can be held the same day, is to practice reading the questionnaire aloud. This can be completed at the training venue by dividing the training participants into pairs. The purpose is to give participants a chance to practice reading through the questionnaire aloud including following the SKIP instructions on a paper-based questionnaire (skips are programmed and automated in an electronic questionnaire).

3.5. How to Coordinate and Organize the Survey Activities

3.5.1. Data collection plans

The data collection team for each SA should develop a data collection plan. As part of this exercise, each team plans the sequence in which the villages will be visited, the dates where the interviews will be conducted in each sampled village, and the interviewer who will carry out each interview. Since the villages have already been selected randomly, they can be visited in any convenient order. The local teams are best suited for this task as they know the locations well. For example, if a village is a one-hour drive from the daily starting point, the next village visited could be located nearby. Similarly, if a village is situated on one side of a mountain or river, it would be convenient to visit other villages in the same area to avoid multiple crossings. Occasionally, a village may be located in a distant part of an SA and may be the only village visited on that day due to time, accessibility, or transport constraints.

By organizing a data collection plan, the program manager and survey supervisors should know the location of each data collector every day.

3.5.2. Supervision and reliability spot check/validation

Most technical support issues from data collectors typically occur within the first two days of data collection. Afterwards, supervisors can allocate their time to support the weaker data collectors or replace them if they are unable to collect quality data. Supervisors should conduct spot checks by visiting data collectors unannounced during data collection. During these visits, mapmaking (e.g., sketch maps) for segmentation sampling, which is the most complex aspect, should be highlighted and reviewed.

Supervisors are also responsible for conducting a reliability assessment of each data collector. This assessment is a critical step to validate the survey findings, ensuring the data's reliability and the soundness of any conclusions and recommendations. To do this, randomly select one of the villages where data collection has been completed; this is roughly a 10% sample. Select one of the completed questionnaires to evaluate data reliability. To do this, the supervisor revisits the house of the selected questionnaire and re-interviews the same respondent to verify responses using a small subset of preselected questions from the questionnaire. Use questions where the responses are unlikely to change over a short period. For example, the name of the child, their gender and age in months, mother's age, parity, and education, and whether the child has a vaccination card. It is not necessary to recollect the child's vaccination history or responses to the BeSD indicators.

It is preferable to select basic questions from the questionnaire that every data collector would collect similarly so that an error rate can be calculated. The error rate should not exceed 10%. If the reliability study identifies "fabricated" data, the data collector should be immediately replaced, and all of their data should be collected a second time by a reliable data collector or the supervisor.

Once the validation step concludes, you should delete names and other identifying information to maintain ethical clearance and to maintain the confidentiality of the people who were sampled for the study.

3.5.3. Data inventory

Once the data collectors complete the data collection, develop a table showing every SA and the number of completed questionnaires for each target group. For example, if data are collected from a sample of children 0–11 months and 12–23 months, ensure that 19 questionnaires for each age group have been collected. If, upon inspection, you find that questionnaires are missing, make arrangements for additional data collection before the data collectors disband to ensure complete and accurate data for all target groups.

3.5.4. Electronic data collection

Data collection using smartphones or tablets is the most common approach for collecting data. When data collection is conducted using these devices, it is crucial to upload the data daily if possible or as soon as the data collector is within a signal range.

This implies that two essential tasks have already been carried out:

- Ensure that each data collector has sufficient resources on their mobile phones to transmit data daily through their mobile carrier.
- Identify a central point for receiving the data and assign one person responsible for cleaning the data. This involves tracking daily data collection and data uploads to ensure timeliness and that all data entries fall within acceptable ranges. For example, if a data collection point is numbered 21 when the sample size is 19, this indicates a data entry error. Similarly, if a child sampled for the 12–23 months questionnaire is younger than 12 months or older than 23 months, this indicates a sampling error, and the data point must be collected again. Often, these errors can be detected within 24 hours of data collection and then corrected quickly.

Once the data collection is complete and verified, the data should be anonymized and uploaded to a database for analysis. Anonymization means removing any identifying characteristics of the caregiver and child, typically their names, that may have been needed during consenting or the reliability spot check phase.

3.5.5. LQAS survey timetable and reporting

Once you have decided to undertake an LQAS survey and have read these guidelines, develop a timetable to plan the activities, calculate your budget, and recruit the staff you need. Include in it the analysis, report writing, and dissemination of findings. Remember, the purpose of an LQAS survey is to use the findings to take action to improve vaccination coverage. Dissemination should include the districts or subdistricts that helped undertake the survey as well as more central-level stakeholders. While recommendations should be included in your dissemination of findings, it is also important to elicit recommendations from the subnational levels about how to strengthen the immunization program you have assessed.

4. Analysis of SA and CA Level Data

LQAS survey data can produce several complementary outputs to guide immunization program decisions. At the classification level, the method classifies whether each lot/SA meets or falls below a predefined coverage threshold (with a known error). When data from all lots are pooled, overall coverage estimates for the CA can be calculated, including antigen-specific coverage profiles and the distribution of fully vaccinated, partially vaccinated, and UI children in the target population. In addition, the survey can capture information on social and behavioral factors influencing vaccination, as well as the distribution of sociodemographic characteristics, providing valuable context for interpreting coverage patterns and designing targeted interventions.

For a simple manual analysis, the LQAS data can be reviewed and presented as a table, such as the one in Table 4. The table is organized in four columns with the data presented in a simple Yes or No format for each SA. In this example, a district has six SAs with a sample of n = 19 caregivers of children aged 12–23 months in each SA. The upper target (pU) is 80% coverage, which has a decision rule of 13.

In Table 4, the data are displayed as the number who received a DTP3 dose (Yes) and who did not (No).

In the next step, the survey analyst looks at the Yes column, circling any SA that does not reach the decision rule of 13. In this example, SAs 1, 3, and 6 have not reached the decision rule threshold of 13 and are therefore classified in the low-coverage category.

The coverage estimate in this example is only calculated as a crude average by taking the total number vaccinated (70) divided by the total sample size (114), which is (70/114) equals 61.4%. Please note: a *weighted coverage and CI* should also be calculated by using the population of each SA as a weight as shown in Table 4.

Table 4. LQAS Table Used for Indicator Analysis

Indicator	DTP3 coverage for children 12-23 months		
Target = 80%, Decision Rule = 13			
Supervision Area	Vaccinated		Sample
	Yes	No	
SA1	12	7	19
SA2	14	5	19
SA3	6	13	19
SA4	16	3	19
SA5	13	6	19
SA6	9	10	19
Total	70	44	114
Average (crude)	61.4%		

Table 5 shows how to calculate the weighted vaccination coverage for the CA as a whole to produce unbiased overall estimates of coverage. It is important to add survey weights so the contribution from each SA is in proportion to the population there. In the example below, columns 1, 2, 3 are taken from Table 4 above. Column 4 is the crude SA-level vaccination coverage, which is used in subsequent calculations of the weighted coverage for the overall CA but should never be reported as SA-level vaccination coverage as it is imprecise. Column 5 is the total population of the SA, which is essential for understanding the proportional size of each SA within the CA. While total population is typically used, other data, such as number of households, can serve as a measure of relative size of the SA. Column 6 is the percentage of the total CA population residing in each SA. In the final step, each individual SA weight is multiplied by the corresponding SA crude coverage. The sum of these products is the weighted coverage. Many computer programs have a routine to automate the calculation of weighted coverage, which can help avoid the complexities and potential errors of manual calculations. The same approach is used for calculating weighted averages for the BeSD indicators and any sociodemographic variables.

Please note: you should always calculate and report the 95% CI for the weighted coverage estimates of any vaccination antigens or BeSD indicators aggregated across all lots/SAs. This CI provides a measure of uncertainty associated with the overall coverage in the catchment area. As noted above, the Wilson CI is preferred for LQAS coverage data over the Wald CI because it performs better with the small sample sizes typically used in LQAS and is more reliable for proportions close to 0 or 100%. The Wald CI assumes a normal distribution in the data and is inaccurate for small sample sizes. Additionally, LQAS coverage estimates have no meaningful design effect to report because there is no clustering. LQAS described in this manual uses a stratified random sample (lots/SAs = strata) which is allocated proportionally using PPES, also described above.

Table 5. Calculating Weight Vaccination Coverage of the Catchment Area

Supervision Area	Sample	YES Vaccinated	SA crude coverage	Population	wt = SA % of population	wt x (SA coverage)
1	19	12	0.632	6,700	15%	9%
2	19	14	0.737	5,800	13%	9%
3	19	6	0.316	8,500	19%	6%
4	19	16	0.842	10,000	22%	19%
5	19	13	0.684	4,800	11%	7%
6	19	9	0.474	9,500	21%	10%
	114	70		45,300	**Wt'd Cov**	**60.5%**

Related Tools and Resources

- Rapid Convenience Monitoring
- WHO Vaccination Coverage Survey Manual
- Demographic Health Survey (DHS)
- Behavioral and Social Drivers (BeSD)
- Nigeria Learning Hub Decentralized Immunization Monitoring
- Multi-Indicator Cluster Surveys (MICS)
- Reduced Wealth Index – Metrics for Management
- LQAS Sampling Plan Calculator
- LC-LQAS manual
- LQAS: a Practical Introduction Webinar
- Open Data Kit (ODK)
- KoboToolbox

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Annex 1. LQAS Sample Size Calculation and Decision Rule Choice

Sample sizes in LQAS are derived using a binomial formula which calculates the probability of finding a certain number of successes (e.g., vaccinated children) from a population for which, say, 80% are successes (e.g., correctly vaccinated children).

$$P_a = \frac{n!}{a!(n-a)!} p^a x\, q^{n-a}$$

Where;

Pa = the probability of selecting “a” successes (e.g., vaccinated children) in a sample of “n” elements

p = the benchmark for quality (80% in this example)

q = the expected proportion of failures (q = 1-p)

n = the sample size

a = the exact number of ‘successes’ in the sample (i.e., the acceptable performance)

n - a = the number of ‘failures’ in the sample (i.e., the unacceptable performance; in LQAS this expression is referred to as “d”, the “decision rule”).

Using this formula, probabilities can be computed for zero successes, one success, and up to n successes in the sample.[5] Once we have computed these individual probabilities, we can add them together to create cumulative probabilities. The binomial model is used to calculate different sample sizes and decision rules. Since we want to know, for example, the probability of finding at least 13 ‘successes’ in a lot from which a sample of 19 is selected, we can add the individual probabilities, that is the probability of finding exactly 13 successes out of 19, the probability of finding 12 successes out of 19, the probability of finding 11 successes…, etc. This is a property of the binomial distribution—the probabilities add to 1. Thus, a table of cumulative probabilities (Table A1) can be used to determine the sample size, decision rule, and the alpha (α) and beta (β) errors.

From Table A1 note that for a sample size of 19, when the acceptable level of quality (e.g., coverage) is 80%, and the minimum number of vaccinated children in the sample for the SA to classified in the high category defects is 13, the α error is 1 - 0.932 = 0.068. When the unacceptable level of quality is 50%, and the number of successes is 13, the β error is 0.084. The total risk is 0.068 + 0.084 = 0.152. The ideal decision rule for pU = 80% and pL = 50% is the one where $\alpha + \beta$ is the smallest value.

5 Note that in some publications, the ‘decision rule’ is presented as the maximum number of permissible defects, while in others, it is presented as the minimum number of successes in order to accept the lot. Pay close attention to how the decision rule is defined while developing an LQAS sampling plan. Dodge and Romig’s formulation of LQAS in the 1920s was intended to control industrial batch production (Dodge and Romig, 1959). Their LQAS tables counted failures on the production line, such as the light bulbs in their sample that did not work. When LQAS was adapted to public health settings in the 1980s (Valadez, 1986; Valadez, 1991) failures in service delivery were initially used as the basis for selecting decision rules. However, government partners and nongovernmental organizations found it confusing to count failures for LQAS classifications and successes for calculating coverage. Therefore, when the use of LQAS started going to scale in public health in the early 2000s, the approach was adapted to count successes instead of failures for the lot classifications. The statistics do not change and this latter approach is equally valid.

Table A1: Table of Cumulative Probabilities, n = 19

D Successes	0.05	0.10	0.20	0.30	0.40	0.50	0.60	0.70	0.80	0.90	0.95
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.014	0.135	0.377
18	0.000	0.000	0.000	0.000	0.000	0.000	0.001	0.010	0.083	0.420	0.755
17	0.000	0.000	0.000	0.000	0.000	0.000	0.005	0.046	0.237	0.705	0.933
16	0.000	0.000	0.000	0.000	0.000	0.002	0.023	0.133	0.455	0.885	0.987
15	0.000	0.000	0.000	0.000	0.001	0.010	0.070	0.282	0.673	0.965	0.998
14	0.000	0.000	0.000	0.000	0.003	0.032	0.163	0.474	0.837	0.991	1.000
13	0.000	0.000	0.000	0.001	0.012	0.084	0.308	0.666	0.932	0.998	1.000
12	0.000	0.000	0.000	0.003	0.035	0.180	0.488	0.818	0.977	1.000	1.000
11	0.000	0.000	0.000	0.011	0.088	0.324	0.667	0.916	0.993	1.000	1.000
10	0.000	0.000	0.002	0.033	0.186	0.500	0.814	0.967	0.998	1.000	1.000
9	0.000	0.000	0.007	0.084	0.333	0.676	0.912	0.989	1.000	1.000	1.000
8	0.000	0.000	0.023	0.182	0.512	0.820	0.965	0.997	1.000	1.000	1.000
7	0.000	0.002	0.068	0.334	0.692	0.916	0.988	0.999	1.000	1.000	1.000
6	0.000	0.009	0.163	0.526	0.837	0.968	0.997	1.000	1.000	1.000	1.000
5	0.002	0.035	0.327	0.718	0.930	0.990	0.999	1.000	1.000	1.000	1.000
4	0.013	0.115	0.545	0.867	0.977	0.998	1.000	1.000	1.000	1.000	1.000
3	0.067	0.295	0.763	0.954	0.995	1.000	1.000	1.000	1.000	1.000	1.000
2	0.245	0.580	0.917	0.990	0.999	1.000	1.000	1.000	1.000	1.000	1.000
1	0.623	0.865	0.986	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000
0	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

An often-asked question is: *How was the decision rule decided*? Why is the decision rule 13 for pU = 80% and pL = 50%. We know from the preceding paragraph that for 13 vaccinated children the total risk is 0.152 which is arrived by adding together the α and β errors. If we add these errors together for decision rules of 15, 14, 12, and 11 as has been done in the final column of Table A2, you will notice that the lowest total error is with a decision rule of 13. This is why that decision rule was selected for pU = 80% and pL = 50%.

Table A2: How to Select the Optimal Decision Rule

D Successes	pL = 50% which is also β error	pU = 80%	α Error	Total Error
15	0.01	0.673	0.327	0.337
14	0.032	0.837	0.163	0.195
13	0.084	0.932	0.068	0.152
12	0.18	0.977	0.023	0.203
11	0.324	0.993	0.007	0.331

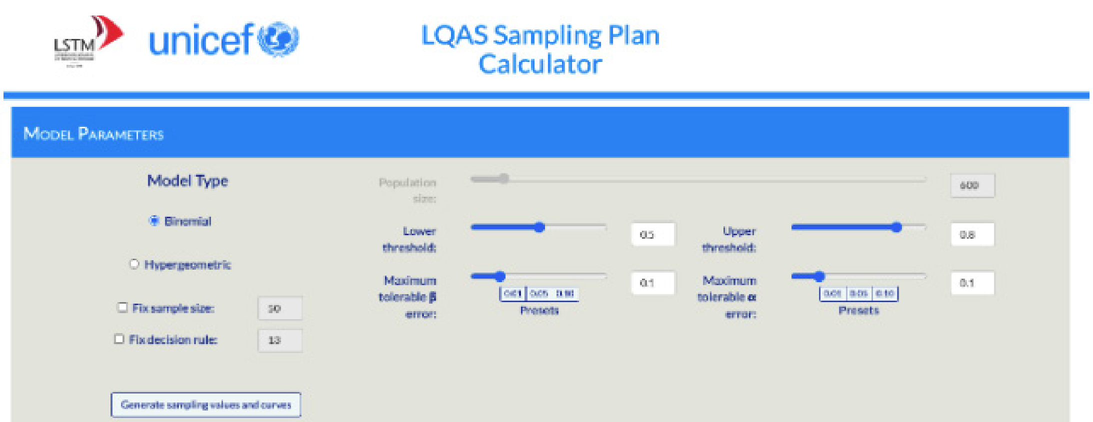
Cumulative probabilities for different sample sizes and decision rules can be plotted graphically to facilitate the selection of appropriate sample sizes, decision rules, and the acceptable alpha and beta errors. The resulting graph is termed the Operating Characteristic (OC) Curve (see below for more detail). The great benefit of an OC curve is that it graphically shows all classification errors for coverage proportions of all values from 0 to 100%.

The most efficient way to select a decision rule and to calculate the α and β errors is with the LQAS calculator which was initially developed by the Liverpool School of Tropical Medicine for UNICEF. It is an easily accessible free app available at http://lqas.spectraanalytics.com/. The app produces an easy-to-read graphic which is depicted in Figure A1.

The calculator is automatically set to pU = 80% and pL = 50%; however, you can enter the values you prefer into the cells on the upper right side. Just below this setting are the errors which are set to a maximum of 10% which can also be changed. The calculator provides the option to use the Binomial or Hypergeometric models. For our purposes we will use the Binomial only. You can also select a specific sample size and decision rule to calculate the errors associated with it. In our example, we are selecting only pU = 80% and pL = 50% and the maximum errors.

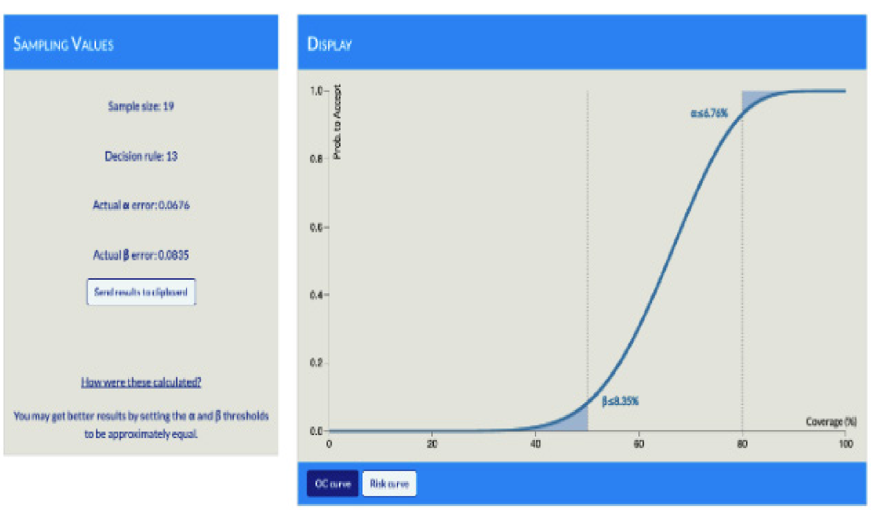
When the choices are made, the last step is to generate the sampling values and OC curve which is explained below.

Figure A1. LQAS Sampling Plan Calculator (Available at http://lqas.spectraanalytics.com/)



The resulting output shows the following information on the left side of the image: the sample size, the decision rule, and the actual α and β errors. The right side is the Operating Characteristic Curve which is explained in Figure A2.

Figure A2. Example Output from Sampling Plan Calculator



How to interpret an LQAS Result

We have discussed LQAS as a classification tool for identifying SAs with vaccination coverage at or above pU or at or below pL with errors that do not exceed 0.10 in the examples we have used. We have used pU = 80% as it was assumed to be a vaccination target and pL = 50% because it indicates unacceptable coverage 30 percentage points below pU. However, it is important to understand that all supervision areas have true coverage that ranges anywhere from 0% to 100% coverage. True SA coverage could be, for example, 93%, 72%, 68%, 45% or another value between 0% and 100%. SA coverage is classified as in the high or low category with known amounts of error. It is important to understand how these coverages are classified. The probabilities of classification are depicted in an Operating Characteristic (OC) curve (Figure A3).

Every LQAS design with a pU, pL, sample size, and decision rule has an OC curve which shows the probability it will be classified in the high category (reaching the pU target). The X axis is coverage. The Y axis is the probability of an SA with that particular coverage being classified in the high category. An SA with 80% coverage is depicted by a dotted line going from 80% on the X axis up to a coordinate that crosses with the Y axis at 0.9324 or 93.24% which is the probability it will be correctly classified in the high category. In this example, 100% - 93.24% = 6.76% is the probability it will be misclassified in the lower category. This is the alpha error. In simple terms, we don`t know for sure if the coverage is above 80% in this SA, but we are almost sure it is not below 80%. In practice, only 6-7% of the time will an SA with 80% coverage or higher be misclassified as having inadequate coverage.

If you follow the other dotted line at the pL value of 50% and follow it over to the Y axis, it crosses with 9.35% showing the probability that an SA with coverage below 50% will be classified incorrectly in the high category. This is the beta error. Now let's take 90% coverage. If you put your finger on 90% and bring it up to the line of the OC curve and then across to the Y axis, you see the probability of acceptance is about 99.8% with error near to zero.

Figure A3. Operating Characteristic Curve for n = 19, pU = 80%, pL = 50%, d = 13

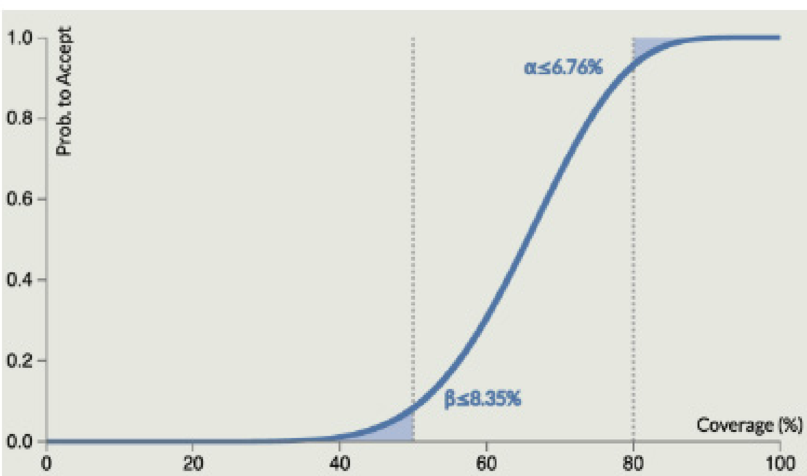


Figure A4 depicts the pattern of classification for 55 SA in groups of 5 going from low to high coverage. Each grouping is 5 percentage points higher than the preceding grouping. Row 1 is the SA grouping. Row 2 is the coverage in the SA. Row 3 is the probability of acceptance. Using these probabilities, rows 4 and 5 show the number of SAs classified in the high category or in the low one.

Figure A4. Classification of 55 SA with pU = 80% and pL = 50%, Decision Rule = 13, n = 19

SA	5	5	5	5	5	5	5	5	5	5	5
Coverage	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%
	0.012	0.03	0.08	0.17	0.31	0.48	0.67	0.83	0.93	0.98	0.998
HIGH	0	0	0	1	2	2	3	4	5	5	5
LOW	5	5	5	4	3	3	2	1	0	0	0

The OC curves show the probabilities and errors for all coverage levels. You can obtain the OC curve for your design using the LQAS Sampling Plan Calculator.

Annex 2. Example Random Number Table

Random Number Table with Five Columns

87172	43062	39719	10020	32722	86545	86985	04962	54546	23138	62135	55870	97083	67875
28900	50851	30543	89185	16747	95104	49852	26467	58869	79053	06894	23975	34902	23587
86248	71156	55044	13045	33161	95604	57876	23367	10768	78193	60477	70307	06498	48793
10531	51391	41884	69759	32741	70072	01902	96656	90584	59263	49995	27235	40055	20917
02481	90230	81978	39127	93335	74259	25856	52838	49847	69042	85964	78159	40374	49658
23988	13019	78830	17069	58267	69796	94329	34050	25622	55349	10403	93790	77631	74261
37137	47689	82466	24243	10756	54009	44053	74870	28352	66389	38729	80349	50509	56465
38230	82039	34158	90149	82948	60686	27962	39306	53826	47852	76144	38812	76939	03119
98745	08288	19108	84791	58470	59415	45456	44839	86274	25091	42809	56707	47169	95273
44653	58412	91751	14954	87949	81399	51105	29718	82780	11262	23712	99782	42829	26308
88386	66621	16648	19217	52375	05417	26136	05952	71958	25744	52021	20225	01377	47012
50660	58138	01695	69351	25445	20797	74079	60851	47634	36633	93999	96345	58484	12506
36732	74234	84240	46924	62744	39238	78397	60869	26426	55588	56963	59506	17293	45096
34187	78277	83678	34754	46616	45250	25291	04999	19717	60324	66915	03473	98329	82447
26095	98131	79362	39530	53870	87445	26277	90551	28604	39865	40686	05435	74511	69866
00067	74289	20706	74076	28206	36960	09231	82988	57062	35331	08212	68111	52199	05065
42104	26434	30953	15259	76676	63339	75664	23993	63538	34968	47655	44553	61982	13296
82580	46580	87292	23226	21865	60338	04115	33807	38395	98484	40387	69877	24910	13317
89266	14764	17681	68663	66030	12931	17372	35601	63805	55739	42705	30549	31697	33478
47100	92329	89435	69974	40783	52649	93444	41317	02749	19052	34647	92814	88046	34020
59566	26527	44706	85670	96223	36275	82013	82673	60955	62617	90214	24589	59715	57612
10946	24676	66513	56743	96911	89042	08263	70753	89045	39189	04306	06090	94515	17772
34013	69250	27977	84597	55192	65088	55739	35953	18533	39339	78037	32827	68269	69218

21606	11751	30073	71431	53569	27865	90215	34772	21779	11734	64313	49764	30816	56852
56620	92612	77157	90231	90144	29781	01683	52503	60080	73703	70080	80686	47379	33279
49238	90475	84356	87159	21222	40106	02671	52684	38514	68434	16407	58164	13341	48142
50738	21999	73539	51802	78179	27872	57937	29696	67783	29373	96563	74619	77099	17190
58761	21571	71692	19723	25088	10483	71430	47068	78378	80237	32113	09381	62931	29243
55335	71937	22025	33538	04648	74232	57839	62431	61835	04784	06732	34202	93497	72070
26515	31143	83795	78445	32869	31489	81587	90354	97672	70106	35008	37899	36246	97805
32625	36806	00082	26902	26250	28919	38054	49027	22209	42696	46980	17065	61288	30208
20311	96089	20141	30362	04980	32703	04202	91080	28660	89691	84660	73433	70169	11273
10941	73003	87930	85620	06956	38719	88711	61454	64076	13316	02203	54437	54306	78229
56982	46636	34070	30803	39095	80387	08971	25067	07377	70704	13629	68474	99229	05535
14661	10670	15811	00454	81124	46977	89983	48836	48182	17054	06344	24267	16686	21401
52760	78118	23277	29760	00099	97325	54762	43117	73199	19621	24599	11030	64809	35088
48874	20831	02286	73635	93771	54264	49801	22653	01524	84621	91023	64028	29278	15987
44817	77408	48447	25934	22912	43086	68126	92970	91833	26418	72454	97636	94593	07880
17896	79375	70883	70135	21589	51181	71969	32951	35036	17219	27357	96517	55307	84470
27166	22347	92146	92189	16301	15747	72837	59174	75024	39459	54910	95335	95013	47068
13665	30490	63583	73098	19976	03001	94645	40476	43617	85698	66512	42759	20973	98759
58644	73840	08103	97926	57340	63077	08114	10031	35668	21740	33787	44756	20527	65367
72570	36278	06602	56406	85679	85529	08576	50874	59706	01019	29980	56742	05356	04810
92041	68829	02163	59918	83041	71241	90678	79835	86324	13075	29913	99831	25688	53648
71240	74119	53090	23693	14007	90107	68804	54927	68964	26535	28184	21630	12362	67990

Annex 3: LQAS Table Showing Upper Thresholds, Sample Sizes, Decision Rules, and Sampling Errors

LQAS Table: Decision Rules for Sample Sizes of 12-30 and Coverage Targets of 10% - 95%

Sample Size*	Average Coverage or Coverage Benchmarks																	
	10%	15%	20%	25%	30%	35%	40%	45%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%
12	N/A	N/A	1	1	2	2	3	4	5	5	6	7	7	8	8	9	10	11
13	N/A	N/A	1	1	2	3	3	4	5	6	6	7	8	8	9	10	11	11
14	N/A	N/A	1	1	2	3	4	4	5	6	7	8	8	9	10	11	11	12
15	N/A	N/A	1	2	2	3	4	5	6	6	7	8	9	10	10	11	12	13
16	N/A	N/A	1	2	2	3	4	5	6	7	8	9	9	10	11	12	13	14
17	N/A	N/A	1	2	2	3	4	5	6	7	8	9	10	11	12	13	14	15
18	N/A	N/A	1	2	2	3	5	6	7	8	9	10	11	11	12	13	14	16
19	N/A	N/A	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
20	N/A	N/A	1	2	3	4	5	6	7	8	9	11	12	13	14	15	16	17
21	N/A	N/A	1	2	3	4	5	6	8	9	10	11	12	13	14	16	17	18
22	N/A	N/A	1	2	3	4	5	7	8	9	10	12	13	14	15	16	18	19
23	N/A	N/A	1	2	3	4	6	7	8	10	11	12	13	14	16	17	18	20
24	N/A	N/A	1	2	3	4	6	7	9	10	11	13	14	15	16	18	19	21
25	N/A	1	2	2	4	5	6	8	9	10	12	13	14	16	17	18	20	21
26	N/A	1	2	3	4	5	6	8	9	11	12	14	15	16	18	19	21	22
27	N/A	1	2	3	4	5	7	8	10	11	13	14	15	17	18	20	21	23
28	N/A	1	2	3	4	5	7	8	10	12	13	15	16	18	19	21	22	24
29	N/A	1	2	3	4	5	7	9	10	12	13	15	17	18	20	21	23	25
30	N/A	1	2	3	4	5	7	9	11	12	14	16	17	19	20	22	24	26

N/A: Not applicable, meaning LQAS cannot be used in this case because the coverage is either too low to evaluate an SA

Alpha or beta errors are ≥ 10%

Alpha or beta errors are > 15%

Annex 4: LQAS Frequently Asked Questions (FAQs)

The following list of FAQs summarize the question & answer portion of the LQAS: a Practical Introduction Webinar supported by the MOMENTUM Knowledge Accelerator (MKA) Program in February 2024.

Question 1: Are supervision areas similar to low-coverage areas?

Answer: Supervision areas (SAs) (also known as lots) are defined by how the services are delivered within a health system. SAs represent the operational units for delivering services and are assessed using LQAS to determine whether they are meeting a specific target. For example, in Nigeria, a Local Government Area (like a district) has several ward-level teams providing vaccinations across villages. In this case, the wards are the SAs. Supervision areas can vary in their performance, with some achieving high or adequate coverage and others falling short.

Question 2: It seems there are three classifications in LQAS: above 80%; below 50%; and in between 50%-80%. What's the interpretation of the "in between" classification category in terms of, for instance, recommendation to programs?

Answer: LQAS classifies SAs in a binary manner only—either meeting or failing to meet a predetermined coverage target. There is no in-between classification category. If you use the LQAS Sample Size Calculator, you'll find it displays an Operating Characteristics Curve (OCC) which is explained in Annex 1. This curve illustrates what is often referred to as "the gray area", where the classification of SAs is not straightforward. The OCC shows the probability of an SA being classified as acceptable for any level of coverage. SAs that are near but not precisely at the target threshold will have a higher likelihood of being categorized as acceptable or unacceptable, depending on which side of the OCC they are closer to.

For example, if the true coverage of an SA is close to 80% but does not quite reach it, it is still likely that it will be classified as having reached the 80% target. Conversely, if the coverage is only slightly higher than 50% (and thus in the gray area) there is a high likelihood it will be classified as not meeting the target and performing poorly. The key purpose of LQAS is to classify the extremes: the best and the worst performing areas. Those SAs that have low coverage but are not the absolute lowest will most likely be grouped with the lowest to prioritize them for improvement efforts. The method is designed to help EPI and other managers to focus resources on areas with the most need, not those already performing well. Over time, as conditions and coverage improve, the target may be adjusted, bringing previously overlooked SAs into focus for improvement efforts.

Question 3: If aggregating results from supervision areas to determine prevalence of a district/region, and you can't assess all the supervision areas in a discrete time period (e.g., a month or quarter) what are implications for interpretation if the data are collected as a rolling sample over a longer period (e.g., one year)?

Answer: Large Country LQAS (LC-LQAS) was specifically developed to handle such scenarios. For example, in Kano State, Nigeria, which has 44 LGAs, training and managing teams in every LGA would have been very expensive and logistically challenging. LC-LQAS addresses this by determining the minimum number of LGAs (which are the SAs in this design) that need to be sampled to accurately gauge the state's prevalence while also classifying LGAs based on performance targets.

In practical terms, LC-LQAS can be carried out in several rounds over a defined period (e.g., every six months or annually) to take random samples of LGAs in each round. Subsequent rounds take a random sample of LGAs, without replacement, to avoid repeating previously sampled ones. By doing this over a period of time, one would be able to then have a continually populated map showing the classifications of all the LGAs (e.g., SAs) and the corresponding estimate of coverage at the state level. Each round of LC-LQAS allows state teams to analyze feedback and make informed decisions promptly. The number of LGAs that are sampled depends on how heterogeneous a given state is. We use the error terms from the most recent DHS to drive the LC-LQAS calculations. For example, in the more homogeneous Kano State, only 12 out of 44 LGAs might need to be sampled in each round. In contrast, a state like Gombe State, which exhibits more variability, might require a larger sample size. For further details and to use the LC-LQAS Sample Size Calculator, you can refer to this link: http://lqas.spectraanalytics.com/lc-lqas.html. See also the LC-LQAS manual supported by the World Bank in Nigeria.

Question 4: Please explain the LQAS Decision Rule.

Answer: A decision rule is a statistically determined cutoff point used to determine whether a specific target has been met within a given geographical area. For example, if the target is 80% DTP1 vaccination coverage and a sample of 19 children is taken, the LQAS decision rule would be set at 13. This means that once you reach the 13th child in your sample who has received the DTP1 vaccine, you can classify the area as having reached the indicator target. Those SAs that have less than 13 vaccinated children have not satisfied the decision rule and are classified as low performing and needing improvement.

The decision rule is a statistically determined cutoff that is determined using the cumulative probabilities of the binomial. Although this cutoff value can be used for an immediate assessment, it is standard practice to collect all data from the sample in each SA so you can calculate a precise measure of prevalence across all SAs combined. Additionally, collecting data for the full sample will enable users to measure other indicators, given that many surveys include multiple indicators and not all indicators will use the same coverage target or decision rules. Therefore, we normally collect all of the data in every SA.

Question 5: Regarding aggregation (for district, state, provincial or national coverage) should the data be weighted and how? What processes (weighting/others) are involved in combining the lots/SAs for a representative coverage estimate of the larger area?

Answer: When aggregating data to estimate coverage for a larger area, it is standard practice to weight the results by the population size of the SAs. Given that we use probability proportional to size to identify the sampling locations, those are the weights which go into the calculation. While unweighted, or crude coverage is usually sufficient to inform program decisions at the local level, for formal reporting purposes—such as for state or national-level decision-making or for reporting to donors—we recommend using weighted results. There is often a difference between the crude and weighted coverage, highlighting the importance of weighting in certain contexts.

Question 6: In a health facility assessment where the facility (or a group of facilities) serve as the SA, could you consider either consecutive patients or some other sample based off a client list to be an adequate estimation of a simple random sample (SRS) to be used for LQAS?

Answer: There are two main scenarios to consider:

1. In facilities where many patients are already present who meet the age and condition(s) of interest, we ask caretakers meeting the inclusion criteria to identify themselves. This enables us to randomly sample from this group, (i.e. simple random sampling).
2. When fewer children are present, sampling consecutive patients as they arrive at the clinic and meet the inclusion criteria is viable. This approach assumes there is no particular pattern in the timing of their arrivals and approximates a randomizing method.

Regarding using the client list for sampling, if the list reflects those caregivers who were present at the time of sampling, it can provide insights similar to a community survey or client exit interviews. However, using a client list to conduct community-wide sampling is problematic. It will only include individuals on the list who attended the health facility, potentially underrepresenting the broader population, especially in areas like South Sudan where health service utilization varies widely. Similarly, using a list provided by local leaders or village chiefs also demands scrutiny due to potential biases in how individuals are included or excluded from the list.

In practice, segmentation sampling has proven to be a straightforward and effective way of random sampling. It involves community leaders in creating a rough map of the area, which takes about 40 minutes and is well worth the time. Lists should be used with caution and typically only in specific contexts, such as among defined groups like military personnel, where they can be expected to be comprehensive and accurate.

Question 7: What are your thoughts on adjusting the coverage target after data collection with a sample of 19?

Answer: If you opt to change the initially set target before analyzing the data, this adjustment is generally acceptable. However, if you later find that all your supervision areas fail to meet this revised target, it may indicate that the target was set too high for any area to achieve. In such cases, without detecting variation among the SAs, it's challenging to identify priority areas for intervention.

If you're considering lowering the target incrementally to see if this introduces more variation among the results, be cautious. While LQAS is intended for practical use and management, repeatedly using the same data for different statistical tests is not recommended. Instead, you might consider using the average coverage across all supervision areas as a new benchmark. You can then identify areas performing below this average, which can be a practical approach to pinpointing those in need of focused intervention.

Ultimately, LQAS is designed to be a practical tool for management purposes, particularly for identifying priority areas that require attention for program improvement.

Question 8: How do you identify the sample of 19? Is it a set of conveniently located 19 households? Is it random? What sort of sampling method is involved?

Answer: LQAS always uses random sampling to identify the 19 interview locations. Randomization is critical when selecting interview locations, and it begins with a thorough training for the team on how to collect a random sample. The typical randomizing technique involves segmentation sampling. We start by creating a hand-drawn map of the community with the help of local leaders marking significant landmarks such as roads, footpaths, schools, religious buildings, football pitch, graveyards, and natural landmarks such as big stones, prominent trees, etc. The leaders then estimate the approximate number of houses or compounds in the mapped areas.

In some contexts, such as Northern Uganda, if numeracy is a challenge, leaders might use physical objects like stones to represent the number of houses in each area, which effectively illustrates the density of the community. That method has proven to be very effective. You then divide the community into segments of roughly equal size and you enumerate all segments. Next, you randomly select one of the segments using a random number table, a tool that is straightforward for data collectors to use in the field. If a selected segment contains 20 to 30 houses or fewer, we enumerate all houses and randomly select one. For segments with more houses, further subdivision may be necessary. Segments that have 15 or fewer houses are ideal.

After selecting a segment and a specific house—referred to as the reference house—we do not start the interviews there. Instead, to ensure inclusivity, especially in cases where some houses may not have been mapped, we start the interviews at the next nearest house. This approach allows every household, including those initially missed, a chance to be included in the sample.

Segmentation sampling is particularly effective in densely populated or irregular areas, such as slums or areas with unusual terrain, and it was also successfully implemented in urban settings with apartment buildings. This method ensures a fair and representative sample, crucial for the integrity of the data collection process.

Question 9: Can you use LQAS to conduct patient chart reviews at health facilities?

Answer: Medical records can often be difficult to interpret consistently, as different individuals may read the same information differently. The use of these records depends on the specific purpose—whether for diagnosis, prescribing medication, or assessing service quality. In Costa Rica, for example, we sampled medical charts and compared the findings with community survey results, discovering that the records were generally representative of the community. This was facilitated by Costa Rica's high coverage and easy access to health posts, which may not be the case in other countries. When analyzing the results, we noticed discrepancies: some individuals who reported not receiving services were recorded as having received them in their medical charts, and vice versa. These discrepancies tended to offset each other when calculating overall coverage, highlighting the challenges and limitations of relying solely on medical records for accurate data.

Question 10: Can LQAS be effectively utilized for Demographic and Health Surveys (DHS) or mortality surveys in conflict areas, where the goal is not to monitor intervention coverage? Is it suitable for producing aggregated national-level data?

Answer: While we can't speak to whether LQAS should be utilized for DHS which is considered the gold standard that has the benefit of having a methodology that is comparable across time and across locations, LQAS can certainly be used for producing aggregated national-level measures. It has been used in countries like South Sudan and Eritrea for this purpose. As for its accuracy, a study in Uganda compared LQAS results with DHS outcomes collected over a similar timeframe and similar geographic area. The two sets of data aligned very closely, except for two indicators where discrepancies arose due to differences in the questions asked by each method. This research is documented and available for further review (Anoke, 2015). Additionally, studies supported by USAID in Uganda have shown that trained local health workers can gather data of quality comparable to that collected by disinterested parties (e.g., hired research assistants). These findings are also published (Biedron, 2010). Thus, while LQAS should not replace the DHS, it is a robust tool that can complement traditional survey methods, especially in specific contexts like conflict areas or when rapid data collection is needed.

Annex 5: Example Methods Content for an LQAS Study Protocol

Introduction

This section should describe the following:

- Background/context and purpose for the study
- Type of study – e.g., cross-sectional survey, baseline or follow-up survey
- General location and dates of data collection

Overview of LQAS

The household survey will be conducted using Lot Quality Assurance Sampling (LQAS) principles. LQAS is an established classification method developed in the 1920s for quality control of industrial batch-production and adapted to healthcare settings during the mid-1980s 130. In industry, it is used to classify a production unit as reaching or not reaching a predetermined level of quality 131 with a small sample of products. In healthcare settings, the production unit is referred to as the supervision area where health services are delivered by the government or an NGO, or it could be an area that has special geographical challenges.

Characteristics of the methodology include the following:

- LQAS sampling procedures and analyses are relatively simple and the findings can be used by local managers and health workers to priotize resources for poor performing .
- The data from individual Supervision Areas (SA) can be aggregated into an estimate of coverage for the entire program Catchment Area (e.g. district).
- Only a small sample is needed to classify an SA as inadequate relative to the average coverage of the CA or to a predetermined programme target.

Methodology

Survey Terms

For this LQAS survey, the following terms are used:

- **Catchment Area:** The catchment area (CA) is the higher administrative area where vaccination services are monitored and where coverage is estimated. In this study, the District/LGA constitutes an LQAS catchment area.
- **Supervision Area/Lot:** Each catchment area is subdivided into supervision areas (SA) or lots. Normally, the areas of supervision correspond (as much as possible) to the administrative or geographical organization of the delivery of immunization services. For this example, we used the existing administrative divisions to subdivide each LGA (catchment area) into lots according to the ward-level administrative boundaries in each. Each ward constitutes a group of multiple settlements that are served by the vaccination team at the ward level. The lots formed the strata for the study.

- **Interview Location:** For this LQAS study, the term "interview location" means the set of two interviews that correspond to the two age groups of the survey (e.g., children aged 14 weeks-11 months and 12-23 months). Each supervision area will hold a total of 19 interview locations. In each interview location, only one mother/caregiver of a child aged 18 weeks to 11 months, and only one aged 12 to 23 months will be surveyed. The number of interview locations in a village is determined on a s sampling allocation proportional to size and depends on the population size of the village.

Survey Target Groups

This survey focuses on two target groups (age groups) which are children aged 14 weeks to 11 months and 12 to 23 months. These two age groups correspond to the specific vaccination indicators measured in this survey and provide the necessary data for calculating the related denominators.

Please note: these are the recommended age cohorts for measuring timeliness of vaccination (14 weeks – 11 months) and coverage of individual antigens (12-23 months). Your survey may include other age cohorts related to different key indicators.

Sampling

In this study, four study districts serve as the LQAS catchment areas (CA). Each CA is divided into Lots or Supervision Areas (SA) which align with the existing administrative divisions or management units in the area. The SAs forms the strata for the study.

This section describes the standard LQAS sample size of n=19 for each age cohort in each supervision area. This sample is used to classify the supervision areas in relation to predetermined targets for each indicator. The samples from all the supervision areas of the intervention area are aggregated and treated as a stratified random sample that is weighted by the size of each community in each supervision area. This calculation produces a weighted proportion of vaccination coverage for the intervention area with an accuracy of +/-10% and a 95% confidence interval.

Studies typically use the binomial model to select a fixed sample size (n) and a corresponding decision rule (d). If d or more cases in the sample fail to have the trait of interest (e.g., vaccination coverage), the area was classified as having unacceptable coverage of service delivery; and otherwise, the area was classified as acceptable. Classifying supervision areas allows management teams to prioritize scarce resources for areas with unacceptable coverage. In this study, nineteen sets of surveys will be carried out in each SA. The SA sample size of 19 is based on the cumulative probabilities of the binomial formula used to select a decision rule needed to classify each SA as reaching or not reaching a predetermined target.

In order to define n and "d", the minimum number with the trait of interest to classify the SA as being acceptable, four decisions are necessary: defining a coverage target or threshold, for example, 80% vaccination coverage (pUpper, pU), a lower threshold indicating unacceptably low coverage where problems need to be corrected (pLower, pL), and two errors permitted: α-error <0.10 for misclassifying adequate coverage (pU) as low, and β-error <0.10 for misclassifying a very low coverage (pL) as high 130. In practical terms, the α- and β-errors allow +/- 10% error of erroneously missing areas with low coverage that do indeed need attention or likewise, erroneously identifying areas as problematic where problems may not exist. In this study, pU=0.80 and pL=0.50 with maximum α and β errors set to <0.10. We used the LQAS Calculator developed by LSTM (www.bit.ly/LQAS_Sample_Size_Calculator) to 132 arrive at the LQAS sampling design of pU=0.80, pL=0.50, n=19, d=13.

An LQAS sample of n=19 in each of 5 SAs yields a stratified random sample of 19x5=95 for each CA. This sample size produces a precision that will not exceed +0.10 with 95% confidence. We set p=0.50 to produce the largest sample size needed for a precision of d=0.10 130. A sample size of 95 produces approximately the same precision as a sample of n=96 shown in the formula below. As a result, a sample size of 19 per SA is preferable because it is the smallest sample with an acceptable amount of error (<10% alpha and beta error) for LQAS classifications of each SA using any value of p-Upper with p-Lower being 30 percentage points lower. Also, a minimum of 5 SAs per CA is recommended so the aggregate measure of coverage has a precision not exceeding +10%130. The desired sample size for the aggregate sample with p=0.50 for the study area for all survey indicators was calculated with:

$$n = 1.96^2 \frac{pq}{d^2} = 96 = 1.96^2 \frac{0.50 \ x \ 0.50}{0.10^2}$$

Sampling Design by District

Using probability proportional to size sampling, 19 interview locations will be selected in each SA/Lot, yielding a total sample of n=760. Table A5 shows the total number of interviews (for each age cohort) in the survey. The study team will sample in each CA separately, which will give four individual samples of n=95 each to estimate vaccination coverage at the district level in the selected districts.

This sample will give two levels of information:

- Vaccination coverage and estimated prevalence at the district level for each indicator with a 95% confidence interval.
- Classifications of supervision areas using targets or average coverage for each indicator. This information identifies areas of supervision where there are likely to be problems accessing services.

Table A5. LQAS sample by Catchment Area

Catchment Area	Lots per CA	n in each Lot	n in each CA	Age cohorts	Total sample (N)
District 1	5	19	95	2	190
District 2	5	19	95	2	190
District 3	5	19	95	2	190
District 4	5	19	95	2	190
				Total	**760**

Segmentation sampling will be used to select the household where the survey would be conducted. This is done by constructing sketch maps in the selected village with the support of a local leader to subdivide the village into sections of approximately the same population size. One segment is randomly selected using a random number table. This segment is further sub-divided for selection until a manageable number of houses results in the subsection. One house in the selected subsection is then randomly selected using a random number table. If more than one survey location is needed in a village, the process of segmentation sampling is done again from the beginning using the same community sketch map. Simple random sampling using a random number table also will be carried out at the household level in cases where more than one person met the eligibility criteria for the survey in a given household.

This study will sample two age cohorts (sampling groups) that corresponded to different age-dependent indicators for maternal and child health, as follows:

1. **Mothers/Caregivers of Children 14 weeks to 11 months** to assess indicators related to timeliness of vaccination.
2. **Mothers/Caregivers of Children 12-23 months** to assess coverage of childhood immunisation and prevalence of zero-dose and under-immunized children.

We will select an independent sample of children in both age ranges to main the statistical power in each group. We use parallel sampling to select respondents in each age group. Parallel sampling involves sampling only one randomly selected child from among the two target populations in the selected household and then going to the next nearest house (using the principle of the next nearest door) until both target populations are sampled per interview location. In this manner each target population is independently sampled and analysed separately. The primary caregiver will be interviewed for the survey.

Survey Instrument

The LQAS household survey measures childhood vaccination antigens, the WHO Behavioral and Social Drivers (BeSD) indicators as well as information on household wealth and demographic characteristics of the study respondents (see Annex 8). The survey consists of a structured questionnaire for both sampling groups mentioned above based on existing LQAS tools that had been developed and used by the ZDLH in Nigeria and Mali.

Annex 6: LQAS Sampling Frame Template

Download the workbook

Annex 7: Household Wealth Index Variables

Variables Used in the Household Wealth Index

	Name of variable	Less Poor	More Poor
1	Material of the walls of house	1=Cement block or Burnt bricks with cement or Burnt bricks with mud or Stone	0=Thatch/straw or Mud and poles or Timber or Unburnt bricks or Tarpaulin
2	Material of the floor	1=Mosaic or tiles or Bricks or Cement or Stones or Wood	0=Earth sand or Earth and cow dung
3	Roof material	1=Tiles or Galvanized iron sheets or Asbestos	0= Glass/thatch/straw or Banana fiber or Polythene or plastic sheets or Tarpaulin
4	Fuel used for cooking	1=Alcohol/Ethanol or Gasoline/Diesel or Kerosene/Paraffin or Coal/lignite or Processed biomass pellets/woodchips	0 =Charcoal or Wood or Crop residue/grass/straw or Animal Dung/waste or Garbage/plastic or Sawdust
5	Crowding in the household	1= 5 or fewer people living in the household	0= 6 or more people living in the household
6	Toilet facilities	1 = flush toilet or ventilated improved pit (VIP) latrine or latrine with a super-structure	0 = open pit or none (bush field) or latrine with no slab or super structure
7	Electricity *	1 = yes	0 = no
8	Has a television*	1 = yes	0 = no
9	Has a sofa*	1 = yes	0 = no
10	Has cupboard*	1 = yes	0 = no
11	Has a Cassette/CD/DVD player*	1 = yes	0 = no
	Own any of above (#7-11)	**1 = Yes**	**0 = No**
12	HH member had a mobile phone*	1 = Yes	0 = No
13	HH member has a bank account	1 = Yes	0 = No
14	Ownership of house	1 = Self or family	0= Landlord, employer or Government
15	Own or lease land	1=Own	0=Lease or No

** Variables not available for 0–59-month age group. Ownership of the five items in #7-11 was summarized as a single yes/no variable because the majority of responses to the individual items was no.*

Annex 8: Example LQAS Questionnaire

QUESTIONNAIRE FOR CAREGIVERS OF CHILDREN 0-11 MONTHS

Construct	Question
Identification	QUESTIONNAIRE NUMBER: ________________ LQAS INTERVIEW NUMBER: ________________ SUPERVISION AREA: ____________________
Date	DAY /MONTH /YEAR OF INTERVIEW: ____ /_______________ /________
Participant	PARTICIPANT ID: ____________________
Location	DISTRICT NAME: ________________________________ SUBCOUNTY/WARD: _____________________________ SETTLEMENT: __________________________________ VILLAGE: _____________________________________ GPS COORDINATES: _____________________________
Typology	IS THIS AREA: o RURAL o URBAN
Supervision	INTERVIEWER NAME: ____ CHECKED BY (SUPERVISOR NAME): ____

Consent	Hello, I am [INTERVIEWER NAME] with [ORGANIZATION NAME]. We are interviewing caregivers to help improve childhood vaccination services in [DISTRICT NAME]. I know you are busy, so this will take only a few minutes. Your participation is completely voluntary and anonymous. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take the survey? o YES o NO IF "YES": Thank you very much. Do you have any questions for me before we begin? PROCEED TO SURVEY SCREENING. IDENTIFY ELIGIBLE CHILD AFTER ADDRESSING ANY QUESTIONS. IF "NO": Thank you very much. END INTERVIEW.

Section A: Caregiver's Background

No.	Questions and Filters	Coding Categories	Skip to
A1	How old are you?	AGE (IN COMPLETED YEARS): __ __	
A2	What is the month and year of your birth? **CHOOSE '98' IF THEY DO NOT KNOW MONTH OR YEAR OF BIRTH**	DATE OF BIRTH MONTH _____ DK MONTH........98 YEAR _____ DK YEAR........98	
A3	What is your gender?	o Woman o Man o Nonbinary o Prefer not to say	
A4	Are you the parent or primary caregiver of [NAME OF SELECTED ELIGIBLE CHILD]?	YES........1 NO........2 IF "NO": Unfortunately, you are not eligible to participate in the survey. Thank you very much for taking the time to answer my questions. END INTERVIEW.	END
A5	How many children do you have who are younger than 5 years old?	Number of children under 5__________	

A6	What is your relationship to [NAME OF CHILD]? Would you say…	Mother........1 Father........2 Grandparent........3 Uncle or aunt........4 Brother or sister........5 Other........96 *Specify*	
A7	What is the highest level of school you completed?	Preschool........1 Primary........2 Secondary........3 Higher........4 None........5	
A8	What is your **current** marital status? **READ ALL RESPONSE OPTIONS TO CAREGIVER**	SINGLE, NO PARTNER........1 SINGLE, NON-REGULAR PARTNER........2 SINGLE WITH REGULAR PARTNER........3 MARRIED........4 COHABITING........5 WIDOWED........6 DIVORCED/SEPARATED........7	
A9	To what religious community do you belong?	MUSLIM........1 CATHOLIC........2 PROTESTANT........3 PENTACOSTAL........4 ORTHODOX........5 SEVENTH DAY ADVENTIST........6 N/A........7 Other........96 *Specify*	

A10	To what ethnic group do you belong?	LUGBARA ....1 MADI.... 2 ARABIC .... 3 DINKA.... 4 NUER.... 5 BARRI .... 6 ZANDE....7 MURLE.... 8 SHILUK .... 9 ACHOLI ....10 BAKA .... 11 MURU ....12 Other .... 96 *Specify*	
A11	How many people live in this house?	_____________ Number of people	

Section B: Caregiver's Assets

No.	Questions and Filters	Coding Categories	Skip To
B1	Who owns this house? **DO NOT READ THE POSSIBLE RESPONSES**	Myself ....1 Family ....2 Landlord ....3 Employer ....4 Government....5 Other ....96 *Specify*	
B2	Does your household have: **READ EACH OPTION AND CIRCLE 1 (YES) OR 2 (NO) FOR EACH ITEM**	**CIRCLE ONLY ONE RESPONSE FOR EACH OF THE OPTIONS BELOW**	
	a) Electricity?	Yes = 1 No = 2	
	b) Television?	Yes = 1 No = 2	
	c) Sofa?	Yes = 1 No = 2	
	d) Cupboard?	Yes = 1 No = 2	
	e) Cassette/CD/DVD player?	Yes = 1 No = 2	
B3	Does any member of your household own a mobile phone?	Yes = 1 No = 2	
B4	Does any member of your household have a bank account, mobile money account or account with an agent?	Yes = 1 No = 2	
B5	What is the **primary construction material** of the walls? **OBSERVE THE MAJOR CONSTRUCTION MATERIALS OF THE EXTERNAL WALLS** **CIRCLE ONE RESPONSE ONLY**	Thatch, Straw ....1 Mud and poles ....2 Timber....3 Un-burnt bricks....4 Burnt bricks with mud ....5 Burnt bricks with cement....6 Cement blocks....7 Stone....9 Tarpaulin....10 Other ....96 *Specify*	

B6	What is the **primary construction material** of the floor? **OBSERVE THE MAIN MATERIAL OF FLOORING IN THE HOUSE** **CIRCLE ONE RESPONSE ONLY**	Earth sand......1 Earth and cow dung......2 Mosaic or tiles ......3 Bricks......4 Cement ......5 Stones ......6 Wood......7 Other ......96 *Specify*	
B7	What is the **primary construction material** of the roof? **OBSERVE THE MAIN MATERIAL OF DWELLING ROOF IN THE HOUSE** **CIRCLE ONE RESPONSE ONLY**	Grass/Thatch/Straw ......1 Iron sheets......2 Tiles ......3 Banana fiber......4 Asbestos......5 Polythene or plastic sheets......6 Other ......96 *Specify*	
B8	What is the **main type** of latrine/toilet used in your household? **MAY I SEE THE LATRINE/TOILET/ FACILITY?** **OBSERVE AND RECORD MAIN TYPE OF LATRINE/ TOILET FACILITY USED BY MEMBERS OF THE HOUSEHOLD** **CIRCLE ONLY ONE RESPONSE**	Flush toilet ......1 Ventilated Improved Pit (VIP) latrine......2 Latrine with super-structure......3 Latrine without a super-structure......4 No facility/bush ......5 Composting toilet......6 Latrine with no slab......7 Other ......96 *Specify*	

B9	What type of fuel do you use **most often** for cooking?	ALCOHOL / ETHANOL..........................1 GASOLINE / DIESEL...............................2 KEROSENE / PARAFFIN.........................3 COAL / LIGNITE......................................4 CHARCOAL..5 WOOD...6 CROP RESIDUE / GRASS / STRAW / SHRUBS..................................7 ANIMAL DUNG / WASTE.......................8 PROCESSED BIOMASS (PELLETS) OR WOODCHIPS....................................9 GARBAGE / PLASTIC............................10 SAWDUST..11 OTHER...96 *SPECIFY*	
B10	Do you own or lease land?	YES/OWN..1 YES/LEASE..2 NO..3	

Section C: Infant's Background

No.	Questions and Filters	Coding Categories	Skips
C1	**RECORD THE NAME OF SELECTED CHILD:**	_________________________ NAME OF SELECTED CHILD	
C2	What is the sex of [NAME]?	MALE..1 FEMALE....................................2	
C3	In what month and year was (NAME) born? ***PROBE*: ....** **WHAT IS THEIR BIRTHDAY?** **ENTER THE DAY IF KNOWN; OTHERWISE, CIRCLE 98 FOR DAY** **MONTH AND YEAR MUST BE RECORDED.**	DATE OF BIRTH DAY ____________ DON'T KNOW DAY..............................98 MONTH _________ YEAR__ __ __ __	
C4	How old is (NAME)? ***PROBE*: HOW OLD WAS (NAME) AT THEIR LAST BIRTHDAY?** **RECORD AGE IN COMPLETED MONTHS.** **RECORD '0' IF LESS THAN 1 MONTH.**	AGE (IN COMPLETED MONTHS) ________	

Section D: Antenatal Care – USE ONLY IF MOTHER IS RESPONDENT

No.	Questions and Filters	Coding Categories	Skips
D1	Did you see anyone for antenatal care during your pregnancy with (NAME)?	YES......1 NO......2	➔ D4
D2	Whom did you see? **PROBE:......** **ANYONE ELSE?** **PROBE FOR THE TYPE OF PERSON SEEN AND CIRCLE ALL ANSWERS GIVEN**	HEALTH PROFESSIONAL: DOCTOR......1 NURSE......2 MIDWIFE......3 OTHER PERSON TRADITIONAL BIRTH ATTENDANT......4 COMMUNITY HEALTH WORKER......5 OTHER *(SPECIFY)*......96	
D3	How many times did you receive antenatal care during this most recent pregnancy?	NUMBER OF TIMES: __ __ DON'T KNOW......98	
D4	Did you have a maternal card when you were pregnant with (NAME)? **IF MOTHER ANSWERS YES, THEN ASK TO SEE THE CARD**	YES, SEEN BY INTERVIEWER......1 YES, BUT NOT AVAILABLE/LOST /MISPLACED......2 NEVER HAD A CARD......3 DON'T KNOW......98	➔ D8 ➔ D8 ➔ D8
D5	**RECORD THE NUMBER OF ANTENATAL CARE VISITS LISTED ON THE MATERNAL CARD**	___________ NUMBER OF ANTENATAL CARE VISITS	
D6	How many months pregnant were you when you first received antenatal care for this pregnancy? **CHECK MATERNAL CARD IF AVAILABLE**	3 MONTHS OR LESS......1 MORE THAN 3 MONTHS......2 DON'T KNOW......98	

<table>
<tr><td>D7</td><td>Look at the antenatal card or vaccination card and record the dates (day / Month / year) for the last five Tetanus Toxoid injections.

IF TT INJECTION WAS NOT RECEIVED, WRITE 00 IN EACH SPACE</td><td><table><tr><th></th><th></th><th></th><th></th></tr><tr><td>FIRST</td><td></td><td></td><td></td></tr><tr><td>SECOND</td><td></td><td></td><td></td></tr><tr><td>THIRD</td><td></td><td></td><td></td></tr><tr><td>FOURTH</td><td></td><td></td><td></td></tr><tr><td>FIFTH</td><td></td><td></td><td></td></tr></table></td><td></td></tr>
<tr><td>D8</td><td>Who assisted with the delivery of (NAME)?

PROBE: ANYONE ELSE?

CIRCLE ALL ANSWERS GIVEN.

IF RESPONDENT SAYS NO ONE ASSISTED, PROBE TO DETERMINE IF ANY ADULTS WERE PRESENT AT THE DELIVERY.</td><td>HEALTH PROFESSIONAL:
DOCTOR....1
NURSE 2
MIDWIFE....3
OTHER PERSON
TRADITIONAL BIRTH ATTENDANT 4
COMMUNITY HEALTH WORKER 5
RELATIVE / FRIEND 6
NO ONE....7
OTHER (SPECIFY)__________________96</td><td></td></tr>
</table>

D9	Where did you give birth to (NAME)? **PROBE TO IDENTIFY THE TYPE OF FACILITY.** **IF UNABLE TO DETERMINE WHETHER PUBLIC OR PRIVATE, WRITE THE NAME OF THE PLACE IN THE SPACE BELOW:** **_____________________** **(NAME OF PLACE)**	HOME YOUR HOME .... 1 OTHER HOME .... 2 PUBLIC SECTOR GOVT. HOSPITAL .... 3 GOVT. CLINIC / HEALTH CENTRE .... 4 OTHER PUBLIC (*SPECIFY*) .... 5 PRIVATE MEDICAL SECTOR PRIVATE HOSPITAL .... 6 PRIVATE CLINIC .... 7 PRIVATE MATERNITY HOME .... 8 OTHER PRIVATE MEDICAL (*SPECIFY*) .... 9 OTHER (*SPECIFY*)_________________96	

Section E: Childhood Immunizations

No.	Questions and Filters	Coding Categories	Skips
E1	Do you have a child health card where (NAME's) vaccinations are written down? **IF YES, ASK TO SEE THE CHILD CARD**	Yes, seen by interviewer........1 Yes, not seen........2 No........3 DON'T KNOW........98	➔E3
E2	Why is the vaccination card not available?	Lost/misplaced/not available........1 Card not issued/not received........2 Child never vaccinated........3 DON'T KNOW........98 Other ________________________ 96 *(specify)*	➔E4 ➔E4 ➔E4 ➔E4 ➔E4
E3	**COPY VACCINATION DATE (DAY, MONTH AND YEAR) FOR EACH VACCINE FROM [NAME'S] CHILD HEALTH CARD.** **WRITE '44' IN 'DAY' MONTH AND YEAR COLUMNS IF CARD/PASSPORT SHOWS THAT VACCINATION WAS GIVEN BUT NO DATE IS RECORDED.** **WRITE '00' IF A VACCINATION WAS NOT GIVEN**		

Vaccines	Day	Month	Year
BCG			
HEPB 0			
DPT/PENTA 1			
DPT/PENTA 2			
DPT/PENTA 3			
OPV 0			
OPV 1			
OPV 2			
OPV 3			
IPV 1			
IPV 2			
PCV 1			
PCV 2			
PCV 3			
MEASLES 1			
MEASLES 2			
ROTA 2			
ROTA 2			
ROTA 3			

E4	Did (NAME) ever receive any vaccinations to prevent him/her from getting diseases, including vaccinations received in a national immunization day campaign?	Yes ....1 No 2	➔F1
E4	Did (NAME) receive a BCG vaccine against tuberculosis, that is, an injection in the right arm that usually causes a scar? **LOOK AT RIGHT ARM TO VERIFY PRESENCE OF SCAR**	Yes ....1 No ....2 Don't know....98	
E5	Did (NAME) receive a Polio vaccine, that is, drops in the mouth	Yes ....1 No ....2 Don't know....98	➔E8
E6	When did (NAME) receive the first polio vaccination, within 2 weeks after birth or later?	Within 2 weeks after birth....1 Later....2 Don't know....98	
E7	How many times did (NAME) receive the polio vaccine?	_ _ _ _ _ _ Number of times Don't know....98	
E8	Did (NAME) receive DPT/PENTA vaccine, that is, an injection given in the thigh?	Yes ....1 No ....2 Don't know....98	➔E10
E9	How many times has (NAME) been given DPT/PENTA vaccination injection?	_ _ _ _ _ _ Number of times Don't know....98	
E10	Did (NAME) receive a measles vaccine, that is, an injection in the left arm?	Yes ....1 No ....2 Don't know....98	

E11	Where did (NAME) receive most of the vaccines?	Government Health Centre........1 Government Hospital........2 Private Hospital/Clinic........3 PNFP........4 National Campaign........5 Other ______________________ 96 *(specify)*	
E12	Where did (NAME) receive other vaccines?	Government Health Centre........1 Government Hospital........2 Private Hospital/Clinic........3 PNFP........4 National Campaign........5 Other ______________________ 96 *(specify)*	
E13	Did you pay for (NAME)'s vaccines?	Yes........1 No........2	➔F1
E14	Where did you pay for (NAME)'s vaccine?	Government Health Centre........1 Government Hospital........2 Private Hospital/Clinic........3 PNFP........4 National Campaign........5 Other______________________ 96 *(specify)*	
E15	How much did you pay for the last vaccine received by (NAME)?	______________ Specify Amount DON'T KNOW........98	

Section F: Behavioural and Social Drivers (BeSD) of Vaccination

The WHO BeSD Childhood Vaccination Survey is a globally standardized tool for assessing the drivers of vaccination for children. The first five questions are the priority BeSD indicators. When it is not possible to use the full set of 19 survey questions below, at least complete the first five priority indicators.

Trained interviewers should read the survey questions and response options aloud to respondents. Interviewers *should not* read aloud the instructions in [square brackets] and any text that is in ALL CAPITALS. Interviewers should emphasize all underlined words.

No.	BeSD Domain	Coding Categories	Type
F1	**Intention to get child vaccinated**	[COUNTRY NAME] has a schedule of vaccines for children. Do you want your child to get none of these vaccines, some of these vaccines or all of these vaccines? o NONE o SOME o ALL	**Priority Indicator**
F2	**Confidence in vaccine benefits**	How important do you think vaccines are for your child's health? Would you say… o Not at all important, o A little important, o Moderately important, *or* o Very important?	**Priority Indicator**
F3	**Family norms**	Do you think most of your close family and friends want you to get your child vaccinated? o NO o YES	**Priority Indicator**
F4	**Know where to go to get vaccination**	Do you know where to go to get your child vaccinated? o NO o YES	**Priority Indicator**
F5	**Affordability**	How easy is it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, plus the cost of taking time away from work. Would you say… o Not at all easy, o A little easy, o Moderately easy, *or* o Very easy?	**Priority Indicator**

F6	**Confidence in vaccine safety**	How safe do you think vaccines are for your child? Would you say… o Not at all safe, o A little safe, o Moderately safe, *or* o Very safe?	
F7	**Confidence in health workers**	How much do you trust the health workers who give children vaccines? Would you say you trust them… o Not at all, o A little, o Moderately, *or* o Very much?	
F8	**Peer norms**	Do you think most parents you know get their children vaccinated? o NO o YES	
F9	**Religious leader norms**	Do you think your religious leaders want you to get your child vaccinated? o NO o YES	
F10	**Community leader norms**	Do you think your community leaders want you to get your child vaccinated? o NO o YES	
F11	**Health worker recommendation**	Has a health worker recommended your child be vaccinated? o NO o YES	
F12	**Received recall**	Have you ever been contacted about your child being due for vaccination? o NO o YES	
F13	**Mother's travel autonomy**	If it was time for your child to get vaccinated, would the mother need permission to take your child to the clinic? o NO o YES	

F14	**Took child for vaccination**	Have you personally ever taken your youngest child to get vaccinated? o NO o YES	
F15	**Vaccination availability**	Have you ever been turned away when you tried to get your child vaccinated? o NO o YES	
F16	**Ease of access**	How easy is it to get vaccination services for your child? Would you say… o Not at all easy, o A little easy, o Moderately easy, *or* o Very easy?	
F17	**Reasons for low ease of access**	What makes it hard to get vaccination services for your child? Would you say… [READ ALOUD ALL RESPONSE OPTIONS PAUSING AFTER EACH TO ALLOW RESPONDENT TO ANSWER 'YES' OR 'NO' AFTER EACH RESPONSE OPTION. RESPONDENTS MAY SELECT MULTIPLE RESPONSE OPTIONS.] o Nothing, it's not hard, [IF NOTHING, SKIP REST OF RESPONSES] o Getting to the clinic is hard, o The clinic opening times are inconvenient, o The clinic sometimes turns people away without vaccinating, o The waiting time in the clinic takes too long, *or* o Is there something else? [RECORD ANSWER: _______________]	
F18	**Service satisfaction**	How satisfied are you with the vaccination services? Would you say… o Not at all satisfied, o A little satisfied, o Moderately satisfied, *or* o Very satisfied?	

F19	**Service quality**	What is not satisfactory about the vaccination services? Would you say… [READ ALOUD ALL RESPONSE OPTIONS PAUSING AFTER EACH TO ALLOW RESPONDENT TO ANSWER 'YES' OR 'NO' AFTER EACH RESPONSE OPTION. RESPONDENTS MAY SELECT MULTIPLE RESPONSE OPTIONS.] o Nothing, you are satisfied, [IF NOTHING, SKIP REST OF RESPONSES] o Vaccine is not always available, o The clinic does not open on time, o Waiting times are long, o The clinic is not clean, o Staff are poorly trained, o Staff are not respectful, o Staff do not spend enough time with people, *or* o Is there something else? [RECORD ANSWER: _______________]	

THANK YOU - THE END

QUESTIONNAIRE FOR CAREGIVERS OF CHILDREN 12-23 MONTHS

Section A: Caregiver's Background

No.	Questions and Filters	Coding Categories	Skip to
A1	How old are you?	AGE (IN COMPLETED YEARS): __ __	
A2	What is the month and year of your birth? **CHOOSE '98' IF THEY DO NOT KNOW MONTH OR YEAR OF BIRTH**	DATE OF BIRTH MONTH _____ DK MONTH........98 YEAR _____ DK YEAR........98	
A3	What is your gender?	o Woman o Man o Nonbinary o Prefer not to say	
A4	Are you the parent or primary caregiver of [NAME OF SELECTED ELIGIBLE CHILD]?	YES........1 NO........2 IF "NO": Unfortunately, you are not eligible to participate in the survey. Thank you very much for taking the time to answer my questions. END INTERVIEW.	END
A5	How many children do you have who are <u>younger</u> than 5 years old?	Number of children under 5__________	
A6	What is your relationship to [NAME OF CHILD]? Would you say…	Mother........1 Father........2 Grandparent........3 Uncle or aunt........4 Brother or sister........5 Other_________________________96 *Specify*	
A7	What is the highest level of school you completed?	Preschool........1 Primary........2 Secondary........3 Higher........4 None........5	

A8	What is your **current** marital status? **READ ALL RESPONSE OPTIONS TO CAREGIVER**	SINGLE, NO PARTNER .... 1 SINGLE, NON-REGULAR PARTNER .... 2 SINGLE WITH REGULAR PARTNER .... 3 MARRIED .... 4 COHABITING .... 5 WIDOWED .... 6 DIVORCED/SEPARATED 7	
A9	To what religious community do you belong?	MUSLIM .... 1 CATHOLIC .... 2 PROTESTANT .... 3 PENTACOSTAL .... 4 ORTHODOX .... 5 SEVENTH DAY ADVENTIST .... 6 N/A .... 7 Other_________________________96 *Specify*	
A10	To what ethnic group do you belong?	LUGBARA .... 1 MADI .... 2 ARABIC .... 3 DINKA .... 4 NUER .... 5 BARRI .... 6 ZANDE .... 7 MURLE .... 8 SHILUK .... 9 ACHOLI .... 10 BAKA .... 11 MURU .... 12 Other_________________________96 *Specify*	
A11	How many people live in this house?	_____________ Number of people	

Section B: Caregiver's Assets

No.	Questions and Filters	Coding Categories	Skip To
B1	Who owns this house? **DO NOT READ THE POSSIBLE RESPONSES**	Myself ....1 Family ....2 Landlord ....3 Employer ....4 Government....................5 Other_________________96 *Specify*	
B2	Does your household have: **READ EACH OPTION AND CIRCLE 1 (YES) OR 2 (NO) FOR EACH ITEM**	**CIRCLE ONLY ONE RESPONSE FOR EACH OF THE OPTIONS BELOW**	
	a) Electricity?	Yes = 1 No = 2	
	b) Television?	Yes = 1 No = 2	
	c) Sofa?	Yes = 1 No = 2	
	d) Cupboard?	Yes = 1 No = 2	
	e) Cassette/CD/DVD player?	Yes = 1 No = 2	
B3	Does any member of your household own a mobile phone?	Yes = 1 No = 2	
B4	Does any member of your household have a bank account, mobile money account or account with an agent?	Yes = 1 No = 2	

B5	What is the **primary construction material** of the walls? **OBSERVE THE MAJOR CONSTRUCTION MATERIALS OF THE EXTERNAL WALLS** **CIRCLE ONE RESPONSE ONLY**	Thatch, Straw ....1 Mud and poles ....2 Timber ....3 Un-burnt bricks....................4 Burnt bricks with mud ....5 Burnt bricks with cement....................6 Cement blocks....................7 Stone ....9 Tarpaulin ....10 Other_________________96 *Specify*	
B6	What is the **primary construction material** of the floor? **OBSERVE THE MAIN MATERIAL OF FLOORING IN THE HOUSE** **CIRCLE ONE RESPONSE ONLY**	Earth sand ....1 Earth and cow dung....................2 Mosaic or tiles ....3 Bricks....................4 Cement ....5 Stones ....6 Wood....................7 Other________________ 96 *Specify*	
B7	What is the **primary construction material** of the roof? **OBSERVE THE MAIN MATERIAL OF DWELLING ROOF IN THE HOUSE** **CIRCLE ONE RESPONSE ONLY**	Grass/Thatch/Straw ....1 Iron sheets....................2 Tiles ....3 Banana fiber....................4 Asbestos....................5 Polythene or plastic sheets............6 Other_________________96 *Specify*	

B8	What is the **main type** of latrine/toilet used in your household? **MAY I SEE THE LATRINE/TOILET/ FACILITY?** **OBSERVE AND RECORD MAIN TYPE OF LATRINE/ TOILET FACILITY USED BY MEMBERS OF THE HOUSEHOLD** **CIRCLE ONLY ONE RESPONSE**	Flush toilet ....1 Ventilated Improved Pit (VIP) latrine....................2 Latrine with super-structure..........3 Latrine without a super-structure....................4 No facility/bush ....5 Composting toilet....................6 Latrine with no slab....................7 Other_________________ 96 *Specify*	
B9	What type of fuel do you use **most often** for cooking?	ALCOHOL / ETHANOL ....1 GASOLINE / DIESEL....................2 KEROSENE / PARAFFIN ....3 COAL / LIGNITE....................4 CHARCOAL....................5 WOOD....................6 CROP RESIDUE / GRASS / STRAW / SHRUBS....................7 ANIMAL DUNG / WASTE ....8 PROCESSED BIOMASS (PELLETS) OR WOODCHIPS....................9 GARBAGE / PLASTIC ....10 SAWDUST....................11 OTHER....................96 *SPECIFY*	
B10	Do you own or lease land?	YES/OWN....................1 YES/LEASE ....2 NO 3	

Section C: Infant's Background

No.	Questions and Filters	Coding Categories	Skips
C1	**RECORD THE NAME OF SELECTED CHILD:**	_____________________________ NAME OF SELECTED CHILD	
C2	What is the sex of [NAME]?	MALE....................1 FEMALE....................2	
C3	In what month and year was (NAME) born? ***PROBE:*** **..........** **WHAT IS THEIR BIRTHDAY?** **ENTER THE DAY IF KNOWN; OTHERWISE, CIRCLE 98 FOR DAY** **MONTH AND YEAR MUST BE RECORDED.**	DATE OF BIRTH DAY ____________ DON'T KNOW DAY....................98 MONTH _________ YEAR__ __ __ __	
C4	How old is (NAME)? ***PROBE*: HOW OLD WAS (NAME) AT THEIR LAST BIRTHDAY?** **RECORD AGE IN COMPLETED MONTHS.** **RECORD '0' IF LESS THAN 1 MONTH.**	AGE (IN COMPLETED MONTHS) ________	

Section E: Childhood Immunizations

No.	Questions and Filters	Coding Categories	Skips
E1	Do you have a child health card where (NAME'S) vaccinations are written down? **IF YES, ASK TO SEE THE CHILD CARD**	Yes, seen by interviewer.......1 Yes, not seen.......2 No.......3 DON'T KNOW.......98	➔E3
E2	Why is the vaccination card not available?	Lost/misplaced/not available.......1 Card not issued/not received.......2 Child never vaccinated.......3 DON'T KNOW.......98 Other ______________________ 96 *(specify)*	➔E4 ➔E4 ➔E4 ➔E4 ➔E4
E3	**COPY VACCINATION DATE (DAY, MONTH AND YEAR) FOR EACH VACCINE FROM [NAME'S] CHILD HEALTH CARD.** **WRITE '44' IN 'DAY' MONTH AND YEAR COLUMNS IF CARD/PASSPORT SHOWS THAT VACCINATION WAS GIVEN BUT NO DATE IS RECORDED.** **WRITE '00' IF A VACCINATION WAS NOT GIVEN**	(see table below)	

Vaccines	Day	Month	Year
BCG			
HEPB 0			
DPT/PENTA 1			
DPT/PENTA 2			
DPT/PENTA 3			
OPV 0			
OPV 1			
OPV 2			
OPV 3			
IPV 1			
IPV 2			
PCV 1			
PCV 2			
PCV 3			
MEASLES 1			
MEASLES 2			
ROTA 2			
ROTA 2			
ROTA 3			

E4	Did (NAME) ever receive any vaccinations to prevent him/her from getting diseases, including vaccinations received in a national immunization day campaign?	Yes ....1 No 2	➔F1
E4	Did (NAME) receive a BCG vaccine against tuberculosis, that is, an injection in the right arm that usually causes a scar? **LOOK AT RIGHT ARM TO VERIFY PRESENCE OF SCAR**	Yes ....1 No ....2 Don't know.... 98	
E5	Did (NAME) receive a Polio vaccine, that is, drops in the mouth	Yes ....1 No ....2 Don't know.... 98	➔E8
E6	When did (NAME) receive the first polio vaccination, within 2 weeks after birth or later?	Within 2 weeks after birth....1 Later....2 Don't know.... 98	
E7	How many times did (NAME) receive the polio vaccine?	_ _ _ _ _ _ Number of times Don't know.... 98	
E8	Did (NAME) receive DPT/PENTA vaccine, that is, an injection given in the thigh?	Yes ....1 No ....2 Don't know.... 98	➔E10
E9	How many times has (NAME) been given DPT/PENTA vaccination injection?	_ _ _ _ _ _ Number of times Don't know.... 98	
E10	Did (NAME) receive a measles vaccine, that is, an injection in the left arm?	Yes ....1 No ....2 Don't know.... 98	

E11	Where did (NAME) receive most of the vaccines?	Government Health Centre....1 Government Hospital....2 Private Hospital/Clinic....3 PNFP....4 National Campaign....5 Other ______________________ 96 *(specify)*	
E12	Where did (NAME) receive other vaccines?	Government Health Centre....1 Government Hospital....2 Private Hospital/Clinic....3 PNFP....4 National Campaign....5 Other ______________________ 96 *(specify)*	
E13	Did you pay for (NAME)'s vaccines?	Yes....1 No....2	➔F1
E14	Where did you pay for (NAME)'s vaccine?	Government Health Centre....1 Government Hospital....2 Private Hospital/Clinic....3 PNFP....4 National Campaign....5 Other ______________________ 96 *(specify)*	

E15	How much did you pay for the last vaccine received by (NAME)?	_______________ Specify Amount DON'T KNOW.. 98	

Section F: Behavioural and Social Drivers (BeSD) of Vaccination

The WHO BeSD Childhood Vaccination Survey is a globally standardized tool for assessing the drivers of vaccination for children. The first five questions are the priority BeSD indicators. When it is not possible to use the full set of 19 survey questions below, at least complete the first five priority indicators.

Trained interviewers should read the survey questions and response options aloud to respondents. Interviewers *should not* read aloud the instructions in [square brackets] and any text that is in ALL CAPITALS. Interviewers should emphasize all underlined words.

No.	BeSD Domain	Coding Categories	Type
F1	**Intention to get child vaccinated**	[COUNTRY NAME] has a schedule of vaccines for children. Do you want your child to get none of these vaccines, some of these vaccines or all of these vaccines? o NONE o SOME o ALL	**Priority Indicator**
F2	**Confidence in vaccine benefits**	How important do you think vaccines are for your child's health? Would you say… o Not at all important, o A little important, o Moderately important, *or* o Very important?	**Priority Indicator**
F3	**Family norms**	Do you think most of your close family and friends want you to get your child vaccinated? o NO o YES	**Priority Indicator**
F4	**Know where to go to get vaccination**	Do you know where to go to get your child vaccinated? o NO o YES	**Priority Indicator**

F5	**Affordability**	How easy is it to pay for vaccination? When you think about the cost, please consider any payments to the clinic, the cost of getting there, plus the cost of taking time away from work. Would you say… o Not at all easy, o A little easy, o Moderately easy, *or* o Very easy?	**Priority Indicator**
F6	**Confidence in vaccine safety**	How safe do you think vaccines are for your child? Would you say… o Not at all safe, o A little safe, o Moderately safe, *or* o Very safe?	
F7	**Confidence in health workers**	How much do you trust the health workers who give children vaccines? Would you say you trust them… o Not at all, o A little, o Moderately, *or* o Very much?	
F8	**Peer norms**	Do you think most parents you know get their children vaccinated? o NO o YES	
F9	**Religious leader norms**	Do you think your religious leaders want you to get your child vaccinated? o NO o YES	
F10	**Community leader norms**	Do you think your community leaders want you to get your child vaccinated? o NO o YES	
F11	**Health worker recommendation**	Has a health worker recommended your child be vaccinated? o NO o YES	

F12	**Received recall**	Have you ever been contacted about your child being due for vaccination? o NO o YES	
F13	**Mother's travel autonomy**	If it was time for your child to get vaccinated, would the mother need permission to take your child to the clinic? o NO o YES	
F14	**Took child for vaccination**	Have you personally ever taken your youngest child to get vaccinated? o NO o YES	
F15	**Vaccination availability**	Have you ever been turned away when you tried to get your child vaccinated? o NO o YES	
F16	**Ease of access**	How easy is it to get vaccination services for your child? Would you say… o Not at all easy, o A little easy, o Moderately easy, *or* o Very easy?	
F17	**Reasons for low ease of access**	What makes it hard to get vaccination services for your child? Would you say… [READ ALOUD ALL RESPONSE OPTIONS PAUSING AFTER EACH TO ALLOW RESPONDENT TO ANSWER 'YES' OR 'NO' AFTER EACH RESPONSE OPTION. RESPONDENTS MAY SELECT MULTIPLE RESPONSE OPTIONS.] o Nothing, it's not hard, [IF NOTHING, SKIP REST OF RESPONSES] o Getting to the clinic is hard, o The clinic opening times are inconvenient, o The clinic sometimes turns people away without vaccinating, o The waiting time in the clinic takes too long, *or* o Is there something else? [RECORD ANSWER: _______________]	

F18	**Service satisfaction**	How satisfied are you with the vaccination services? Would you say… o Not at all satisfied, o A little satisfied, o Moderately satisfied, *or* o Very satisfied?	
F19	**Service quality**	What is not satisfactory about the vaccination services? Would you say… [READ ALOUD ALL RESPONSE OPTIONS PAUSING AFTER EACH TO ALLOW RESPONDENT TO ANSWER 'YES' OR 'NO' AFTER EACH RESPONSE OPTION. RESPONDENTS MAY SELECT MULTIPLE RESPONSE OPTIONS.] o Nothing, you are satisfied, [IF NOTHING, SKIP REST OF RESPONSES] o Vaccine is not always available, o The clinic does not open on time, o Waiting times are long, o The clinic is not clean, o Staff are poorly trained, o Staff are not respectful, o Staff do not spend enough time with people, *or* o Is there something else? [RECORD ANSWER: _______________]	

THANK YOU – THE END

Annex 9: Example Questionnaire for LQAS Validation

VALIDATION QUESTIONNAIRE FOR EITHER AGE COHORT

Construct	Question
Identification	VALIDATION QUESTIONNAIRE NUMBER: ________________ LQAS INTERVIEW NUMBER: ________________ SUPERVISION AREA: ______________________
Date	DAY /MONTH /YEAR OF **VALIDATION** INTERVIEW: ____ /______________ /________
Participant	PARTICIPANT ID: ____________________
Location	DISTRICT NAME: _______________________________ SUBCOUNTY/WARD: ____________________________ SETTLEMENT: _________________________________ VILLAGE: _____________________________________ GPS COORDINATES: ____________________________
Age Cohort	COHORT OF SAMPLED CHILD TO BE VALIDATED? ☐ 0-11 MONTHS ☐ 12-23 MONTHS
Supervision	INTERVIEWER NAME: _______________________________ __________ CHECKED BY (SUPERVISOR NAME): _______________________________

Consent	Hello, I am [INTERVIEWER NAME] with [ORGANIZATION NAME]. We are interviewing people to help improve children's vaccination services in [DISTRICT NAME]. I know you are busy, so this will take only a few minutes. Your participation is completely voluntary and anonymous. If you do not want to answer a question or wish to stop the interview, just let me know. Would you be willing to take the survey? ☐ YES ☐ NO IF "YES": Thank you very much. Do you have any questions before we begin? IF "NO": Thank you very much. END INTERVIEW.

Section A: Caregiver's Background

No.	Questions and Filters	Coding Categories	Skip to
A1	How old are you?	AGE (IN COMPLETED YEARS) __ __	
A3	What is your gender?	☐ Woman ☐ Man ☐ Nonbinary ☐ Prefer not to say	
A4	Are you the parent or primary caregiver of [NAME OF SELECTED ELIGIBLE CHILD]?	YES....1 NO.... 2 IF "NO": Unfortunately, you are not eligible to participate in the validation survey. Thank you very much for taking the time to answer my questions. END INTERVIEW.	
A7	What is the highest level of school you completed?	Preschool....1 Primary ....2 Secondary ....3 Higher ....4 None....5	

A8	What is your **current** marital status? **READ ALL RESPONSE OPTIONS TO CARE-GIVER**	SINGLE, NO PARTNER ....1 SINGLE, NON-REGULAR PARTNER... ....2 SINGLE WITH REGULAR PARTNER................3 MARRIED...................................... ....4 COHABITING...5 WIDOWED............................. ....6 DIVORCED/SEPARATED...7	

Section B: Caregiver's Assets

No.	Questions and Filters	Coding Categories	Skip To
B1	Who owns this house? **DO NOT READ THE POSSIBLE RESPONSES**	Myself ....1 Family ....2 Landlord ....3 Employer...4 Government.................................5 Other_________________99 Specify	
B2	Does your household have: **READ EACH OPTION AND CIRCLE 1 (YES) OR 2 (NO) FOR EACH ITEM**	**CIRCLE ONLY ONE RESPONSE FOR EACH OF THE OPTIONS BELOW**	
	a) Electricity?	Yes = 1 No = 2	
	b) Television?	Yes = 1 No = 2	
	c) Sofa?	Yes = 1 No = 2	
	d) Cupboard?	Yes = 1 No = 2	
	e) Cassette/CD/DVD player?	Yes = 1 No = 2	
B3	Does any member of your household own a mobile phone?	Yes = 1 No = 2	

Section C: Child's Background

No.	Questions and Filters	Coding Categories	Skips
C1	**SAY THE NAME OF CHILD WHO HAD BEEN SELECTED FOR LQAS SURVEY:**	_ NAME OF SELECTED CHILD	
C2	What is the sex of [NAME]?	MALE...1 FEMALE..2	
C4	How old is (NAME)? **RECORD AGE IN COMPLETED MONTHS.** **RECORD '0' IF LESS THAN 1 MONTH.**	AGE (IN COMPLETED MONTHS)........................	

Section E: Childhood Immunizations

No.	Questions and Filters	Coding Categories	Skips
E1	Do you have a child health card where (NAME) vaccinations are written down? **IF YES, ASK TO SEE THE CHILD CARD**	Yes, seen by interviewer............................1 Yes, not seen...2 No ....3 DON'T KNOW...98	➔ E3 ➔ E4 ➔ E4
E3	**COPY VACCINATION DATE (DAY, MONTH AND YEAR) FOR EACH VACCINE FROM [NAME'S] CHILD HEALTH CARD** **WRITE '44' IN 'DAY' MONTH AND YEAR COLUMNS IF CARD/PASSPORT SHOWS THAT VACCINATION WAS GIVEN BUT NO DATE IS RECORDED.** **WRITE '00' IF A VACCINATION WAS NOT GIVEN**	(see vaccine table below)	
E4	Did (NAME) ever receive any vaccinations to prevent him/her from getting diseases, including vaccinations received in a national immunization day campaign?	Yes...1 No...2	➔ F1

Vaccines	Day	Month	Year
OPV 0			
OPV 1			
OPV 2			
OPV 3			
DPT/PENTA 1			
DPT/PENTA 2			
DPT/PENTA 3			

E5	Did (NAME) receive a Polio vaccine, that is, drops in the mouth	Yes......1 No......2 Don't know......98	→ E8
E7	How many times did (NAME) receive the polio vaccine?	☐ Number of times Don't know......98	
E8	Did (NAME) receive DPT/PENTA vaccine, that is, an injection given in the thigh?	Yes......1 No......2 Don't know......98	→ E10
E9	How many times has (NAME) been given DPT/PENTA vaccination injection?	☐ Number of times Don't know......98	

Annex 10: LQAS Survey Report Template Example

1. Executive Summary

This section should be written last, only after the rest of the report has been written. It should be no more than one page long with one paragraph for each bullet point. It should summarize the following:

- **Background:** Summarize – where, when, and why the survey was conducted.
- **Methods:** Explain that LQAS was used as the survey methodology. Explain how many respondents were surveyed in how many Lots (e.g., wards). State how many data collectors carried out this task over how many days.
- **Key Findings:** Summarize the most important results which came out of the survey.
- **Conclusions:** Summarize the main conclusions drawn from this report. What, according to your survey, are your main priorities?
- **Recommendations:** Summarize the main recommendations you would make to address the priorities you identified in the conclusion.

2. Background and Introduction

This section should contain very similar information to the background section of the study protocol.

3. Objectives of the Survey

Include the main objectives of the survey as written in the study protocol. Also, explain why it is being carried out in the program context of your program.

4. Overview of the Sampling Methodology

This section should include similar information as the background section of the study protocol.

4.1 Catchment Area, Supervision Areas, and Sample Size: explain that the District/LGA represents the catchment area while each ward represents the Lot/Supervision Area. Explain that wards are comprised of a group of settlements. Describe the sample used in each ward and LGA.

4.2 Survey Target Groups: mention the two survey age cohorts (Caregivers of children 14 weeks-11 months, and Caregivers of children 12-23 months).

4.3 Survey Indicators: mention that the study team prepared a comprehensive list of vaccination and BeSD indicators for each of the two age cohorts. Explain how the indicators were selected and make clear that vaccine uptake and BeSD indicators were assessed in this survey.

4.4 Supervision Areas and Sampling Design: number of Lots/SAs per CA, and number of interviews conducted in each Lot/Ward and CA/LGA. A table is usually the best way to display the sample size per lot and CA. Also mention that PPES was the first-stage sampling used to select the 19 sample interview locations for each Ward in the targeted LGA. Subsequently segmentation sampling was the second stage sampling used.

4.5 Household and Respondent Selection: a general description of how the households and eligible respondents were selected, including use of parallel sampling if relevant.

5. Questionnaire Development

What were the main topics covered in the survey? Who developed the questionnaire? How many universes/modules did the questionnaire include? What language was the questionnaire produced in? Explain that smartphones were programmed with the ODK software.

6. Overview of Data Collection

6.1 Dates and Location of the Survey: explain when the data collection was carried out. Provide a table showing the location of the survey by State and LGA; number of Wards, sample size per ward and total sample size per LGA; overall dates of the activity.

6.2 Interview process: What language were the interviews conducted in? (were translators required etc?) Was any data validation conducted? (e.g. 10% of samples re-interviewed to check for consistency) Identify any difficulties or limitations with the data collection.

6.3 Data Collection Teams: Mention the number of data collection teams deployed at the LGA, and the number of data collectors and supervisors used for data collection. Explain how data collectors were screened and recruited based on selected criteria. Also describe the ODK data collection process (e.g., smartphones were used for data collection. Phones were programmed with ODK software using the approved final questionnaires). Explain how the data were uploaded and checked on a regular basis (by whom?).

6.4 Training of Data Collection Teams: How many data collectors and supervisors were trained? How many days of training did they receive? Who conducted the training? When and where were they trained? Mention that the training included a field practice exercise where the participants could practice the standard principles of LQAS for selecting households and respondents and for administering effective interviews to ensure good-quality data.

6.5 Supervision of Data Collection: Explain who supervised data collection and what were their main tasks.

7. Ethical Approval

Describe how ethical approval was granted for the research and provide the protocol number if possible. Also, explain that the data collection tool incorporated a sheet for respondents' consent to the interview. Each participant was required to understand the "Informed Consent" sheet and indicate their agreement to participate in the survey. Each interview in this survey was conducted in private and the information collected was kept confidential.

8. Data Management

8.1 Maintaining the Reliability of the Data: Include the objectives, methodology, and a summary of the results of the Reliability Study conducted during the data collection process.

8.2 Uploading the data: Explain the ODK data collection process and how the data were uploaded from the tablets/phone and checked for data quality.

8.3 Data Cleaning, and Analysis: Who carried out the data cleaning, and analysis? What software was used?

9. Results

This section presents all of the survey results in tables and graphs.

9.1 Characteristics of Respondents: demographics, etc.

9.2 Ward Level Findings: Priority Indicators

- Identification of priority Wards that do not reach the LGA vaccination average coverage point estimate, using standard LQAS principles for classification.

- Classify Wards as having reached the coverage target or not (pass/fail).
- Explain that a decision rule of 13 will be used to identify priority Wards for DPT, those that are not reaching the 80% national target in Nigeria.

See below example tables for displaying the classification of wards by indicator:

Table A6. LGA and Priority Wards based on LGA Average Coverage Point Estimates: Vaccination Uptake Indicators

Indicator	Average Coverage (%) (95%CI)	Ward name	Ward name	Ward name	Ward name	Ward name	Decision Rule
A	93.7 (± 5.0)	18	18	17	18	18	16
B	71.6 (± 9.2)	15	15	17	18	3	12
C	80.0 (± 8.2)	16	13	14	17	16	13
D	38.9 (± 10.0)	8	7	7	4	11	6

Look at the results of each Ward to identify the priority wards that are classified as failing vis a vis the selected threshold in this table (e.g., LGA average coverage point estimate). What could be the reasons for this?

Table A7. LGA and Priority Wards based on National Coverage Targets: Vaccination Uptake Indicators

Indicator	Program National target (%)	Ward name	Ward name	Ward name	Ward name	Ward name	Decision Rule
A	80%	18	18	17	18	18	13
B	80%	15	15	17	18	3	13
C	80%	16	13	14	17	16	13
D	80%	8	7	7	4	11	13

Review the results of each Ward and identify the priority wards that are classified as failing relative to the selected threshold in this table (e.g., national program target of 80%). What could be the reasons for this?

9.3 LGA Findings: Coverage Point Estimates

- Estimating average coverage proportions for uptake vaccination and BeSD indicators at targeted LGA level with a 95% confidence level and Confidence intervals (CI) of no more than 10%.
- LGA weighted average coverage proportion for each indicator:
  - The individual samples from all the wards should be aggregated and treated as a stratified random sample to calculate the average coverage proportion for each survey indicator.
  - the LGA average coverage point estimates will be weighted with the population size of each Ward over the population size of the respective targeted LGA.

See below example tables for displaying average coverage point estimates of indicators at the LGA level.

Table A8. LGA Average Coverage Point Estimates: Uptake Vaccine Indicators

Indicator	Coverage (%) (95%CI)
A	93.7 (± 5.0)
B	71.6 (± 9.2)
C	80.0 (± 8.2)
D	38.9 (± 10.0)

Table A9. LGA Average Coverage Point Estimates: Priority BeSD Indicators

Indicator	Coverage (%) (95%CI)
A	93.7 (± 5.0)
B	71.6 (± 9.2)
C	80.0 (± 8.2)
D	38.9 (± 10.0)

- Assess the accomplishment of the 80% national vaccination coverage target for 2024 by targeted LGA. Explain that the 2024 target for DPT is 80%, and AFENET used this as the benchmark for comparison. Any findings from the LQAS Pilot Survey below 80% would indicate areas needing improvement.

Table A10. LGA Average Coverage vs National Program Targets: Uptake Vaccine Indicators

Indicator	Coverage (%) (95%CI)	Coverage Target (%)	Target Achievement
A	93.7 (± 5.0)	80%	Yes
B	71.6 (± 9.2)	80%	No
C	80.0 (± 8.2)	80%	Yes
D	38.9 (± 10.0)	80%	No

Present the main findings. Do not comment on all the results, but rather pick out the most relevant results and especially the priorities.

10. Discussion of Results

Recommendations at LGA and State level

- Following on from the key conclusions, what are the recommendations at LGA and State level?
- What strategic changes need to be made? Who is responsible for these changes?
- What are the main actions that need to be undertaken at LGA and State level?

11. Conclusions

Ideally, this should be just one or two paragraphs summarizing the main points from section 5.

- What are the main observations from the survey?
  - Do some wards have better results than others?
  - Are some indicators worse than others?
  - What are the priorities for both indicators and wards?

References

Appendices

1. Survey Questionnaires
2. Reliability Study Questionnaire
3. LQAS Table for Selecting the Decision Rule
4. Data Collection Teams
5. Other

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