

## 2. Design the survey and develop protocol

*This section should be read in association with the World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1).*

The quality and utility of serosurvey results depend on good survey design answering the research questions while remaining within the available resources. A serosurvey requires many resources, so it is essential to define, carefully and clearly, the serosurvey objectives and establish the protocol before the serosurvey begins. Key considerations when designing a serosurvey are detailed in Box 2-1.

### 2.1. Convene steering and technical committees

A planning and implementation team should be assembled as the first step of a serosurvey. The size and composition of the team will depend on the potential size and complexity of the serosurvey but will often include both a steering committee and technical committee.

#### 2.1.1. Steering committee

A serosurvey steering committee usually includes senior staff from the national Ministry of Health, members of the Inter-agency Coordinating Committees (ICC) and/or the National Immunization Technical Advisory Group (NITAG), international immunization activities partners and leading experts with appropriate survey, laboratory and statistical skills. It is important to include representatives from the National Statistics (Census) Office or equivalent, who have experience with sampling frames and household listing processes. If the survey is going to be combined with another survey (e.g. DHS), relevant additional representatives should be included in the steering committee. Local academic or research institutions with recent experience on conducting serosurveys (on any infections/conditions) could be considered as their experience will be valuable. Local knowledge will help customize the serosurvey to meet each region's unique challenges. The steering committee will be responsible for:

- coordinating stakeholders
- liaising with the ICC and the NITAG
- identifying and securing the necessary funds
- preparing the terms of reference for the survey coordinator
- providing oversight for the protocol development and approval
- providing guidance for all aspects of the survey planning and implementation
- assisting with interpretation and dissemination of results.

For survey implementation, the steering or technical committee will recruit a primary survey coordinator, field supervisor and laboratory supervisor and provide terms of reference for each role.

#### 2.1.2. Technical committee

Depending on the size and complexity of the activities planned, the steering committee may appoint a technical committee to take responsibility for developing the protocol and all necessary forms and reports. Measles and rubella serosurveys should be guided by epidemiologists and laboratory scientists experienced in survey design, planning, implementation, training, data collection and analysis, specimen collection and laboratory procedures. Additional serosurvey personnel can include statisticians, staff responsible for survey participant enrolment and specimen collection, laboratory technicians, supervisory staff, data managers, coordinators and others as needed. More information about hiring and training staff may be found in **Section 3** below.

## 2.2. Define survey objectives

The early steps for designing a serosurvey are illustrated in Figure 2-1. In order to define the serosurvey objectives, the first step is to identify the primary questions. The objectives should define the study population (geographical area, age range, any inclusion and exclusion criteria), specific strata (such as age bands, urban or rural, or specific communities of interest) and biomarkers of interest (measles and/or rubella, with or without other organisms). When defining primary questions and objectives, an iterative process is often needed to arrive at a survey design which is feasible to conduct in a timely manner and within the available resources.

Categorize multiple objectives as primary or secondary. The primary objectives will be considered when choosing a study design and sampling methodology. The primary objectives need to be clearly defined and should be small in number as they will be used to drive the study design and make sample size calculations. There are three types of primary questions:

- Estimation questions that will result in a quantitative estimate of seroprevalence;
- Classification questions that yield qualitative seroprevalence labels (e.g. “high”, “intermediate” or “low” instead of precise quantitative estimates); and
- Comparative or hypothesis testing questions that compares seroprevalence with an important programmatic threshold (e.g. target immunity levels for measles) or across time, or between categories such as populations or geographic strata, or characteristics like sex, education or wealth.

See World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) Section 2.3 for more detailed explanation of differences between estimation and classification.

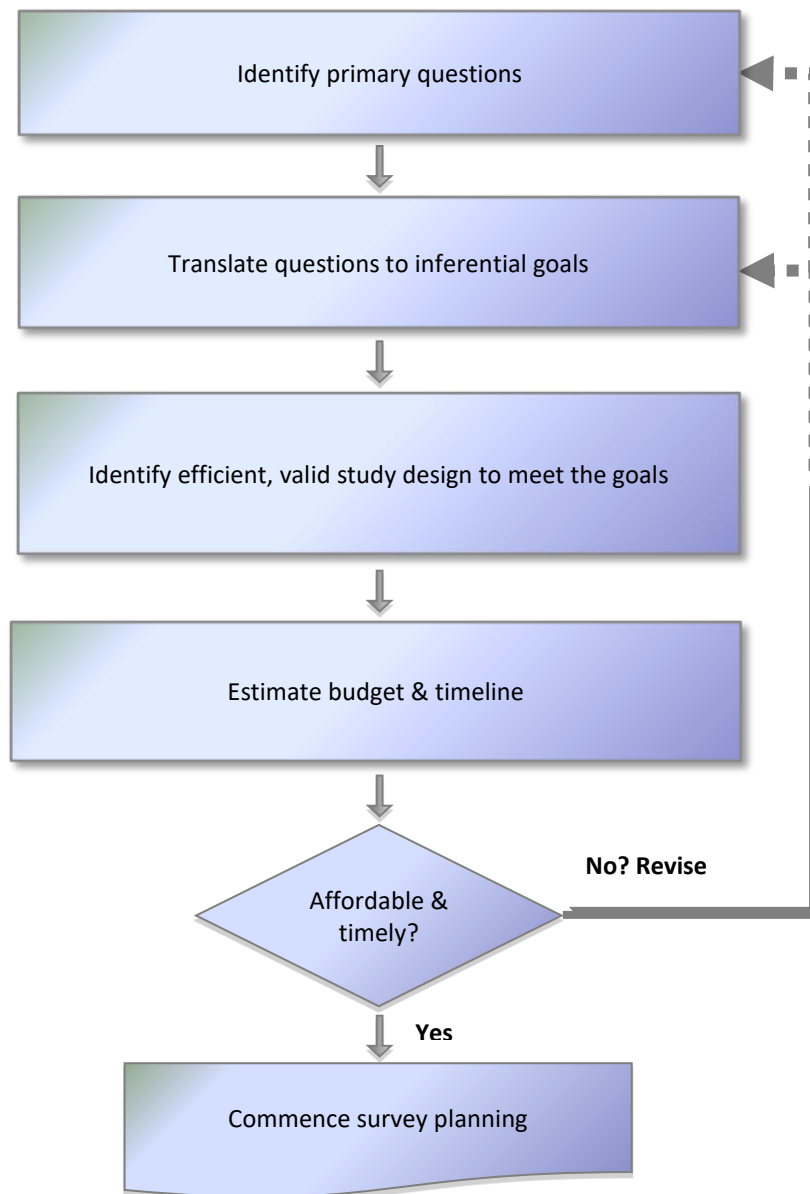
## 2.3. Define target population

An important step in clarifying the primary objectives is to specify the eligibility criteria of the target population being surveyed. Consider the following population characteristics when defining the target population:

- **Demographic groups.** Demographic groups could be based on age cohorts, gender, geography (urban vs. rural) or some combination of demographic factors. If the survey aims to evaluate the effect of an SIA on population immunity, then at a minimum, the age range included in the SIA should be included in the serosurvey. It will often be helpful to extend the survey eligibility age range to older age groups in order to identify any gaps in immunity in other age groups. Serosurveys for rubella immunity might have the eligibility age range extended into childbearing years or conduct a survey only in women of childbearing age.
- **Geographic or administrative population.** An important design parameter to determine is the geographic or administrative populations for which results will be estimated. This will depend on the objectives and the complexity of the serosurvey, including decisions as to whether precise results are needed at sub-national level, which means stratifying the survey at the corresponding administrative level. Alternatively, a single national estimate may suffice. Occasionally, only specific regions within a country are selected for a survey (e.g. after a subnational SIA). Specifying clearly the administrative and demographic groups for which results will be reported will aid the planning of sample size and logistics for data collection, data management, analysis and reporting.

See World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) Section 2.4 for more information on defining target populations.

Figure 2-1. Early Steps in Survey Design



(Adapted from World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual)

## 2.4. Set inferential goals

Once the survey's primary objectives have been identified, the inferential goals should be set. An inferential goal determines how much uncertainty in the outcome is acceptable. Classically, this parameter is expressed as *plus or minus X percent* ( $\pm \%$ ). In general, the more certainty required in the outcome of the survey, the more respondents are required (larger sample size) and so the more expensive the survey. Uncertainty and inferential goals are described in different ways depending on the primary survey question.

- **Confidence interval.** When **estimating** prevalence, the inferential goal is expressed as a confidence interval (CI). The smaller the confidence interval, the more accurate your estimate.

- **Classification error (or misclassification).** When *classifying* immunity prevalence, the inferential goal is expressed using the probability of making a classification error (often called misclassification).
- **Statistical power to detect difference.** When *comparing* two prevalence estimates using a formal statistical hypothesis test, the inferential goal is expressed as statistical power to detect a given detectable difference. The design and sample size are driven by a compromise between the ability to find a difference of a programmatically relevant magnitude (statistical power) and budget or time.

See World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) Section 2.5 for more information on setting inferential goals.

## 2.5. Decide if existing data and specimens may be used

If considering using archived specimens, it is critical to ensure that the original protocol, including ethics approval and consent forms, included the possibility for additional future testing. If the original survey consent form did not specifically approve the use of leftover serum for further testing, further specific consent should be obtained, and the proposed use of the samples should be clearly communicated to the person.

Existing specimens can either be linked or unlinked to identifying information. Each option has implications for data collection and informed consent:

### Unlinked anonymous testing without informed consent

- Testing of unlinked specimens collected for other purposes
- No personal identifiers obtained, no informed consent, no follow-up required
- Coded specimen.

### Unlinked anonymous testing with informed consent

- Testing of unlinked specimens collected solely for surveillance purposes
- No personal identifiers or names obtained, no follow-up required
- Coded specimens.

### Linked confidential testing with informed consent

- Testing of specimens linked to the person by name
- Informed consent and post-test follow-up required if seronegative
- Personal identifiers or names obtained
- Coded specimen with code linked to personal identifying information.

Before conducting a serosurvey with archived specimens, do an assessment and inventory to confirm the completeness of the original sample set, including the volume remaining and whether they are legibly labelled. Also check the quality of the stored specimens, including the history of specimen storage according to the specific cold chain requirements. In addition, it is critical to have a thorough understanding of the initial study protocol, including the sampling methods used to collect the archived specimens and the data available on the individuals participating in the original study (e.g. age, sex, geographic location).

There may be further limitations with conducting serosurveys using existing, residual specimens:

- the immunity status of the population may have changed since the specimens were collected due to outbreaks or SIAs;

- the demographic and epidemiological information associated with the specimen might be limited or lacking some variables of interest, such as vaccination status;
- the population sampling methods used might not be a representative sample of the population, age groups, or geographical subpopulations of interest in the current study; and
- the archived specimens might have been collected conveniently and not using representative sampling methods, resulting in bias overestimating or underestimating population immunity.

However, specimens that are residual from other systematic surveys or biorepositories can nonetheless be very useful and are used in several countries routinely (2, 3, 4). It is noted that specimens collected *de novo* can also have bias introduced. If the set of archived specimens is quite large and has sufficient metadata associated with it or can be linked to such data to enrich understanding of the source population, consider selecting predefined groups of interest or strata that meet the survey objectives. This will reduce the overall number of tests and therefore the costs required to meet the objectives.

## 2.6. Select a survey design and sample

Once the survey's primary questions have been identified and eligibility criteria and specified inferential goals determined, a survey design, including appropriate sample size and analysis plan, can be developed. Note that seroprevalence and vaccination coverage are both proportions (often expressed as percentages) and therefore all steps in designing surveys for coverage can be applied to seroprevalence surveys design.

See the World Health Organization's Vaccination Coverage Cluster Surveys: Reference Manual (1) **Section 2.6** for more information on survey design.

### 2.6.1. An example for the design of a common serosurvey.

The following example is a survey design and sample size calculation to estimate measles and rubella seroprevalence after a national a measles-rubella SIA that targeted children aged 9 months to 14 years. The serosurvey is planned to be implemented two months after the SIA is completed.

#### 1. Define survey objectives

##### *Primary objective:*

To estimate the prevalence of antibodies to measles and rubella of the population among children in the age group that was targeted for the SIA (aged 9 months to 14 years at the time of the SIA; henceforth termed age 9 months to 14 years) at national level.

##### *Secondary objectives:*

- to estimate the seroprevalence of measles and rubella among the age group 15 to 39 years at national level;
- to estimate the proportion of children aged 9 months to 14 years who received MR vaccine during the SIA;
- to estimate the proportion of children aged 9 months to 14 years who had never received measles-containing vaccine before the SIA; and
- to compare the history of vaccination during the SIA and measles and rubella antibody prevalence after the SIA, among children with and without a history of previous measles vaccination.

## **2. Identify primary questions affecting survey design**

The primary objective is an estimation question. For the purposes of sample size calculations, the primary question is the prevalence of measles and rubella antibodies among children aged 9 months to 14 years. A descriptive comparison of SIA coverage and seroprevalence among children with and without a history of measles-rubella vaccination before the SIA will be performed but the study will not be designed to have sufficient power to detect a statistically significant difference between groups.

The prevalence of rubella antibody will be described by five-year age bands within the age range 15 to 39 years, and data will be used to model the force of infection among women of childbearing age. The survey will not be designed to have sufficient power to detect statistically significant differences between age bands or between men and women.

## **3. Define target population**

There are two strata for the survey:

- Children aged 9 months to 14 years at the time of the SIA
- Individuals aged 15 to 39 years

All individuals in the relevant age groups who spent the night in the households selected for the survey are eligible for inclusion, whether or not they were living there at the time of the SIA (but information will be collected about travel during the time of the SIA).

## **4. Set inferential goals**

- To estimate national seroprevalence of measles and rubella antibody among children aged 9 months to 14 years at the time of the SIA, with a 95% confidence interval of  $\pm 3\%$ , assuming an expected measles antibody prevalence of 81%.
- To estimate national seroprevalence of rubella antibody among individuals aged 15 to 39 years with a 95% confidence interval of  $\pm 5\%$ , assuming an expected seroprevalence of 85%.

## **5. Determine if existing survey data and serum samples may be used**

There were no serum samples available for use in this survey because the primary objective is to measure seroprevalence after the upcoming SIA.

## **6. Select survey design**

A national cross-sectional cluster sample household survey will be conducted to estimate the prevalence of measles and rubella IgG antibodies among persons 9 months to 14 years and 15 to 39 years of age. The methods recommended in the World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) will be used. The target number of 219 clusters (see table below) will be selected from a list of enumeration areas (EA), with their respective population size, to be obtained from the Census Office. Probability proportional to estimated size sampling will be used (see Section 3.6.5 of the World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual). In each selected EA, a first step of household listing will follow the procedures detailed in Section 3.6.6 and Annex F of the World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual. At each selected household, all individuals in the respective age ranges will be invited to participate.

## 7. Calculate sample size

To budget the survey accurately, a sample size that meets the inferential goals was calculated. Working with a sampling statistician is recommended, as is using the detailed information and calculation worksheets in the World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) Section 2.7 and Annex B1. The result of the calculation indicates the number of clusters to visit in every stratum and how many households to visit in each cluster to yield, on average, the target number of respondents per cluster. An example of sample size calculations for the objectives is shown in Box 2-2. For other designs including stratified surveys or other inferential goals see Section 2.7.1 of the World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual.

### 2.6.2. Note about probability sampling

To report seroprevalence estimates that are representative of the target population, it will be necessary for participants to be selected using a *probability sampling method* wherein:

- every eligible respondent has a non-zero chance of being selected into the survey sample; and
- the probability of selection can be calculated for those respondents who are selected.

These guidelines assume that the study population will be too large and geographically spread out for a simple, random sample. A cluster sampling design will be logistically feasible and economical and effective. See World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual Section 3.6.2 for detailed explanation of how to conduct a probability household survey including how to select clusters, how to map and enumerate households within the selected clusters, how to select households for the survey and how to ensure high quality survey implementation. Particular attention should be paid to ensuring that standard procedures are followed correctly at each step.

Once the sample has been selected, it is important that every household identified as part of the sample should be visited and revisited if no one is at home. The number of revisits should be clearly defined in the protocol and the outcome of every visit recorded. The protocol may indicate that every eligible respondent is to be interviewed (as in the example above), or there may be a selection process to randomly identify at most one eligible respondent per household. Precise and clear instructions should be provided to the field teams in situations of absenteeism, abandoned households, refusals (for interview and/or for provision of a specimen), not eligible individuals in the selected household, students living in boarding schools, etc. Below are some general instructions:

- Selected households should not be excluded because they are harder to reach.
- If nobody is at home at the selected household at the time of the interview, do not replace the household, but re-visit up to three times and document the result.
- If any selected member of the household is not at home at the time of the interview:
  - try to arrange a visit when the person is back home
  - revisit three times on different days or at different times and document the result
  - do not replace the selected person by any other household member.
- If a participant in one of the selected households is living in another household (e.g. with grandparents or relatives), do not include them in the list of eligible people for the selected household, since they can be eligible and selected from the household where they live.
- If the selected household is abandoned or is no longer a household (e.g. shop, office or business), do not replace this household. Document it on the household information sheet.
- If none of the household members is eligible, document this and do not replace the household.

- If participants agree to be interviewed but not to provide a specimen, complete the interview and indicate that a specimen was refused. In analysis, the demographics of those who did and did not provide a specimen will be compared to assess potential bias.

Although the survey sample size calculation uses a target number of completed questionnaires and blood samples per cluster, it is very important that the target number not be made known to the field data collection staff. This is to minimize the selection bias. These guidelines recommend against using a quota sample in which the team stops once a target sample size has been achieved in each cluster. Rather, the team should visit every household that was randomly selected and collect data from every household with eligible respondents, from all eligible participants in these households. As a result, survey teams will find different numbers of eligible respondents in different clusters. These differences will be accounted for using the survey sampling weights.



**Box 2-2: Example of sample size estimation: parameters required**

Parameter	Assumption	Rationale for assumption
Primary objective on which sample size based	Measles antibody prevalence among children eligible for the SIA	Specified in protocol. The number of participants in the older age group will be larger.
Target population size	5,201,904	Total population of the country is 25,009,153 22.8% of population is aged <15 years and 2% of population is aged <9 months
Anticipated measles antibody prevalence among children eligible for the SIA (p)	81%	Assume SIA reaches at least 90% coverage among the target population and vaccine effectiveness is 90% in this age group. Conservatively, we assume no prior natural or vaccine-induced immunity among children not vaccinated in the SIA.
Intra-cluster correlation coefficient (ICC)	1/6	Conservative assumption used from Annex B1.2 of WHO guidelines (14)
Design effect (DEFF)	2.5	Following step 3 and table C of Annex B1.2 of WHO guidelines (14)
Confidence level ( $\alpha$ )	5%	As is traditional, the confidence intervals for estimation will be calculated at $(100-\alpha)\%$ , or 95%.
Confidence interval (CI) half width	3%	This measures the precision of a coverage estimate. The 95% CI are to be no wider than $\pm 3\%$ (e.g. 95% CI (78%, 84%) hence this value is 3%.
Target number of respondents aged 9m-14 years per cluster (m)	10	Recommended in WHO guidelines (14). Higher numbers per cluster are less efficient.
Effective sample size	788	The sample size that would be needed if a simple random sample were taken – Annex B1, Table B-1 of WHO guidelines (14) (taking 80% seroprevalence from this table which is very close to our assumed 81%)
Expected participation rate including adequate serum sample collected	90%	Based on previous experience in serosurveys in the country (e.g. tetanus (18) or hepatitis B (26) serosurvey). If no previous experience, use a more conservative value like 80%.
Total sample size accounting for cluster design and participation rate	2189	$ESS * DEFF * 100/90$ See Annex B1.2 of WHO guidelines (14)
Target number of clusters per stratum (note, we have one single stratum)	219	Total sample size (2189) divided by m Only a single stratum – the national level
Expected # of households to visit to find a child aged 9m-14 years	1.2	See equations B1-1 and B1-2 of annex B1-2 of WHO guidelines (2); assumes birth rate 16/1000; infant mortality rate 39/1000; average household size = 4
Average # of households per cluster at which a child will be invited to participate	12	$=m*1.2$ Useful to plan the logistics of the survey

## 2.7. Minimize survey error

The sample size calculation helps ensure the results will have a defined level of precision to support subsequent action. Generally, larger samples yield greater precision or confidence in the serosurvey results. But other factors can cause survey results to be inaccurate and inappropriate for programmatic decision-making. These factors are known as sampling error and non-sampling error:

$$\text{Total survey error} = \text{Sampling error} + \text{Non-sampling error}$$

Sampling error refers to the inherent uncertainty that comes from basing conclusions on a sample instead of a census. Non-sampling error is everything else that might introduce uncertainty and includes:

- **Selection bias.** Occurs when the survey does not use a proper random sample, either because some of the target population is excluded from the sampling frame or because the respondent selection process is not entirely random (e.g. households with no one at home are replaced in the sample with those who are at home; field data collectors decide not to visit a portion of a cluster that is hard to reach; certain subgroup of the community refuses to provide a specimen). Selection bias can be reduced by selecting the sampling units (EAs, households or individuals) before starting fieldwork and obtaining excellent community participation to minimize refusal rates.
- **Information bias.** Occurs when responses are affected by factors that are systematically non-random (e.g. bias or variable sample processing or storage methods; field data collectors influence survey respondents).
- **Bias in laboratory data.** An important non-sampling error is the sensitivity and specificity of the laboratory assay(s) used. The assay's performance characteristics need to be taken into consideration when interpreting results. For recommendations about how to minimize this bias through careful selection of laboratories and assays: see **Section 4: Laboratory Methods** below.
- **Data transcription or data entry errors.** Careful training and supervision is needed to reduce errors when completing paper forms or entering data on digital devices and to ensure that labelling and identification of specimens is done accurately. A practical and reliable method to link data from interviews to laboratory results must be ensured.
- **Missing data.** If the reason that the data are missing is related to the outcome being studied, the results may be biased.

In addition to using an adequate sample size and selecting respondents in a disciplined, random and representative fashion, it will be important to spend resources to minimize non-sampling error. Training should be thorough and supervision during the fieldwork is very important. Training of supervisors should include opportunities to select only those who meet pre-specified performance standards by the end of training. Field teams should pilot the questionnaire and practice all steps with real interviews in non-selected EAs, to ensure the field data collectors ask questions in a standard and neutral manner. Practice should include:

- reading and explaining the purpose of the visit, procedures and benefits of participation
- obtaining the informed consent
- listing the eligible individuals within the household
- conducting random selection of the individuals within the household, if this is part of the protocol
- collecting the interview data
- use of the tablets or other devices
- recording geographic position system (GPS) coordinates when part of the survey protocol
- collecting, labelling and safely transporting the specimens
- recording in a computer database directly.

In addition to training field teams, laboratory teams need to be trained and relevant standard operating procedures (SOPs) developed for documenting the receipt of specimens, handling specimens, conducting assays and storing any remaining specimens.

Because it is difficult to detect survey error with any simple quantitative tests, it is advisable for the steering committee to draw up a list of all possible sources of error and plan to mitigate each. The quality plan will involve rigorous quality control with clear and consistent supervision and training and well-described protocols for the fieldwork, the laboratory procedures and data management. See World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) Section 7.2 and elsewhere (5) for additional information on how to reduce bias.

The quality plan should be drafted early and adhered to and deviations should be documented. When drafting the report, the authors will be able to describe the team's efforts to identify, mitigate and minimize biases. If the plans fail or if poor quality work is detected during implementation, appropriate steps can be taken to correct the data or to conduct sensitivity analyses to understand the possible consequences. The lengthy and substantial description of steps taken to ensure quality will persuade the reader that the team worked hard to address common biases and therefore the estimated prevalence figures and their confidence intervals may indeed shed clear light on the immunity profile of this population.

In cases where a series of quality problems cast strong doubts on the representativeness of the data, the best course of action is to document these honestly and clearly in the report so the reader is empowered to decide what is to be learned from the survey experience, data and results obtained and to judge the conclusion of the report independently.

## **2.8. Assess resources and timeline**

Serosurveys can be lengthy, resource-intensive activities. Adequate resources should be made available to ensure they are well managed and closely coordinated.

### **2.8.1. Assess timeline**

Research and plan for procurement timelines for all necessary supplies. These supplies may include electronic devices for data collection (such as tablet portable devices), field specimen collection supplies and laboratory test kits. If the survey must be done at a certain time, procurement should be done far enough in advance to avoid having to do fieldwork first and laboratory testing later.

Consider the timing of the survey in relation to other events. If the serosurvey objectives include the evaluation of a SIA, be sure to collect specimens when antibody levels to measles and rubella are likely to be highest, i.e. six weeks to six months after the SIA. Interview questions on whether or not the individual participated in the SIA are usually included. To reduce recall bias, the surveys should be scheduled within three months of the SIA. Sometimes the child's finger is marked with an indelible pen during SIAs for intra-campaign monitoring purposes. There may be a trade-off of waiting for maximum IgG levels but missing the ability to see finger marks.

Refer to World Health Organization Vaccination Coverage Cluster Surveys: Reference Manual (1) Table 2, Timeframe for a National Coverage Survey, for more details.

### **2.8.2. Assess available laboratory assets and capacity**

The serosurvey design and methods must consider the technical and logistical resources that are available. Conduct a thorough pre-survey assessment to identify and consider available laboratories capable of testing serosurvey specimens. The assessment of laboratories capable of performing testing to support the serosurvey should be conducted by a member of the serosurvey steering or

technical committee, or someone experienced in serosurvey design, planning and implementation, who has knowledge of specimen collection and laboratory procedures. A checklist could be developed to aid in this process.

The pre-survey laboratory assessment will identify and catalogue available public or private laboratories that potentially could participate in the serosurvey. During the assessment, gather information on costs for in-country staff time, equipment, supplies and other aspects of the serosurvey implementation such as training and logistics needed for specimen collection and transport as well as laboratory data management. Visit candidate laboratories and assess each laboratory's capacity to manage the number of samples expected according to the protocol. Assess the expertise and experience of the participating laboratory staff, available specimen storage-facilities, type and condition of testing equipment, electronic data management and accreditation status (ISO, WHO, national accrediting bodies). If there are sufficient suitable laboratories in the region, tendering for testing services may be considered. This approach will help identify and document testing service requirements and possibly deliver cost savings.

#### *Storage and transport*

If a laboratory at the district level has capacity, trained staff and freezer space, then centrifugation, aliquoting and storage can be conducted at the district level until the specimens are shipped to the selected laboratory for testing. Otherwise, establish a system for shipment to the selected laboratory under cold conditions based on the type of samples to be shipped: whole blood, centrifuged or aliquots of serum.

#### *Capacity development*

In many cases, it will be necessary to improve laboratory capacity and data management and build more advanced technical capability before a survey can be initiated. Training can be provided by the Global Specialized Laboratories and Regional Reference Laboratories of the Global Measles and Rubella Laboratory Network (GMRLN) if required. These specialized laboratories can provide electronic templates for setting up assays runs, collecting and analysing data, performing quality control and reporting results. New equipment may have to be purchased or existing equipment may need to be improved. For example, if microtitre plate enzyme immunoassays (EIAs) are used, the plate reader should be able to collect and store all of the assay data electronically without a need for manual data entry. Direct transfer of these data to a database for use in the survey may require purchase of computers and software that are compatible with the existing plate readers as well as providing training for local staff on electronic data collection and storage. Data storage and backup systems may also have to be purchased.

### **References for Chapter 2**

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