Training for the comprehensive analysis of vaccination coverage surveys

Summary Report
Kathmandu, Nepal | 21 to 24 February 2017

Executive Summary

From 21 to 24 February 2017, 25 participants from Ministries of Health, National Statistics Offices and research institutes from Cambodia, China, Indonesia, Nepal and Thailand, plus World Health Organization (WHO) officials from South East Asia and the Western Pacific, and a person from WHO Inter-Country Support team for South and East Africa, in addition to the Swiss Tropical Institute and two consultants joined the "Training for the comprehensive analysis of vaccination coverage surveys". The training was facilitated by WHO, UNICEF, and 5 consultants, 2 of whom were participants in the "Statistical Training on the 2015 WHO Vaccination Coverage Survey Reference Manual" in Madrid, Spain in 2016.

The objectives of the "Training for the comprehensive analysis of vaccination coverage surveys" were to have participants:

1. Understand the recommendations from the WHO Vaccination Coverage Cluster Survey Reference Manual
2. Recognize not only the most common immunization indicators obtained from vaccination coverage surveys, but also other indicators that can provide further insights into the performance of Immunization Programmes
3. Use weighting for data analysis, as appropriate
4. Adapt and use the "Vaccination Coverage Quality Indicators (VCQI)" to analyse existing survey data, and
5. Help plan and implement Vaccination Coverage Cluster Surveys

Since the early 1990s, the World Health Organization (WHO) has provided guidance to Member States, partner agencies and institutions on methods for measuring immunization coverage through surveys. With the goal of improving survey precision, accuracy, and overall quality, an extensive review and revision of coverage survey methods and materials resulted in the release, in 2015, of the working draft of WHO Vaccination Coverage Cluster Survey Reference Manual. While the statistical methods outlined in the Survey Manual, particularly related to probability sampling, are commonly used on large households health surveys, such as Demographic and Health Surveys (DHS) and UNICEF's Multiple-Cluster Indicator Surveys (MICS), Immunization Programmes are less familiar with them and will likely lack the expertise needed to properly conduct the sampling and analyses recommended in the Manual.

To help bridge Immunization Programmes and institutions conducting health surveys, WHO's Expanded Programme on Immunization (EPI) is developing tools to facilitate the management, analysis, presentation and interpretation of immunization survey data. One of these tools, "Vaccination Coverage Quality Indicators (VCQI)[1]" is set of Stata programs intended to be used by statisticians and epidemiologist to analyse survey data; and for analysts to add further modifications and additional indicators. VCQI allows conducting

[1] Pronounced "Vicky"

analysis not only for Vaccination Coverage Cluster Surveys done following WHO recommendations, but also from existing survey databases, such as DHS, MICS and others.

Seeking to strengthen countries' capacities to enhance the use of existing survey databases to conduct secondary analyses of interest to immunization programmes, a workshop took place in Kathmandu, Nepal 21-24 February 2017. Invited countries – Cambodia, China, Lao PDR (unable to attend), Indonesia, Nepal and Thailand – had recent health surveys (or EPI surveys in the case of China) that reported vaccination coverage estimates. Some of them were used as case studies to emphasize concepts around immunization indicators (traditional ones such as vaccination coverage estimates and additional ones) as well as statistical notions related to surveys like accuracy, bias, precision, probability sampling and weighted analysis. Participants were introduced to the tool VCQI to calculate crude and valid coverage, vaccination drop-outs, timeliness, simultaneity, and missed opportunities for vaccination. Using VCQI outputs from the 2014 Cambodia DHS, 2014 Nepal MICS and 2012 Thailand MICS, participants discussed concepts around immunization indicators, home-based record availability, weighted and unweighted analyses and presented a brief summary of secondary indicators from said surveys proposing actions to better understand the causes of the issues detected and potential solutions to improve EPI performance.

The analytical skills developed during the workshop, along with planned mentoring of participants, will also help promote capacity-building on survey statistics and promote the implementation of quality vaccination coverage surveys implemented in South East Asian and Western Pacific countries of the near future.

All the material used in this training is available in a shared DropBox, available at: https://www.dropbox.com/sh/5p0dhkp7ftu8jfi/AACyHk_oC_S6bICxcdga_o0ka?dl=0

We thank WHO-Nepal and SEARO, UNICEF and the Bill & Melinda Gates Foundation for making this workshop possible.

Participants

1. Phan Chinda, *National Institute of Statistics, Cambodia*
2. Cao Lei 曹雷老师, *China Centers for Disease Control and Prevention (China CDC)*
3. Duan Mengjuan 段梦娟, *China CDC*
4. Cao Lingsheng, 曹玲, *China CDC*
5. Lulu Ariyantheny Dewi, *National Immunization Program, Indonesia*
6. Lely Indrawati, *National Institute of Health Research Development, Indonesia*
7. Paudel Binod, *Management division, Department of Health Services, Nepal*
8. Kapil Prasad Timalsena, *Planning and Monitoring Section, Child Health Division, Department of Health Services, Ministry of Health, Nepal*
9. Shekh Abdul Majeed, *Center for Molecular Dynamics, Nepal*
10. Nisachol Cetthakrikul, *International Health Policy Program, Thailand*
11. Nareerut Pudpong, *Healthcare Accreditation Institute, Thailand*
12. Chaninan Sonthichai, *Division of Vaccine Preventable Diseases, Thailand*
13. Padejsak Chobthun, *Division of Vaccine Preventable Diseases, Thailand*
14. Meike-Kathrin Zuske, *Swiss Tropical Institute, Switzerland*

Independent Consultants

15. Robin Biellik
16. Jorge Mendoza
17. Francisco Nogareda
18. Hilde Sleurs

World Health Organization

19. Jethro Chakauya, *African Regional Office (AFRO) -Intercountry Support Team South East* (IST-SE)
20. Haditya Mukri, *WHO Indonesia*
21. Mona Lacoul, *WHO Nepal*
22. Rahul Pradhan, *WHO Nepal*
23. Sushil Shakya, *WHO Nepal*
24. Aree Moungsookjareoun, *WHO Thailand*
25. Deepak Dhongde, *Southeast Asia Regional Office* (*SEARO)*

Facilitators

1. Tom Albani, *Biostat Global Consulting*
2. Anthony (Tony) Burton, *Consultant*
3. Carolina Danovaro, *WHO-Headquarters (HQ)*
4. Mamadou Diallo, *UNICEF*
5. Augusto Llosa, *Consultant*
6. Dale Rhoda, *Biostat Global Consulting*
7. John Wagai, *Consultant*

Administrative Support

1. Carine Cruz, *WHO-HQ*
2. Sanjeeb Tamrakar, *WHO-Nepal*

Highlights from Each Session

Welcome

Participants were welcomed by Dr. Jos Vandelaer, Representative WHO Nepal, Dr. Rownak Khan, Deputy Representative UNICEF Nepal, and Dr. Bikash Lamichhane, Director Child Health Division, DOHS, Government of Nepal. They emphasized the importance of using more existing surveys to conduct secondary immunization analyses to help inform Immunization Programme managers and were excited about the tool Vaccination Coverage Quality Indicators (VCQI[2]). They finally encouraged the participants to enjoy the workshop, but also to get to see some of what the city of Kathmandu has to offer.

Training objectives and agenda

The objectives of the training were highlighted and an overview of the agenda given. See agenda in annex 1. The participants introduced a fellow participant as part of an opening icebreaker.

Setting the stage: Briefing on vaccine-preventable diseases and immunization and why we assess vaccination coverage

The training started with an introduction to immunization and vaccine-preventable diseases (VPDs) given that some of the participants were not familiar with immunization. The objectives of the session were to share with the participants a definition of VPDs, provide them with a brief history of successes in the fight against VPDs, describe how vaccination coverage relates to VPD control and elimination, describe some of the existing types of barriers to vaccination and explain the difference between lack of access ("left-outs") to vaccination and loss to follow-up ("drop-outs").

The presentation also highlighted the importance of monitoring of immunization systems, with a focus on how vaccination overage is measured. Coverage is monitored through administrative routine systems and often validated using periodic vaccination coverage surveys. The limitations of administrative routine systems for monitoring coverage were described and the role of surveys introduced.

An optional session was held on day 2 for participants who wanted to know more about survey design – strata, schedule, age cohorts, to be included from the EPI perspective.

Presentation of the WHO vaccination coverage survey reference manual

The WHO Vaccination Coverage Cluster Survey Reference Manual, published as a working draft in 2015, was introduced to the participants. The rationale to develop new guidance on vaccination coverage surveys aimed at improving survey accuracy and overall quality was presented. This new manual provides a methodology more aligned with well-accepted household cluster survey methods, and renews emphasis on taking steps to minimize bias

[2] VCQI is pronounced "Vicky".

and improve data quality; it also promotes better highlighting limitations to minimize unmet expectations or misuse of results; and emphasizes the use of results for action. Emphasis was given to seven aspects of the new Manual that are new in relation to previous WHO guidance on vaccination coverage surveys. The main seven aspects are:

1. Defining the Survey Scope
2. Using probability sampling and weighted analyses
3. Improving vaccination status ascertainment (from home-based records, registers from health facilities, and using pictures)
4. Providing guidance on digital data collection
5. Outlining clear steps to minimize bias and bolster data quality
6. Presenting innovative graphs to display the main results
7. Writing reports that are comprehensive and persuasive about survey quality and limitations

The WHO Vaccination Coverage Cluster Survey Reference Manual was shown and a "map" (see annex 2) distributed to familiarize the participants with the sections of the Manual.

The presentation also mentioned the role of vaccination coverage surveys and the three main types of such surveys:

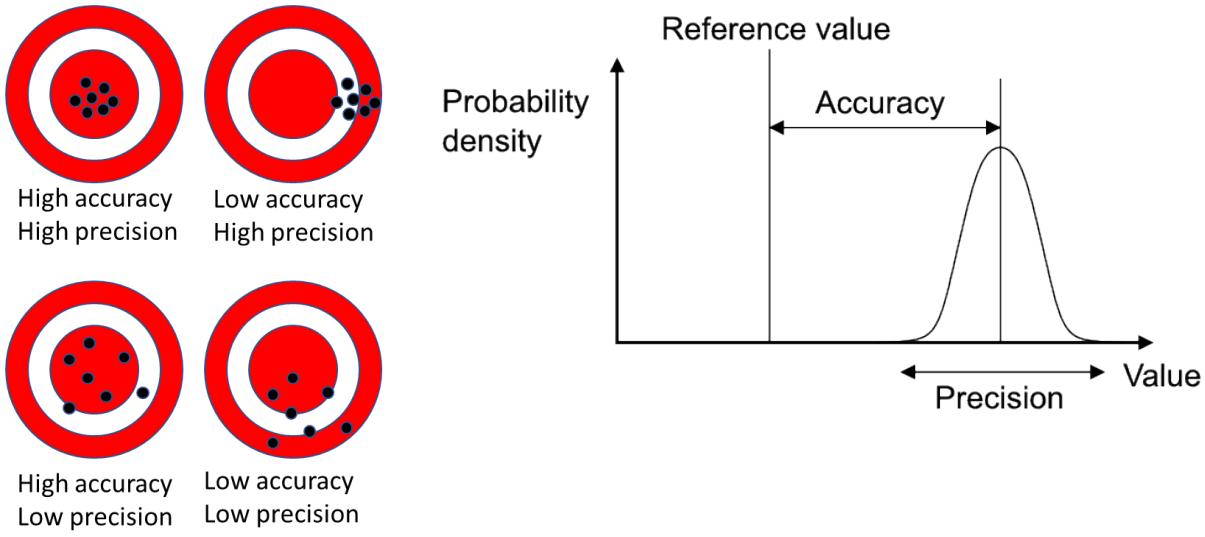
1. Routine Immunization
    a. Usually among infants
    b. But other options exist (school-aged; adolescents)
2. Post-supplementary immunization activity (SIA)/ campaign
    a. Often following measles and measles/rubella campaigns
3. Tetanus among pregnant women

The workshop emphasized surveys for routine immunization (RI). As such, the rationale for different vaccination schedules was discussed, i.e., achieving a balance between an optimal immune response and the risk to get a VPD and/or the severity of that VPD in the targeted age group in a given setting. The schedules were later discussed when talking about valid coverage, vaccination timeliness and simultaneity and how to set-up the Vaccination Coverage Quality Indicators (VCQI) tool for each survey.

Accuracy and Precision, bias and sample size

This session discussed the concepts of accuracy and its relation to bias, as well as precision and its relation to sample size.

Accuracy is the proximity of measurement results, in our case of a survey coverage estimate, to the true value of vaccination coverage in the target population. Precision is the repeatability, or reproducibility of the measurement, i.e., how similar the survey vaccination coverage estimates will be if a given population is sampled multiple times. The diagrams below illustrate the differences between accuracy and precision.



For survey results to be accurate, the persons in the sample need to represent the target population. On the one hand, this concept relates to strata, in case one wants the survey to provide estimates for a given sub-national level or a particular group (e.g., vulnerable populations, rural vs. urban, etc.), and bias. On the other hand, accuracy relates to bias or non-sampling error. Bias refers to the tendency of a measurement process to over- or under-estimate the value of a population parameter. In survey sampling, bias would be the tendency to systematically over- or under-estimate vaccination coverage, i.e., to provide a coverage estimate that is not accurate. Bias in vaccination coverage survey estimates cannot be "measured" as one does not know "true coverage". However, several measures can be taken in survey planning and implementation to reduce bias. For example, to reduce selection bias, one should use probability sampling (and then use weighted analysis), pre-select households, etc. To reduce measurement/ ascertainment bias, EPI should improve the documented evidence of vaccination in home-based records and in health facility registries; surveys can photograph HBRs and registries to reduce data recording errors. Finally, intense and quality training and supervision will ensure adherence to the protocol and Standard Operating Procedures (SOPs), thus, reducing the risk of introducing bias.

Regarding precision, statistical measures for how precise the estimate is, in our case the survey vaccination coverage estimates, include variance, standard errors and confidence intervals (CI). Increasing sample size will result in better precision. However, it was noted the one of the main drivers of survey cost is the sample size. Parameters used to calculate sample size include expected vaccination coverage (expected proportion), alpha and beta errors, and design effect (DEFF)/intracluster correlation coefficient (ICC). The interpretation of 95%CI should be "If there is no bias in the survey or if the positive biases cancel the negative biases, then we are 95% confident that the population coverage figure falls inside the 95% CI." Also, "if there is no bias in the survey or if the positive biases cancel the negative biases, then if the sample were repeated many times and we calculated a 95% CI for each sample, the true population coverage figure would fall inside 95% of the CIs".

Finally, to answer the key question for EPI of "how precise is precise enough?" when planning a survey, the working answer put forward was "if you would select a different action when you learned that true coverage was at the lower rather than upper limit (or confidence interval), then one might say that *your estimate is not precise enough."*

Key vocabulary and terms related to survey statistics and to vaccination coverage surveys is available in annex 3.

Types of surveys

This session started with an overview of the current context of vaccination coverage surveys, where countries are quickly adding new and much more expensive vaccines (pneumococcal conjugate vaccine-PCV, rotavirus-RV) into their vaccination schedules, leading t mixed schedules with lagging card distribution; targeting new age groups (for example for the 2nd dose of measles-containing vaccine (MCV2), influenza, HPV); and using a mix of strategies for vaccine delivery (fixed site, outreach, mobile teams, Child Health Days and Supplementary immunization activities (SIAs)).

In addition to Vaccination Coverage surveys, also known as EPI [coverage] surveys or Coverage Evaluation Surveys (CES), the main household surveys that include vaccination coverage estimates were introduced, namely the Demographic and Health Survey (DHS) and UNICEF's Multiple Cluster Indicator Survey (MICS).

DHS covers abroad range of indicators, with immunization being in the Maternal and Child Health category and the immunization question inserted in the DHS Woman's Questionnaire. MICS also covers a wide range of indicators, but the immunization questions are part of the Questionnaire for Children Under Five (English); Since MICS5, MICS added a standard Questionnaire Form for Vaccination Records at Health Facility (English). Effectively, this means that DHS only includes vaccination data from children of the women being interviewed (excluding orphans for example).

The sample sizes in the DHS and MICS depend on funding and the needs of the government, and certainly not on immunization needs. The DHS and MICS provide estimates at the national level, for urban and rural areas, and usually for about five to ten subnational administrative areas. DHS surveys cover the entire country, whereas MICS do either national level or sub-national surveys. Both types of household surveys use two-stage probability sampling (clusters and then households); the sampling frame is a list of the entire population.

Basic indicators for routine immunization (RI) available from DHS, MICS, Vaccination Coverage Surveys and most other surveys that report RI data include:

- Home-based records (Cards) (%)
  - Given
  - Seen
- Zero dose (% and 95% CI)
- Coverage by vaccine (% and 95% CI)

- By card (and now by health facility documentation)
- By recall
- **Card + recall**
- 12-23 months of age
- By 12 months
- By stratifier (geographical/sex/rural vs urban, etc)

The indicator most commonly used from these surveys is coverage at time survey among children 12-23 month by card plus recall, with newer surveys sometimes adding coverage by documented evidence in health facilities.

Unlike DHS and MICS, Vaccination Coverage Surveys are usually commissioned (and before implemented) by EPI, include reasons for no vaccination, have as many strata as per needed by EPI and they can have secondary objectives, for example, related to special populations or linked to data quality. Other differences between DHS/MICS and Vaccination Coverage Surveys are:

DHS/ MICS	VCS
Periodic	Based on needs
Long multi-indicator surveys	Focused on immunization
Not all eligible children	All eligible children for RI
Reports usually 12-23 months, now also 24-35 months	Reports can be tailored, but usually 12-23 months & 24-35 ms
Usually not visits to health facilities or pictures (but some do)	Recommends pictures and visits to health facilities
EPI usually not in training	EPI involved in training
No reasons for no vaccination	Includes reasons for no vaccination

A brief comparison between the old EPI coverage survey methodology and the 2015 recommendations was presented and is summarized in annex 4.

Weighting

This session was an introduction to sample weighting, building on annex J of the WHO Vaccination Coverage Survey Reference Manual; but it also presented in more detail the weighting steps and reviewed non-response and post-stratification adjustments. Weighting is crucial to make inferences about the entire population.

In order to proceed with weighting, the selection process needs to be random and the probability of selection must be known. Two main sources of information needed for weighting are: 1) the sampling frames (stratification, MOS, listing), given that probability of selection needs to be calculated for each stage, and 2) the data collected (updated MOS,

HH/person response status). Weight variations should be minimized, or reduced to the extent that it is operationally manageable, to avoid losing precision.

Steps to calculate weights

Step 1: Calculation of base weights ($\boldsymbol{w_b}$), or the inverse of the probability of selection

Step 2: Calculation of respondent weights ($\boldsymbol{w_R}$)

$$\boldsymbol{w_R = w_b * \left(\frac{sum\ of\ all\ the\ weights\ in\ the\ class}{sum\ of\ the\ weights\ of\ the\ respondents\ in\ the\ class}\right)}$$

Step 3: Calculation of post-stratification weights (if applicable)

$$\boldsymbol{w_{PS} = w_R * \left(\frac{Known\ total\ in\ the\ poststratum}{sum\ of\ all\ respondent\ weights\ in\ the\ poststratum}\right)}$$

Step 4: Calculation of normalized weights (if applicable)

$$\boldsymbol{w_{normalized} = w * \left(\frac{C}{sum\ of\ all\ the\ weights\ w\ to\ normalized}\right)}$$

NB. It is possible to skip Step 4 and directly normalized the respondent weights

In the non-response adjustment, the redistribution of the weights of the non-respondents to the respondents within adjustment classes was presented. For post-stratification adjustment, the adjustment factor was discussed, as well as normalizing the final weight, if desired (similar to DHS normalized weights). The tool Vaccination Coverage Quality Indicators (VCQI) expects the weights to be *post-stratified* (see below). Participants had an opportunity to do some practical exercises and discuss how weight variations may reduce the precision of the estimates.

Finally, as in sampling, the importance of documenting the weighting procedures was emphasized.

An optional session was held for participants who wanted to know more about weighting.

Immunization Indicators and the Vaccination Coverage Quality Indicators (VCQI) tool

The basic points covered in this session were that many surveys report only basic indicators; which may be sufficient if coverage is poor. This session went beyond to describe elements of a thorough analysis. A model of a survey report is available in annex 5.

Commonly used immunization indicators obtained from vaccination coverage surveys, including crude and valid coverage were discussed, along with definitions for "zero dose", "fully vaccinated" and the management of missing data and "don't know responses". Also, different sources for vaccine information were discussed, namely documented vaccination (in home-based records and/or registers in health facilities); parental or caregiver recall; Card + recall. The take home-message here was that the so-called "basic indicators" have much detail and how they are calculated and reported can vary. It should be very clear what is being reported and how it is calculated. To this end, WHO has developed the

Vaccination Coverage Quality Indicators (VCQI) tool, now in Stata 14, to do many of these analyses, in addition to summary outputs related to the quality of the data (e.g., missing values, dates with obvious problems, level of agreement between documented vaccination and recall, etc). VCQI is a set of Stata programs intended to be used by statisticians and epidemiologist to analyse survey data; and for programmers to add further modifications and additional analysis indicators. VCQI strives to be clear about what it does (as the analyses are well documented) and VCQI is available for people to use.

The importance to clearly understand the different schedules and year of introduction of new vaccines was also emphasised, as this is crucial to establish definitions for valid coverage, fully vaccinated, among other nuances. At this time, valid coverage in VCQI includes all children in the denominator, but in the future the option to calculate "valid coverage among those with documented vaccination (with date information)" will be added.

Participants had an opportunity to examine data collection forms and then data dictionaries and how they relate to the main analyses presented in survey reports.

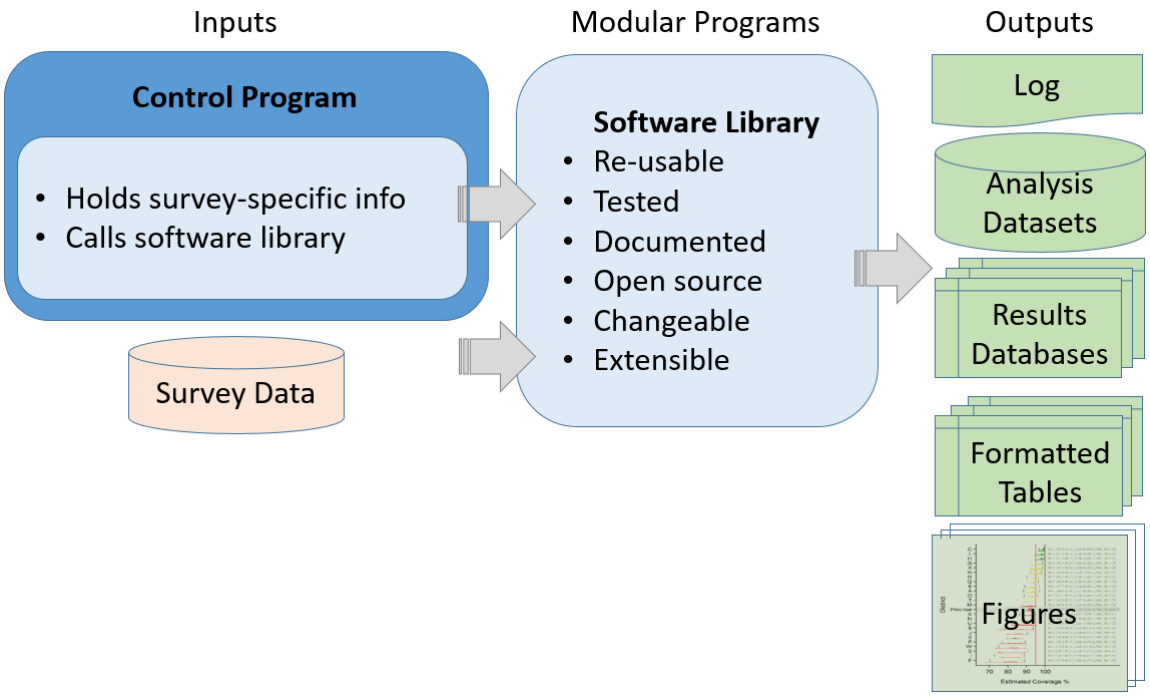
The second part of the session focused on data analysis (Survey Reference Manual chapter 6), describing standard and optional vaccination coverage survey analyses, weighted and unweighted indicators, comparing coverage with a programmatic threshold (classification) or between or within strata, and over time. Coverage classification using one-sided confidence bounds was also introduced, along with "organ pipe" and "inch worm" plots. Here, it was also discussed the importance of calculating and reporting the "design effect" (DEFF)[3] calculated for different vaccination indicators; this DEFF will help inform the design of future surveys.

Key points of the presentation were that:

- Many indicators have been developed to characterize the quality of vaccination coverage
- The survey steering committee should, early on, develop an analysis plan with tables and figures to be produced from the analysis, to ensure that the right questions are included to yield the data needed for analysis
- Software that uses weights and accounts properly for the sampling design should be used. This includes calculating proper confidence intervals for proportions (e.g., modified Wilson)
- The indicators that estimate population level coverage should be weighted
- Some indicators may be unweighted, but this needs to be clearly written in the methods section of the survey protocol and report
- Indicators should be clearly defined and described in the in the methods section of the survey protocol and report
- The tool VCQI is available to support survey analysis (see section below).

[3] See survey vocabulary in annex 3.

The vision for VCQI includes separating analysis code from survey details, defining formats for datasets and survey metadata, testing code with datasets and metadata from different surveys, and defining a process for new code. VCQI also makes code open source so that others can modify and contribute. Indicators clearly define inclusion and exclusion criteria, role of survey weights, numerators and denominators, and how to calculate them.
The rest of the session had a demonstration of the VCQI tool, with its inputs and outputs.



Currently, VCQI calculates indicators for:

- Routine immunization (RI) surveys (18)
- Tetanus protection at birth surveys (TT) (1)
- Post-SIA coverage surveys (4)
- Dataset description (3)
- Coverage differences (2)

A module for importing data from other surveys such as DHS and MICS is being developed.

On day 3, participants were exposed to the Forms and Variable Lists Structured for Compatibility with VCQI. The types of inputs needed for VCQI include relational databases, variable names vs description, variable code vs label, and the uses of a data dictionary were presented. Also, an overview of control program sections, and how they affect and control outputs, was given. VCQI is expected to be used to analyze a database that has been previously "cleaned" (and that cleaning, well documented).

Finally, most participants were able to install Stata 14 and run VCQI using actual datasets from DHS Cambodia 2014; MICS Nepal 2014 and MICS Thailand 2012.

The VCQI tool and user's guide were made available to participants and updated versions will be continuously added to the training DropBox. Furthermore, in annex 6 you can find short guide on "What VCQI Output should I Look at First?"

"Additional" Analyses

During the last day of the training, participants were presented some "additional" analyses, such as those related to availability of home-based records or cards (ever received a card vs. card seen at time of survey), drop-outs, vaccination timeliness, simultaneity and missed opportunities for vaccination. Each group run different analyses (from DHS Cambodia 2014; MICS Nepal 2014 and MICS Thailand 2012 datasets) and presented their finding to the rest of the team. This session was highly interactive and many suggestions to design additional studies or surveys to better understand some of the findings were proposed. Given that all participating countries are planning a survey that will contain vaccination indicators, it is expected that some of the outputs produced and discussions had, help inform the design of those upcoming surveys.

What's next?

To conclude the training, participants were invited to stay in contact and share their experiences. In case of upcoming vaccination coverage surveys, or if secondary analysis of existing surveys such as MICS or DHS are proposed, facilitators from this training can serve as mentors to the participants. Similarly, participants with experience related to vaccination coverage surveys may also serve in a mentorship role to others.

Finally, participants were encouraged to join TechNet-21 where they can share experiences and take advantage of an existing Resource Library that includes survey-related material. It can be viewed at http://www.technet-21.org/en/resources/vaccination-coverage-surveys See annex 7.

It was observed that it is important to make immunization data publicly available and encourage epidemiologists knowledgeable in VCQI to analyze these datasets ("crowdsourcing" to a certain extent) who may bring up elements of analysis not have conducted during the initial analysis in order to share with the relevant countries.

Certificates of participation and assessment

At the conclusion of the workshop participants were given participation certificates and "VCQI tee-shirts" (pictures are available in the DropBox). They were also asked to complete an overall rating for the workshop experience and a retrospective self- assessment, where participants rated their skill level of various tasks before the training and after the training. (Annex 8). The overall rating, collecting feedback related to the overall organization and functionality of the workshop, was extremely positive; main suggestions were to have more practical exercises and maybe a longer workshop to bring people up-to-speed with some tools like Stata. The summary of the evaluations is available in the training's DropBox.

Annex 1. Training Agenda

Training for the Comprehensive Analysis of Vaccination Coverage Surveys

Hotel Radisson, Kathmandu, Nepal

21-24 February 2017

Since the early 1990s, the World Health Organization (WHO) has provided guidance to Member States, partner agencies and institutions on methods for measuring immunization coverage through surveys. With the goal of improving survey precision, accuracy, and overall quality, an extensive review and revision of coverage survey methods and materials resulted in the release, in 2015, of the working draft of WHO Vaccination Coverage Cluster Survey Reference Manual. While the statistical methods outlined in the Survey Manual, particularly related to probability sampling, are commonly used on large households health surveys, such as Demography and Health Surveys (DHS) and UNICEF's Multiple-Cluster Indicator Surveys (MICS), Immunization Programmes are less familiar with them and will likely lack the expertise needed to properly conduct the sampling and analyses recommended in the Manual.

To help bridge Immunization Programmes and institutions conducting health surveys, WHO's Expanded Programme on Immunization (EPI) is developing tools to facilitate the management, analysis, presentation and interpretation of immunization survey data. One of these tools, "Vaccination Coverage Quality Indicators (VCQI)" is set of Stata programs intended to be used by statisticians and epidemiologist to analyse survey data; and for programmers to add further modifications and additional analysis indicators. VCQI allows conducting analysis not only from surveys done using WHO Vaccination Coverage Cluster Surveys, but also from existing survey databases, such as DHS, MICS and others.

WHO is seeking to strengthen countries' capacities to enhance the use of existing survey databases to conduct secondary analyses of interest to immunization programmes, such analyses include vaccination drop-outs, timeliness, simultaneity, and missed opportunities for vaccination. These capacities will also help promote capacity-building on survey statistics in countries where vaccination coverage surveys are to be implemented in the near future.

Target Audience:

Persons working on Immunization and statisticians or field epidemiologists with strong analytic or statistics skills with experience in immunization, and senior statisticians from fields other than public health.

Training goal:

To train persons working on Immunization and a cadre of statistics professionals who, in partnership with Immunization Programmes, can conduct secondary immunization analyses from existing surveys. These professionals can then be also mentored to become in-country partners or consultants for vaccination coverage survey design and implementation using the 2015 working draft of the WHO Vaccination Coverage Cluster Survey Reference Manual.

Training objectives:

After completing this training, it is expected that participants will be able to:

6. Understand the recommendations from the WHO Vaccination Coverage Cluster Survey Reference Manual
7. Recognize not only the most common immunization indicators obtained from vaccination coverage surveys, but also other indicators that can provide further insights into the performance of Immunization Programmes
8. Use weighting for data analysis, as appropriate
9. Adapt and use the "Vaccination Coverage Quality Indicators (VCQI)" to analyse existing survey data, and
10. Help plan and implement Vaccination Coverage Cluster Surveys

Training Agenda

Tuesday 21 February – Chair – Dr. Mamadou Diallo (UNICEF)

Time	*Topic*	*Facilitator/ Speaker*
7:30 – 8:00	Registration	
8:00 – 8:30	Welcome	Dr. Jos Vandelaer, Representative WHO Nepal Dr. Rownak Khan, Dy. Representative UNICEF Nepal Dr. Bikash Lamichhane, Director Child Health Division, DOHS, Gov. Nepal
8:30 – 9:00	Training agenda, objectives Introductions, icebreaker and introduce parking lot Practical information / announcements	Dr. Carolina Danovaro (WHO) Carine Cruz (WHO)
9:00 – 10:00	Briefing on immunization and vaccine-preventable diseases Why we assess vaccination coverage	Carolina Danovaro (WHO)
10:00 – 10:30	Coffee Break	

10:30 – 11:00	Setting the stage: Current survey recommendations for immunization and the new WHO vaccination coverage survey manual; schedules – map of the Manual	Carolina Danovaro (WHO)
11:00 – 12:00	Accuracy and precision. Survey design elements: strata; sample size (estimation vs. classification, balance between No. of clusters and number of persons in each cluster and relation to ICC); bias; quality control and checks; costs; etc	Tony Burton (Consultant) and participative presentation
12:00 – 12:15	Q&A	
12:15 – 13:45	Lunch Break	
13:45 – 15:15	Types of surveys – DHS, MICS – Health surveys (E.g., Indonesia) – Vaccination Coverage Surveys – EPI surveys (E.g., China) – Differences between Vaccination Coverage Survey and DHS/MICS Moderated discussion using a template	Mamadou Diallo Carolina Danovaro
15:00 – 15:15	Stretching	Dale Rhoda
15:15 – 16:45	Overview of weighting, weights in DHS, MICS, WHO coverage survey, calculating Design Effect (DEFF)/DEFT and Intra-cluster Correlation (ICC) Exercise	Mamadou Diallo and Dale Rhoda Facilitators: 1. Mamadou Diallo 2. Dale Rhoda – Tony Burton 3. John Wagai – Carolina Danovaro 4. Augusto Llosa – Tom Albani
16:45 – 17:00	Wrap-up and session assessment - What went well today? What can be better tomorrow?	Carolina Danovaro
17:00	Coffee	

Wednesday 22 February – Chair: Dr. John Wagai (Consultant)

Time	*Topic*	*Facilitator/ Speaker*
8:00-8:45	*Coffee with facilitators re: weighting (optional)*	Dale, Mamadou
8:00-8:45	*Coffee with facilitators re: From the EPI perspective, on survey design – strata, schedule, cohort to be included (optional)*	Carolina, Tony
8:45 – 9:00	Q&A from previous day	Mamadou Diallo
9:00 – 10:30	Commonly used immunization indicators obtained from vaccination coverage surveys,	Tony Burton (Consultant)

	including coverage (%, Confidence Intervals, Design Effect) and issues around coverage (crude and valid coverage, etc) – different schedules Calculation of crude vaccination coverage – Documented (card, register in health facility); Recall; Card + recall – Zero dose – "Fully *vaccinated*" – Management of missing data and "don't know responses" Presentation and group work (4 groups) using questionnaires and report tables (*variables for weight calculation also)	Facilitators
10:30 – 11:00	Coffee Break	
11:00 – 12:30	Table shells (outputs) Group work using questionnaires and report tables	Tony Burton and John Wagai Facilitators
12:30 – 14:00	Lunch Break	
14:00 – 15:00	Data analysis – Overview – Chapter 6 from vaccination coverage survey manual – Introduction to VCQI – Steps to prepare, run, interpret, troubleshoot	Dale Rhoda (Consultant)
15:00 – 15:15	Coffee Break	
15:15 – 16:45	Vaccination Coverage Quality Indicators (VCQI) – Initial exercise – Look together at some VCQI output (already prepared) – Run example control program & generate output (tables, log and augmented database) Change control program & see effects	Dale Rhoda and Tom Albani Facilitators
16:45 – 17:00	Wrap-up and session assessment	John Wagai
18:30	Welcome Cocktail	

Thursday 23 February – Chair: Dr. Augusto Llosa (Consultant)

Time	*Topic*	*Facilitator/ Speaker*
8:00-8:45	*Coffee with facilitators re: VCQI (optional)*	Dale, Tom

8:45 – 9:15	Q&A from previous day	Dale Rhoda
9:15 – 10:45	Putting databases in VCQI-compatible format – Steps to prepare databases from DHS, MICS – Setting VCQI parameters Presentation and group work (groups of 4-5 participants)	Dale Rhoda and Augusto Llosa Facilitators
10:45 – 11:15	Coffee Break	
11:15 – 12:30	Inchworm and organ pipe plots. Examples	Dale Rhoda and Tony Burton Facilitators
12:30 – 14:00	Lunch Break	
14:00 – 15:30	VCQI control program sections in detail – Disaggregating by domain ("adding stratifiers" for analysis; e.g., coverage by sex, rural/urban, etc) – Run example control program & generate plots – DESC & COVG_DIFF indicators (examples of outputs)	Dale Rhoda Facilitators
15:30 – 15:45	Coffee Break	
15:45 – 16:45	VCQI continued – Running basic analyses (two countries)	Facilitators
16:45 – 17:00	Wrap-up and session assessment	TBD

Friday 24 February – Chair: Dr. Carolina Danovaro (WHO)

Time	*Topic*	*Facilitator/ Speaker*
8:00-8:45	VCQI continued… Running basic analyses for each country and putting them in a template (optional)	Facilitators
8:45 – 9:15	Q&A from previous day	Augusto Llosa
9:15 – 10:30	Overview of additional analysis (weighted, unweight, CI, DEFF) – Valid coverage – Timeliness – Simultaneity – Missed opportunities for vaccination	Carolina Danovaro & Dale Rhoda Facilitators
10:30 – 11:00	Group Photo and Coffee Break	
11:00 – 12:30	VCQI examples of secondary analyses using already prepared databases	Facilitators
12:30 – 14:00	Lunch Break	
14:00 – 15:00	Group "stories" using additional analyses (examples and proposals) and questions raised - Group work	Dale Rhoda Facilitators
15:00 – 16:00	Presentation of group work	Group representative
16:00 – 16:30	What's next?" – Mentoring and ongoing support – Conclusions Wrap-up and session assessment	Carolina Danovaro & Mamadou Diallo
16:30 – 17:00	Certificates and t-shirts	
17:00	Coffee Break	

Annex 2. Mapping of the Vaccination Coverage Manual

	Step	Manual Resources
Getting started	1. Assessing Need for a Survey	
	2. Creating Steering Group	Manual section 2.1
	3. Defining Survey Scope and Budget	Manual section 2.2-2.3, Annex B Manual section 2.9, Annex C
Planning	4. Setting Survey Schedule	Manual section 3.1
	5. Developing Survey Proposal	
	6. Confirming Funding is in Place	
	7. Deciding who will Conduct Survey	Manual section 3.2
	8. Finalizing Survey Protocol	
	9. Verifying Ethical Clearance	Manual section 3.3
	10. Designing Data Collection Tools	Manual section 3.4, Annex H
	11. Hiring Staff & Coordinating Logistics	Manual section 3.6
	12. Selecting Sample	Manual section 3.8, Annexes D to F
	13. Training Staff	Manual section 3.9, Annex G
Implementing	14. Conducting Field Work	Manual section 4.1 – 4.5
	15. Entering, cleaning & Managing Data	Manual section 5.1-5.5, Annex I
	16. Analyzing Data	Manual section 6.1 – 6.5, Annexes J to O
Taking action	17. Interpreting and Sharing Survey Results	Manual section 7.1-7.7

Annex 3. Survey vocabulary

term	definition
1. Bias	Tendency of a sample statistic to systematically over- or under-estimate a population parameter
2. Cluster	A collection of elements grouped within defined geographical or administrative boundaries
3. Design Effect	A measure of variability due to selecting survey subjects by any method other than simple random sampling.
	=1+ (*m*-1) x ICC where *m* is the average number of respondents per cluster
4. Effective Sample Size	The number of simple random sample respondents that would yield the same magnitude of uncertainty as that achieved in the complex sample survey
5. Intracluster Correlation Coefficient (ICC)	A measure of within-cluster correlation of survey responses
6. Precision	A measure of how close estimates from different samples are to each other; estimated by the standard error from a single survey.
7. Primary Sampling Unit (PSU)	The group of respondents selected in the first stages of sampling
8. Probability Based Sample	A selection of subjects in which each eligible respondent in the population has a quantifiable and non-zero chance of being selected
9. Probability Proportional to Estimate Size (PPES)	Sampling method for clusters where the selection probability for an individual cluster is related to the estimated size of that cluster
10. Sampling Error	Estimated uncertainty due to observing the measure of interest on a random subset of the target population
11. Sampling Frame	A list of names, places, or other items to be used as sampling units
12. Sampling with Replacement (WR)	Method that allows a unit to be sampled more than once
13. Sampling without Replacement (WOR)	Method that insures that a unit can only be sampled at most one time
14. Self-weighting Survey	A survey where the selection probability of each observational unit is the same (also known as EPSEM=equal probability sampling method).
15. Simple Random Sample (SRS)	A sample drawn from a set of eligible units or participants where each unit or participant has an equal probability of being selected
16. Stratification	Population is divided into exhaustive and *mutually exclusive* subgroups for the purpose of controlling the allocation of the sample to these subgroups, e.g. urban and rural
17. Two Stage Cluster Sample	A sample in which clusters are selected randomly, and then within each selected cluster a subset of eligible respondents is selected to be interviewed
18. Weight	An estimate of the number of population units represented by a given sampled unit
19. Type I Error	Rejecting the null hypothesis when in fact the null hypothesis is true
20. Type II Error	Failing to reject the null hypothesis when in fact the null is false

Annex 4. Main differences between the "old" and the "new" (2015) WHO Vaccination Coverage Surveys

	"Old" EPI Cluster Survey	**"New" Vaccination Coverage Cluster Survey**
Sampling	Non-probabilistic sampling, analysis gives equal weight to every respondent (non-interpretable confidence intervals)	Probabilistic sampling, weighted analysis and meaningful confidence intervals
	Data collectors select households to visit and randomly select first dwelling using spin the pen/bottle technique	Households (HHs) to be interviewed are pre-selected (*requires good maps and usually field visits prior to interviewers field work*)
	Usually 30 clusters of 7 *children* each (quota sampling)	Sample size defined according to survey objectives (estimation, hypothesis testing or classification). Pre-defined number of *HHs* to find an *approximate* number of children in each cluster
	Assumed design effect (DEFF) of 2 (intra-cluster correlation of 1/6)	Recommends DEFF depending on number of eligible people per cluster
	No attempts at revisits No attempts at revisits recommended recommended	Recommends at least two revisits to obtain interviews in pre-selected HH; document outcomes of each visit
Vaccination Status	Relies on home-based records (cards) and/or maternal recall	Relies on home-based records (cards) and/or maternal recall, but encourages visits to health care facilities to document vaccination using registries
		Recommends photographing cards
Data entry	Only paper forms included	Includes section of mobile data collection (using mobile devices)
Survey report	Not clear guidance on report writing	Encourages using the results for action Encourages detailed report writing to clearly understand limitations
Overall quality		Renewed emphasis on taking steps to ensure minimize bias and improve data quality

Annex 5. Suggested Report Outline

1. High level executive summary
2. Historical background section
    - The EPI (include vaccination schedule(s) that cover all birth cohorts targeted by the survey) and health sector in "COUNTRY".
    - If there have been recent changes in the national immunization programme—such as the introduction of new vaccines or changes in delivery strategy—or the health sector (e.g., introduction of universal health insurance), include in the historical overview.
    - Summary of recent administrative coverage data or disease outbreak description in the case of a post-SIA survey
    - Summary of previous vaccination coverage survey results
    - Justification to do this survey
    - Survey objectives (primary, secondary)
3. Survey methods
    - Sampling
        i. Target population and exclusions for practical reasons
        ii. sampling frames
        iii. sample size calculations
        iv. Selection methods at each stage
        v. Replacement methodology at each stage
    - Profile of implementing personnel
    - Training and piloting
    - Field work (data collection tools, pictures)
    - Ethical considerations
    - Data management (overview of issues related to data collection, segmented clusters with the necessary information, checking, storage and security, etc)
    - Weighting
        i. Overall base weight calculation
        ii. Weight adjustments (e.g. nonresponse)
    - Brief summary of the results in terms of sample sizes, response rates, etc. (unweighted or weighted depending on the tables)
        i. Final number of clusters (initial, replaced, non-respondent, etc.) by stratum
        ii. Final number of households (initial, replaced, non-respondent, etc.) by stratum
        iii. Final number of children (initial, replaced, non-respondent, etc.) by stratum
    - Analyses done
4. Results section
    - Summary of available info on those not included in the analysis (e.g., refusals, partial completes)
    - Description of sample

    - Summary of respondent background characteristics as appropriate
    - May want to put here issues about number of age-eligible children per HH estimated vs what was observed in each strata/cluster
  - Main results (include tables; graphs such as inchworm plots, if relevant; maps; and highlight main findings as text)
    - Vaccination cards given vs. seen and reasons (if collected)
    - Estimated coverage: crude, valid, zero dose
    - Drop-outs
    - Vaccination timeliness and simultaneity (as appropriate, eg. Penta3 together with OPV3, IPV1 and PCV3)
    - Missed opportunities for vaccination
    - Reasons for no vaccination
    - Factors associated with no/incomplete vaccination
    - Highlight clusters with an "alarmingly low" (define) number of vaccinated people (if any)
5. Discussion section, with strengths and limitations and implications of limitations (eg. Likely bias towards lower/higher coverage)
  - In design (examples of limitations: sampling frame, maps, sampling size too big for SIA, training-related issues and what was done to reduce)
  - In implementation (examples of limitations: selection of eligible persons; data collection; boundaries and not being able to use the GIS features of tablets; any inaccessible areas that had to be excluded from the sampling frame inaccessible clusters at the time of visit; any difficulties extracting vaccination data from home-based records; low percentage of documented vaccination, especially for SIA)
6. Implications and recommendations
  - Main recommendations based on the results.
  - Examples:
    - Clusters with an "alarmingly low" number of vaccinated people
    - Significant lower coverage some districts compared in the rest of the country
    - Drop-out
    - Low card distribution and/or availability, variety of cards? Forms not separating different vaccines (for example, pentavalent together with OPV in the daily form)?
    - Private vs public sector?
7. Annexes

All survey materials (including questionnaires, sketch maps for selected clusters, material related to selection of field staff including terms of reference, field staff training agendas and tools, Standard Operational Procedures (SOPs), letters of introduction from government to local leaders, final ethical review approval correspondence, etc.)

Annex 6. What VCQI Output Should I Look at First?

1. What % of children are fully vaccinated with valid doses by age 1 (RI_COVG_03)?
   If high, **report the good news and maybe look no farther.**
   If low or medium, then **continue through this list**.

2. What % of children are fully vaccinated per crude coverage (RI_COVG_03)?
   If high, **report the good news** and investigate why the doses are listed as crude but not valid. Is it because card availability is low and the doses are per caretaker recall, or is card availability high and the dates are available, and the evidence indicates there are many invalid doses?
   If low, **make a plan** to address low coverage.

3. What % of children ever received a card? (RI_QUAL_02)
   If high, **report the good news.**
   If low, **make a plan** to address card distribution.

4. What % of children showed a card? (RI_QUAL_01)
   If it is = the % who received one, **report the good news.**
   If it is lower than % who received one, **make a plan** to address card retention.

3. How high is crude coverage? (RI_COVG_01 & RI_ACC_01)
   If high, **report the good news.**
   If low, **make a plan** to address coverage.
   If low for the early doses, **make a plan** to address access to vaccination services.

4. If crude coverage for early doses is high, look at drop-out (RI_CONT_01).
   If low, **report the good news.**
   If high, **make a plan** to address drop-out.

5. If crude coverage is high:

   What is valid coverage compared with card/register availability? (RI_COVG_02 vs RI_QUAL_01)
   (In the best case, the % of valid doses will = the % of children with card or register)

   If valid coverage is low compared with card/register availability, **find out why:**
   a) Data on cards are ticks instead of dates (Data quality report)
   b) Doses given early (RI_QUAL_03 & RI_QUAL_04)
      If low, **report the good news.**
      If high, **make a plan** to address.
   c) Doses with too short an interval (RI_QUAL_05)
      If low, **report the good news.**
      If high, **make a plan** to address

If valid coverage is nearly as high as card/register availability, **report the good news and go on to check:**

Are the doses given in a timely manner? (RI_QUAL_06 & RI_QUAL_13)
If yes, **report the good news.**
If not, **make a plan** to address.
Are the intervals long-enough (RI_QUAL_05) but not too long (RI_QUAL_12)?
Are there a substantial number of missed opportunities for simultaneous vaccination (RI_QUAL_07, RI_QUAL_08 & RI_QUAL_09)?
If yes, **make a plan** to address missed opportunities.
If no, **report the good news**.

Note that for each of the indicators mentioned here, you can use both geographic sub-regions and demographic sub-groups to investigate whether performance is uniformly good/poor or whether it varies by region or by sub-group.

Revised 2017-03-15
Please send comments or feedback to Dale.Rhoda@biostatglobal.com

Annex 7. TechNet Resource Library

The TechNet Resource Library (TRL) is an online repository of journal articles, documents, tools, websites, and other immunization resources. It includes about 1000 entries relating to Immunization Information Systems (IIS) and it includes a powerful search tool.

Also, recently a new page with **survey-related material** is now available and can be viewed at http://www.technet-21.org/en/resources/vaccination-coverage-surveys.
To visit the TRL you need to sign up to TechNet.

- Go to the following link and register for Technet-21 (takes 2 minutes): http://www.technet-21.org/register-new-users
- Once you are registered, you will receive administrator/moderator's approval and will be ready to go.

Some of the key features within the TRL are:

- Browse and search according to your information needs
- Add and share your own resources with a wide network of immunization professionals
- Create collections of your favourite resources and share them with your colleagues

Annex 8. Evaluation forms

Name (optional) _____

Training for the comprehensive analysis of vaccination coverage surveys

Workshop Evaluation

Please help us support you by responding to the following statements:

In regard to the course topics taught, HOW ABLE ARE YOU to put what you learned into practice on your job?
A. I am NOT AT ALL ABLE to put the concepts into practice.
B. I have GENERAL AWARENESS of the concepts taught, but I will need more training/practice/guidance/experience TO DO ACTUAL JOB TASKS using the concepts taught.
C. I AM ABLE TO WORK ON ACTUAL JOB TASKS, but I'LL NEED MORE HANDS-ON EXPERIENCE to be fully competent in using the concepts taught.
D. I am ABLE TO PERFORM ACTUAL JOB TASKS at a FULLY COMPETENT LEVEL in using the concepts taught.
E. I am ABLE TO PERFORM ACTUAL JOB TASKS at an EXPERT LEVEL using the concepts taught.

In regard to the concepts taught, how motivated WILL YOU BE to USE these skills in your work?
A. I will make this one of my HIGHEST PRIORITIES when I get back to my day-to-day job.
B. I will make this a HIGH PRIORITY when I get back to my day-to-day job.
C. I will make this a MODERATE PRIORITY when I get back to my day-to-day job.
D. I will make this a PRIORITY-BUT A LOW PRIORITY- when I get back to my day-to-day job.
E. I will NOT MAKE THIS A PRIORITY when I get back to my day-to-day job.

We want to help you succeed in regards to design and analysis of vaccination coverage surveys.

Do you feel like you know where/how to get help or support if needed? Y/ N

As you apply what you learned and to maintain a peer support network (support from people in the training), what is your preferred format for technical support? Check all that apply.

	e-learning		WhatsApp		Web-based platform		Email communications
	Mentors		Teleconferences		In-person workshops		Other (describe)

Overall, what is your opinion of the workshop?

How could the workshop be improved?

BEFORE THE WORKSHOP				RATE YOUR ABILITY TO	NOW, AT THE END OF THE WORKSHOP			
1 Poor	2 Fair	3 Good	4 Excellent	1. Understand the main recommendations from the 2015 WHO Vaccination Coverage Cluster Survey Reference Manual	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	2. Understand the importance of knowing well the country vaccination schedule to design, analyze and interpret vaccination survey indicators	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	3. Understand the relationship between accuracy and bias	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	4. Identify sources of bias (selection, ascertainment) in vaccination coverage surveys	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	5. Develop some concrete actions to reduce potential bias (sampling, training, supervision, etc)	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	6. Understand the difference between survey accuracy and precision	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	7. Get a sense of the main drivers of sample size	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	8. Identify types of surveys that collect immunization data	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	9. Review a data collection form for quality (for immunization data)	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	10. Design a database appropriate for the survey	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	11. Understand the importance of calculating weights for survey analyses	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	12. Understand the importance of calculating and reporting design effect (DEFF) and/or intra-cluster correlation coefficient (ICC)	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	13. Describe common immunization indicators (crude coverage, valid coverage, zero doses, "fully vaccinated", drop-out rates)	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	14. Interpret data in tables from MICS and DHS surveys	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	15. Use chapter 6 (of the WHO Survey Manual) for survey analyses	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	16. Interpret basic Vaccination Coverage Quality Indicators (VCQI) outputs	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	17. Conduct survey data analysis using VCQI	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	18. Identify some secondary analyses that can be done from DHS, MICS, other health surveys and EPI survey databases	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	19. Describe the importance of having dates of birth and vaccination for vaccination analyses	1 Poor	2 Fair	3 Good	4 Excellent
1 Poor	2 Fair	3 Good	4 Excellent	20. Know who to contact to get survey support	1 Poor	2 Fair	3 Good	4 Excellent

Name (optional) _____