

white paper

Harmonizing vaccination coverage measures in household surveys: A primer

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Abbreviations

BCG, Bacillus Calmette–Guérin vaccine

CAP, computer assisted personal interview

CES, coverage evaluation survey

DHS, Demographic and Health Survey

DTP, diphtheria-tetanus-pertussis vaccine

EPI, Expanded Programme on Immunization

FBR, facility-based record

FVC, fully vaccinated child

FVC<1, fully vaccinated child by the age of one year

FVC<2, fully vaccinated child by the age of two years

fIPV, fractional dose of inactivated polio vaccine

HBR, home-based record

HebB-DP, Hepatitis B birth dose

IPV, inactivated polio vaccine

MCV, measles-containing vaccine

MDGs, Millennium Development Goals

MICS, Multiple Indicator Cluster Survey

MOH, Ministry of Health

OPV, oral polio vaccine

PAPI, paper and pencil interviewing

PIRI, Periodic intensification of routine immunization

RI, routine immunization

SDGs, Sustainable Development Goals

SIA, supplementary immunization activity

UNICEF, United Nations Children's Fund

USAID, United States Agency for International Development

VCQI, Vaccine Coverage Quality Indicators tool

WHO, World Health Organization

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1 Background [▲contents](#)

1.1 Purpose of this document [▲contents](#)

This white paper provides practical information related to the collection, processing, analysis, and reporting of vaccination coverage indicator data in household surveys. In doing so, the document focuses on:

- Vaccination coverage indicators that provide a perspective on immunization system delivery performance using survey data. The indicators can be used to help immunization programmes identify potential challenges that might need further study.
- Technical specifications for indicators and preferred practices that can be followed by all surveys to facilitate comparison of vaccination coverage indicator results across dimensions of place and time.

It is important to note that the vaccination coverage indicators in this document are focused on:

- Coverage indicators for vaccinations delivered through routine immunization (RI) services¹ rather than through supplementary immunization activities (SIAs)². Surveys to assess SIAs, such as campaigns, are out of the scope of this document. Post-SIA surveys require very specific timing vis-à-vis the completion of the campaign and therefore tend not to be suitable for inclusion within multi-domain household surveys.
- Measurement of vaccination coverage among children receiving vaccinations during the first and second years of life per recommended RI schedules.

This document will provide you with:

- A standard set of vaccination coverage indicators. We will point to accompanying documents that will provide additional detail on specifications, so you can code variables for analysis yourself. (If desired, there is also analytic software available to facilitate analysis.)
- Guidance on how to report the indicators and how to interpret them.
- A model set of vaccination-related survey questions to collect data for the indicators.
- Guidance on how to clean, interpret, and report the indicators (See [Section 6](#) of this White Paper and Section 5, 6 and 7 of [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1])

This document will not include guidance on adding questions related to knowledge, attitudes and practices, or barriers related to immunization. A separate working group is addressing questions related to demand and barriers.³

¹ Routine immunization services are delivered on a regular basis (e.g., daily, weekly or monthly) through a combination of in-facility, fixed site outreach and mobile team service delivery. During a routine immunization visit, children are screened for prior vaccine doses received, ideally based on the documented vaccination history in the home-based record (HBR) or in a facility-based record (FBR). Delivered vaccine doses are recorded on registers, tally sheets and HBRs. See [Annex 8](#) Differentiating vaccine delivery strategy.

² Supplementary immunization activities (SIAs) are characterized as mass vaccination events that aim to identify and vaccinate many children in a community during a short time period irrespective of past receipt of that vaccine, to increase population immunity to the target disease. SIAs complement but do not replace routine immunization. Although they are usually national, SIAs may be conducted locally in response to outbreaks or less often, targeted to subnational areas of a country that have been identified at high risk of transmission of the infection based on the epidemiology of disease and patterns of routine immunization access and utilization. SIAs are used as a key strategy in efforts to combat selected diseases including but not limited to measles, rubella, polio and yellow fever. In the past, vaccine doses delivered through SIAs were rarely documented as part of the delivery; however, this is slowly changing on recommendation from WHO so that all vaccine doses are recorded in HBRs or on a separate document given to show the vaccination given in the SIA [World Health Organization. *Planning and Implementing High-Quality Supplementary Immunization Activities for Injectible Vaccines Using an Example of Measles and Rubella Vaccines*. World Health Organization: Geneva, Switzerland, 2016. Available online: <http://www.who.int/immunization/diseases/measles/SIA-Field-Guide.pdf?ua=1>]. See [Annex 8](#) Differentiating vaccine delivery strategy.

³ For more information, email vpdata@who.int and use “White Paper” as the subject line

1.2 Target readers of this document [▲contents](#)

The intended readers of this document are survey planners / managers who are considering inclusion of vaccination coverage indicators either as part of a stand-alone vaccination coverage survey or a multi-indicator household survey. Because the document is aimed at groups planning and managing a household survey using probability sampling methods, we do not discuss sampling issues and the specifics of how to conduct a high-quality probability household survey; we refer readers to the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1] for these issues.

1.3 Brief history of vaccination coverage survey and document motivation [▲contents](#)

Vaccination coverage surveys are one of several available methods for measuring vaccination coverage [2]. From 1979 [3], the World Health Organization's (WHO) Expanded Programme on Immunization (EPI) has supported methods of immunization programme implementation and evaluation that are easily implemented and effective. Chief among these was the so-called EPI 30 x 7 cluster coverage survey, reviewed by Henderson and Sundaresan [4], that followed on survey work conducted during smallpox eradication efforts of the 1960s [5]. Following the first release of WHO guidance on methods for measuring vaccination coverage through surveys in 1979 [3], guidance was revised in 1991 [6] and again updated in 2005 [7]. With the goal of improving survey precision, accuracy and overall quality, WHO completed an extensive review and revision of vaccination coverage survey methods and materials, first as a working draft in 2015 and as a final version in 2018 [1]. The revision reflects recent approaches in conducting high quality probability household surveys, including those used by the United States Agency for International Development (USAID) supported Demographic and Health Surveys (DHS) [8], United Nations Children's Fund (UNICEF) supported Multiple Indicator Cluster Surveys (MICS) [9] and United Nations Statistical Division [10], all of which have been providing guidance on household survey methods using probability sampling methods for decades.

In the process of revising the coverage survey guidelines, reviews of survey reports (including those from EPI or vaccination coverage surveys⁴ and household health surveys that include immunization indicators) demonstrated several shortcomings, particularly with regards to survey sampling, coverage indicator definitions, survey questions and analysis and results presentation [11,12,13].

- **Coverage indicators are not always clearly or correctly defined or lack more standardized definitions.**
- **Survey questionnaires often do not use standard questions.**
- **Standard analyses are not conducted and do not make full use of available survey data.**
- **Survey results are not presented in a manner that appropriately conveys uncertainty nor that facilitates comparisons over place and/or time.** There is also often a lack of secondary analysis or contextualization that helps with decision-making based on the results of the survey.
- **Training procedures are rarely described.** When training is described, it is often clear training is insufficient to accommodate the increasing complexity of vaccination schedules, the various recording practices and types of documents with vaccination history as well as how to best probe to elicit caregiver recall about vaccination when documentation is not available.

There are standardized definitions of some vaccination coverage related indicators as well as pro forma questionnaires and presentation styles for results. However, expectations in these areas have evolved over time and previously have not been formally communicated. This document, alongside the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1], aims to address this gap.

⁴ Vaccination coverage surveys also have been referred to as EPI surveys or Coverage Evaluation Surveys (CES), often interchangeably. In this document we refer to vaccination coverage surveys.

2 Preparing for the survey [▲contents](#)

2.1 Visit the immunization programme [▲contents](#)

We encourage survey planners / managers to engage with the national immunization programme (NIP) or Expanded Programme on Immunization (EPI) staff in the country as early as possible in the survey planning and to help outline the review/feedback processes. Early engagement will enable you to better understand current and recent activity that may influence how you plan to collect and report on vaccination coverage data (see [Section 2.2](#)). The immunization programme staff, and their technical partners (e.g., the EPI Inter-Agency Coordinating Committee, the EPI Technical Advisory Committee, the WHO country office, National Bureau of Statistics), are a critical resource for planning the survey, assisting in training (e.g., training of your interviewers on the vaccination-related survey questions), analysis (e.g. pointing out which indicators may be most important to the programme), results reporting and interpretation. The more national immunization programme staff are engaged and understand the survey, the more likely it is that high quality data will be collected and that the NIP will trust and use results to improve their programme.

2.2 Gather immunization information for survey planning [▲contents](#)

Jointly, survey planners and immunization programme staff should consolidate information on the following items. This information will inform questionnaire design, survey planning, and interpretation of survey results for dissemination.

- *Information on recommended immunization schedules for the preceding three (3) years⁵*

The national immunization schedule establishes what vaccine doses children should receive. Information on the current national immunization schedule and changes that may have occurred in the preceding three (minimum) to five years is important for designing the survey questionnaire. In areas that border countries with a different immunization schedule, it may be important to incorporate the national immunization schedule for the regions in neighbouring countries that serve persons who cross borders to seek immunization services. Additionally, some countries have private sector or non-profit providers that constitute large portions of care-seeking including immunizations. Survey planners need to consider the value of including versus excluding private sector immunization schedules. For more information on the private sector, see [Annex 3](#).

- *Information on new vaccine introductions or changes during the preceding three (3) years⁴*

It is important for survey planners to be aware of new vaccine introductions during the preceding three to five years. The immunization programme will be able to inform you whether new vaccines were introduced uniformly across the country at a single point in time or introduced using geographic phase-in where children residing in some areas of the country received the vaccine before children in other areas. Any delays that occurred in distributing appropriate records on which to record the administration of new vaccines should also be noted.

⁵ This may need to be 4 or 5 years, depending on the population to be eligible for the survey. For example, if the survey targets children aged between 12 and 59 months, survey planners will need to be aware of immunization schedules and changes in the previous 5 years.

- *Copies of all home-based records (HBR) and health facility registers (FBR) used in the survey focus area during the preceding three (3) years⁴*

We will discuss sources of vaccination history in [Section 3](#). Briefly, Interviewers will ask mothers and/or caregivers (*Nota bene*: moving forward, we will refer to caregivers with awareness that mothers are often but not always the child's caregiver) to show HBRs to interviewers in order to obtain documented evidence of vaccination. Therefore, this is important to incorporate examples of HBRs into survey field team training. This requires collecting examples of all HBRs used to record vaccinations, including those used in the private sector and those given out during immunization campaigns. Similarly, if visits to health facilities are being considered, then examples of the registers used in the public and private sectors of different regions are needed to prepare training and to decide how productive such visits may be. For example, if HBR availability is 95% in a country, there may not be a need to include FBR in the survey design. If HBRs or FBRs have changed over time, it is important to collate all the versions that a survey team may encounter while conducting the survey. If records differ by region, it is important to collate a copy of each regional version.

- *Knowledge of the contribution of the private sector to vaccination.*

In some areas, vaccination is provided not only by the public sector but also by private health facilities. These health facilities might use a different vaccine schedule from that recommended by the national immunization programme and might use different recording practices.

- *Current standards/recommendations on location of vaccine administration*

Because not all caregivers will have a HBR documenting the vaccinations received by their child, it is often necessary to ask the caregiver to recall the child's vaccination history. Therefore, it is useful to know where specific vaccines are administered as a matter of practice in the country. For example, Country C recommends that diphtheria-tetanus-pertussis vaccine (DTP)-containing vaccine is administered in the left thigh, measles containing vaccine in the right upper arm, etc. This is very important to distinguish between injectable vaccines such as DTP-containing, inactivated polio vaccine (IPV), and PCV, or measles-containing and yellow fever or Japanese encephalitis vaccines may all be administered in the same visit, but in different thighs/locations.

For each of the vaccines noted in the national immunization schedule, it is useful for the survey planner to know the recommended administration (e.g., single intradermal injection at the insertion of the left deltoid) for each vaccine as well as any notes on compliance (e.g., good, fair, poor, unknown) related to administration practices in order to better design the questionnaire, particularly when probing for recall.

- *A detailed record of immunization campaigns/child health days/supplementary immunization activities including dates, antigens, geographic areas, and age groups targeted during the period of time for which children in the survey would have been eligible to participate in a campaign and if said campaign distributed vaccination records (e.g., for surveys of children aged 12-23 months, obtain details of these events 12-23 months before the survey date. For surveys of children under age 5 years, obtain details of these events in the 5 years preceding the survey date.).*

Information needed for survey analysis and reporting:

- *Knowledge of stock-outs of home-based records, health facility registers, vaccines or any components of the vaccine bundle (e.g., diluent, mixing syringes, syringes) during the preceding three years*

Information on vaccine or vaccine delivery related supply stock-outs can be important for the planning of the survey since interruptions in the supplies can impact immunization service delivery which is the focus of measurement. Card stock-outs also have important implications for survey monitoring. Furthermore, additional probing might be required to gather information around issues with last-mile distribution or sub-national stock-outs.

- *Knowledge of any serious adverse events related to vaccination, natural disasters or civil unrest or mass population displacement that might have interrupted or affected vaccination.*

For more information on survey planning, information gathering, and supervision, please see Section 2.10, 3.4, 3.8, and 4.3 of the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1].

3 Sources of information on vaccination [▲contents](#)

Vaccination history information is most often derived from two distinct sources: documented evidence sources and survey respondent memory recall (hereafter referred to as ‘recall’). We describe these in further detail below.

3.1 Documented evidence [▲contents](#)

Documented evidence of vaccination is the written and retained record of the administration of a vaccine and includes the vaccine dose administered and the date of service for the vaccination. In some settings the documentation also includes who administered the vaccine dose and where (i.e., health facility location) it was administered. In almost all instances, vaccination information from documented sources is preferred.

3.1.1 Home-based records

Home-based records (HBRs) — sometimes referred to as vaccination cards, child health books, well baby books — are a common source of documented evidence of vaccination. At the time of the survey, often at the beginning of the interview, the interviewer asks the respondent if she can provide any documents on which her child’s vaccination history is written. The interviewer might even use a visual cue for what is being requested by showing examples of the national HBR to the respondent. More recently, interviewers have made explicit requests for any documents with written vaccination history recognizing that HBRs officially issued by the government may have been damaged or stocked out, leading to the use of home-made, replacement HBRs. Some surveys have added questions to allow distinction between current officially issued HBRs and older HBR versions or non-official records. If one or more records are available, the interviewer will use the record(s) to transcribe relevant information on the child’s vaccination history including vaccination date information (day, month, year) or marked areas (perhaps a tick-mark, see [Annex 1](#)) indicating that a vaccine dose was received.

3.1.2 Health facility-based records

Health facility-based records (FBRs) are a second source of documented evidence of vaccination. As part of administrative RI information systems, health facility staff record each vaccine dose delivered within a facility record, often referred to as a register or registry. Ideally, these facility registers record the name of the child that received vaccination, perhaps alongside additional demographic details (e.g., date of birth) and/or a unique identification number, such that the child’s complete vaccination history can be recorded over time and the child can be followed throughout their life in the facility register. A complete FBR of a child’s vaccination history requires that several events occur:

- Either the child must visit the same health facility or outreach session each and every time they receive immunization services, **OR** vaccination registers must be interconnected across facilities as is the case in some electronic nominal immunization registry systems.
- The health facility staff must locate and search the appropriate register to find each child’s first line entry into the document/system and update that line entry rather than start a new line entry (some health facilities start a new page for each date of activity which makes it very difficult to track an individual child’s vaccination status).
- The child’s name or other identifying information must not change over time or mechanisms must be in place to allow for data entry updates and searching of updated data fields.

Perhaps not unexpectedly, the potential for problems are numerous. Children may not visit the same health facility for immunization services, or they receive RI services during outreach sessions that may not be recorded in a manner that updates the facility-based register. Health facilities have stock-outs of registers or may not have a safe, dry place to store them to protect them from damage. There are often delays to production and distribution of updated registers when new vaccines are introduced. The facility register may not be well organized to facilitate quick identification of a child's vaccination record. Health facility staff may feel overwhelmed and choose to start a new entry rather than update a prior entry. And, children's names may change as is the case in some communities during the first year of life, per local customs or traditions, thus the possibility for incomplete and/or duplicate records may be high in some settings. Each of these practical field realities create challenges for health facility trace-back exercises, thus, piloting this component of the survey may give useful information to decide whether to conduct facility trace-back and how to best proceed.

3.1.2.1 When should health facility-based records be sought?

When the HBR is not available, or is poorly filled (illegible or incomplete; not the standard HBR pre-printed document), survey planners / managers are encouraged to seek out evidence of vaccination from FBRs at the child's usual health care facility(s) [1]. Readers are encouraged to reference Section 3.7 of the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1] for additional detail.

For survey planners / managers considering whether to include a facility trace-back exercise for those children without a HBR or where the information in the HBR is not clear, there are several things to consider during planning. These include:

- What is the likely proportion of children with HBRs available to show? (based on recent surveys and pre-survey information gathered – See [Section 2.2](#))
- What is the feasibility of gaining access to health facility records, records from volunteer health workers who may have recorded births and early vaccines, and private providers if they provide an important proportion of vaccinations in the country (see [Annex 3. Awareness of vaccination in the private sector](#))?
- What are the additional units of staff time needed?
- What are the logistical issues, including vehicles and drivers to get to health facilities, usual field team or specific trace-back team, additional training time that may be necessary?
- What is the best question/prompt to identify the child's usual place / source of immunization services? Should the "last place of vaccination" be used?
- What permissions need to be obtained from caregivers and the health facilities to gain access to FBRs?
- Should my field teams assigned to facility trace-back exercises have copies of official letters from the Ministry of Health in addition to any pre-approval letters from facility directors?
- How long will it take to identify, find and transcribe or make photos of the FBRs? This may vary by the age of the child as the FBRs from older years may be stored in difficult-to-access places or not exist at all.
- How will the child identification number and the survey form be linked to the data collected, often extemporaneously, in health facilities?

Unfortunately, at present, little formal guidance is available to help immunization programmes decide whether to add facility trace-back exercises to a vaccination coverage survey. However, gathering answers to the questions above is necessary. In addition, both the UNICEF-supported MICS and the USAID-

supported DHS programmes have included facility trace-back exercises in some of their survey work and may be a valuable resource.

In spite of the concerns above, it is important to keep in mind, that although facility trace-back exercises require additional time and therefore expense, the contribution of additional documented evidence of vaccination may be worthwhile, particularly in settings where the likely proportion of children with HBRs is low (below 80%) and where facility registers are available and organised by name rather than by date of visit. For example, in a DHS in Ethiopia in 2016, only 34% of children had data from HBRs, but an additional 23% of children had documented evidence from a health facility [14].

Complementary Data Quality Activity Using Facility Traceback

In some surveys the visit to the health facility has been used to obtain other related immunization information as a complementary activity. For example, comparing the number of doses between tally sheets and monthly reports as well as assessing some qualitative aspects of the recording, reporting and archiving practices such as those recommended in data quality self-assessments [15] and data quality reviews [16], or even to get qualitative interviews with facility staff on vaccination practices. Combining a survey facility trace-back with data quality related activities may make the visits to health facilities more worthwhile and cost-effective, but one must ensure that the main objective of the activity, i.e., identify and transcribe vaccination data from selected children is not compromised [13].

3.1.3 Additional considerations when collecting data from HBRs / FBRs

There are many nuances that arise when dealing with documented sources of vaccination, and it is impossible to predict whether any of the specific situations described below will arise in your survey. It is, therefore, extremely important to be well prepared and communicate with the national immunization programme in the planning phase of the survey. Additional considerations are described below.

- **Border crossing to seek services may introduce new HBRs.** Survey planners / managers must keep in mind that caregivers may take their child across borders into a neighbouring country to receive vaccinations. These caregivers may keep HBRs from other countries either in addition to or in lieu of the country conducting the survey. Thus, it is important to obtain copies of the HBRs from the neighbouring country as well. The local WHO and UNICEF country offices, where relevant, can facilitate this collection.
- **Vaccination recording practices vary across providers.** Survey planners are encouraged to visit points of vaccination to review health worker recording practices that may be relevant for survey field teams involved in date of vaccination abstraction from HBRs or FBRs. Local practices may include writing the date of next visit in pencil and then writing the date when the vaccine dose is actually administered in pen, with or without erasing the pencil date. In some areas, health workers may use different columns in the record to indicate the expected return date. Visits to points of vaccination will also be helpful to decide whether or not to include attempts to obtain health facility documents for children without a HBR. This is the case in validating doses via outreach, for example, where a register may not be used during the outreach session and/or where data are transferred subsequently after the outreach session to the register that is left at the facility. See [Annex 4](#) on data abstraction for further information.

- **Multiple providers exist in urban settings.** Checking FBRs may not be feasible in urban settings, because caregivers might seek immunization services from multiple sites. It is likely that the child will only be registered at the first provider and countries might have weak systems for cross- sharing of immunization data between facilities.
- **Documented sources of vaccination are not free of error.** It is important to note that although documented evidence of vaccination is preferred, home- and facility-based records are also subject to errors.
 - The information in the records may have been mis-recorded for a variety of reasons ranging from casual errors to intentional falsifications.
 - Survey respondents may provide interviewers the incorrect HBR for the child being asked about.
 - Finally, it is possible that vaccinations may be recorded in the HBR or FBR without having been administered and conversely, vaccinations that were administered were not recorded.

At this time, no data on the added cost of conducting facility trace-back are available. Costs are likely to vary significantly across settings. Furthermore, the additional costs must be considered vis-à-vis the proportion of documented vaccination evidence to be gained.

3.2 Respondent recall [▲contents](#)

When the HBR is not available for the interviewer to see at the time of survey, WHO recommends that vaccination coverage surveys ascertain vaccination history for the child from the survey **respondent's recall**. There is concern regarding how well respondents correctly recall from memory which vaccines and how many doses for recommended multi-dose vaccines were received by their child [17]. This concern is believed to be amplified today compared to prior time periods as a result of the increasingly complex recommended infant and childhood RI series [18,19].

4 Questionnaire for collecting vaccination coverage data [▲contents](#)

One of the most important components of any vaccination coverage survey is the design and development of sound questions that accurately measure the event, experience or behaviour of interest and the organization of those questions to form the survey questionnaire that constitutes basis for all collected information.

4.1 Vaccination coverage survey questionnaire considerations [▲contents](#)

The following are key considerations for any (vaccination coverage) survey questionnaire.

- Customize based on local immunization program information
- All proposed forms to be used in a survey should be field tested, ideally in different parts of the country and/or in areas predominantly served by the private or the public sectors before finalization.
 - Survey managers should conduct a mock survey and pilot the questionnaire prior to upcoming national coverage survey.
- Surveys should have clearly written questions, accurate translations and specified skip patterns, AND proper layout to avoid compromising the integrity of the survey questionnaire
- For every vaccine dose for which a vaccination date is recorded from a HBR and/or FBR, there must be corresponding vaccination history recall question(s).
- Questionnaire design should facilitate both the interviewers task to gather information and the respondent's task to provide information.
- Questionnaire design should facilitate data entry. For paper forms, there should be adequate form space for survey field staff to record each answer clearly and to cross-out mistakes and record the correct answer next to it. and to write legibly so that data entry staff can easily read it
- Questionnaire order matters. The ordering of questions especially when skip patterns are included can impact findings of a survey.
- Survey abstraction form design for vaccination dates. To facilitate field data abstraction from the HBR, survey planners are encouraged to model the order of vaccine doses in the survey form as closely as possible to the order of vaccine doses in the HBR. If for some reason a HBR is not organized in some form of chronological order, it may make sense for the flow of questions to proceed from those received at birth towards those received later. Also, be aware of the terminology used to refer to vaccines in the HBR and mirror this as much as possible in the survey form. Finally, local terminology used to refer to a HBR should be reflected in the survey questionnaire and verbal prompts.
- The challenges of differentiating the mode of vaccine delivery, RI from SIA, are essential for questionnaire design. There may be recommendations in some settings to document SIA doses separate from RI doses on HBR. This has particular implications for the calculation of the fully vaccinated child coverage indicator (FVC) discussed in [Section 6.3.3](#).

When using computer-assisted personal interview (CAPI) software, a new set of issues may arise. Readers are encouraged to refer to Chapter 4 and Annex I in the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1] for a discussion on using electronic tools for data collection.

Whether using paper-and-pencil interviewing (PAPI) or CAPI, it is important to train survey field staff to avoid forcing respondents into an answer and forcing themselves into recording an answer when the respondent genuinely provides a response of “unsure” or “I do not know”. For example, respondents may be unable to recall how many doses of a particular vaccine the child received. If there is no option for surveyors to record “do not know” or “unsure”, or, if using CAPI, the interviewer cannot proceed through the interview without

recording a number value, the surveyor may be forced to “impute-on-the-fly” or make-up an answer. This should be avoided.

4.2 Model vaccination coverage survey forms [▲ contents](#)

A set of model vaccination coverage survey forms is available online at https://www.who.int/immunization/monitoring_surveillance/routine/coverage/en/index2.html. In developing these forms, considerations were given to the survey questions used by DHS and MICS. The following forms will be found at the link above:

- Household listing form
- Household member form
- Routine immunization form for collection of vaccination coverage data

Included in the forms are proposed instructions for the collection of photographs of HBRs and FBRs as well as for facility-trace back exercises.

Additional supporting documents to accompany the model vaccination coverage survey questionnaires will be available at the web link.

5 Training for the Survey [▲contents](#)

Training procedures were identified as another area for improvement in vaccination coverage surveys, however this aspect will not be covered in this White Paper, as it is well described in Section 3.9 and Annex G of the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1]. A brief inclusion on the importance and key aspects of training are noted below.

Key Participants:

- EPI staff
- Survey supervisors
- Interviewers

Tools:

- Schedule and site of administration in country
- Local terms for diseases/vaccines
- Copies of all HBRs and FBRs used in the survey focus area during the preceding three (3) years

Supervision:

- Regular supervision and data quality checks should be done during the survey data collection period. Some key process monitoring indicators like “% HBR by team” should be collected.

Questionnaire Interviewers should be trained on the following:

- *Classroom and piloting (field practice)* using mock questionnaires and practice interviews to model the interview flow.

Training materials and exercises developed for difficult data collection situations (i.e. missing data, don't know, multiple doses recorded per line of HBR, new vaccines missing from HBR, etc)

Distinct questions for RI vs SIA should be included for polio, measles, rubella, and any other doses provided through campaigns during relevant timeframe for survey target age

- *Data entry and collection for the questionnaire.*

Of utmost importance to the collection of vaccination history from a respondent's recall are well trained interviewers and well structured, specific questions that are clearly understood and accompanied by appropriate and exhaustive responses (e.g. Yes, No, Don't Know, Refused, including a “don't know” option for number of doses for multi-dose vaccines). Readers are encouraged to visit Section 3.9 and Annex G of the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1].

- *Prepare for the unexpected.* It is important to prepare interviewers for the unexpected, which is admittedly difficult to do. Scenarios that have arisen in the past include:
 - HBRs and registers may be damaged and information on vaccination history lost as a result [20].
 - Records in use may be older versions that do not include fields for newly introduced vaccines for which the child was eligible; recordings may take place in the margins.

- Records, particularly facility registers, may not separate different vaccines across columns if the vaccines are recommended at the same age, regardless of whether one or all vaccines recommended were simultaneously administered.
- The facility registers at health facilities conducting regular outreach for vaccination services may be disproportionately incomplete or have data entered in an outreach register or section separate from the facility-based register.
- HBRs and facility registers may contain check marks rather than dates, or a single date may be written across several vaccines.
- SIA doses might be recorded on a separate HBR. Interviews should ask for all documentation and record accordingly.
- Handwriting in the HBR and FBR may be illegible impacting on the interviewer's ability to transcribe dates of vaccination.
- Errors may occur due to survey staff transcription errors or misinterpretations of unclear information on the HBR or facility record.
- When photographs of documented evidence are available, reference to those images during data cleaning and analysis is at least possible, an exercise that cannot be conducted with respondent recall.

Most important, however, is for survey planners / managers to empower the field teams to tell their field supervisors that vaccination history information written on the HBR / FBR was unclear. Experience highlights instances where survey field team staff assumed that a child received an undocumented vaccine dose because other vaccine doses recommended at the same time were received and documented. Such situations are problematic and avoidable with good training and by providing the field staff with ways to relay their uncertainty based on the information in front of them. **Survey staff should transcribe the evidence for every vaccine recorded in the HBR just as it is observed.** Nothing more, nothing less.

NOTE: The [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1] (see Section 3.4.5) provides guidance on collecting photographs of HBRs and/or FBRs to facilitate data cleaning and field work monitoring as well as general advocacy with those concerned about results). A standard operating procedure [21] for handling such imaging was produced and shared from a vaccination coverage survey conducted in Bolivia in 2013, though additional practical field guidance is needed [22].

6 Descriptions of key vaccination coverage indicators [▲ contents](#)

Monitoring the performance of immunization systems requires the use of well-defined vaccination coverage indicators. Vaccination coverage indicators⁶ provide information on how well an immunization programme is reaching its target population. Immunization indicators are included in monitoring the Sustainable Development Goals (SDGs) [23] and they were also a part of the Millennium Development Goals (MDGs) [24]. Immunization indicators also serve a critical role in the monitoring of immunization specific strategic activities at the international level through the Global Vaccine Action Plan [25], regional level through regional action plans [26] and national level.

Vaccination coverage indicators differ several dimensions, including:

- **Crude versus valid vaccination coverage:** Whether the vaccine doses provided are likely to be immunogenic.

Crude vaccination coverage reflects all doses received by the child—those doses may or may not be immunogenic (i.e., able to produce a biologic immune response) depending on whether the dose was administered before the recommended age or earlier than the minimum accepted interval. In contrast, *valid vaccination coverage* reflects vaccine doses that are considered most likely to be immunogenic, based on respecting timing in the national schedule (age and minimal interval between doses).

- **Timing of vaccine dose delivery.** How the vaccine coverage indicator reflect disease risk:
 - Crude vaccination coverage by time of survey;
 - Crude vaccination coverage by 12 months of age for vaccine doses recommended before the first birthday;
 - Crude vaccination coverage by 24 months of age for vaccine doses recommended between the first and second birthday.

For vaccine doses recommended before the child's first birthday, those received after the first birthday leave the child at risk of disease for longer than those received before the first birthday (i.e., by 12 months of age). Thus, high coverage levels for vaccination recommended and received before the first birthday are likely to have greater impact on disease than late vaccinations received after the recommended age – but remember, better late than never! This data also provides critical information about the strength of the RI system and program quality. If many children are immunized prior to 9 months for measles, that is a programmatic gap.

- **The source of evidence of receipt of vaccine doses.** In most vaccination coverage surveys, evidence of vaccination is based either on documented sources (e.g., HBRs, HFRs) or, in the absence of documented evidence, on information provided by the respondent based on memory alone (i.e., recall).

In this section, we will briefly describe the vaccination service delivery performance indicators that are desired from any household survey including vaccination coverage. A listing of these indicators is provided in [Table 1 and Table 2](#) and some of them are further discussed below. Additional indicators are listed in [Section 6.7](#). See Table 4 in [Annex 13](#) for an example table of recommended indicators. **Detailed definitions and technical specifications for each indicator are available in the WHO document *Vaccination Coverage***

⁶ We define an indicator as a specific, observable and measurable characteristic that can be used to identify change or monitor progress that a programme is making toward achieving a specific outcome.

Quality Indicator Working List of Vaccination Survey Analyses and Software Specifications, which is available online www.biostatglobal.com/VCQI_resources.html

Recommended vaccination schedules are specific to each country and are available from the national immunization programme (see [Section 2.2](#)). In addition, the WHO compiles key information on routine immunization schedule recommendations for immunization programme managers found here: http://apps.who.int/immunization_monitoring/globalsummary/schedules. The tables are available online at http://www.who.int/immunization/policy/immunization_tables.

Table 1. Vaccination coverage indicators recommended in household surveys

Crude / Valid (likely elicits an immunological response)	Timing	Source of evidence	Weighted analysis*
Crude vaccination coverage	by time of survey	based on documented evidence**	Yes
	by time of survey	based on respondent recall	Yes
	by time of survey	based on the combination of documented evidence and respondent recall	Yes
Fully vaccinated (“basic antigens***”) coverage	by time of survey	based on the combination of documented evidence and respondent recall	Yes
Never vaccinated (with any of the basic antigens) coverage (by RI or SIAs)	by time of survey	based on the combination of documented evidence and respondent recall	Yes
Never vaccinated (with any of the basic antigens) coverage (by RI only)	by time of survey	based on the combination of documented evidence and respondent recall	Yes
Valid vaccination coverage (based on specified age and minimal interval between doses)	by time of survey	based on documented evidence	Yes****
HBR system performance			
HBR ever ownership	by time of survey	based on the combination of documented evidence (HBR) and respondent recall	Yes
HBR current ownership	by time of survey	based on documented evidence (HBR)	Yes

* See [Section 7.1](#) for a discussion on weighted analysis and the Vaccine Coverage Quality Indicators tool (VCQI). Weighted analyses are meant to provide an estimate that is generalizable to the entire population, whereas, unweighted analyses are used to describe the sample. No global consensus exists; however, WHO currently proposes not to weigh indicators that include only a subset of the sample.

** Documented evidence includes that identified in home-based records (e.g., vaccination card, child health book) and/or facility-based records

*** Six basic antigens include BCG vaccine, 3 doses of DTP-containing vaccine, 3 doses of polio vaccine excluding the birth dose, one dose of measles containing vaccine (MCV).

Valid coverage indicator is weighted if the denominator includes all persons in the survey sample, i.e., sum of weights for all respondents. If the denominator is restricted to those with documented evidence available, then the valid coverage indicator is not weighted.

Table 2. Numerators and Denominators for Key Weighted* Vaccination Coverage Indicators

Indicator	Numerator	Denominator
Crude vaccination coverage by time of survey based on documented evidence	Sum of weights for all respondents identified in the denominator who received the specified vaccine dose(s) by documented evidence (HBR or FBR) by any date prior to the survey	Sum of weights for all respondents in the sample in a defined target population
Crude vaccination coverage by time of survey based on respondent recall	Sum of weights for all respondents identified in the denominator who received the specified vaccine dose(s) by only recall by any date prior to the survey	Sum of weights for all respondents in the sample in a defined target population
Crude vaccination coverage by time of survey based on the combination of documented evidence and respondent recall	Sum of weights for all respondents identified in the denominator who received the specified vaccine dose(s) by either documented evidence (HBR or FBR) or recall by any date prior to the survey	Sum of weights for all respondents in the sample in a defined target population based on the combination of recall and documented evidence
Fully vaccinated (“basic antigens”) coverage	Sum of the sample weights for all respondents who received all recommended vaccine doses for the basic six antigens**, by the time of the survey	Sum of weights for all respondents in the sample in a defined target population
Fully vaccinated (“current national schedule”) coverage	Sum of the sample weights for all respondents who received all vaccine doses according to the national schedule by any date prior to the survey	Sum of weights for all respondents in the sample in a defined target population
Never vaccinated (with any of the basic antigens) coverage	Sum of the sample weights for all respondents who received none of recommended vaccine doses for the basic six antigens, by the time of the survey	Sum of weights for all respondents in the sample in a defined target population
Valid vaccination coverage by time of survey based on documented evidence	Sum of the sample weights for all respondents in a defined target population who are vaccinated where the doses followed the earliest recommended age <u>and</u> minimum interval between doses	Sum of the sample weights for all respondents in a defined target population
HBR ever ownership	Sum of the sample weights for all respondents who say they have ever received a HBR for the child by the time of the survey	Sum of weights for all respondents in the sample in a defined target population
HBR current ownership	Sum of the sample weights for all respondents who for whom a HBR is readily available to be seen by the time of the survey	Sum of weights for all respondents in the sample in a defined target population

* Weighted. See [Section 7.1](#) for a discussion on weighted analysis and the Vaccine Coverage Quality Indicators tool (VCQI).

**Six basic antigens include BCG vaccine, 3 doses of DTP-containing vaccine, 3 doses of polio vaccine excluding the birth dose, one dose of measles containing vaccine (MCV).

6.1 Recommended vaccination schedules [▲contents](#)

As a survey planner / manager, it is important to be aware that childhood vaccines are administered by trained health professionals according to recommended schedules that specify when vaccine doses should be administered, including the **minimum age** a child should receive a vaccine dose as well as any relevant recommended **minimum intervals between vaccine doses**. These two concepts will be important to define valid doses to calculate valid coverage indicators.

For most vaccines, there is no maximum age recommended for a vaccine dose to be valid. An exception is Bacillus Calmette–Guérin, or BCG, vaccine, which is usually not recommended beyond the first year of life. Also, the *birth dose* of hepatitis B vaccine and polio vaccine have a maximum age. For hepatitis B birth dose, even though it is most effective when administered within 24 hours after a child's birth, policies on the maximum age vary by country. The birth dose of oral polio virus (OPV), or "polio zero", recommended in polio-endemic countries and in countries at high risk for importation and subsequent spread of poliovirus, is to be administered at birth, or as soon as possible after birth, but policies on the maximum age also vary by country. When rotavirus vaccine was first recommended, there were age limits for the first and last vaccine dose; however, current recommendations (though still encouraging timely administration) do not limit the age for rotavirus vaccination [18].

6.2 Crude vaccination coverage [▲contents](#)

In its most general form, **crude vaccination coverage**, by time of survey, refers to the percentage of children who are vaccinated against one or more specified vaccine preventable diseases by any date prior to the survey. For example, crude coverage for the first dose of DTP-containing vaccine among children aged 12-23 months at the time of the survey refers to the percentage of children aged 12-23 months who received a first dose of DTP-containing vaccine by the time of the survey. Thus, the vaccine may have been received on time at 6 weeks of age as recommended, or it may have been received early or late. This indicator can be subdivided according to the source of evidence of vaccination that is accepted – see Table 1.

The denominator for all crude vaccination coverage indicators described in Table 1 and in more detail below is the sum of the sample weights for those children of survey respondents⁷. Children included in the defined target population will be included in the denominator irrespective of whether they have any information contributing to the numerator of the indicator. Use of the term 'crude' implies that any vaccination is considered towards the numerator, regardless of whether the recommended minimum age and recommended intervals between doses were respected (see [Section 6.5](#)).

Children with a "do not know" response from the respondent's recall or with unknown evidence of vaccination for a vaccine dose are included in the denominator but are not included in the numerator. Excluding children with "do not know" or unknown values from the denominator introduces a bias, or a distortion, into the estimated vaccination coverage. This can be avoided by including all children in the denominator. Additional denominator related notes are provided in [Annex 2](#). For a detailed description of technical specifications on this coverage indicator, visit the Vaccine Coverage Quality Indicators tool (VCQI) Interpretation and Quick Reference Guide at www.biostatglobal.com/VCQI_resources.html.

⁷ The 2018 WHO Survey Reference Manual recommends that crude coverage be calculated as a weighted measure, so both the denominator and numerator will technically be sums of weights rather than counts of respondents. They represent, respectively, the estimated number of eligible children in the population (not the sample) and the estimated number of vaccinated children in the population.

6.2.1 Crude vaccination coverage by documented evidence

Crude vaccination coverage by documented evidence refers to vaccination coverage based only on evidence of vaccination obtained from a document (HBR and, in some surveys, HFR), by time of survey.

It is important to understand that crude vaccination coverage by documented evidence includes only children in the numerator who were identified as being vaccinated based on documented evidence. If a child did not have documented evidence of vaccination but only had evidence based on respondent recall, then the child is not counted in the numerator for this indicator.

It is also important to note that crude vaccination coverage by documented evidence cannot be greater than the percentage of children with HBRs or FBRs. That is, if 50% of children had documentation of vaccination, then crude vaccination coverage by documented evidence could not be greater than 50% and that would only occur if all children with documentation also received the specified vaccine dose for which coverage was being estimated.

6.2.2 Crude vaccination coverage by respondent recall

Crude vaccination coverage by respondent recall refers to vaccination coverage based only on evidence of vaccination obtained from a respondent's recollection from memory alone (i.e., by recall) by time of survey. In contrast to above, the crude vaccination coverage by recall indicator includes only children in the numerator who were identified as being vaccinated based on the respondent's recall. Documented vaccine doses are not counted in the numerator for this indicator. Usually, this indicator is only reported and interpreted alongside the crude vaccination coverage by documented evidence and used as a component of the crude vaccination coverage by any source (see below).

In general, caregivers are only asked whether a particular vaccine-dose was received if the vaccination is not recorded on the HBR or if the HBR is not available at the time of the survey. A discussion of sources of vaccination is detailed below in [Section 3](#) that highlights current concerns of the relevance of respondent recall of a child's vaccination history given recent increases in the recommended number of vaccines, some of which require multiple doses.

6.2.3 Crude vaccination coverage by documented evidence and recall (any source)

Crude vaccination coverage by documented evidence and respondent recall refers to vaccination coverage based on the combination of documented evidence and respondent's recall by time of survey. For this indicator, the numerator includes children who were identified as being vaccinated based on the combination of both documented evidence and respondent recall.

If the same denominator is used for all three crude vaccination coverage indicators (i.e., by documented evidence, by respondent recall, by documented evidence and recall), as it should be, then crude vaccination coverage by the combination of documented evidence and recall is equal to the sum of crude vaccination coverage by documented evidence and that by recall.

Crude coverage with HBR + Crude coverage with recall = Crude coverage with HBR and recall

6.3 Fully vaccinated coverage indicator [▲contents](#)

As recommended immunization schedules have changed since the beginning of the Expanded Programme on Immunization (EPI), so too have the national immunization schedules used in countries. In fact, there have been dramatic changes from the “basic” (original) six antigens used to define a fully vaccinated child in the early 1980s: BCG vaccine, 3 doses of DTP-containing vaccine, 3 doses of polio vaccine excluding the birth dose, one dose of measles containing vaccine (MCV). New vaccines have been added, while some vaccines have been retired. Not surprisingly, the fully vaccinated coverage indicator has evolved as well.

To enable immunization programmes to compare current achievements with past performance in reaching children with the full complement of infant vaccines, programmes may want to measure and report the percentage children who are of fully vaccinated with the “basic” (original) six EPI antigens noted above. In addition, to enable immunization programmes to assess current achievements in reaching children with the full package of recommended vaccines including new vaccines, programmes are also encouraged to measure and report the percentage of children who are received all recommended vaccine doses *per the national immunization schedule* in use at the time children in the survey were infants (i.e., 0-11 months of age).

Further considerations are described below in [Section 6.3.3](#). For a detailed description of technical specifications on this coverage indicator, visit the VCQI Interpretation and Quick Reference Guide at www.biostatglobal.com/VCQI_resources.html.

6.3.1 Fully vaccinated (basic antigens) coverage indicator

The **fully vaccinated (basic antigens) coverage indicator** refers to the percentage of children who received all recommended vaccine doses for the basic six antigens, by the time of the survey. These often include: BCG vaccine, 3 doses of DTP-containing vaccine, 3 doses of polio vaccine excluding the birth dose, one dose of MCV. The numerator for this indicator is defined as sum of the sample weights for those children of survey respondents (same as the denominator identified in the crude vaccination coverage indicator, see [Section 6.2.3](#)) who received all of the specified basic vaccine doses by any date prior to the survey. We recommend presentation of the fully vaccinated coverage indicator by the combination of documented evidence and recall.

6.3.2 Fully vaccinated (according to national schedule) coverage indicator

The **fully vaccinated (according to national schedule) coverage indicator** refers to the percentage of children who received all recommended vaccine doses according to the national schedule, by the time of the survey. The numerator for this indicator is defined sum of the sample weights for those children of survey respondents (same as the denominator identified in the crude vaccination coverage indicator, see [Section 6.2.3](#)) who received all vaccine doses according to the national schedule by any date prior to the survey. We recommend presentation of the fully vaccinated coverage indicator by the combination of documented evidence and recall. No matter which vaccines are included, it is a good practice to include a clear definition of the vaccine doses included in the construction of this indicator when presenting the results.

6.3.3 Fully vaccinated coverage indicator considerations

There are several issues to consider when measuring the proportion of FVC:

- Because there is often a lag between the time of vaccine introduction and the point at which new vaccine coverage reaches levels similar to those of established vaccines, programmes are often reluctant to include new vaccines into their fully vaccinated indicator definition.
- It may take time to start using the most updated recording forms and new HBRs that include the new vaccine, causing difficulties in determining whether the vaccines were given and not recorded due to lack of space in the document or the form, or were not administered.
- For vaccines introduced in the recent past, the survey target pop will be a heterogeneous group of those eligible and not eligible to receive the new vaccine (i.e. some children aged 12-23 months may not have been eligible while others would have been eligible for a new vaccine introduced 18 months prior to the survey). Programme reluctance to use this indicator is driven by how the indicator is measured whereby the proportion of fully vaccinated children cannot be greater than the lowest vaccination coverage level of its individual component vaccines. To avoid low coverage levels related to new vaccine introduction, coverage surveys are encouraged to wait one-, perhaps two-, years beyond the introduction of a new vaccine before including a new vaccine in the fully vaccinated (according to national schedule) indicator definition.
- Uptake of recommended vaccines in the second year of life often falls behind coverage levels for vaccines in the infant series.
- Differentiating the mode of vaccine delivery, RI versus SIA. Until such time that robust mechanisms are in place to facilitate and ensure the ability to differentiate, *it is recommended that all doses be considered towards the fully vaccinated indicator*. (See [Annex 7](#) for additional information on SIAs). For example, consider a child who is 18 months of age and received their first dose of measles containing vaccine (MCV1) through a measles campaign seven months prior (when the child was 11 months) but who has no evidence of receiving measles vaccine through routine service delivery. In most coverage surveys, if evidence of vaccination was obtained in a HBR or FBR, then we would assume the vaccine dose was received through RI services; if evidence of vaccination was obtained from respondent recall, then we would not know whether the vaccine dose was received through routine services or a campaign. In such a situation, the child's measles dose should, nonetheless, be counted in the numerator alongside their other vaccine doses towards being fully vaccinated.

Although the final decision on how to define the fully vaccinated coverage indicator depends in part on the goal of the survey and priorities for Ministry of Health (MOH) and/or EPI, by presenting the fully vaccinated coverage indicator using both definitions described above (according to national schedule and with “basic vaccines”), programmes maintain the ability to compare performance achievement from the beginning of the programme as well as the ability to identify shortcomings in performance related to the introduction of newer vaccines or vaccine doses.

6.4 Never vaccinated coverage indicator [▲contents](#)

The **never vaccinated coverage indicator** refers to the sum of the sample weights for those of children who received none of the recommended vaccine doses specified in the fully vaccinated coverage indicators described above. For definitional purposes, the listing of vaccine doses used in the fully vaccinated coverage indicators are utilized again in defining the never vaccinated indicator. The numerator for the never vaccinated indicator will include those children for whom there is no indication of receiving the vaccines specified in the fully vaccinated coverage indicators, either in documented evidence or by respondent recall.

Depending on the survey questionnaire and survey aims, the never vaccinated indicator may reflect that a child never received vaccine doses through RI service delivery or may reflect that a child never received

vaccine doses of any kind through RI or SIAs. As noted in [Section 6.3.3](#), it is critical that clear definitions are provided as to how the indicator is being defined.

For a detailed description of technical specifications on this indicator, visit the VCQI Interpretation and Quick Reference Guide at www.biostatglobal.com/VCQI_resources.html.

6.5 Valid vaccination coverage [▲contents](#)

Valid vaccination coverage refers to the proportion of children in a defined target population who are vaccinated where the doses followed the earliest recommended age and minimum interval between doses are counted in the numerator. Valid vaccination coverage is an important programme performance measure because vaccine doses received earlier than recommended or received with inappropriately short intervals between doses may result in a suboptimal immune response to the vaccine. Again, it is important for the survey planner / manager to obtain information that details the recommended minimum age for each vaccine and minimum interval between vaccine doses in the national schedule, values that most often are derived from WHO recommendations provided in vaccine position papers [18]. See [Section 6.1](#).

Valid vaccination coverage calculation requires knowledge of the child's birth date and the vaccination date for a specific vaccine dose. Vaccination coverage surveys do not ask respondents to recall dates of vaccination because there is a high probability of recall error. Thus, valid coverage is based on date evidence obtained from documents such as HBRs or HFRs and only considers valid dates. **Thus, this coverage indicator is only recommended when the availability of documented vaccination evidence is high, for example, at least 80% among the survey sample.** A discussion of documented evidence sources is provided in [Section 3](#). See [Annex 1](#) for considerations when dealing with date values.

In computing valid vaccination coverage, the appropriate denominator to be used for generalizable valid coverage indicator results is the sum of the sample weights for those children of survey respondents, exactly the same as that described above for crude vaccination coverage ([Section 6.2.3](#)). We want to know the percentage of all children (the denominator) that received a valid dose, and we will only obtain a generalizable estimate of this measure if we have documented evidence for all (or nearly all) respondents.

If survey analyses restrict the denominator for valid coverage to those with documented evidence only, then it is important to note that the analysis result is representative of only those with documented evidence, a group that may be different from those without documented evidence in ways that are associated with greater uptake of vaccination and other primary care services. Thus, restricting the denominator of valid vaccination coverage to those persons with documented evidence means that the conclusions should only be generalized to the portion of the population who have documented evidence.

For a detailed description of technical specifications on this coverage indicator, visit the VCQI Interpretation and Quick Reference Guide at www.biostatglobal.com/VCQI_resources.html.

6.5.1 Valid vaccination coverage analysis considerations

The survey report must describe what is meant by a “valid dose”. Each of the following parameters, underlined below, should be clearly defined for each vaccine dose according to the national immunization schedule.

- a) The minimum age of eligibility for the dose.

- b) The maximum age of eligibility for the dose (if relevant).
If the schedule specifies a maximum age of eligibility, then the child must be within the allowable age range when they received the dose.
- c) The minimum interval between doses.
If the dose is number 2 or 3 (or higher) in a multi-dose sequence, then the minimum interval must have passed since receiving the earlier dose, so the child was eligible to receive the next dose.

As highlighted above, the valid coverage indicator requires complete data (day, month and year) on birth date and dates of vaccination. Dates of vaccination in documents are not always perfect – they may be incomplete (e.g. missing the day or illegible). Recommendations for dealing with date values are described in [Annex 1](#).

Analysis should also document how valid doses later in a multi-dose series are considered. For example, if the first dose of DTP-containing vaccine is administered early, and the second dose is administered 4 weeks later, then the second dose is used to give credit for a valid first dose of DTP-containing vaccine.

Finally, a survey protocol may specify that vaccination date evidence be sought in facility-based registers for all children OR only for those children without a HBR. If the former option was taken and a vaccination date for a given child is available from both documents and both dates disagree, then if either source indicates that the vaccine dose was valid, then the child is credited with receiving a valid dose. If dates from both sources are unusable, we recommend converting the documented evidence to “tick-marks” as described in [Annex 1](#); observations with tick-mark evidence cannot contribute to the numerator of valid coverage indicators. The report should be clear on how data were analysed.

6.6 Home-based record monitoring indicators [▲contents](#)

HBRs play an important role in immunization service delivery [27]. With the shift towards a life-course approach to immunization, HBRs are increasingly being needed beyond infancy; for example, proof of vaccination at school entry is now required in some countries. Because the functional role of HBRs is compromised if the document is not available for distribution and appropriately utilized and retained, it is important for immunization programmes to be able to identify challenges to the HBR system. To this end, immunization programmes are encouraged to monitor HBR ever ownership (i.e., the proportion of children who have ever received a HBR or “ever HBR ownership”) as well as HBR current ownership (i.e., the proportion of children for whom a HBR is readily available to be seen). Both indicators are available through surveys when appropriate questions are included in the survey.

For a detailed description of technical specifications on this coverage indicator, visit the VCQI Interpretation and Quick Reference Guide at www.biostatglobal.com/VCQI_resources.html.

6.7 Additional immunization system performance monitoring indicators [▲contents](#)

In addition to the coverage indicators noted above, immunization programmes may be interested in the following immunization system quality performance indicators described in the WHO EPI cluster survey reference manual section 6, the [VCQI Interpretation and Quick Reference Guide](#), and the Pan-American Health Organization ([PAHO](#)) [Tools for Monitoring the Coverage of Integrated Public Health Interventions](#) Module 6. The indicators include:

- Identified clusters with alarming low coverage
- Drop-out between two vaccine doses (i.e. Dropout rate between 1st and 3rd doses of pentavalent vaccine)
- Crude vaccination coverage by 12 or by 24 months of age (this coverage indicator is only recommended when the availability of documented vaccination evidence is high)
- Percentage of vaccine doses that were invalid
- Timeliness of vaccination
- Percentage of vaccine doses administered before a specified age, e.g., “too early” to elicit the desired immunological response⁸
- Percentage of visits during which there was a missed opportunity for simultaneous vaccination
- Percentage of children with a missed opportunity for simultaneous vaccination
- Potential valid coverage had there been no missed opportunities for vaccination
- Number of additional visits needed to be fully vaccinated (basic antigens / according to national schedule)

⁸ See WHO recommendations for routine immunization - summary tables. Available at: http://www.who.int/immunization/policy/immunization_tables

7 Reporting vaccination coverage indicator data [▲contents](#)

The focus of this section is to highlight several key points for survey planners / managers to be aware of as they work alongside the analytic team to decide what the survey report should include and how results should be presented. We do not discuss presentation specifics as there are numerous books and online resources for data visualization principles.⁹

7.1 Survey weights [▲contents](#)

In a household coverage survey that uses a probability sample, every child that lives in a household is eligible to be selected into the sample, and they have a non-zero and quantifiable probability of being selected. But, not all households, and therefore not all children, are selected; only a sample of households are selected and the identified caregiver is interviewed. Each completed interview respondent, and their children, is assigned a survey weight that is proportional to the overall population that is being represented by that respondent and their child. The survey probability is the product of probabilities of selection at each stage of the survey i.e. strata, cluster, household, or individual.

When we discuss indicators, the definitions of numerators and denominators will differ depending on whether the calculation is unweighted or weighted. If an indicator is unweighted, then each respondent contributes a value of “1” to the denominator if they are part of the sample used to calculate it. The respondent contributes a value of “1” to the numerator if they have the outcome of interest and a 0 if they do not. For unweighted analysis, the denominator is the total number of respondents included and the numerator is the sum of respondents with the outcome of interest.

$$\text{unweighted indicator} = \frac{\text{Sum of all individuals with the outcome of interest}}{\text{Sum of all individuals in the sample}}$$

If the indicator is weighted, different respondents will have different survey weights based on their probability of being selected to the final sample. Each respondent contributes a value equivalent to their survey weight to the denominator. If the respondent has the outcome of interest, they will contribute their survey weight to the numerator; if they do not have that outcome, they will contribute a value of “0” to the numerator. So, after summing, the denominator is the sum of weights for the respondents eligible for the calculation and the numerator is the sum of weights for persons in the denominator who had the outcome of interest.

$$\text{weighted indicator} = \frac{\text{Sum of weights of all individuals with the outcome of interest}}{\text{Sum of weights of all individuals in the sample}}$$

Reasonable people can disagree on the nuances of how survey weights should be calculated or of which measures should be weighted or unweighted. It is important for a survey report to be clear about how the calculations were done. It is also very important that the overall sample design is well described including a description of the weight calculations of probabilities.

⁹ We encourage the reader to refer to work by Tufte [28,29,30] as a starting point. Other references include those by Few [31], Cairo [32] and Robbins [33].



IMPORTANT NOTE

For many years, vaccination coverage surveys, particularly the EPI 30 x 7 cluster surveys, have been analysed using statistical methods and software analysis programs that assume the respondents each have the same probability of selection and that there was no replacement of respondents who were not at home or refused to be interviewed. In fact, these assumptions were probably never true.

The revised [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1], acknowledges that each sampled individual will not have an equal probability of selection and some who are selected will not be available or cooperative. Therefore, it is both important and necessary to:

1. Conduct a weighted analysis, to avoid a biased estimate of coverage, and
2. Account for the survey sampling design and weights when calculating confidence intervals.

See Section 6.2 of the [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1].

Confidence interval formulas

Furthermore, earlier guidance and practice has used a symmetric Wald-type confidence interval [7], but for estimated proportions, an asymmetric interval, like the survey-modified logit interval or Wilson interval, is a better interval for several reasons. First, it never calculates a confidence bound below 0% or above 100%. And second, it is more likely to contain the true population level coverage figure than the Wald interval [34]. The [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1] recommends reporting a survey-modified Wilson interval, which will be symmetric and similar to the Wald if the sample size is very large, or if coverage is 50%, and will be appropriately asymmetric when the sample size is modest or coverage approaches 0% or 100%. If estimated coverage is exactly equal to 0% or 100%, the logit and Wilson intervals are not defined, but the analyst can calculate a Clopper-Pearson confidence interval, with no adjustment for survey design. (Because if estimated coverage is 0% or 100% then the estimated intra-cluster correlation coefficient is 0 and the design effect is 1.)

7.2 Standard results presentation [▲contents](#)

Our aim is to highlight several key considerations for survey planners / managers as they prepare to report vaccination coverage indicators. And, while we do not aim to be too prescriptive with regards to results reporting, we believe the following are desired elements for any survey report presenting vaccination coverage indicator results. A sample results table is provided in [Annex 13](#).

- a. **Present a sample survey table** describing the sample and how it compared to what was planned:
 - Response rates
 - Refusals
 - Any areas/clusters excluded from selection

- Whether inaccessible were replaced after selection (not recommended)
 - Source and date of sampling frames for cluster and household selection
 - Socioeconomic demographics compared to national census
- b. **Present the survey sample size.** Ideally, the survey report presents the weighted and unweighted sample size for each vaccine dose for which coverage is reported.
- c. **Present crude vaccination coverage indicators, by time of survey (see Table 1).** Ideally, crude coverage is presented as a percentage for each of the vaccine doses in the national immunization schedule:
- by documented evidence in HBRs or FBRs (if available);
 - by respondent recall;
 - by the combination of all sources of evidence (e.g., HBR + recall / HBR + facility + recall).

If it is necessary to include a reduced set of vaccination coverage indicators, we recommend that the reduced set include BCG, first and third doses of DTP-containing vaccine and MCV1.

Be aware that for multi-dose antigens, coverage for the 1st vaccine dose should be greater than or equal (\geq) to that for subsequent doses due to vaccine drop-out. If vaccination coverage for dose 2 or dose 3 exceeds that for dose 1, then it is necessary to go back and verify the field work recording, data entry and/or analytic code.

Also, because the same denominator is used for coverage ‘by documented evidence’, ‘by recall’ and ‘by the combination of sources’, the sum of vaccination coverage results for these categories should equal that of ‘by the combination of all sources’.

$$\text{Crude coverage with HBR} + \text{Crude coverage with recall} = \text{Crude coverage with HBR and recall}$$

Estimated vaccination coverage by HBR should not be greater than the percentage of children with a HBR seen. Similarly, estimated vaccination coverage by FBR should not be greater than the percentage of children for whom a FBR was found.

- d. **Present valid vaccination coverage as a percentage for each vaccine dose in the national immunization schedule (see Table 1).**
As a rule of thumb when reviewing results, valid vaccination coverage should be less than or equal to (\leq) crude vaccination coverage for a given vaccine dose combination.
- e. **Present fully vaccinated child (FVC) coverage indicators (see Table 1).**
It is critical that in reporting fully vaccinated coverage, the survey report must include the recommended immunization schedule used in the country at the time the survey sample was eligible for vaccination and the vaccine doses used the “fully vaccinated” coverage indicator definition(s), including how campaign doses were treated.
- f. **Present the never vaccinated coverage indicator according to the national immunization schedule (see Table 1).**
- g. **Present the percentage of children who ever received a HBR (ever-ownership indicator) as well as the proportion with HBR seen by the survey field team (current HBR ownership indicator). (see Table 1)**

Cumulative coverage by age plot

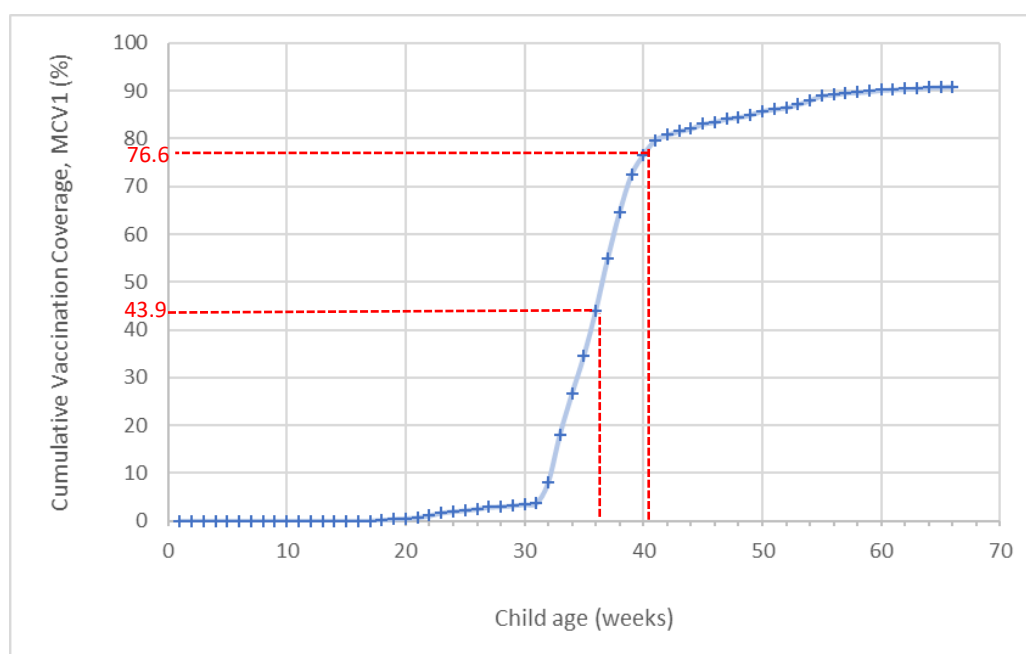
It is also useful to generate cumulative vaccination coverage plots by age of child. Cumulative coverage by age plots are visual representations of the cumulative percentage of children vaccinated across discrete age groups, often measured in days, weeks or months. These plots allow one to readily identify the cumulative percentage of children vaccinated by a given age, for example, the percentage of children that received their first dose of measles containing vaccine by 40 weeks of age. It is important to note that these cumulative coverage by age plots are for documented coverage, and can only be interpreted meaningfully if HBR availability is very high.

The plot is constructed by first calculating the percentage of children receiving a specified vaccine for discrete age groups, e.g., up to and include 1 week of age; 2 weeks of age; 3 weeks of age, etc. A running total of vaccination coverage is then obtained across each discrete age group as shown in the table below. Coverage values are then plotted on the y-axis against the corresponding age value on the x-axis.

For example, if we are interested in knowing the percentage of children who received their first dose of measles-containing vaccine by 40 weeks of age, we can simply draw a vertical line at 40 weeks along the x-axis and identify the corresponding value (i.e., 76.6%) on the y-axis. We can also see the percentage of children with MCV1 who received the dose before the recommended age of 36 weeks (43.9%) on the y-axis.

Example table. Cumulative vaccination coverage for measles containing vaccine from birth through 66 weeks of age by age for children aged 12-23 months at the time of survey with dates of vaccination from documented evidence

Age (weeks)	coverage, MCV1 (%)	cumulative coverage, MCV1 (%)	Age (weeks)	coverage, MCV1 (%)	cumulative coverage, MCV1 (%)
0 (birth) – 17	0	0	42	1.1	80.8
18	0.2	0.2	43	0.8	81.6
19	0.2	0.4	44	0.5	82.1
20	0.1	0.5	45	1	83.1
21	0.2	0.7	46	0.4	83.5
22	0.4	1.1	47	0.7	84.2
23	0.6	1.7	48	0.3	84.5
24	0.3	2	49	0.5	85
25	0.2	2.2	50	0.8	85.8
26	0.3	2.5	51	0.4	86.2
27	0.4	2.9	52 (12 months)	0.3	86.5
28	0.1	3	53	0.7	87.2
29	0.2	3.2	54	0.8	88
30	0.3	3.5	55	1	89
31	0.2	3.7	56	0.2	89.2
32	4.3	8	57	0.4	89.6
33	10.1	18.1	58	0.1	89.7
34	8.5	26.6	59	0.2	89.9
35	7.9	34.5	60	0.3	90.2
36	9.4	43.9	61	0.1	90.3
37	10.9	54.8	62	0.1	90.4
38	9.7	64.5	63	0.1	90.5
39	7.9	72.4	64	0.2	90.7
40	4.2	76.6	65	0.1	90.8
41	3.1	79.7	66 (15 months)	0.1	90.9



In the documentation that accompanies the results presentation, it is important to include a clear description of:

- The target population and denominator(s) used for indicators (see [Annex 2](#) and [Annex 6](#)).
- How imperfect date values were handled (see [Annex 1](#)).
- How missing values, 'do not know' and 'unsure' responses are handled in the analysis (see [Annex 1](#)).
- How tick-mark evidence of vaccination was handled (see [Annex 1](#)).
- Whether valid and "timely" vaccination coverage indicators were produced for all observations or only those with documented evidence (see [Section 3.3.1](#)).
- How vaccine doses received in the private sector were considered (or not) (see [Annex 3](#)).
- What steps, if any, were taken to differentiate vaccine doses received through RI versus those received through SIAs (see [Annex 7](#)).
- The national immunization schedule used as a reference for the survey and any impacts on vaccination coverage indicator definitions (see [Annex 8](#)).
- Steps taken to facilitate differentiating orally administered (see [Annex 9](#)) polio virus vaccine (see [Annex 10](#)), rotavirus vaccine and vitamin A.
- Steps taken to address identification of the birth dose of hepatitis B (see [Annex 13](#)).
- How photographs of documented evidence were used in data entry and/or data cleaning (see [Section 4](#)).
- Which formula or approach was used to calculate confidence intervals.
- Discussion of survey limitations
- Discussion of extraneous circumstances that might impact interpretation of survey results or decision-making (i.e. knowledge of stock-outs of home-based records, health facility registers, vaccines or any components of the vaccine bundle e.g., diluent, mixing syringes, syringes during the preceding three years)

7.3 Standard age groups to report [▲contents](#)

As a general rule, for vaccinations recommended up to 12 months of age, survey planners / managers are encouraged to report vaccination coverage indicators on the cohort of children 12-23 months of age at the time of the survey. This group of children reflects the most recent system performance of infant immunization (see [Annex 6](#)). Increasingly, national immunization schedules include vaccine doses recommended at older ages and the selection of the appropriate cohort(s) for analysis has been problematic. The simple rule is the following:

- For vaccine doses recommended between 0-11 months, report coverage on the cohort of children aged 12-23 months.
- For vaccine doses recommended between 12-23 months of age, report coverage on the cohort of children aged 24-35 months.
- For vaccine doses recommended between 24-35 months of age, report coverage on the cohort of children aged 36-47 months.

Usually vaccination coverage is not reported for children <12 months because several observations may be censored before the child would have been eligible to receive a vaccine and also to account for delayed vaccination. However, if vaccination data has been collected for children aged <12 months, including a coverage indicator for this age group may be considered. For example, one could calculate coverage for BCG, polio and DTP-containing vaccines among children 14 weeks to 11 months, where 14 weeks of age is the

recommend age for the third doses of polio and DTP-containing vaccines, i.e., most low and middle-income countries. However, this indicator would have to be interpreted with caution as delayed vaccination is common and several of the children who had not received these vaccines at the time of survey may receive them before their first birthday.

7.4 Reporting disaggregated or stratified results [▲contents](#)

There is increasing interest in studies of disparities in immunization service delivery [35]. The steps required to conduct a stratified analysis or secondary analysis to examine differences in vaccination coverage across different groups or sub-population characteristics are beyond the scope of this document. There are numerous resources available online to help guide such analyses. However, it is important to acknowledge the importance of such analyses for decision making based on the results of the surveys, especially to implement equitable immunization strategies. When information on household and/or individual characteristics are available (e.g., household wealth, caregiver occupation / education, religion, race, ethnicity, caste, vaccination by public vs private provider, etc), we encourage presentation of stratified coverage results if there are enough respondents in each group to support the calculation. The [2018 WHO Vaccination Coverage Cluster Survey Reference Manual](#) [1] suggests that results should perhaps not be presented for sub-groups if the estimation has fewer than 12 so-called *degrees of freedom* (see Section 2.15 of [1]). This recommendation is consistent with guidance from the US Centers for Disease Control for analysis of their National Health and Nutrition Examination Survey (NHANES).

Finally, we would like to acknowledge the importance of summarizing the survey findings in a brief, concise narrative description that accompanies the results tables and graphs. We encourage survey planners to develop preliminary analyses with an immunization technical advisory group. See [Annex 13](#) on sample table layouts to best communicate results in a standardized manner.

8. References [▲ contents](#)

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Annex 1 Dealing with date values and tick mark evidence [▲contents](#)

- [Data processing considerations for date values](#)
- [Data quality reporting concerning dates and evidence of vaccination](#)
- [Data processing considerations for interrupted or out-of-sequence vaccine dose information with multi-dose vaccines](#)
- [Data processing considerations for tick mark evidence of vaccination](#)
- [Data processing considerations for tick mark evidence of vaccination and determinations of valid doses](#)

Data processing considerations for date values

Computation of valid and age-appropriate vaccination coverage indicator measures requires complete and accurate information for date of birth as well as date of vaccination. Thus, coverage estimates and trends in such levels may be affected by misreporting of ages, dates of birth and of vaccination. Challenges in these data values are known to exist requiring careful attention to age and date data during data cleaning and processing.

Careful attention is required when working in non-Gregorian calendar dates. In such situations, it is possible that dates may need to be converted to a Gregorian calendar as part of the date data processing prior to analysis.

Date of birth considerations

When considering birth date data collected in a survey, attention should be given to ensure the following for each child record in the survey dataset.

- Each child has a single birth date that has been identified as appropriate for date-based age-at-vaccination calculations, or they do not.** There may be four or more sources of date of birth for a child (one given during listing of household members, one given by the caregiver in the vaccination module, one copied from the HBR and one copied from a facility-based record). If the sources agree, simply proceed. If the sources disagree, an algorithm will be needed to identify which value to use in the analysis. The following algorithm is recommended:
 - If across all sources of date-of-birth there is a single month value, a single day value, and a single year value, and if the date formed by these values falls in the window that makes the child eligible for the survey, use that date.
 - If there are multiple dates that do not agree, use the date of birth that appears most often and falls in the window that makes the child eligible for the survey. If there are more than one possible date of birth and no date appears more often than others, use the earliest of them that falls in the window that would make the child eligible for the survey.
- b. The birth date is on or after the earliest birth date for respondents to be eligible for this survey;
- c. The birth date is on or before the latest birth date for respondents to be eligible for this survey
- d. The birth date is a complete (not partial) date;
- e. The birth date is a real date and not a nonsensical combination of numbers like February 30 or April 31.

Date of vaccination considerations

For dates of vaccination, attention should be given to ensure the dates of vaccination for each observation is clean, meaning:

- a. Each vaccine dose has a variable for the recorded clean date of vaccination from each documented source. Thus, if HBRs and FBRs are used, then there should be two variables for each vaccine: one for recording the date from the HBR and one for recording the date from the FBR.
- b. Each vaccination date occurs on or after the earliest possible birth date for eligibility in this survey;
- c. Each vaccination date occurs on or before the final date of survey fieldwork;
- d. Each vaccination date occurs on or after the child's date of birth;
- e. Each vaccination date is complete (not partial);
- f. Each vaccination date is a real date;
- g. Dates for a vaccine sequence (DTP1, DTP2, DTP3) occur in order such that the date for the first dose precedes the second and third (if available) doses and that for the second follows the first while preceding the third (if available).

See Table 4 of Module 6 of the [PAHO Tools for Monitoring the Coverage of Integrated Public Health Interventions](#) for step-by-step instructions on determining non-sensical dates for vaccination in a survey.

Even when teams are well trained, and work is conducted with emphasis on careful transcription of the evidence of vaccination, a small number of dates will likely be recorded that are not complete or nonsensical or are clearly too early or too late to be true. These dates should be retained in the survey dataset, but in the analysis, they should be replaced with a tick mark. If the only evidence for a dose is from an incomplete or impossible date, the dose will be counted in the indicators for crude coverage (we have evidence that the child received the dose) but will not be included for date-based analyses (we do not know when they received it).

Most datasets will include very few bad dates, so the analysis will not suffer from converting them to ticks. If there are a lot of partial dates or bad dates, then one must ask whether the dataset is of high enough quality to warrant date-based analyses. For some tasks, some analysts may wish to impute values for partial dates. The analyst should describe clearly how the imputation is done, and in the datasets that are shared, it should be clear what was the evidence recorded by the survey, and what was the value imputed. In other words, the imputation should not prevent other analysts from understanding what was recorded by the survey team. The imputations should be documented and reversible for purposes of sensitivity analyses – See [Annex 5](#) for further details on handling missing data.

Data quality reporting concerning dates and evidence of vaccination

One hallmark of a well-run vaccination programme is the availability of clear, consistent and complete evidence of vaccination. If HBRs are not available and FBRs are not well organized, it may be likely that coverage and timeliness are also sub-par. If documented records hold a lot of partial dates and ticks, there may be a training opportunity or a flag to dig deeper into the quality of documentation and the quality of the survey fieldwork. It can be helpful to produce a set of tables to document the number of dates recorded and how many of them conformed to expectations and how many did not.

An analytic coding package exists that can produce an optional report listing:

- Number of respondents for whom HBRs were seen; recall data was recorded; facility-based records were found;
- Number of dates recorded (by source);
- Number and percent of dates that were complete, made sense and fell in the survey-eligible window;
- Number of partial dates;
- Number of nonsensical dates;
- Number of dates in a dose sequence that were out-of-order;
- Number of tick marks;
- Number of children with a date-of-birth appropriate for date-based vaccination calculations;
- Number and percent of vaccination dates that occur before the child's date of birth or after the survey date;
- When several sources of vaccination are recorded for the same children, the report calculates the percent of records where the sources agree (HBR agrees with recall; HBR agrees with facility-based record; recall agrees with facility-based record).

The elements of these tables give the analyst a sense of the quality of the dataset. If the data appear to be of poor quality, the tables cannot reveal whether the problem lies with the HBRs and FBRs or whether it lies with poor transcription, but the tables can serve as a starting point for additional scrutiny. If photographs were taken of HBRs and FBRs then the first step is to look at the photographs of source documents to exclude problems with survey field work.

Data processing considerations for interrupted or out-of-sequence vaccine dose information with multi-dose vaccines

If dates in a sequence of doses are out-of-order, it probably indicates a data entry problem. If the HBR or FBR was photographed, look carefully at the photo and correct the dates if possible. If there are no photos available, or if the source document does indeed list dates out-of-order, then the originally recorded dates should be preserved in the dataset. But, in the analysis, those dates should be converted to tick marks. In such cases, credit will be given for crude coverage, but not for valid coverage nor for other date-based analyses.

The next section further discusses data processing considerations for tick mark evidence of vaccination history.

Data processing considerations for tick mark evidence of vaccination

Documented evidence of vaccination most often includes recorded dates of vaccination but may also include so-called 'tick' marks. These marks are recorded by health workers indicating that the child received a given vaccine dose, but they do not provide information on the date of vaccination. Doses recorded with ticks receive credit in the numerator for crude coverage, but not for valid coverage nor for other date-based analyses. If tick marks are common, it would be a good idea to ascertain why. If the survey collects photos of HBRs and FBRs, the photos can be used to be sure that field data collectors are not recording ticks instead of dates as a time-saving measure.

Data processing considerations for tick mark evidence of vaccination and determinations of valid doses

If any of the doses in a series are recorded with a tick mark, it is recommended for that child to be excluded from the numerator of valid coverage or other date-based indicators for any of the doses in that series.

Annex 2 Denominator related notes [▲contents](#)

As primary care interventions go, childhood vaccination coverage indicators are relatively easy to define in as much as the population in need of the intervention most often includes **all** children. A survey to measure infant (i.e., children aged 0-11 months) vaccination coverage will sample children aged 12-23 months of age at the time of survey to capture the youngest annual cohort of children who should have completed the vaccination schedule. And, because all children should receive the recommended vaccines, the total number of sampled children aged 12-23 months at the time of the survey should be eligible to capture vaccination history from. For those vaccines recommended during the second year of life (i.e., 12-23 months), the vaccination coverage indicator denominator will normally include all children aged 24-35 months. In contrast, some older surveys calculated coverage for vaccines recommended at, or close to, 12 months, among children aged 18-29 months. However, the 2018 WHO Survey Reference Manual [1] advises to calculate coverage for those vaccines among children aged 24-35 months in this instance.

Care must be taken to document decisions made with regards to identified children and whether they are eligible to be included in the survey sample and thus in the coverage indicator denominator. For example, some surveys may capture information on foster children and orphans in a household as well as the respondent's biological children. In other surveys, only children born to the woman being interviewed are included. Some surveys may not distinguish between biological and non-biological children of the respondent. Surveys may collect information for all age-eligible children in the household while others may randomly select one child or purposively select the youngest age-eligible child.

Surveys may incorporate strict definitions on residency status of the child in the household. For example, “de jure” residence in practice refers to whether the child is a “usual” resident of the household. “De facto” residence refers to “actual” residence, or “slept in the household last night”. Others may require that the child has resided in the household for the past month or past six months. The 2018 WHO Survey Reference Manual does not recommend restrictions related to residency status (see section 1.4 of the Reference Manual).

It is most important that the children eligible to be included in the survey sample is clearly documented in the survey report.

Annex 3 Awareness of vaccination in the private sector [▲contents](#)

Throughout many low- and middle-income countries, immunization service delivery systems are characterized by predominant public financing and service delivery. However, greater attention is being directed toward how public and private sectors can work together to address the challenges confronting immunization service delivery.

As the private sector contribution expands, vaccination coverage surveys will need to be aware that an increasing percentage of children in the survey sample may have received vaccination from a private, rather than a public, health provider. This is important to take into account for several reasons.

- **Private health providers may utilize different vaccines than the public sector.** This may impact the survey questionnaire as well as survey team training and abstraction activity.
- **Private health providers often issue their own home-based record rather than use the officially issued government record.** From a training perspective, it is best if survey field staff are familiar with different HBRs from which they may abstract vaccination histories.
- **Immunization programme may desire information on use of private providers for immunization services for planning purposes.** Again, there may be an impact on the questionnaire, perhaps a need to collect information on the type of provider used for each vaccination, *which would be difficult if not impossible*, or the type of provider used for the most recent vaccination received.

Be aware that, depending on the country, the national immunization programme may or may not be well connected with the private sector. Additional efforts may be needed to connect with professional societies or other organization that represent private sector health providers.

Annex 4 Considerations for vaccination history data abstraction [▲ contents](#)

We purposively do not discuss survey field implementation detail in this document with the exception of practices related to vaccination data collection. However, experience has demonstrated the need for a few notes of caution for survey planners / managers with regards to the collection of vaccination history from home-based records (HBRs) and/or facility-based records.

We noted in [Section 3](#) that it is important for the survey planning process to include the collection of as many different forms of HBRs that survey field teams may encounter while in the field. This includes records distributed by the public sector, private sector and NGOs that may provide services. These different forms should be incorporated into the pre-survey field training work.

It is important to collect not only vacant HBRs without information recorded in them, but also images of records that have been completed to review frontline health worker recording practices. Remember that survey field teams will be abstracting information from the HBR; as such, it is important for the field team staff to become as familiar as possible with the different nuances of health worker recording practices.

For example, although not a preferred practice, some health workers may record a single vaccination date across columns or rows for multiple vaccines administered on that date (see image below). The preferred recording practice is to record the date of vaccination next to each vaccine dose administered.

Vasina / Idade	Wainhira moris	Semana 6	Semana 10	Semana 14	Fulan 9
BCG	06/15	X	X	X	X
DPT	X	17/	14/	13/	X
Hepatitis B	X	8	9/	015	X
Polio	06/15	15	15	10	X
Sarampo	X	X	X	X	9/4/16 + 1PV

5,1 kg

kapsula vitamina A doze boot
leta lumbriga doze seluk

Image source: World Health Organization. Results of a digital image review and assessment of home-based record durability and recording practices. Published December 2016. Available at: <https://www.technet-21.org/en/library/main/download/file?fid=83.4779>. Accessed 2018 March 26.

In areas where a new vaccine has been introduced, there are often delays for revised HBRs with the new vaccine dose recording area to reach health facilities for distribution. Moreover, health workers often lack time to copy a child's vaccination dates from the old HBR onto one of the new HBRs; instead they often

improvise and write the dates for newly introduced vaccines in the old HBR margins or in clinical notes pages. In some settings, separate sheets of paper are used by health workers to record dates for new vaccines and those extra papers may not be attached (or *stay* attached) to the HBR. In the image above, IPV, a newly introduced vaccine in this country, is recorded in the margin next to the recorded date of vaccination for measles containing vaccine.

Annex 5 Considerations handling for missing or ‘do not know’ values in data processing [▲contents](#)

Missing data or observations with a ‘do not know’ or ‘unsure’ response to a vaccination history recall question are frequently encountered in vaccination coverage quality indicator analyses. It is important to document the approach taken during data processing to handle these values.

Some surveys include only those participants without missing observations in the analysis. Not only does this approach reduce statistical power, analysing only observations with complete data will often result in biased estimates since it is unlikely that patterns of missing data are the result of completely random processes. Another popular method is to replace missing values using imputation methods that statistically model the probability they were vaccinated and impute values that say ‘vaccinated’ to some children and ‘unvaccinated’ to others. And in other situations, missing values are assigned a fixed value.

We encourage the latter approach and **systematically treat all observations with missing information on vaccination history, whether a response of ‘do not know’, ‘unsure’ or otherwise missing as having not received vaccination**. Thus, in considering the vaccination coverage indicators, these children contribute to the denominator but not the numerator of the coverage indicator. This is perhaps the most conservative approach.

Regardless of which approach is taken, it is critical that survey documentation includes a statement of how missing values, ‘do not know’ and ‘unsure’ responses are handled in the analysis. Even though these observations are treated as having not received vaccination under our recommendation, strong consideration should be given to quantifying the occurrence of these values and including a report out in survey report of the frequency of missing values.

Annex 6 Age eligibility determination and documenting the survey reference period [▲contents](#)

Most vaccination coverage surveys are interested in the routine immunization services received by children aged 0-11 (children aged < 12 months or < 1 year), 12-23 and 24-35 months at the time of the survey, consistent with the three youngest annual birth cohorts.

These age ranges establish the survey reference period, or the time frame for which survey respondents are asked to report activities related to their child's vaccination history. Estimated vaccination coverage results for children aged 12-23 months provide the routine immunization experience of the youngest annual birth cohort that has had a full 12 months (in some instances more than 12 months) to complete the recommended infant immunization schedule.

Not only is it important for survey reports to clearly document the age groups of interest, but reports should also include documentation of how children were determined eligible for inclusion. We are aware of the following approaches.

- Approach 1: The interviewer is provided with a pre-specified range of dates that correspond to the earliest and latest date of birth, relative to the period of survey field work that is consistent with an age range, e.g., 12-23 months. If a sampled child's date of birth falls between date #1 and date #2 (where date #1 precedes date #2), then the child is age eligible for inclusion; otherwise, the child is not age eligible.
- Approach 2: The interviewer computes exact age in the field based on the date of birth provided by the respondent and the date of the interview. Using the exact age calculation, the interviewer then makes an assessment relative to the survey date as to whether the child is age eligible or not.
- Approach 3: The interviewer asks the respondent, what is the age (in months) of the child? The interviewer then classifies the child age eligible or not based on the self-reported age.

Across the three possible approaches, experience informs a recommendation to use Approach 1 or Approach 2. Recommended use of Approach 2 depends on implementation, however. If the interviewer carries an electronic device with a validated age calculation application, then Approach 2 tends to work fine. In the absence of an automatic calculation, the required real-time age calculation in Approach 2 can also create challenges, particularly near the margins of age eligibility ranges since it is often difficult to ensure consistency in categorization. **Approach 3 is not recommended** based on research that has documented the challenges of reported age values [36, 37].

Annex 7 Differentiating vaccine delivery strategy [▲contents](#)

Understanding patterns in mode of delivery is often important for immunization programmes. It is therefore often important for survey planners / managers to be aware of the differences between vaccination delivery modes: **routine immunization** and **supplementary immunization activities** (SIAs), or campaigns.

Most of this primer is focused on measurement of vaccination coverage resulting from routine immunization. Routine immunization is defined by WHO as “the sustainable, reliable and timely interaction between the vaccine, those who deliver it and those who receive it to ensure every person is fully immunized against vaccine-preventable diseases”.¹⁰ Routine immunization services are delivered on a regular basis (e.g., daily, weekly or monthly) through a combination of in-facility, fixed site outreach and mobile team service delivery. During a routine immunization visit, children are screened for prior vaccine doses received, ideally based on the documented vaccination history in the HBR or in a facility-based record. Delivered doses are recorded on registers, tally sheets and HBRs. So, when we think of the day-to-day operations of vaccination delivery where a caregiver takes their child to a health facility to receive one or more vaccines as part of the child’s regular primary care during the first year of life, these are vaccine doses delivered through routine immunization. From a programme perspective, strong routine immunization delivery is desired reflected by high levels of routine immunization coverage.

In contrast, SIAs are characterized as mass vaccination events that aim to identify and vaccinate many children in a community during a short time period irrespective of past receipt of that vaccine, to increase population immunity to the target disease. SIAs complement but do not replace routine immunization. Although they are usually national, SIAs may be conducted locally in response to outbreaks or less often, targeted to subnational areas of a country that have been identified at high risk of transmission of the infection based on the epidemiology of disease and patterns of routine immunization access and utilization. SIAs are used as a key strategy in efforts to combat selected diseases including but not limited to measles, rubella, polio and yellow fever. In the past, vaccine doses delivered through SIAs were rarely documented as part of the delivery; however, this is slowly changing on recommendation from WHO so that all vaccine doses are recorded in HBRs or on a separate document given to show the vaccination given in the SIA.¹¹ Whether or how SIA doses are differentially documented in a HBR varies and must be researched in each survey setting.

Because of the cost of SIAs and their importance in programmes aiming to eliminate infections such as polio, measles and rubella, measuring coverage of vaccinations during SIAs is important for immunization programmes. For GAVI-funded campaigns, a survey is recommended soon after the campaign to evaluate the coverage attained. For all countries, however, it is helpful to obtain as much information as possible on vaccinations received during SIAs in addition to vaccinations received through routine immunization as this information is critical for mathematical models of the transmission and control of infection.

Recently, the lines between routine immunization and SIAs have become blurred through the use of periodic intensification of routine immunization activities (PIRI)¹² which look like mass vaccination events but differ because children may be screened for their vaccination history and vaccinations are recorded. As the

¹⁰ World Health Organization. Global Routine Immunization Strategies and Practices (GRISP). Available at: http://www.who.int/immunization/programmes_systems/policies_strategies/GRISP/en/. Accessed 2018 June 8.

¹¹ World Health Organization. *Planning and Implementing High-Quality Supplementary Immunization Activities for Injectable Vaccines Using an Example of Measles and Rubella Vaccines*. World Health Organization: Geneva, Switzerland, 2016. Available at: <http://www.who.int/immunization/diseases/measles/SIA-Field-Guide.pdf?ua=1>. Accessed 2018 June 13.

¹² World Health Organization. Periodic Intensification of Routine Immunization: Lessons learned and implications for action. Geneva: WHO, 2009. Available at: http://www.immunizationbasics.jsi.com/Docs/PIRImonograph_Feb09.pdf

reader might expect, the distinctions between routine immunization, PIRI and SIAs are largely unknown to the respondent caregiver.

SIAs of injectable vaccines, unlike those for oral polio vaccine, are not administered in the home but at health posts, clinics, and temporary vaccination sites. Many of these are the same sites as are used for routine immunization, including routine outreach. The caregiver takes her child to a health facility or outreach site for vaccination, or the child receives vaccination alongside many others in the community either in the household or at a central location in the village or town. She may or may not notice whether the health worker screened the child for their vaccination history or not, and whether the health worker recorded what vaccines were delivered or not. The absence of a readily distinguishing characteristic of SIAs for the caregiver can create challenges for those who wish to distinguish modes of delivery when measuring vaccination coverage. This is particularly so in communities where SIAs (such as for measles or polio) are frequently conducted and where documented evidence of vaccination in HBRs is not universally available. In these settings, measurement of vaccination coverage based on respondent recall is a particular challenge because it may be unclear whether the respondent is reporting evidence of vaccination obtained through routine immunization events or SIA events when asked if her child received a specific vaccine dose. Survey planners should find out what if and how doses during those initiatives are entered in FBRs and HBRs for questionnaire design and survey interviews.

At present, we are not aware of a validated approach to facilitate effectively differentiating routine immunization doses from those received during SIAs. Nonetheless, survey planners should find out which SIAs have been conducted in recent years for which the cohort(s) of children in the survey would have been eligible. **Questions about participation in those SIAs should be included in the survey.** It is important that this question(s) is asked of all respondents (including those with a date of vaccination on the HBR for the relevant vaccine) and not just those for who recall questions are asked. Sometimes, a separate vaccination record is given during the SIA. Interviewers need to ask for any SIA records. PIRI activities were conducted in a community; the survey may include questions about whether other specific services (e.g., receipt of vitamin A drops, tablets to kill parasitic worms, etc) or commodities (e.g., oral rehydration salts, bednets, etc) were received at the time of vaccination. Again, the question on participation in the PIRI activity should be asked of all respondents. Unfortunately, the reliability and accuracy of respondent recall of vaccination during those events is largely unknown and further work is needed to develop a set of standard questions.

Annex 8 Considerations due to changes in national immunization schedules [▲ contents](#)

The national schedule determines which vaccines health workers deliver to children and thus also impacts the information to be collected in a survey including vaccination coverage indicators. National immunization schedules have changed greatly during the past 20 years, particularly for immunization programmes in low- and middle-income countries. Novel vaccines or formulations are introduced. New age groups for which vaccines are recommended have been identified. And, new delivery strategies (including periodic intensification of routine immunization¹³; targeted outreach sessions that require health facility staff to leave their facility to take services directly into the community) are being used. Further complicating recommended schedules, not all vaccines are universally recommended for all children; for example, some vaccines (e.g., yellow fever virus vaccine) are recommended specifically to children residing in certain at-risk geographic areas. Any of these changes can impose stressors on immunization delivery systems and also have implications for the planning and implementation of surveys that include vaccination coverage indicators.

Because WHO encourages vaccination coverage surveys to include all recommended childhood vaccinations in the coverage assessment, survey planners / managers must be aware of changes in the national schedule for the annual birth cohorts being focused on by the survey. Survey planners should also identify whether private practitioners delivering vaccination follow the national immunization schedule published by the Ministry of Health or whether they follow a different set of guidelines, such as those recommended by a professional paediatrics society.

Survey planners / managers must also be aware of new vaccine introductions including how the vaccine was rolled-out, any delays that may have occurred in some areas but not others or phased-in introduction strategies. New vaccine introductions are complex events, and new vaccines are often not universally available across an entire country at the same time. There are often intentional or unintentional delays in the roll-out of new vaccines across communities that may be included in the survey sample. Survey planners and implementation coordinators must be aware of the manner in which new vaccines were rolled out in order to assess whether there are implications for the vaccination coverage survey.

In addition, new vaccine introductions require updates to recording tools such as HBRs and FBRs. Revised HBRs and FBRs may not be distributed in advance of the vaccine introduction thus leading to ad-hoc recording practices for the new vaccine. It is important to understand health worker recording practices with the new vaccine. Their recording practices may differ depending on whether the new vaccine is a new formulation of an existing vaccine or the introduction of an entirely new antigen.

For example, in country C, pentavalent DTP-HepB-Hib vaccine was introduced in mid-2005 to replace DTP-HepB vaccine which had been used for the prior five years. A vaccination coverage survey was conducted in 2006 with plans to measure vaccination coverage in children aged 0-11, 12-23 and 24-35 months. Survey planners recognized that changes in national vaccination schedule did not necessarily conform to the survey's three-year period of interest. As such, not all children would be expected to have received the same vaccinations. The survey planners were alert and conducted a pre-survey field observation exercise to learn how health workers recorded the administration of DTP-HepB-Hib vaccine on HBRs since revised records were not quickly distributed to health facilities in advance of the new vaccine roll-out. To address the challenges of documenting the new vaccine on old HBRs, health workers were found

¹³ World Health Organization. Periodic Intensification of Routine Immunization: Lessons learned and implications for action. Geneva: WHO, 2009. Available at: http://www.immunizationbasics.jsi.com/Docs/PIRImonograph_Feb09.pdf

to simply record in the field for DTP-HepB without marking that the vaccine administered was DTP-HepB-Hib. Others marked through the text for DTP-HepB and wrote the new vaccine name in the margin. Still other health workers recorded the vaccine and date of vaccination in the 'Other Clinic Notes' section of the HBR. Survey planners quickly noted these practices and included them in their field staff training exercises.

Annex 9 A brief note on capturing vaccination history of oral administered polio vaccine, rotavirus vaccine and vitamin A [▲contents](#)

Survey planners / managers should be aware of concerns related to survey recall from memory questions for oral polio vaccine, rotavirus vaccine and vitamin A. Because each of the aforementioned is orally administered, it is possible that caregivers are unaware which of these her child has received thereby impacting her ability to accurately recall vaccination history for oral polio vaccine and rotavirus vaccine. It is common for oral polio vaccine doses to be recommended at birth and at 6, 10 and 14 weeks. Rotavirus vaccine, depending on the manufacturer, may be recommended in either a two-dose or three-dose schedule with the first dose recommended no earlier than six weeks of age. Vitamin A drops are often first administered at six months of age with children in living in areas where vitamin A deficiency is a public health problem receiving vitamin A doses every four-to-six months.¹⁴

Depending on where the child resides and when she visits the health facility for primary care services, it is not only expected that she should receive recommended doses of oral polio vaccine, rotavirus vaccine and vitamin A or any combination thereof, it is also possible that she may receive all of these in the same visit. It is therefore very possible for a caregiver to not be aware whether her child received oral polio vaccine and vitamin A but not rotavirus vaccine, rotavirus vaccine and vitamin A but not oral polio vaccine or any other possible iteration let alone to accurately recall the number of doses of each of these.

Because there are differences in the physical appearance between oral polio vaccine vials, rotavirus vaccine vials and vitamin A capsules, it is possible that there may be a place for visual cues to assist and improve recollection. Oral polio vaccine is also described as having a pinkish colour, and vitamin A supplements tend to be slippery between the fingers. Rotavirus vaccine is put into the mouth/cheek (depending on the vaccine used) to differentiate it from oral polio vaccine (OPV) drops. However, the added value of visual cues has not been studied.

¹⁴ World Health Organization. Vitamin A supplementation. Available at: http://www.who.int/elena/titles/full_recommendations/vitamina_supp/en/

Annex 10 A brief note on polio vaccine [▲ contents](#)

Polio vaccine takes one of two forms: an orally administered vaccine and an injectable vaccine. Detailed descriptions of these vaccines are provided elsewhere.¹⁵ It is important for the survey planner / manager to be aware of these two vaccine forms when communicating with immunization staff and during interviewer training since it is possible for lay audiences to speak of polio vaccine in general terms without specifying whether they are referring to oral, OPV or injectable, IPV. This may be particularly true for survey respondents. Depending on the country, it is possible for OPV and IPV to be administered to a child at the same vaccination session. Yet again, this can create challenges for accurately eliciting a child's vaccination history from caregiver recall.

Survey planners / managers should be aware of two additional polio related issues that require special attention. The first relates to the recommended schedule used for polio vaccines. In many countries, oral polio vaccine is recommended at birth and again at 6, 10 and 14 weeks (or 2, 4, 6 months) with a single dose of injectable inactivated polio vaccine recommended at 14 weeks. However, some countries utilize a so-called *sequential schedule* for polio vaccine. In a sequential schedule, doses of inactivated polio vaccine are followed by oral polio vaccine, an approach used to acquire the advantages of both IPV and OPV while minimizing adverse reactions. For the survey planner / manager, knowledge of the sequential schedule is important when considering the data collection forms.

Finally, because of vaccine supply disruptions, some countries administer fractional, rather than full, doses of IPV. The survey planner / manager is encouraged to ask the immunization programme staff whether a dose-sparing fractional IPV (fIPV) dose strategy was used in the country and whether there were any special recording practices related to administration of a fractional doses vis-à-vis a full dose.

¹⁵ World Health Organization. Poliomyelitis. Available at: <http://www.who.int/topics/poliomyelitis/en/>. Accessed 2018 June 13.

Annex 11 Evidence for hepatitis B birth dose vaccination [▲contents](#)

Currently, WHO recommends a birth dose of hepatitis B vaccine (HepB-BD) be administered as soon as possible following birth and preferably within the first 24 hours to prevent perinatal transmission of the hepatitis B virus.^{16,17} Many, if not most, vaccination coverage surveys do not probe for the *time* of the day when a particular vaccine is administered; rather, only the date of vaccination is recorded. Thus, while a vaccination whose administration date coincides with the date of birth may be assumed to have been timely, the vaccination given on the next day after birth can be up to 23 hours late.

It is recognized that obtaining the hour of vaccine administration in the course of a coverage survey is likely unrealistic and certainly not possible given current recording practices; thus, some overestimation of HepB-BD coverage using the date-based method is inevitable unless other methods can be used to exclude late doses given on the 2nd day of life are developed.

The reliability of information on HepB-BD from respondent recall is questioned and the probing for eliciting Hepatitis B birth dose may bias the response. It is quite possible that the caregiver, while present at the time of birth, would not necessarily know the date/time of vaccine administration. Conversely, if the caregiver is probed about a vaccine given within 24 hours after birth, the caregiver may leave out a HepB dose given later, but that had the HBR been available this dose would have been recorded as HepB-BD.

At present, a firm recommendation is not available; however, a preferred approach is to only consider those doses of HepB for which documented evidence is available that the dose was administered within 24 hours of birth and separately analyse late HepB doses given as a single antigen, as opposed to HepB given as part of a combination vaccine, usually with a diphtheria and tetanus toxoid with pertussis containing vaccine (DTPCV).

¹⁶ World Health Organization. Hepatitis B vaccines: WHO Position Paper. Wkly Epidem Rec. 2009; 84(40): 405-420. Available at: <http://www.who.int/wer/2009/wer8440.pdf?ua=1>

¹⁷ World Health Organization. WHO position paper on hepatitis B vaccines - July 2017 Wkly Epidem Rec. 2017;92(27):369–392. Available at: <http://www.who.int/wer/2017/wer9227/en/>. Accessed 2018 June 13.

Annex 12 Evidence for BCG vaccination [▲contents](#)

Bacille Calmette-Guerin, or BCG, vaccine is an important part of tuberculosis prevention strategies, particularly among children. BCG vaccine generally leaves some scarring at the site of injection. The BCG scar has been used as a surrogate marker for BCG vaccination, although, evidence exists highlighting failure to form a scar as well as variation in tuberculin conversion following administration of BCG.¹⁸

It is recommended to treat BCG similarly to other vaccines in terms of the evidence used to indicate vaccination: first look for documented evidence in HBRs, and if absent, ask respondents to recall from memory whether the child received BCG vaccine. Presence of BCG scar and mother's or caretaker recall could serve as a good evidence for BCG vaccination.

If health facility-based evidence of vaccination is part of the survey, then search for evidence of BCG vaccination in the facility records. However, it is important to note that in some health facilities BCG vaccination (as well as other vaccinations recommended at birth, birth dose of oral polio vaccine or hepatitis B vaccine) is conducted by maternity services and the child's vaccination records may be held by that service rather than the immunization service department.

¹⁸ World Health Organization. BCG position paper. Available at: http://www.who.int/immunization/policy/position_papers/bcg. Accessed 2018 March 26.

Annex 13 Sample results table layout [▲contents](#)

The following table presents vaccination coverage estimates for a hypothetical household sample survey collecting vaccination coverage data for children aged 12-35 months at the time of the survey. Survey results are presented separately for the annual birth cohorts of children aged 12-23 months and those aged 24-35 months.

The point estimate for coverage is presented for each component source of evidence (e.g., by HBR, by FBR, by recall) while the point estimate for coverage alongside the estimated 95% confidence interval is presented for coverage based on the combination of documented evidence and recall. See the note on [confidence intervals](#) provided in Section 6.

Table 3. Hypothetical national immunization schedule:

Recommended vaccine	Birth	6 weeks	10 weeks	14 weeks	9 months	18 months
BCG	X					
DTP-HepB-Hib		X	X	X		
Oral Polio (OPV)	X	X	X	X		
Inactivated Polio (IPV)				X		
Pneumococcal conjugate (PCV)**		X	X	X		
Rotavirus**		X	X			
Measles containing (MCV)**					X	X

** Note that pneumococcal conjugate vaccine and rotavirus vaccine were introduced into the national immunization schedule midway through the year of vaccination captured for children aged 24-35 months. Similarly, a second dose of measles containing vaccine was introduced into the schedule around the same time. Thus, it is not expected that all children aged 24-35 months will have had an opportunity to receive PCV, rotavirus vaccine and MCV2.

The survey collected documented evidence of vaccination from home-based records and from facility-based records for those children without a home-based record.

Table 4. Example table of Standard presentation of crude vaccination coverage indicators for vaccines recommended during the first and second year of life

Children aged 12-23 months at the time of survey						Children aged 24-35 months at the time of survey				
Sample size: 2859 Weighted percentage of children with a HBR seen: 57.8% Weighted percentage of children with no HBR for whom a FBR was found: 13.9%						Sample size: 2345 Weighted percentage of children with a HBR seen: 49.4% Weighted percentage of children with no HBR for whom a FBR was found: 11.8%				
Vaccine dose	by documented evidence			by recall	by HBR+FBR+recall	by documented evidence				by HBR+FBR+recall
	HBR	FBR	HBR+FBR			HBR	FBR	HBR+FBR	by recall	
BCG	55.8%	12.4%	68.2%	28.1%	96.3% (95.9,96.8)	49.0%	10.8%	59.8%	29.6%	89.4% (79.9,89.9)
DTP-HepB-Hib ^a 1	56.8	12.0	68.8	26.1	94.9 (94.2,95.3)	49.2	11.5	60.7	28.3	89.0 (88.2,89.7)
DTP-HepB-Hib 2	55.7	10.3	66.0	23.2	89.2 (88.8,89.7)	48.6	10.7	59.3	26.9	86.2 (85.6,86.7)
DTP-HepB-Hib 3	52.6	9.0	61.6	16.5	78.1 (77.1,79.2)	48.1	9.8	57.9	21.6	79.5 (78.7,80.1)
OPV birth dose	57.8	10.2	55.8	23.7	79.5 (78.8,80.1)	46.2	8.6	54.8	27.2	82.0 (81.1,83.0)
OPV 1	57.0	11.6	68.6	25.9	94.5 (94.0,94.9)	45.9	11.6	57.5	26.4	83.9 (83.1,84.6)
OPV 2	56.1	9.1	65.2	21.0	86.2 (85.7,86.8)	45.1	10.9	56.0	24.3	80.3 (79.5,81.1)
OPV 3	52.2	6.6	58.8	7.0	65.8 (64.7,66.4)	44.8	9.7	54.5	17.3	71.8 (70.9,72.7)
IPV 1	54.8	7.4	62.2	15.0	77.2 (76.1,78.0)	48.9	9.5	58.4	11.4	69.8 (68.9,70.5)
Pneumococcal ^b 1	56.7	9.2	65.9	25.6	91.5 (91.1,91.8)	28.9	7.2	36.1	22.5	58.6 (57.4,59.9)
Pneumococcal 2	55.4	7.6	63.0	22.2	85.2 (84.6,85.7)	26.2	6.5	32.7	21.7	54.4 (53.1,55.8)
Pneumococcal 3	53.2	5.1	58.3	17.1	75.4 (74.8,76.1)	23.1	5.7	28.8	19.4	48.2 (46.8,49.7)
Rotavirus ^c 1	7.6	2.1	9.7	11.6	21.3 (20.4,22.4)	2.3	0.8	3.1	7.1	10.2 (8.8,11.6)
Rotavirus 2	6.9	2.0	8.9	8.5	17.4 (16.6,18.4)	1.8	0.4	2.2	5.7	7.9 (6.8,9.0)
MCV 1	53.5	10.1	63.6	23.4	87.0 (86.1,87.8)	48.9	11.3	60.2	24.3	84.5 (83.9,84.9)
MCV 2	0	0	0	0	0	17.9	8.4	26.3	21.2	47.5 (46.3,48.6)
Yellow fever	49.8	3.4	53.2	24.3	77.5 (77.0,78.3)	48.3	10.6	58.9	25.1	84.0 (83.5,84.5)
FVC, basic ^d	47.7	2.8	50.5	4.7	55.2 (54.5,55.9)	40.3	5.4	45.7	12.6	58.3 (57.0,59.6)
FVC, all ^e	6.7	1.9	8.6	3.8	12.4 (11.9,13.1)	1.1	0.2	1.3	5.1	6.4 (5.1,7.8)
Never vaccinated	0	0	0	1.3	1.3 (0.7,2.0)	0	0	0	2.1	2.1 (1.1,3.2)

NOTES

95 percent confidence intervals reported in parentheses.

Abbreviations: HBR, home-based record; FBR, facility-based record; OPV, oral polio vaccine; IPV, inactivated polio vaccine; MCV, Measles containing vaccine; FVC, fully vaccinated child

^a Pentavalent DTP-HepB-Hib vaccine

^b Pneumococcal conjugate vaccine

^c Rotavirus vaccine

^d Fully vaccinated coverage with the “basic” (original) vaccine doses. For children aged 12-23 months at the time of the survey, the percentage of children who received 1 dose of BCG vaccine, 3 doses of DTP-containing vaccine, 3 doses of oral polio vaccine and 1 dose of measles containing vaccine before the survey. For children aged 24-35 months at the time of the survey, the percentage of children who received 1 dose of BCG vaccine, 3 doses of DTP-containing vaccine, 3 doses of oral polio vaccine and 1 dose of measles containing vaccine before the survey.

^e Full vaccinated coverage with all recommended vaccine doses according to the national immunization schedule. For children aged 12-23 months at the time of the survey, the percentage of children who received 1 dose of BCG vaccine, 3 doses of DTP-HepB-Hib vaccine, a birth dose + 3 doses of oral polio vaccine, 3 doses of pneumococcal conjugate vaccine, 2 doses of rotavirus vaccine, 1 dose of measles containing vaccine and 1 dose of yellow fever vaccine before the survey. For children aged 24-35 months at the time of the survey, the percentage of children who received 1 dose of BCG vaccine, 3 doses of DTP-HepB-Hib vaccine, a birth dose + 3 doses of oral polio vaccine, 3 doses of pneumococcal conjugate vaccine, 2 doses of rotavirus vaccine, 2 doses of measles containing vaccine and 1 dose of yellow fever vaccine before the survey.

^f Never vaccinated reflects the percentage of children who received none of the vaccinations noted for fully vaccinated coverage according to the national immunization schedule. That is, children who received no doses of BCG vaccine, of DTP-HepB-Hib vaccine, of oral polio vaccine, of pneumococcal conjugate vaccine, of rotavirus vaccine, of measles containing vaccine and of yellow fever vaccine before the survey.