Estimating and monitoring yellow fever reactive campaign vaccination coverage: overview of survey and monitoring methods
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## Abbreviations

<table>
<thead>
<tr>
<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>EYE</td>
<td>Eliminate Yellow fever Epidemics [Strategy]</td>
</tr>
<tr>
<td>ICG</td>
<td>International Coordinating Group on Vaccine Provision</td>
</tr>
<tr>
<td>IM</td>
<td>Independent monitoring</td>
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<tr>
<td>LQAS</td>
<td>Lot quality assurance survey</td>
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<tr>
<td>RCM</td>
<td>Rapid convenience monitoring</td>
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<tr>
<td>RM</td>
<td>Rapid monitoring</td>
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<tr>
<td>RVC</td>
<td>Reactive vaccination campaign</td>
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<tr>
<td>YF</td>
<td>Yellow fever</td>
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Glossary

**Administrative vaccination coverage** Percentage representing the number of administered doses recorded in the registration system divided by the total target population (e.g. children aged <1 year)

**Cluster** Collection of units (e.g. houses, communities or cases) grouped together within clearly defined geographical or administrative boundaries

**Cluster survey** Survey in which the population is divided into clusters or groups of individuals (people or things) that share common characteristics, called “observation units”

Note: in the study sample, subjects are selected from each cluster.

**Confidence interval** Range within which it is expected to find the true value of the sample with an established degree of certainty (e.g. 95% or 99%)

Note: the confidence interval represents the probability of random error but not the probability of systematic error or bias.

**Coverage** In epidemiology, the measurement of the extent to which the services offered meet the potential health needs of a community

Note: coverage is expressed as a proportion, where the numerator is the number of service units delivered and the denominator is the number that should have been provided.

**Epidemic** Cases of a disease, specific behaviours or other health-related events in a given community or region in larger numbers than expected

**Local level or local area** Smallest administrative unit in a country with governmental organization (e.g. municipality)

**Lot** Group of units studied in a **lot quality assurance survey**

Note: a lot may refer to a specific population (e.g. children in a specific age group) that resides in a given area (e.g. a community assigned to a health facility) or to a set of records for a particular service.

**Lot quality assurance survey (LQAS)** Technique based on the sampling of lots (individual people or units with shared characteristics, also called “observation units”) that makes it possible to draw conclusions on the achievement of a programme’s coverage goal, either for each lot (groups of individuals) or by summing the weighted results of all lots

**Monitoring** Ongoing process of data measurement and systematic analysis to track the progress of plans and programmes

Note: through information and measurements obtained using standardized and systematic techniques and parameters, health programmes may analyse and verify progress and fulfilment of plans and goals on a regular, ongoing or periodic basis. The objective is to identify achievements and problems, analyse their causes, and immediately implement effective measures to meet programme goals.

**Non-probabilistic sampling** Sampling method in which selected individuals do not all have the same probability of selection, meaning that results cannot be generalized to the entire population studied, since they are not fully representative
<table>
<thead>
<tr>
<th><strong>Population</strong></th>
<th>Group of individuals or elements that share the characteristics of time and place</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Probabilistic sampling</strong></td>
<td>Sampling method in which all individuals have the same probability of selection, making it possible to determine everyone’s chance of selection</td>
</tr>
</tbody>
</table>
| **Random** | Depending on chance  
Note: in this publication, “random” refers to the method used to generate a randomized sequence, using either a random number table or computer program. |
| **Representativeness** | Quality indicating that the set of observations being analysed about a particular event, at a given confidence level, represents the real value for the total population studied |
| **Sample** | Group of observation units or research units taken from the total population under study or at risk  
Note: the sample may or may not be chosen randomly and may or may not be representative of the study population. Different sampling methods exist, including simple random sampling, stratified sampling and cluster sampling. |
| **Sample size** | Number of individuals in the sample group selected from the population |
| **Survey** | Collection of data on a subset of the universe under study, using various data analysis designs and methods to make inferences about the population |
| **Target population** | People from a given sex or age group with specific characteristics that make it possible to apply an intervention strategy – such as vaccination, deworming or administration of supplements |
1. Introduction

1.1 Background to the guide

Yellow fever (YF) is an acute viral haemorrhagic disease transmitted by infected mosquitoes. **YF is prevented by a highly effective, safe and affordable vaccine:** a single dose of vaccine provides sustained immunity and lifelong protection against YF disease.

Unprecedented urban outbreaks in 2016 in Angola and the Democratic Republic of the Congo demonstrated that, despite routine immunization, challenges remain in ending YF epidemics. Outbreaks occur in Africa and the Americas, but there is also increased risk of international spread through viraemic travellers, as seen in 2017 with YF cases who travelled to China.

The comprehensive global strategy **Eliminate Yellow fever Epidemics (EYE)** is a coalition of partners (Gavi, the Vaccine Alliance, the United Nations Children’s Fund and WHO) and affected countries set up in response to these challenges. The EYE Strategy is aligned to face YF’s changing epidemiology, the resurgence of mosquitoes, and the increased risk of urban outbreaks and international spread.

When a YF outbreak occurs, countries must implement high-quality reactive vaccination campaigns (RVCs) rapidly to interrupt transmission and halt the outbreak. An emergency stockpile of YF vaccines exists, and vaccines can be delivered quickly to affected countries. The stockpile is managed by the International Coordinating Group on Vaccine Provision (ICG), and WHO serves as its secretariat.

Any country with a YF outbreak can send an application to the ICG, detailing the epidemiology and context of the outbreak, and outlining vaccine needs. Vaccination campaigns should be launched within 10 days of vaccine arrival in a country.

A post-campaign report and evaluation, including coverage assessment, is a mandatory requirement for each RVC for countries receiving ICG support.¹ The report should include several key elements:

- campaign dates;
- target areas;
- target populations;
- number of people vaccinated (disaggregated by age, target area and gender);
- funds used during the campaign;
- doses of vaccine used and any quantity leftover at the end of campaign;

• how planning was done;
• readiness assessment conducted and number of planned and operational vaccination posts;
• number of vaccination workers and supervisors deployed;
• number of adverse events following immunization;
• rapid convenience monitoring;
• major challenges;
• lessons learned; and
• recommendations.

The independent coverage assessment is a core requirement; however, there can be flexibility as to the methods used, depending on country circumstances and the size of the response. A summary of key expected timelines for efficient vaccination response described in the ICG standard operating procedures is provided in Box 1.

### Box 1. Target timings for key steps of the ICG process

- The vaccine request should be submitted to the ICG within seven days of confirmation of a YF outbreak.
- Vaccines should be delivered to the country ideally within seven days of receipt of the request.
- The YF RVC should be launched within 10 days of the arrival of the vaccines in the country.
- A vaccination coverage survey should be implemented no more than one month after the YF RVC.
- The coverage survey and campaign report should be submitted to the ICG no more than three months after the YF RVC.

### 1.2 Using the guide

This guide is intended to support countries with planning and implementing high-quality and timely coverage assessments to fulfil the reporting requirements to the ICG within three months of the RVC. It includes suggestions on how to adapt coverage survey methods to meet the urgency and resource context of the outbreak response. It also provides an overview of the alternative options that may be necessary in special circumstances or for very small responses (fewer than 100 000 people).

The guide reviews the different approaches to monitoring and measuring a YF RVC. It focuses on preparation and planning for monitoring and coverage survey purposes, which must be done quickly, collaboratively and effectively – all while considering the country context, experience and urgency.

This guide focuses on the following key steps:

- Step 1: reviewing monitoring/coverage survey needs and methodologies;
- Step 2: identifying appropriate monitoring/coverage survey methodology;
- Step 3: preparing for the monitoring/coverage survey;
- Step 4: designing and planning the monitoring/coverage survey;
- Step 5: implementing a monitoring/coverage survey;
• Step 6: analysing data from the monitoring/coverage survey;
• Step 7: using information from the monitoring/coverage survey to improve future campaigns.
Annexes 1–4 give examples of tools used by YF programmes and other immunization programmes.

Note: if modifying the tools, the target ages and populations of the YF RVC should be used.

Immunization programmes have extensive experience of using campaign monitoring and coverage surveys. The key resources used by the authors in preparing this guide are listed in the bibliography.

1.3 Target audience

This guide is intended for national and regional immunization managers and outbreak response managers. It aims to inform decision-making on the most appropriate monitoring/coverage survey assessment for a YF RVC, in line with ICG guidelines and the national context. The guide provides advice on how to prepare for those assessments in a timely manner, while considering the size of the outbreak, data needs and cost.
2. Overview of YF RVC monitoring and surveys

2.1 ICG requirements

The ICG stipulates that a coverage survey should be conducted no more than one month after a YF RVC, and that a post-campaign report and coverage survey results should be submitted within three months of the end of the YF RVC. The ICG is flexible in its requirements for campaign monitoring, but the reporting needs to be timely, and should include accurate information and data on the performance of the RVC, as this is crucial to stopping YF outbreaks.

All YF RVCs should include rapid convenience monitoring or rapid monitoring to ensure the quality of the YF RVC implementation. There should also be a measurement of RVC coverage after the campaign, which can be done with either a clustered lot quality assurance survey (LQAS), which assesses the quality of campaign performance, or a vaccination coverage cluster survey.

Vaccination coverage cluster surveys give a true measure of immunization coverage using a standardized and statistically sound approach. While they are the WHO gold standard and provide representative coverage data, however, they can be costly and time-intensive, and require approaches tailored to the emergency outbreak context. A clustered LQAS can be an alternative for post-RVC performance measurement and a coverage estimate of the RVC, but it is not representative.

The decision about which survey to use needs to be informed by national objectives, practical considerations and resources. To help ensure timely reporting and results, coverage assessments are ideally conducted 30 days after the YF RVC (Box 2; Fig. 1).

**Box 2. Practicality and agility: key requirements**

- Given the stipulated timelines during an outbreak, a quick decision on the most appropriate methodology to use is required.
- Once approval is received from ICG, it is advisable to start planning the monitoring/survey approach early.
- The emergency context should always be considered when designing the survey.
- Coverage assessments are recommended to be completed within 30 days of completion of the campaign.
Once a YF outbreak is confirmed, countries must submit their application to the ICG urgently to receive vaccines as soon as possible to stop the outbreak.
2.2 Summary of coverage and assessment methodologies

The following methodologies can be used to monitor the impact of a YF RVC. Selection of the survey approach will be based largely on urgency, the size of the target population, what aspects need to be measured for the outbreak response, and the available human and financial resources. The main methodologies are as follows.

- **Rapid convenience monitoring (RCM)** is implemented during and just after the RVC by independent monitors to assess the performance and reach of immunization campaigns.

- **Rapid monitoring (RM)** uses existing health structures and staff to assess campaign performance. Supervisors work with communities to identify challenges and find solutions. This methodology is used extensively in the Americas. It can be conducted during and after an RVC.

- **Independent monitoring (IM)** is also conducted as part of an RVC to assess performance, and helps to avoid bias. Independent monitors conduct RCM during and/or after the RVC to find missed populations and areas for improvement; provide real-time identification of missed populations to facilitate course-corrective actions (such as mop-up vaccination activities); and verify performance.

- **Clustered LQASs** are household surveys that assess RVC performance and verify whether the RVC has reached a minimum acceptance coverage target.

- **Vaccination coverage cluster surveys** are the WHO gold standard to measure immunization coverage data statistically. Wherever possible, this method should be employed for large-scale YF RVCs (target populations of over 100,000). The most recent guidance should be used to inform protocol design (currently the 2018 reference manual).

RCM/RM and IM must be conducted as part of a YF RVC to monitor performance, identify unvaccinated populations and verify administrative coverage during and after the RVC. For countries with a target population of fewer than 100,000 people, RCM/RM or a clustered LQAS can be used in place of a vaccination coverage cluster survey (see Fig. 1).

2.3 Key points before implementing a monitoring and coverage survey

Planning, implementing and monitoring a YF RVC is highly time-sensitive. To help achieve rapid turnaround, the following key points should be considered.

- **Planning early**
  It is important to begin development of the monitoring and coverage assessment plan at the same time as the request is sent to the ICG, and to ensure that all aspects are included in the budget.

- **Focusing on the outbreak context**
  The monitoring/coverage survey should be able to be implemented rapidly. Coverage surveys during emergencies can have more limited objectives, with simpler questionnaires, and can be quicker to implement than those for routine immunization.

- **Building from existing experience**
  It is helpful to leverage any recent surveys or coverage assessments in the country to gain efficiencies where possible.

- **Collaborating**
  It is essential to work closely with partners, learning their best practices and technical expertise on RVC monitoring and implementing coverage surveys.

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• **Preparation**
  Protocols, questionnaires and data analysis strategies should be prepared early to allow time for review.

• **Defining objectives**
  The survey needs to assess the coverage/quality of the YF RVC, and to ensure that the YF RVC has reached all at-risk communities. It is imperative to be clear about what is being measured, and to ensure that it meets the monitoring needs of the YF RVC, the country programme and the ICG.

• **Funding**
  It is vital to ensure that funding for the chosen methodology is in place. Funding also needs to be included in the operational fund request to the ICG (where applicable).

• **Managing costs and expectations**
  Strategies for reducing costs of monitoring/coverage survey should be identified, if necessary, without reducing the quality of the results. By adapting to the outbreak context, cost savings can be realized.

• **Communicating findings**
  Reports should be submitted to the ICG according to the reporting schedule within three months of the campaign.
3. Steps for YF RVC monitoring/coverage survey

3.1 Step 1: reviewing monitoring/coverage survey needs and methodologies

During a YF outbreak, the most crucial factor is to identify and vaccinate at-risk populations and stop transmission. The team needs to identify the location of the outbreak, the extent of disease spread and the required response, and then needs to start planning the YF RVC. It is vital to make quick planning decisions based on issues including:

- the size of the outbreak and speed of transmission;
- the context of the outbreak and RVC scope of response;
- the presence of rural, urban marginalized populations (such as hard-to-reach or nomadic communities and those living in urban slums);
- available funds and human resources; and
- leverage of past experiences.

A key early step in planning for the RVC is to ensure development of the monitoring plan. This should include at minimum the number of personnel deployed, the number of people vaccinated, occurrence of any adverse events following immunization, wastage and vaccine leftovers, best practices and lessons learned, and a post-campaign vaccination coverage assessment.

The team needs to decide on the post-campaign coverage assessment methodology used to monitor implementation and measure coverage. The survey should provide a timely and accurate assessment of areas targeted by the YF RVC, and should ideally include coverage data disaggregated by age, gender and specific targeted populations.

Selection of the methodology will depend on the size of the target population, the circumstances of the response and the preference of the country (Fig. 2).

Note: a vaccination coverage cluster survey requires extensive planning, coordination, and financial and human resources. It is vital to be specific about what needs to be measured before deciding to conduct a cluster survey.

If the outbreak occurs in a specific/smaller area (with a target population of fewer than 100,000 people), either a vaccination coverage cluster survey or an alternative method can be used to:

- assess coverage and fix problems rapidly during and after the campaign;
- collect information on campaign performance and data on targeted age groups, vaccination card retention, gender and reasons for non-vaccination;
- identify areas for mop-up vaccination activities.

If the YF outbreak is large (with a target population of over 100,000 people) and/or occurring in different regions or districts, the ICG recommendation is to measure vaccination coverage with a vaccination coverage cluster survey. This can be done as complement to other monitoring activities.

A vaccination coverage cluster survey provides a representative and statistically correct estimate of YF vaccination coverage during the RVC and/or routine immunization. It can be used to:

- measure coverage of a YF RVC;
• measure routine YF vaccination coverage given through the national immunization programme (if applicable);
• measure immunization coverage by age, gender and other determinants;
• measure vaccination card retention;
• identify areas of low coverage, underserved communities and missed areas;
• identify reasons for non-vaccination.

In the event of extenuating circumstances – such as lack of access to the response area due to insecurity, conflict or natural disaster, for example – then an alternative method may be selected. In this instance, the team is encouraged to discuss the issue with regional YF focal points and to document the prevailing circumstances clearly in the campaign report and coverage assessment.

Fig. 2. Decision-tree for selection of coverage survey method after YF RVC

### 3.2 Step 2: identifying appropriate monitoring/survey methodology

This section summarizes the monitoring/coverage survey methodologies and outlines what needs to be considered when planning and implementing YF RVC monitoring.

As a starting-point, previous experience with YF or vaccination campaign monitoring should be leveraged – particularly experience of an outbreak response in the relevant country. The team should talk to colleagues about their experience with the surveys, including any innovative approaches or enhancements to the methodology.
Experts from previous coverage surveys should be sought out, as should people who have completed WHO training on the vaccination cluster coverage survey (such as the Survey Scholar programme), and those from public health academic institutions and/or local field epidemiology training programmes. They can help with decision-making and protocol development, reviewing, planning and implementation. The YF and vaccination focal points at WHO regional and global levels can support identification of skilled personnel on request of the country.

**RCM, RM and IM**

RCM and RM, conducted by independent monitors, are similar approaches to campaign monitoring and are used to evaluate the quality of campaign coverage. These methodologies are conducted during and immediately after a campaign to guide mop-up vaccination activities and to assess performance. RM is an approach used primarily in countries in the Americas; it builds on an established monitoring and routine supervision structure.

Questions about routine immunization can be included in RCM/RM. This is especially important in areas that may be underserved or that have not had recent supervision visits. These are familiar methods in many contexts, as used by poliomyelitis (polio), measles and other programmes to monitor the quality of coverage and assess quickly whether coverage targets were reached at local level, to inform course-corrective action.

IM is also conducted during and immediately after the YF RVC to assess performance, identify areas for mop-up vaccination activities and seek feedback on the YF RVC; it will often follow an RCM approach.

*Note:* IM does not provide representative data, and is not a formal measurement of vaccination coverage.

RCM, RM and IM are integral to in-process monitoring for vaccination campaigns, and can also be used post-campaign as a type of assessment. The use of these methods intra- or post-campaign does not preclude conducting other forms of evaluation after the campaign, such as a clustered LQAS or a vaccination coverage cluster survey. In countries where the YF response target population is lower than 100,000, information from the RCM/RM may be considered as an option for post-campaign coverage assessment.

**RCM and independent monitors**

RCM is used to assess a campaign’s quality and reach. Teams conduct door-to-door monitoring and out-of-house monitoring, using standardized questionnaires on campaign performance. Monitoring visits are conducted by independent monitors during a campaign or immediately after the teams have completed their work. RCM is an opportunity to find weaknesses in campaign performance (such as reasons for non-vaccination) and correct them.

While RCM does not use random sampling and does not produce statistically valid estimates of coverage, it can be used to monitor campaign coverage, identify missed populations and determine areas for mop-up vaccination activities.

RCM is usually implemented in selected high-risk or poor-performing areas identified during the review of administrative data and outbreak reports. These are likely to be areas where people are often missed by vaccination teams and/or areas with migrant, marginalized or minority populations.

The results of the RCM are compared with routine administrative coverage to find discrepancies and compare performance. The information collected can also help inform the immunization programme on potential missed areas for routine immunization or other campaigns.
Independent monitors are the personnel trained to implement RCM and may also support intra-campaign monitoring. Well trained and independent monitors can avoid possible bias and improve data quality. In addition to RCM, they may identify any missed populations and conduct house-to-house and out-of-house interviews on related challenges (such as awareness of the campaign and reasons for non-vaccination).

Summary of the methodology

- Monitors visit identified communities and go door to door systematically to check on average 10–20 households.
- Monitors check the immunization status of the people in the YF target age group.
- Vaccination is confirmed by card, finger mark or recall.
- Monitors also conduct out-of-house interviews in public areas to check vaccination status and seek responses that may be different from those of households, but that may be similar to each other.
- To pass the RCM, a community should have no unvaccinated people within the target population following the campaign.
- A community fails the RCM if:
  - in a 10-household community, one person within the target population is found to be unvaccinated;
  - in a 20-household community, two people within the target population are found to be unvaccinated.
- Any community failing the RCM should be revisited by a vaccination team.
- If a person has not been vaccinated, the monitor can ask why, and should note the reason on the RCM form.

Some limitations of RCM include the following.

- While identifying a low proportion of vaccinated people suggests problems with the campaign reaching its goals, a high proportion of vaccinated people does not necessarily imply that coverage targets were met, as RCM may also miss populations who have been missed by the campaign.
- Insufficient funding can make it difficult to monitor every subdistrict or high-risk area, which is often where unvaccinated individuals are likely to be found — especially remote or hard-to-reach areas, areas with insecurity and areas facing other public health emergencies.
- RCM is not representative and cannot be used to produce a coverage estimate.

RCM findings can be subject to biases, either in the selection of monitors or the selection of people surveyed. Information bias is possible if vaccination cards are not available or where evidence relies on only finger marking, which fade after few days. Independent monitors with recent training help to

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3 For more detailed information on implementation, refer to:

mitigate against biases. It is important that they remain independent because when they become linked to implementing teams through planning, training or implementation, this may introduce bias and influence results.

**RM**

In countries in Latin America, immunization programme supervisors use RM regularly to check on health interventions in their catchment areas. Supervisors go door to door to check on routine services; to detect and reach unvaccinated people during an outbreak; and to support vaccination campaigns. Supervisors know the people living in their intervention areas, and can provide important input on RVC implementation.

During an RVC, RM optimizes the resources and logistics already available in health services to support campaign activities. Supervisors can identify unvaccinated populations; identify reasons for non-vaccination and address people’s concerns; provide real-time performance data; and help to ensure that coverage goals are met.⁴

**Summary of the methodology**

- The number of monitoring exercises depends on the size of the target population in the target area. For logistical and financial reasons, it is recommended that the evaluation aims to reach at least 3% of the target population.
- For an RVC, the RM team reviews maps and data from local teams to make sure that all areas and populations are included in the assessment.
- To select areas for RM, the RM leader should prioritize those at greatest risk – including areas with geographical or social barriers, underserved populations, refugee camps or immigrant communities, and/or areas with low immunization coverage.
- After selecting areas, the team identifies blocks that may not have been visited in the past.
- Supervisors go house to house in these blocks until they have found 20 people within the YF target age group; they interview these people on their vaccination status and identify reasons for non-vaccination.
- The number of RM visits depends on national campaign guidelines, the size of the population and the age of the target population, as well as the presence of cases.

Guidelines exist in each country on how to determine the size of areas to be monitored, and tools, forms and protocols are usually already established.

Limitations of RM are similar to those of RCM, and also include the following.

- RM does not provide a valid coverage estimate.
- RM cannot be used to measure national coverage.
- RM can be subject to biases, particularly when conducted by personnel who have been involved in the campaign.
- Because RM uses existing staff, there may be a reporting bias for their district/community.

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Clustered LQASs

LQASs are typically conducted within a week after a YF RVC – in addition to RCM/RM – to provide information on the performance of the campaign. They are not representative and do not provide the same precision and accuracy as a vaccination coverage cluster survey, but they do provide quick and useful information for a YF RVC.

LQASs combine cluster sampling and the lot quality assurance sampling technique. Although not primarily designed to estimate vaccination coverage, an LQAS can assess vaccination campaign performance following the campaign in pre-defined areas or “lots”. Lots are based on geographical or administrative boundaries, such as a health district. Clusters (such as villages or settlements) are then selected based on a population proportionate to size methodology. A defined number of people within the cluster will be selected randomly and interviewed. Clustered LQASs can assess the different age groups vaccinated and the quality of the campaign, designating the coverage achieved as “high” (pass), “medium” (warning) or “low” (fail).

LQASs can provide performance trends and information that is helpful for the immunization programme. Clustered LQASs give additional information on the performance of the campaign and actions needed to reach unvaccinated people in those lots not achieving their targets (Box 3).5

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**Box 3. Example of use of a clustered LQAS**

In February 2021, Guinea used a clustered LQAS to measure the YF reactive campaign in an affected district. The survey was conducted after the campaign to confirm the administrative coverage in the district and to rapidly assess the performance of the campaign. The survey showed that campaign coverage was 89.1%: high enough to stop the outbreak.


---

**Summary of the methodology**

- The population is divided into several discrete lots; lots are selected using probability proportional to size sampling.
  - The first household is selected randomly within the lot, and the survey continues using a predetermined sampling interval.
  - One eligible individual in the household is selected at random and checked for vaccination status. Statistical calculations are made to determine the sample size need to verify vaccination coverage.

---

5 For more detailed information on implementation, refer to:


Some limitations of clustered LQASs include the following:

- An LQAS does not calculate a meaningful coverage estimate – it is a measure of campaign performance.
- Data from a clustered LQAS do not provide information on vaccination card retention, gender or reasons for non-vaccination.
- LQASs provide insufficient statistical values to draw conclusions about associated factors.
- There is a risk that lots above the cut-off point will not receive interventions for improvement.

**Vaccination coverage cluster survey**

Vaccination coverage cluster surveys are the WHO gold standard for assessing and verifying coverage of routine immunization and campaigns. In 2018, WHO finalized its vaccination coverage cluster surveys reference manual to include changes to the survey methodology that reduce selection bias, improve representativeness and standardize reporting.²

Note: the 2018 reference manual offers important methodological updates and replaces earlier WHO guidance on cluster surveys.

Cluster surveys use probabilistic sampling, so households have equal and quantified probabilities of being selected at the starting-point. The 2018 reference manual also gives detailed guidance on how to define a target population, calculate the required sample size and number of clusters, design the survey, undertake fieldwork and perform data analysis. Refer to the manual for specifics on each of these areas.

The structure of the RVC survey will need to be adapted for an emergency context so that it can be conducted rapidly, and the results inform the outbreak response quickly. The survey requires rapid protocol development, organization and implementation. It is recommended to leverage the experience of the most recent national vaccination coverage cluster survey – typically conducted approximately every five years – and/or any other recent vaccination coverage cluster surveys (for example, those undertaken for any other campaigns). The lessons learned and protocols from the most recent coverage survey(s) can be an invaluable resource. The team might consider having a standing protocol and ethics approval that can be updated rapidly for other outbreak purposes to facilitate approval.

If a country decides to do a vaccination coverage cluster survey for a YF RVC, the ICG requires the vaccination coverage cluster survey to be done one month after the YF RVC, and the results need to be sent to the ICG within three months of the outbreak.

Box 4 refers to an example of a post campaign coverage survey done in Nigeria following a YF vaccination campaign.

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Summary of the methodology

- Clusters are representative sampling units (such as enumeration areas – operational geographical units for the collection of census data), villages or sections within refugee camps.
- Survey teams interview households, selected randomly in these clusters.
- Interviewers verify coverage and collect information about the campaign (such as vaccination card verification, reasons for vaccination/non-vaccination and communication messages) and other data elements (such as gender, location and coverage of other antigens).
- Results can be used to identify unvaccinated populations and campaign coverage disparities in different areas, and to inform follow-on campaigns and routine immunization services, based on immunization strengths and weaknesses.

Vaccination coverage cluster surveys cover larger populations and can be more expensive and more time-intensive than other methodologies.

Strategies to modify the parameters while still achieving results include the following.

- The number of geographical strata in which conclusions will be reported can be adjusted. If the steering group wants results in all districts but the cost is too high, it might be affordable to do a survey in each province instead.
- The survey goals in different strata can be adjusted. For example, campaign coverage might be estimated at the province level, but routine vaccination coverage assessed only at the national level. Since the target age group for campaign coverage is much wider than for routine immunization, sample sizes are reached by visiting a smaller number of households for the campaign than for routine immunization coverage.
- The desired precision of the coverage estimates in each stratum can be adjusted. Accepting additional uncertainty will decrease the effective sample size.
- Coverage at the lowest geographical hierarchy level can be classified rather than estimated. Rather than calculating a narrow confidence interval in each district, it may often suffice to use a smaller sample to classify coverage in each district, and aggregate data across districts to estimate coverage at the province and national levels. A smaller sample will identify districts that are doing very poorly and those that are doing very well. There is likely to be a middle category of districts that

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**Box 4. Nigeria coverage survey following YF vaccination campaign**

Nigeria is a high-risk country for YF and a priority country for the EYE Strategy. Nigeria has had a re-emergence of outbreaks since 2017. In 2021, there was an outbreak response in Ebonyi and Enugu states, and the National Primary Development Agency conducted a vaccination coverage survey two weeks after the YF reactive campaign. Working with the National Bureau of Statistics, the Agency was able to draw a sample of enumeration areas from a previously developed sampling frame to survey all household members aged 9 months to 44 years.

The results were disaggregated by rural/urban areas, age, gender and local government area. The coverage of the reactive campaign was 74.9%. Nigeria also used the coverage survey to assess COVID-19 preventive measures during the campaign.

are not clearly doing either poorly or well. To identify their current coverage precisely, a larger survey would be needed, but at least the small survey identifies that they are neither at the top nor the bottom of the performance continuum. When three or more strata are aggregated up to the next level of hierarchy, the confidence intervals typically become substantially narrower and more informative.

Table 1 summarizes some of the characteristics, advantages and limitations of the different methodologies for a YF RVC.

### Table 1. Summary of coverage and survey methodologies

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Survey approach or sampling</th>
<th>Timing</th>
<th>For use in a YF RVC</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>RCM and independent monitors</strong></td>
<td></td>
<td></td>
<td>• Verifies RVC administrative coverage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Assesses programme performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Rapid implementation</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Provides real-time identification of missed populations</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Assesses performance in at-risk areas</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Extensive experience using this methodology in countries</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Less costly and less time-intensive than cluster surveys</td>
</tr>
<tr>
<td></td>
<td>• Door-to-door monitoring of households</td>
<td>• Intra- and post-campaign monitoring.</td>
<td>• May miss populations not reached by the campaign</td>
</tr>
<tr>
<td></td>
<td>• Pass/fail assessment</td>
<td></td>
<td>• Not representative and cannot be used to produce a valid coverage figure</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Subject to biases, including information bias, (e.g. low retention of vaccination cards or finger marking during campaign)</td>
</tr>
<tr>
<td><strong>RM</strong></td>
<td></td>
<td></td>
<td>• Verifies RVC administrative coverage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Assesses programme performance</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Engages community in identifying challenges and finding solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Can identify unvaccinated groups and why they were missed</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses supervisors/monitors with local knowledge who can support all aspects of an outbreak response</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Helps to improve performance of overall programme</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Engages community in identifying challenges and can provide local recommendations for solutions</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Similar to the limitations of RCM.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Does not provide a valid coverage estimate</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>• Cannot be used to measure national coverage</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Subject to biases, particularly when conducted by personnel who have been involved in the campaign</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• May be subject to reporting bias for a district/communit y because it uses existing staff</td>
</tr>
<tr>
<td><strong>Clustered LQAS</strong></td>
<td></td>
<td></td>
<td>• Provides rapid RVC performance assessment in defined areas (lots)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Requires limited field deployment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses simple data collection tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Not intended to estimate coverage – instead, classifies campaign quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Insufficient statistical value to draw conclusions</td>
</tr>
<tr>
<td></td>
<td>• Cluster survey based on population proportionate to size methodology</td>
<td>• Less than a week after campaign.</td>
<td>• Provides rapid RVC performance assessment in defined areas (lots)</td>
</tr>
<tr>
<td></td>
<td>• Household survey</td>
<td></td>
<td>• Requires limited field deployment</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Uses simple data collection tools</td>
</tr>
<tr>
<td></td>
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<td></td>
<td>• Not intended to estimate coverage – instead, classifies campaign quality</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>• Insufficient statistical value to draw conclusions</td>
</tr>
<tr>
<td>Methodology</td>
<td>Survey approach or sampling</td>
<td>Timing</td>
<td>For use in a YF RVC</td>
</tr>
<tr>
<td>-------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td></td>
<td>• High-, medium- or low-quality assessment</td>
<td>• Assesses whether campaign has reached a minimum acceptable target</td>
<td><strong>Advantages</strong></td>
</tr>
<tr>
<td>Vaccination coverage cluster survey</td>
<td>• Representative</td>
<td>• Most appropriate for large mass vaccination activities.</td>
<td></td>
</tr>
<tr>
<td>The WHO gold standard for evaluating vaccination coverage.</td>
<td>• Uses probabilistic sampling</td>
<td>• Can be planned to obtain coverage estimate to desired level of precision</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Household survey</td>
<td>• Adaptations for emergency response context to help streamline protocol development and implementation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Within one month after YF RVC</td>
<td>• Representative sample so inference can be made about coverage</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Results to ICG after three months</td>
<td>• Data that can be disaggregated</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Facilitates comparison of a large number of variables</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Largely used for routine immunization coverage but can assess campaigns after intervention</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Extensive experience using this methodology in countries</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Not mandatory for outbreaks in smaller areas/confined spread</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Requires advanced and detailed planning</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Can be resource-intensive and requires technical expertise to develop protocol and implement</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>• Results may not be as prompt as from RCM, RM or LQAS</td>
<td></td>
</tr>
</tbody>
</table>

### 3.3 Step 3: preparing for the monitoring/coverage survey

The time available to prepare the campaign monitoring strategy is limited, so some initial rapid research and discussions with different partners need to happen before planning the most appropriate monitoring approach for the YF RVC.

Recommended activities and preparation work include the following.

- A committee to coordinate the survey/assessment should be established (including the ministry of health, WHO, the United Nations Children’s Fund, health emergency partners, immunization partners and nongovernmental organizations/civil society organizations).
- The ICG application and feedback received from the ICG secretariat and WHO technical focal points should be reviewed, if applicable.
- The coverage assessment should be included in the operational costs budget submitted with the ICG application where applicable and necessary. The overall cost should be reviewed to ensure that it can reasonably cover the essential planning, training, data collection, compilation and reporting needs. This can be supported by a more detailed budget specific to the coverage assessment activity.
• A plan for quality coverage assessment (cluster survey, LQAS or other) should be initiated in parallel with the planning for the campaign. Implementation of the coverage assessment should be able to take place immediately following the campaign aligned to the emergency response context. Coverage surveys in emergencies are expected to be more agile than those used in routine immunization coverage or preventive campaigns.

• The timelines for the coverage assessment activity and reporting should align with ICG standards. For example, data collection should take place within a few days or weeks of the campaign (less than one month), and analysis with report finalization should take place within the three-month timeline to submit to the ICG.

• Necessary ethical procedures required for conducting household surveys should be identified.

• The team should meet with other immunization partners and learn about their recent experience with surveys to answer the following questions.
  o Are the most recent administrative immunization data available?
  o What coverage survey assessments have been used for other supplemental immunization activities/preventive mass vaccination campaigns/reactive campaigns (such as for measles or polio)?
  o What was the coverage survey/assessment budget for the campaign?
  o Is there an existing cohort of trained data collectors/surveyors that could be leveraged for the new survey?
  o What technologies have been used to support the campaign/surveys (such as a global positioning system or open-source mobile data collection platforms like Open Data Kit)?
  o What approvals are necessary at the local level?

• The team should meet with statisticians from the ministry of health and partner agencies. They can help with initial planning and budgeting for survey team size and cluster numbers, and can answer the following questions.
  o What has been their experience with immunization coverage surveys/monitoring?
  o What is their recommended sampling strategy to meet the desired outcomes of the survey?
  o What are some of their recommendations for a reactive campaign survey?
  o What is their recommended source for a sampling frame and population/denominator data for selected areas?
  o What are the benefits and limitations of this sampling frame?

• The team should contact regional YF and immunization focal points with any questions or for technical support, as deemed necessary. The EYE Strategy secretariat can also be contacted at EYE.Strategy@who.int.

3.4 Step 4: designing and planning the monitoring/coverage survey

In an outbreak, timing is crucial. The primary objective in the outbreak response context is to measure the impact of the RVC by assessing vaccination campaign coverage and performance. It is commonly not feasible at the time of the YF RVC to measure other long-term immunization goals.

The immunization programme, along with its partners, must develop a detailed plan with assigned responsibilities, areas of intervention and strategies for RCM, RM, clustered LQASs and vaccine coverage cluster surveys. In the case of a vaccination coverage cluster survey, the team will need to develop or adapt an existing study protocol tailored for the outbreak context rapidly, and to work with health statisticians to ensure that the survey meets the programme’s objectives.
Survey design

The design of a vaccination cluster coverage survey is different from those for RCM, RM and clustered LQASs. Ideally, a working group or steering committee will have been set up to manage whichever methodology is used.

For all surveys, the team will need to identify the primary goal of the survey and any secondary elements that may feasibly be collected during an outbreak response. The data elements the team plans to assess will help to determine the most appropriate survey, and will also support development of questionnaires.

The primary goal of a YF RVC coverage survey is to measure the performance/vaccination coverage of the YF RVC. It must assess overall vaccination coverage by the campaign; and vaccination coverage in select core demographics of age and gender (e.g. infants aged 9–59 months, children aged 5–15 years; adolescents and adults aged 15–60 years, male and female).

Depending on time and budget, secondary elements that could be included are:

- vaccination coverage in different geographical areas/health districts;
- vaccination coverage in frequently missed at-risk populations (such as nomadic or hard-to-reach communities and those living in urban slums);
- reasons for non-vaccination;
- YF vaccination card retention;
- knowledge of communication approaches/tools;
- history of past YF vaccination through routine immunization or other events;
- coverage with other antigens – if applicable and depending on context.

Working closely with statisticians, the immunization programme and partners on sampling and data needs, the team should:

- determine the best available data on the population in the area affected (for example, via recent census data or enumeration from past vaccination activity);
- determine the preferred sampling frame for the area affected;
- calculate the minimum sampling frame;
- review and confirm how data will be collected (digitally or manually via hard copy);
- develop an analysis plan with designated responsibilities.

Throughout the planning process, the team must always consider the budget for the survey, as established in the initial planning for response and ICG operational budget submission (for countries with operational funds from the ICG). The budget estimate can be based on past experience with coverage surveys and previous funding requests to the ICG, Gavi, the Vaccination Alliance, or other partners. It is essential to ensure that funding is sufficient to meet the primary assessment objective.

RCM, RM and clustered LQASs do not collect representative data and are not designed to measure vaccination coverage, so fewer statistical precisions are needed in the study design. The sample size is limited to the area of the intervention, and numbers of households are visited to assess the performance of the campaign.

Vaccination coverage cluster surveys require more specific calculations to determine the necessary sample size to estimate, classify or compare coverage. It is highly recommended that the team works with statisticians on these preparations.
For a vaccination cluster coverage survey, in summary, the team will need to:

- identify the elements that will affect that survey design (for example, whether data are to be measured or compared across different geographical regions; definitions of the different age groups the survey plans to measure; whether data are to be classified against an established threshold);
- identify the uncertainty and inferential goals (establishing the confidence interval and how precise the survey should be);
- calculate the required sample size so that the dataset meets the inferential goals set;
- draft an analysis plan and dummy tables/table shells to assist with data analysis.

This list includes key considerations taken from the 2018 vaccination cluster survey reference manual.7

Data forms/questionnaires

Many countries already have model forms and questionnaires for RCM, RM, clustered LQASs and/or vaccination coverage cluster surveys. The team should investigate what has been used previously, and should discuss any recommendations or ideas about what might need refinement with partners to ensure suitability for the RVC context. It may be possible to select a subset of questions from an existing source that are relevant in the outbreak context, thereby streamlining the overall questionnaire.

Administrative coverage is subject to human error, inaccurate population data and problems compiling data. Training during coverage surveys can help to guide overall improvements in administrative data collection, analysis and use.

Questionnaires/forms for RCM, RM and cluster LQASs are much less complex than questionnaires for vaccination coverage cluster surveys. For RCM, RM and cluster LQASs, the questionnaire/form is designed to check the performance of the campaign, verify administrative coverage and provide information about missed areas and reasons for non-vaccination.

Questionnaires for vaccination coverage cluster surveys in the outbreak context are not as comprehensive as those used in coverage surveys for routine immunization. They need to be shorter and adapted to the emergency.

Countries with frequent outbreaks of YF or other vaccine-preventable diseases may already have or could develop a shorter protocol for outbreak response. They need to respond to the more specific objectives of verifying vaccination coverage across different age groups.

The following is a general list of considerations when designing a questionnaire/data collection form. The team should ensure that:

- the questions measure the objectives of the survey;
- the questionnaire is translated into the appropriate language(s), and any medical or new terms are clearly defined and correctly translated;
- if the questionnaire is translated, that the translation is correct and understandable;
- questions are written clearly, with skip patterns – this applies to both paper and digital questionnaires;

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• closed multiple choice questions are used where possible;
• the design is easy for data entry and leaves space for interviewers to make corrections;
• the questionnaire has been field tested with supervisors and implementors;
• the software is fully updated prior to the survey, and data recording equipment is available and adequate for the number of interviewers;
• the questionnaire is fully loaded onto data recording equipment prior to training of supervisors and interviewers so that they can practice using it.

*Note:* the time to interview people is limited, so the questionnaire needs to be quick to use to obtain an effective response.

**Planning**

In an outbreak situation, all planning needs to be well organized and rapid; this also has an impact on the choice of coverage survey the programme is able to implement.  

8 To plan for the survey/assessment, the team needs to:

• confirm the planned dates and location(s) of the reactive campaign;
• review the ICG budget allocations for monitoring and evaluation activities;  
9 • confirm the choice of monitoring/coverage survey and its related planning:
  o for an **RCM, RM or clustered LQAS**, establishing the number of households that will be interviewed, and planned location(s) to be monitored to estimate staff and logistics;
  o for a **vaccination coverage cluster survey**, establishing the sample size and clusters to estimate staff and logistics;
• develop a budget for the post-campaign coverage assessment, including the number of interviewers, supervisors, independent monitors, drivers, data processors and/or data analysts needed for the survey and logistics needs for the duration of the assessment and analysis;
• confirm approval from local authorities to conduct the survey;
• identify and engage key community leaders and local staff who can help with introductions, implementation and mop-up vaccination activities;
• confirm that ethical approval is obtained, according to national guidelines;
• ensure that all necessary health protocols are understood and implemented, including provision of any personal protective equipment or infection prevention and control supplies;
• ensure that all people involved in the survey are working in a healthy environment, including having access to relevant (YF) vaccinations, and that prevention of sexual exploitation and abuse and sexual harassment training and standards are applied for all personnel;
• review any security requirements/procedures that may be necessary in areas of insecurity, conflict or violence.

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Overview of survey and monitoring methods

Note: areas for assessments and coverage surveys may be in hard-to-reach locations. This may have an impact on logistics or staffing needs.

3.5 Step 5: implementing a monitoring/coverage survey

Training for interviewers, supervisors, independent monitors and data processors should be designed with care. It is important that all participants are aware of WHO policy and standards, including prevention of sexual exploitation and abuse and sexual harassment.

The number of days taken to train the team may vary according to the choice of methodology. Vaccination coverage cluster surveys use longer questionnaires, different approaches to mapping and data collection that need to be learned, and procedures that need practice. In an outbreak response, training can be done in less than three days. RCM and RM use a more simplified approach, but interviewers also need to familiarize themselves with recent technologies and procedures. Average training time is 2–3 days. Clustered LQASs use a simplified data collection tool, but technologies/approaches may be new to interviewers. Average training time is 2–3 days.

The training should, at a minimum:

- provide background information on YF, the vaccine and the outbreak area;
- explain the importance of the YF vaccination card for the International Health Regulations (2005), the campaign and routine immunization;
- explain the reasons for the survey;
- describe the methodology in detail (requiring more time for vaccination coverage cluster surveys);
- describe implementation of the methodology (requiring more time for vaccination coverage cluster surveys);
- review the questionnaire, question by question, and explain the context for the questions being asked;
- review the computerized/digital data capture tools, if applicable;
- allow time to practise the questionnaire/using the digital tools;
- if possible, include time to practise selection of households and interviewing in the community.

During data collection, the supervisors’ role is crucial to ensuring quality data. Supervisors must:

- work closely with their teams to solve problems, correct any performance issues and answer questions;
- check completed questionnaires for all eligible people – if questionnaires are incomplete, make sure that interviewers have given a reason;
- check questionnaires and lists before leaving the cluster area;
- check for discrepancies when revisiting households and repeating interviews;
- give helpful feedback to interviewers when correcting discrepancies;
- at the end of each day, organize daily debrief meetings to review data collection, identify challenges and enter data if collected on paper forms;
- plan for any return visits for corrections or mop-up vaccination activities.

3.6 Step 6: analysing data from the monitoring/coverage survey

The team should meet with statisticians and programme managers early in the process to discuss data collection and analysis. It is important to determine:
• who will be collecting the data (interviewers, supervisors or both);
• how it will be recorded (pen and paper or computer assisted);
• who will enter the data (interviewers or data entry staff);
• who will analyse the data (survey manager, supervisor, independent monitor or a larger review team).

The level of data analysis varies according to the type of survey/assessment conducted. For a vaccination coverage cluster survey, because of its large sample size and methodology, the data analysis is more complex than for RCM, RM or clustered LQASs.

**RCM data analysis**

During RCM, monitors assign a pass/fail assessment of coverage in the households visited to guide mop-up vaccination activities and to identify reasons for non-vaccination. RCM can also collect data on age groups, location and gender, but – as noted earlier – the data are not representative.

RCM data are reviewed daily and shared during daily debrief meetings. Combined with the supervisory and monitoring data, they can identify poorly performing areas and guide strategies for mop-up vaccination activities. Analysis of the reasons for non-vaccination can also help to identify areas for improvement during the campaign.

Other data from RCM can be reviewed and compared to other routine immunization and campaign data. The data analyst will work closely with other team members to review and understand the results of the analysis, ask questions, confirm trends and identify low-performing areas that may need additional support.

**RM data analysis**

Data collected during RM are based on the objectives and indicators to be monitored – for example, the number of people vaccinated with YF vaccine in the targeted population. Monitors collect data on the number of people vaccinated in a household and reasons for non-vaccination (Fig. 3). Data are then checked by supervisors, who look for errors and clean the data.\(^\text{10}\)

High data quality is essential when creating accurate indicators for decision-making. Health workers collecting data should be trained to avoid recording errors. If the data quality is high, the exercise can be assumed to show that the target population has been reached accurately, and to represent the causes of a lack of vaccination.

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Fig. 3. Example of a tabulation sheet used for routine monitoring

| Percentage of children who received a tracer vaccine, a campaign vaccine, or have complete immunization series (5) | 80 |
| Percentage of children dewormed (%) | 70 |
| Percentage of children who received another intervention (%) | 55 |

<table>
<thead>
<tr>
<th>Reasons given:</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
<th>Total NOT vaccinated / NOT dewormed / did NOT receive other intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series was incomplete:</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>2</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Child was not dewormed last year or during the last campaign:</td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4</td>
</tr>
<tr>
<td>Child did not receive another intervention:</td>
<td>9</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>9</td>
</tr>
</tbody>
</table>


Clustered LQAS data analysis

LQASs are used to monitor vaccination activities and assess the quality of coverage (high, medium or low). Polio campaigns use finger marks as an indicator of coverage. For YF, the indicator could be vaccination cards or finger marks (if used). Verbal history should not be considered for clustered LQASs.

For example, the polio framework allows classification in three band ranges: **90% for high;** between **80% and 90% for medium;** and **no evidence of over 80% for low.** There are also opportunities for countries to adapt the LQAS protocol to their context, as desired.

Data managers should analyse the data collected in the questionnaires and estimate coverage for each lot. They should compare it with the coverage target and then classify it according to performance.

If coverage is in the **high** band (≥90%), the lot passes the LQAS.

- Decision: the data do not suggest performance gaps.
- Recommended action: no action is needed.

If coverage is in the **medium** band (80–90%), the lot receives a warning.
• Decision: the data suggest performance gaps, although these may be not the highest priority if there are areas of greater concern.

• Recommended action: other indicators (such as in-process monitoring or administrative coverage) should be reviewed to decide how to increase coverage levels in the lot. While 80% is considered the minimum for population immunity, many campaigns aim for a higher target of 90–95%.

If coverage is in the low band (no evidence of over 80%), the lot fails.

• Decision: the data suggest serious performance gaps – these areas should be given the highest priority in the short term.

• Recommended action: the team should consider redoing the campaign (either the entire lot or selected areas, based on other indicators).

**Vaccination coverage cluster survey data analysis**

For a vaccination coverage cluster survey, the data manager works with several datasets and variables. As noted above, it is recommended that the team should work with statisticians early in the process to identify any derived variables or survey weights needed for the analysis. Data entry, cleaning, tabulation, analysis and reporting of a vaccination coverage cluster survey can take time, so the team should talk to programme managers and statisticians to estimate the amount of time it will take from survey to final report.

The WHO cluster survey reference manual details the steps needed to manage the data analysis process, including guidance on cleaning data, tabulation, graphics, classifying coverage and preparing a report.  

Some errors to look for when cleaning the data are:

• including people not in the target age groups;
• including people who have not been vaccinated with people who have been vaccinated;
• registering people in a particular house who do not meet the definition of residency;
• failing to note reasons given by participants for non-vaccination;
• including reasons for non-vaccination under the heading “Other” when the relevant reason is in the list on the form.

**3.7 Step 7: using information from the monitoring/coverage survey to improve future campaigns**

Whichever survey or assessment the team decides to use, the data from the survey/assessment will provide information not just on the YF RVC but also on other areas of importance for the national, regional and district immunization programmes.

A campaign report is a requirement for the ICG-supported campaign; it should be submitted to the ICG and the YF technical team within three months of the RVC. The campaign report is expected to include a series of data, including the outputs from the coverage survey/assessment and the lessons learned/recommendations. It is important to record the performance results, and to highlight

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opportunities for improvement for the immunization programme for routine YF and other immunizations, as well as for future campaigns.

As part of the post-campaign process, the team is also encouraged to conduct a root cause analysis of the national YF strategy. This should involve decision-makers, epidemiologists, statisticians, health security professionals and routine immunization stakeholders. Questions for discussion could include the following.

- What was observed or learned about RVC coverage for YF?
- Did the campaign reach the target coverage?
- What can the results of the YF campaign demonstrate about at-risk areas and hard-to-reach or marginalized populations? Were zero-dose communities identified?
- Was the survey/assessment methodology appropriate?
- How can YF vaccination be incorporated into the next national immunization cluster survey?
- Does this outbreak call for greater YF prevention and vaccination action – in routine immunization, targeted outreach or catch-up activities, preventive mass vaccination campaigns or other activities?
- What do the data say about reasons for non-vaccination? How can this information help the YF and routine immunization programmes to strengthen acceptance/coverage?
- What are the next steps?

The results of this discussion can also be included in the overall report and distributed widely.

**Conclusion**

This guide has provided a summary of the different options for measuring the performance of a YF RVC, as well as the basics of measuring vaccination coverage with a vaccination coverage cluster survey. Much greater detail and further information on implementation can be found in the publications listed in the bibliography.

The immunization or outbreak response team’s greatest resources are colleagues and team members who have had recent experience in campaign implementation and measurement. They can help the team identify national best practices, tools and technological approaches that have worked well.

Given the nature of an outbreak and reactive campaigns, timing is tight: campaigns need to be implemented quickly to stop the spread of YF. The most important element is to vaccinate and protect all at-risk populations. Monitoring and assessing campaign coverage will help to make sure that the programme achieves this goal.
Bibliography


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12 All references accessed 17–21 July 2023.
Tools for monitoring the coverage of integrated public health interventions: vaccination and
deworming of soil-transmitted helminthiasis. Washington DC: Pan American Health

World Health Organization vaccination coverage cluster surveys: reference manual. Geneva:

Health Organization; 2023 (https://www.who.int/groups/icg/yellow-fever/stockpiles,
accessed 17 July 2023).
Annex 1. ICG page on RCM implementation (for oral polio vaccine)

RCM is conducted in the villages/areas where vaccination teams indicate confirmed complete vaccination of all eligible children.

**General objectives**

To check whether target populations have received the vaccine in the current campaign, and provide/plan mop-up vaccination activities for missed doses where required.

| RCM will identify areas with missed target individuals for planning of mop-up vaccination activities in the area |

**Guidelines for conducting RCM**

The main purpose of the monitoring activity is to identify the areas with missed target populations, and to plan corrective actions (revisits by teams for vaccination) during the mop-up vaccination activities phase. It is not a formal measurement of coverage.

- The monitoring activity should be planned and conducted in as many priority/high-risk areas in the province as possible.
- The villages identified from the mapping format and the microplanning prepared by every health facility should be visited. If the identified area is unreachable for any reason during the time of monitoring, the nearest area from the list should be chosen.
- The identified area should be visited only after the team has claimed that the vaccination coverage for the area as per the microplanning has been completed. Any village in the health centre catchment area can be visited, but the RCM forms should be filled in only when the health worker claims that the activity is completed in the village/area.
- The first house in the identified village should be chosen at random; then every third house should be visited to a minimum of 10 houses in the village. If the selected village contains fewer than 10 houses, all targeted individuals in the village should be surveyed.
- The number of houses visited sequentially should be recorded (Table A1.1). A minimum of 10 houses should be visited in every village (even if more than two missed targeted individuals are detected in the first few houses).
  
  *Note:* the decision to suggest mop-up vaccination activities for any village will be made based on the number of missed target population found, irrespective of the number of houses visited.
- At each house, the team should ask for the target population who are the normal residents of that house and record the information for each house in every row.
- The details of targeted individuals in a house should be recorded if at least one of them is present at the time of visit. If a house has targeted individuals but none of them are present at the time of monitoring, no information about this house should be recorded on the RCM form; instead, the team should proceed to the next house.
- The number of the targeted individuals present at the time of visit should be recorded. This should include any visitors/guests in the house.
- The finger marking of all targeted individuals present in the house at the time of monitoring should be checked.
The team should ask whether each of the targeted individuals is vaccinated. If the targeted individual is reported to be vaccinated, finger marking should be checked, and the number of such individuals written in the “Finger mark” column. If the individual is reported to be vaccinated but no finger marking can be seen, the number should be written in the “Recall” column. “Recall” is valid only for an individual who is present at the time of monitoring but whose finger mark is not visible.

Finger marking will be used to confirm vaccination status; if the parent says the child was vaccinated, the confirmation should be accepted even when there is no finger marking.

If a targeted individual is NOT vaccinated, the number should be written in “No” column. The team should ask the reason for non-vaccination and indicate this using the codes available on the form.

The team should ask about sources of information about the campaign and record the corresponding code.

### Table A1.1. Interpretation of RCM results

<table>
<thead>
<tr>
<th>Situation</th>
<th>No. of houses visited</th>
<th>No. of unvaccinated targeted individuals found</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>0</td>
<td>Proceed to the next village.</td>
</tr>
<tr>
<td>2</td>
<td>10</td>
<td>1</td>
<td>Survey an additional 10 houses in the same village. If one or more unvaccinated targeted individual is found, the team needs to revisit the area for mop-up vaccination activities.</td>
</tr>
<tr>
<td>3</td>
<td>10</td>
<td>2 or more</td>
<td>Continue monitoring in this area. If two unvaccinated targeted individuals are detected at any point in any village, the team needs to revisit the area for mop-up vaccination activities.</td>
</tr>
</tbody>
</table>

No decision on mop-up vaccination activities will be made for any village visited based on the number of people found unvaccinated outside the house (for example, at marketplaces, schools, bus stands, streets or temples).

The RCM monitor should inform the supervisor immediately by mobile phone if at any point during monitoring, he/she detects two or more unvaccinated targeted individuals.

The supervisor should organize a team to visit the village for mop-up vaccination activities – immediately if possible – or plan a follow-up visit by the team.

The village head and community health workers/village health volunteers should mobilize the community visited and the vaccination team should vaccinate all missed people, including any children not yet identified by the RCM team (Fig. A1.1).
**Fig. A1.1. Example of an RCM form for targeted children**

Province ___________ District ___________ Health facility ___________ Village visited ___________

Date of monitoring____________________ Name of monitors_________________

<table>
<thead>
<tr>
<th>Number of households</th>
<th>Total number of eligible children living in this house during the campaign</th>
<th>Age of the children checked by the supervisor/monitor <strong>at the time of visit</strong></th>
<th>Oral polio vaccine received in this round</th>
<th>0-8 months</th>
<th>9-59 months</th>
<th>Finger mark</th>
<th>Recall</th>
<th>0-11 months</th>
<th>12-59 months</th>
<th>Source of information about supplemental immunization activities (multiple codes can be entered)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td>Yes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>No</td>
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<tr>
<td>3</td>
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<td></td>
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<tr>
<td>6</td>
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<td></td>
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<tr>
<td>7</td>
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<td>9</td>
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<td></td>
<td></td>
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<td>10</td>
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<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

**Reason for non-vaccination:** 1. Did not know about the campaign; 2. Knew about the campaign but too busy; 3. Went to vaccination post but vaccinators absent; 4. Went to vaccination post but vaccine not available; 5. Did not know where to go; 6. Vaccination post too far; 7. Child absent during immunization days; 8. Parents absent during immunization days (for children); 9. Unaware of the need for the immunization; 10. Child was sick; 11. Not necessary as the child vaccinated in routine schedule; 12. Vaccine can harm the child; 13. Other


Record here the vaccination status of the target beneficiaries checked outside the house (for example, at marketplaces, schools, bus stands, streets or temples)

- **Number checked**
- **Number of unvaccinated children found** (without finger marking)
• The RCM monitor or supervisor should share the name of the village in which for mop-up vaccination activities are planned with health centre in charge, and with district and provincial Expanded Programme on Immunization managers.

**Sharing the RCM results**

The monitors and supervisors should share the RCM results with the relevant health facility before leaving its catchment area. A detailed discussion session should be organized with the health facility staff to plan the mop-up vaccination activities in the areas missed as an exclusive house-to-house activity. Daily evaluation of the RCM results should be done at the district level to determine areas for planned mop-up vaccination activities. The RCM results should be shared by every external monitor by provincial and district supervisors and with the national immunization programme officers during the campaign for compilation and preparation of feedback.
Annex 2. Example of an RCM form (WHO Region of the Americas)

**HEADING OF THE FORM:** Identification information: Include the information needed in order to identify the place where the RCM is conducted according to the political-administrative-geographical structure of the country.

Name of the first subnational level (department, state, or province)
Name of the second subnational level (district or municipality)
Name of place (locality, community, or parish, and block).

**VARIABLES TO BE INCLUDED IN THE FORM:** Include all the variables needed, depending on the objective and indicators selected to include in the RCM.

<table>
<thead>
<tr>
<th>No.</th>
<th>Variate</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>(A)</td>
<td>Name of place (locality, community, or parish, and block).</td>
<td></td>
</tr>
<tr>
<td>(B)</td>
<td>Name of the second subnational level (district or municipality).</td>
<td></td>
</tr>
<tr>
<td>(C)</td>
<td>Name of the first subnational level (department, state, or province).</td>
<td></td>
</tr>
<tr>
<td>(D)</td>
<td>Place where the RCM is conducted according to the political-administrative-geographical structure of the country.</td>
<td></td>
</tr>
<tr>
<td>(E)</td>
<td>Reasons why (F):</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vaccination series incomplete</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not deparasitized</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Did not receive the other intervention</td>
<td></td>
</tr>
</tbody>
</table>

**SPACE FOR RECORDING THE DATA FOR EACH CHILD INCLUD ED IN THE RCM:** REMEMBER THAT EACH DOOR-TO-DOOR RCM COVERS 20 CHILDREN

<table>
<thead>
<tr>
<th>Space for recording the data for each child included in the RCM</th>
<th>REMEMBER THAT EACH DOOR-TO-DOOR RCM COVERS 20 CHILDREN</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
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<td>6</td>
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<td>7</td>
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<td>9</td>
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<td>10</td>
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<td>11</td>
<td></td>
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<tr>
<td>12</td>
<td></td>
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<td>13</td>
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<td>14</td>
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<td>15</td>
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<td>16</td>
<td></td>
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<td>17</td>
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</tr>
<tr>
<td>18</td>
<td></td>
</tr>
<tr>
<td>19</td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
</tr>
</tbody>
</table>

**SPACE FOR TABULATING THE DATA**

<table>
<thead>
<tr>
<th>Coverage:</th>
<th>Vaccine 1</th>
<th>Vaccine 2</th>
<th>Vaccine 3</th>
<th>Vaccine 4</th>
<th>Vaccine 5</th>
<th>Vaccine 6</th>
<th>Vaccine 7</th>
<th>COMPLETE SERIES</th>
</tr>
</thead>
<tbody>
<tr>
<td>% of children vaccinated (C18&quot;30)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of children deparasitized (5/10&quot;20)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>% of children who received other intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reasons why (F):</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Vaccination series incomplete</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not deparasitized</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did not receive the other intervention</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**IDENTIFICATION DATA OF PERSON CONDUCTING THE RCM**

Name of responsible person
Signature
Date
Other

**REMEMBER TO INCLUDE INSTRUCTIONS ON THE BACK OF THIS FORM**
Annex 3. Examples of data collection tools for clustered LQASs

Fig. A3.1. Example of an LQAS questionnaire

Q1: Lot: ____________________________
Q2: Cluster Number: [__] (1-6)
Q3: Name of the locality for the cluster (village/neighbourhood): ____________________________
Q4: Name of Surveyor: ____________________________
Q5: Name of LQAS Supervisor: ____________________________
Q6: Date: [__] [__] [__] [__] [__] [__] [__]

**Vaccination Status**

Note: Only administer the questionnaire to one eligible child randomly selected per household.

<table>
<thead>
<tr>
<th>Progressive number of household in the cluster</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q7: Age</td>
<td>In months; if above 59 months do not administer questionnaire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q8: Sex</td>
<td>M=Male F=Female</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q9: Vaccinated (Presenting &quot;finger mark&quot;)</td>
<td>Y=Yes N=No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q10: Was caregiver aware of the polio vaccination campaign prior to the arrival of the vaccination teams?</td>
<td>Y=Yes N=No</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q11: Comments</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. A3.2. Example of an LQAS summary sheet

Lot: ____________________________

Lot Number: [__] ____________________________

Date: [__] [__] [__] [__] [__] [__] [__] [__] ____________________________

<table>
<thead>
<tr>
<th>Cluster Number</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of unvaccinated individuals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OPV</td>
<td>/10</td>
<td>/10</td>
<td>/10</td>
<td>/10</td>
<td>/10</td>
<td>/10</td>
<td>/60</td>
</tr>
</tbody>
</table>

Supervisor’s name: ____________________________

Signature: ____________________________

Supervisor’s comments: ____________________________

Annex 4. Roles and responsibilities of assessment team members

AREA COORDINATORS (DISTRICT/REGION) (if applicable)
Profile
- Technical committee members who have actively participated in all survey planning phases – in particular, in development of the standard operating procedures
- Prior experience as a trainer preferred

Responsibilities
- Drawing up a survey workplan for the district/region (and providing a daily progress report)
- Liaising with local authorities to facilitate the work of supervisors and survey staff
- Sending completed files to the central office
- Reporting on the survey’s implementation at the district/regional level to the central office

If the survey is stratified, coordinators will be responsible for one or several strata. In non-stratified surveys, they will be responsible for geographical areas comprising several supervisors and survey agents. These areas may or may not correspond to administrative entities (such as districts, provinces or regions).

SUPERVISORS
Profile
- Sufficient level of education for training purposes
- Good knowledge of local languages
- Prior experience as a supervisor in a household survey

Responsibilities
- Organizing the team’s travel arrangements
- Supervising and supporting survey staff to ensure quality data collection
- Ensuring that the survey is carried out in accordance with the protocol
- Reporting on the survey’s implementation to the central office
- Sending completed files to the central office

SURVEY STAFF
Profile
- Sufficient level of education for training purposes
- Good knowledge of local languages
- Prior work experience in a household survey

Responsibilities
- Drawing up the list of households in the cluster
- Collecting information from the households selected

GUIDES
Profile
- Member of the community
- Recruited in each cluster
Responsibilities
• Assisting survey staff (introducing survey staff in households, acting as a local guide within the cluster)
• Providing translation/interpretation, if needed

INDEPENDENT MONITORS
Profile
• Sufficient level of education for training purposes
• Good knowledge of local languages
• Prior experience as a supervisor in a household survey

Responsibilities
• Collecting data in the field to monitor to quality of the survey
• Analysing data and calculating monitoring indicators

DATA MANAGERS
Profile
• Proficiency in data management software

Responsibilities
• Designing the data input mask
• Drafting the data entry manual
• Training data entry clerks and their supervisors
• Managing the database

DATA ENTRY SUPERVISORS
Profile
• Proficiency in data entry software
• Prior experience as a survey data entry supervisor

Responsibilities
• Checking and organizing forms
• Supporting data entry clerks
• Conducting a daily check of data entered by clerks
• Dataset cleaning

DATA ENTRY CLERKS
Profile
• Proficiency in data entry software
• Prior experience in survey data entry

Responsibilities
• Data entry
• Correcting data entered where necessary

ANALYSTS
Profile
• Good understanding of the extended national immunization programme indicators and analysis of data from surveys using complex sampling
• Proficient in the use of statistical data analysis software
• Prior experience of analysing data from a vaccination coverage survey using probabilistic sampling

**Responsibilities**

• Calculating weightings to attribute to survey subjects
• Analysing survey data in accordance with the plan defined in the protocol
• Producing tables and figures to insert into the report
• Helping to draft the report and provide feedback to country authorities