Annex: Programme Targets (Denominators)

Subnational Level

8

Basic examples of triangulation to assess programme targets for the district and health facility levels

World Health Organization, UNICEF, & U.S. Centers for Disease Control and Prevention

TRIANGULATION FOR IMPROVED DECISION-MAKING IN IMMUNIZATION PROGRAMMES
Working document: July 2020

Background

Triangulation is the synthesis of two or more existing data sources to address important questions for programme planning and decision-making.

Triangulation can include putting different data together in one graph, or stitching information from several graphs together with a story. Triangulation requires critical thinking and basic analysis skills, but the activity goes beyond making graphs — it's about turning data into reliable information for action.

This guidance will walk you through an example of using the 4-step triangulation process for **assessing programme targets** at the **district or facility level.** Other guidance can be found at https://tinyurl.com/triangulation-July2020.

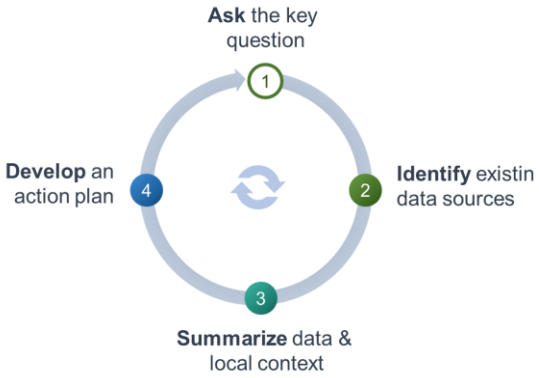


Fig. The 4-step EPI data triangulation process, starting with a key question and ending with action. The process can be repeated in cycles.

INTRODUCTION

Accurate target population estimates (denominators) are necessary to calculate immunization coverage from reported data on vaccine doses administered. Additionally, reliable target population estimates are needed for program planning (e.g., vaccine forecasting, scheduling of outreach sessions) and monitoring to find zero-dose people.

Issues with denominator accuracy can be suggested by coverage greater than 100%, inconsistencies in reported denominators, and disease outbreaks in areas with high reported coverage. Reasons for denominator challenges vary.

QUESTIONS TO ASK

- Are there issues with the accuracy of target population in my area?
- If so, how is this problem impacting program work?
- Are local targets thought to be overestimated or underestimated?

Examples of reasons for inaccurate target population estimates

- Urbanization, migration, seeking care across geographic borders
- Outdated or inaccurate census estimates (groups not counted)
- Inaccurate methods of census projection or other estimation
- Insufficient demographic knowledge among programme planners
- Suboptimal processes to monitor and improve data quality
- Artificial inflation/deflation related to incentives to achieve targets, especially if targets based on previous year's achievement

Can microplan figures or methods be changed?
If target estimates are overestimated, is a target reset feasible?
For underestimated targets, are staff willing to use higher targets?

Population estimation is a challenging process for most public health programmes, especially in smaller areas and in high-coverage settings, where the numerator and denominators are close and a high degree of precision is required. Denominators are often outside of the control of the immunization programme, and any adjustments likely need agreement from the Ministry of Health and national statistics office.

Challenges in target population accuracy can be more deeply understood and addressed, in part, by comparing different data sources for your target population, or annual growth rates, crude birth

rates (CBR), and infant mortality rates (IMR).[1] Considering the demographic trends in your area and who may be excluded from microplanning is also important (e.g., migrants, nomadic populations).

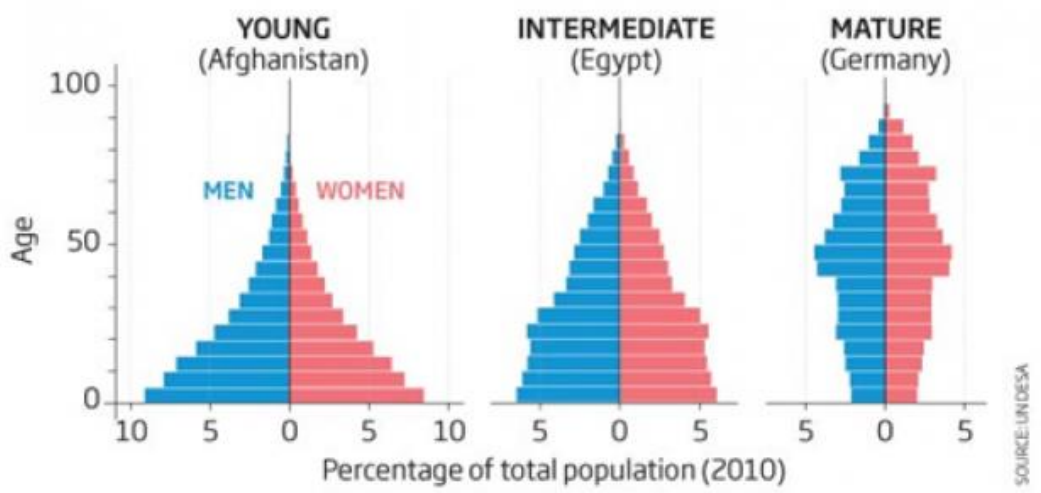
This guide will describe how data triangulation at the operational level (e.g., district or health facility) can help identify limitations with any one of these components and the impact on your target population estimate. Finding potential solutions to issues with target population will enable staff at the operational level to advocate to decision makers that the current estimates need to be amended.

ASK the key question

Example: What is the problem?

In Country X, the total population is growing because people are living to older ages, while births are likely decreasing each year (–0.71%, according to United Nations Population Division) because of where the country is within the "demographic transition" (Figure). However, the *infant* immunization target has increased annually (+1.42%) because a fixed *total* population growth rate (1.37%) is applied during health facility microplanning. Subnational variation in growth rates related to differences in birth rates, infant mortality, and migration patterns are also not accounted for, resulting in errors in local programme targets.

Figure. Demographic transition related to changes in birth and death rates (Source: Reardon. New Scientist, 2585; 19 May 2012)



The target populations for most vaccines in the immunization programme are numbers of births (e.g., BCG vaccine) or numbers of surviving infants (e.g., other infant vaccines). Start by identifying method and the data source (e.g., census projections, or last year's BCG doses) used to estimate a denominator (births and/or surviving infants) for calculating coverage at your level. Also clarify whether this is the same or a different data source used for microplanning at health facilities.

[1] Annual growth rate is the percentage change in the target estimate between consecutive years. CBR is the total number of live b total population. IMR is the number of deaths among children aged <1 year per 1,000 live births.

Knowledge of how your target population is derived (e.g., applying growth rates or IMR, adding left-outs) can help you identify relevant questions to frame your triangulation analysis. There may be known issues about the immunization target population in your area. Developing specific questions based on common problems you have experienced could help direct the analysis and/or make it more relevant for your work. Example of key questions are listed below.

Examples of key questions
Do the current target population values capture everyone in a catchment area?
Are trends in reported denominators for my area aligned with known demographic trends?
Are there alternative population data sources that could be used for local programme target estimates?

- How do you understand the target for your level to be estimated?
- Are both births and surviving infants used for calculating coverage?
- Do facilities use the same or different denominator source?
- By level, do practices for denominator estimation differ from official policy?

Example: What is the key question?

Health Facility Y is a peri-urban health complex in an area with increasing urbanization and migrants coming for industrial work. The District EPI focal point notices that the facility target estimate rose from 29,028 in 2018 to 32,484 in 2019, a 12% increase. They believe the microplan was conducted the same way during both 2018 and 2019 by the following calculation: *doses from highest antigen provided in previous year plus a national growth rate of 1.37%*.

The District EPI focal point decides to conduct a triangulation analysis of 5 years of data to assess annual growth rates and if there is evidence of a recent in-migration affecting the target population in Health Facility Y. Their question: ***Is there a demographic change in my area that is impacting the target population of Health Facility Y?***

IDENTIFY existing data sources

Estimated numbers of births, crude birth rates, and infant mortality rates can usually be found in demographic statistics publications. Meet with the local health, statistics, and civil registration and vital statistics (CRVS) offices to confirm your geographic catchment area and discuss available data sources for your area. When possible, you should collaborate with them throughout the triangulation exercise. Obtain local population data sources corresponding to your geographic catchment area for ≥5 years.

Estimations of live births can be made using local crude birth rates and total population estimates (Formula Box). Estimated numbers of surviving infants must usually be calculated from estimated numbers of births and infant mortality rates. Use of a fixed conversion factor (e.g., 3% infants in total population) will result in errors in estimates and is not recommended because of variation by time and area.

Growth rates may be available for your local area. However, use of age-specific growth rates (births, infants, or 0–4 years) is advised because of differences with that of the total population. Annual

- Does the geographic catchment boundary differ from what was expected?
- Are there any additional data sources available to estimate infant targets?
- What is the reliability of these new data sources?
- Are there any local estimates of infant growth rates?
- Are there special populations in my area? How have they been accounted for (or not) in each data source?

growth rates can be calculated from annual targets in two consecutive years (Formula Box).

There is considerable variation in demographic trends across sub-national levels, related to differences in birth rates, infant mortality, and migration patterns. You are likely familiar with some of the dynamics happening in your area, but a discussion with your local statistics office can help inform the exercise. Be sure to consider relevant contextual information and local knowledge about demographics in your area (e.g., a recent big event that may have impacted local demographic trends).

For the different sources, try to understand when and how each was collected because this may change how you interpret your findings. Projections from censuses conducted more than 10−15 years ago are less reliable for use and other population estimate data sources may be considered (See "Possible population data sources" box below). Consider data quality, persons potentially excluded from the estimate, and how or if estimates account for annual changes.

Possible population data sources

- Census projection estimates
- Civil Registration and Vital Statistics (CRVS) or other birth registration
- Sample registration systems or health and demographic surveillance sites
- Household demographic surveys (include CBR, IMR)
- Electronic Immunization Registries
- Local micro-censuses and house-to-house heads counts
- Routine immunization programme (microplan, BCG, Penta1, PCV1, OPV1 doses)
- Supplementary Immunization Activities (microplan, coverage)
- Other programme data, e.g., campaign (polio, measles, Vitamin A, deworming), antenatal care, family planning, school or voting enrollment
- Modeled estimates (e.g., based on Geographic Information Systems, GIS)

Formula Box

$$Live\ Births = Total\ Population \times Crude\ Birth\ Rate\ /\ 1000$$

$$Live\ Births_{Year\ 2} = Live\ Births_{Year\ 1} \times (1 + Birth\ Growth\ Rate)$$

$$Surviving\ Infants = Births \times (1 - Infant\ Mortality\ Rate)$$

$$Birth\ Growth\ Rate^{2} = \left(\frac{Births\ in\ Year\ 2}{Births\ in\ Year\ 1}\right) - 1$$

$$Infant\ Mortality\ Rate = \frac{(Births - Surviving\ Infants)}{Births} \times 1000$$

[2] This growth rate formula is for consecutive years. To calculate an annual growth rate from non-consecutive years (e.g., census projections for 2016 and 2020), you can use the following, where *ln* is natural logarithm and *n* is number of years:

$$Growth\ rate = \frac{ln(Births\ in\ Year_{n}\ /Births\ in\ Year_{0})}{n}$$

Example: What are the key considerations for existing data sources?

Health Facility Y has the following data sources for EPI target estimates to use for triangulation:

Data Source	Key Considerations for Data Source
Census projections from 2014*	Uses outdated catchment areas; uses a national growth rate of +1.31%
Census projections from 2017*	Uses a national growth rate of +1.31%
Microplan target estimates	Based on highest antigen given in the previous year plus a national total population growth rate of +1.37%; Health Facility Y does not usually account for outsiders/left-outs during microplanning
Reported target in DHIS2	A monthly immunization target for all vaccines is reported in the online DHIS2 system. These numbers could include any updates made to the microplan, but also have data entry errors and missing data.
BCG doses administered	Used as the base estimate for microplanning exercise in Health Facility Y. BCG is given at birth so is often the highest reported antigen, but can be given at different locations than usual (e.g., hospitals).
Penta1 doses administered	Given soon after BCG at age 6 weeks, so good comparison with BCG.

**Note: In this example, the census projections include catchment areas down to the health facility. In many countries, census projections may only go down to the district level. Such considerations should be included analysis/interpretation.*

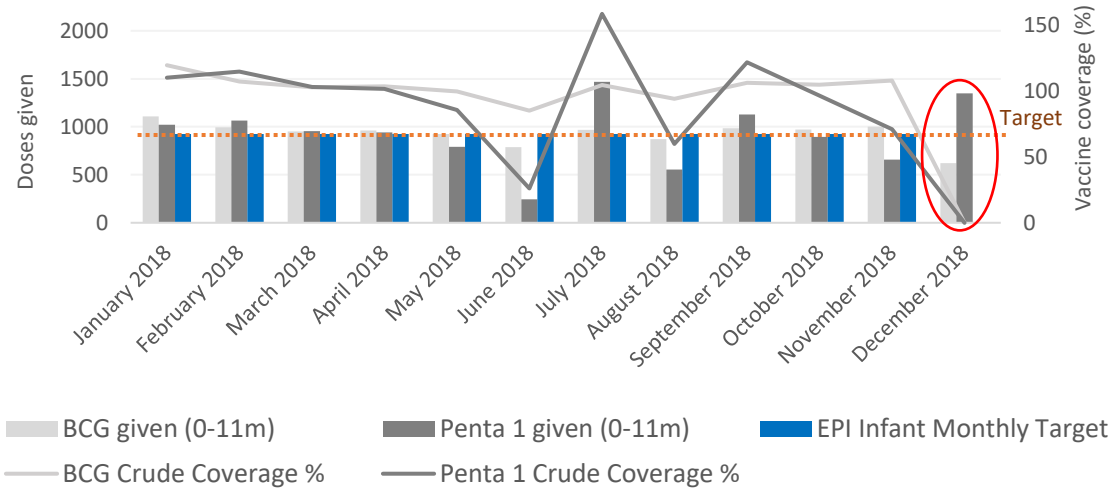
SUMMARIZE data and local context

Analyze data for each health unit before summarizing across that overall catchment area. Below are possible analyses. Note key findings for each analysis so that you can summarize and make conclusions.

A. **Examine quality of reported denominator, vaccine doses (numerator), and coverage by month and health unit.** Looking at time series will help check consistency and highlight any missing data. This is especially important if immunization programme data (e.g., BCG/Penta1 doses) is used for annual microplanning. Recommended checks include:

- Coverage >100%
- Large differences between BCG and Penta1
- Missing values for live births, surviving infants and vaccine doses
- Large outliers, compared to previous months reported data
- Consistency across denominators for non-BCG antigens (if separate denominators are used)

- Are patterns in reported data consistent over time?
- Are there health units with coverage >100%?
- Are live births or surviving infants missing for any months? Are doses given also missing?
- Are there any outliers?
- Why do you think this is occurring?



Example 1. Monthly time series of program target, vaccine doses (BCG and Penta1), and vaccine coverage, Health Facility X, 2018. In December, the program target (denominator) was missing but BCG and Penta1 vaccine doses (numerators) were reported. This data quality issue needs to be accounted for in calculating coverage and target estimate comparisons. Penta1 vaccine coverage is inconsistent over time (indicating a possible supply issue), so BCG doses are probably a better basis for 2019 estimates.

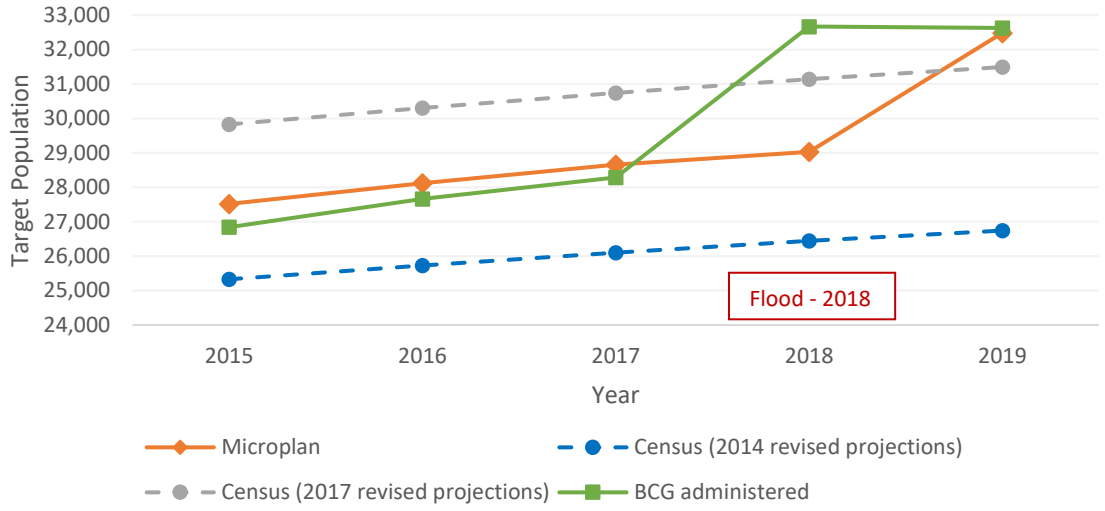
B. **Comparing target estimates with alternative population sources**. Evaluate immunization program data (e.g., previous microplan, BCG, Penta1) with other relevant population data sources (e.g., census, CRVS, birth registries) in a time series graph for 3-5 years (Example 2). Large annual changes (>10%) in estimates should be flagged. Across data sources, a percent difference of <10% is considered good agreement.

- How do absolute numbers & trends differ or agree?
- Are trends generally going up or down?
- How does this agree with local knowledge about demographic trends in the area (e.g., fertility rates, in- and out-migration)?

If local census projections are not available for births or surviving infants, you can multiply the local estimates of total population by the best estimate of CBR for your district (Formula Box). Updated CBR estimates should may be available in reports of demographic health surveys from the statistics office.

Example: 100,000 population x 18.9 births / 1,000 population = 1,890 estimated births

Example: Comparing Target Estimate Data Sources



Example 2. Comparison of target estimates from different data sources for Health Facility Y, 2015–2019.

The District EPI manager noticed that the microplan growth rate from 2018-2019 seems to reflect a large increase in BCG doses given in 2019. When discussing with Health Facility Y staff, they concluded that the reasons for this large increase in BCG doses administered and later increase in the 2019 microplan was caused by a large influx of people from a nearby area due to a flood. The health facility decided to calculate their own growth rate to revise the 2019 microplan to ensure they include this special population for 2019 services. The facility staff explained that they wrote a letter to the local administrators explaining the reason for the change.

By September 2019, the Health Facility noticed there is a decline in BCG doses administered. Some of this special population appeared to be returning to their place of origin. How would you deal with the issue of temporary migration in your target estimate?

Ranked order of reliability of population data sources

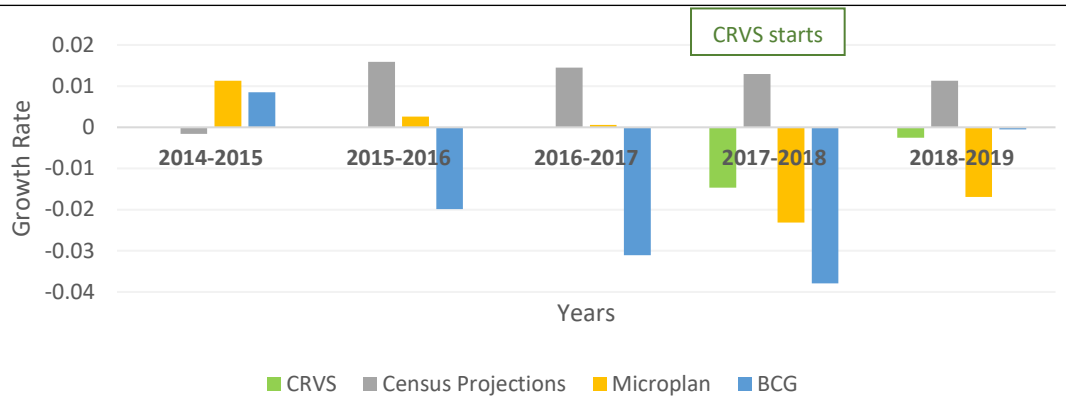
1. Births from CRVS or birth/immunization registry, if high proportion of births enrolled
2. Births from a demographic health surveillance site or sample registration system
3. Births from recent census projections (conducted within last 10–15 years)
4. Births estimated from: Total population projection x CBR (census <10–15 years old)
5. Projections of births from the census (conducted within last 10–15 years)
6. Local enumerations (e.g. community registers, head counts)

C. **Compute growth rates for various local population data sources** (see above) and make comparisons over time (Formula Box). It is recommended to graph as a time series of 3-5 years (Example 2). Compare your estimates to growth rates assumptions used during microplanning target estimation.

Where available and if permitted, use of local growth rates is preferred to using national growth rates because of subnational differences in demographic trends. For example, we know that birth rates in urban areas are lower than those in rural, but urbanization could also be at play. However, comparing local growth rates to national official birth growth rates and national estimates from World Population Prospects

- How do absolute numbers & trends differ or agree?
- Are trends generally going up or down?
- Which data sources agree and disagree?
- How does this agree with local knowledge of demographic trends in the area vs. national?

would be helpful benchmarks. Consider reasons why your estimates might be higher or lower than national estimates.

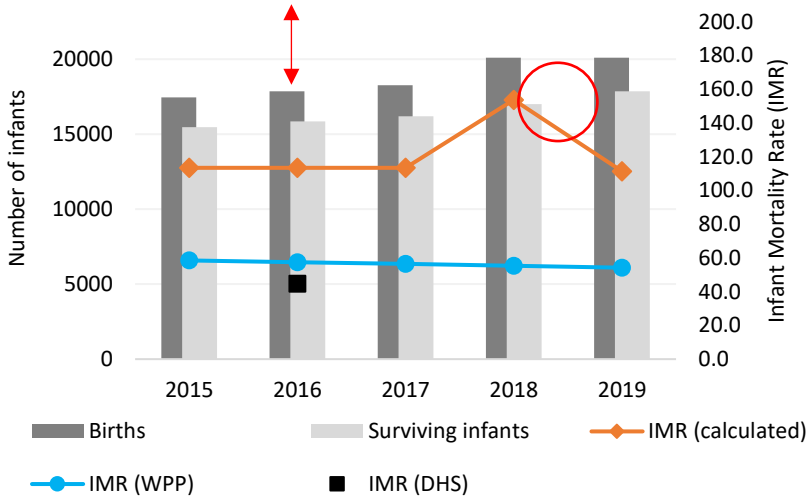


Example 3. Trend analysis of growth rates from different target population data sources for a Health facility X.

Health Facility Z is a well-performing area in a rural area. The District EPI manager noticed the microplan started decreasing in 2018. Analysis showed BCG doses given decreased starting in 2016, before the microplan decrease. In discussions with local staff, they observed that births in the area had been decreasing. They explained that a civil registration and vital statistics (CRVS) system started in 2017, with high quality (>90% of births registered in 45 days). Local staff trusted the CRVS system, and adopted the target, which also shows negative growth rates. The census projections show opposite trends (positive growth), but are based on data 8 years old, so more weight is given to the CRVS estimate. Other evidence that the local target estimates are appropriate include few confirmed measles cases, with all cases <9 months of age (ineligible for vaccination).

D. **Checking the implied Infant Mortality Rate** (IMR) provides a test for errors in estimated annual numbers of births and surviving infants. IMR can be calculated using the formula in the Formula Box. The implied infant mortality rate from the reported data needs to be compared to external data sources, such as Demographic Health Surveys (https://dhsprogram.com/Data/) or World Population Prospects (WPP, URL: https://population.un.org/wpp/).

- How do absolute numbers & trends differ or agree?
- Are trends generally going up or down?
- Which data sources agree and disagree?
- How does local IMR compare with regional/provincial or national rates?



Example 4. Annual births, surviving infants, and implied infant mortality rates (IMR) compared with provincial IMR from 2016 Demographic Health Survey (DHS) and national IMR from World Population Prospects (WPP), Health Facility Z, 2015–2019. The implied IMR calculated from annual births and surviving infant used in the health facility microplan is roughly twice the IMR from the provincial DHS estimate and national estimate estimated from WPP, which is decreasing yearly. A reporting abnormality occurred in 2018, with higher numbers of births reported relative to surviving infants.

E. **Consider who is being left out of microplans and vaccination.**[3] Use of service data is recommended only when census data are outdated enough that usable estimates are unfeasible (see Data Reliability Box on p.6). If using head counts or administrative vaccination data as a target, where the number of doses of BCG or Penta1 delivered last year becomes next year's target, an adjustment is needed to account for left-outs.[4] For example, the number of vaccine doses administered is divided by the most recent district coverage survey estimate for that antigen to get the adjusted target:

Example: 100,000 vaccinated / 0.95 coverage = 105,263 target

Adjusting for completeness of reporting or registration can be more complicated depending on assumptions of whether the facility was working at the same level during the missing reporting period as before and after.[4] If you have an absolute number of infants missed by the program (i.e., from name-based registration or tallies), these could be added to the estimate (instead of dividing by a %).

Reviewing the case-based measles surveillance data for the area can also help get a better qualitative understanding about the accuracy the area's reported coverage and who might be left-out (See also: Immunity Gaps Anne − 1B). For example, you could find many confirmed measles cases are coming from a local migrant workers camp or slum areas.

- How many confirmed measles cases were reported over the last few years?
- What is the age and vaccination status of confirmed cases?
- Are there many young children with zero or only one dose?
- Where do they reside?
- Do stock and supply data agree with reported denominators?

Other options are to review the stock and supply data for the area. Reviewing vaccine doses delivered and used is always useful as a check of immunization targets. It is especially useful to review data for single-dose vials of vaccine with low wastage rates. (See also: Performance Monitoring Annex – 1C). A potential danger of making large changes in immunization targets could result in vaccine stock-outs or over-supply for your area.

It is also important to discuss the issue of left-outs with health facility and staff to better understand the local context and policies. For example, local staff may have knowledge regarding which families or special populations are not accessing health services in their area (e.g., language berries, minority population, migrants). Be sure to ask about local policies for vaccinating special populations (e.g., migrants), including:

- Are these groups included in the target population estimate?
- Are these groups included in reporting of doses administered?
- How long does a migrant need to be in the area to be eligible for vaccination?
- Are there access or utilization issues in the catchment area?

[3] *Left-out* is the proportion of surviving infants who did not receive any doses of the specified vaccine.

[4] Formula for the adjustment is: $n_{adjusted} = n + n(1/c - 1) * k$, where *n* is the service output (vaccinations), *c* is reporting completeness, *k* is the adjustment factor. If missing reports are considered to indicate that no services were provided during the period, then *k* = 0 (no adjustment for incomplete reporting). If services are provided, but at a different level than before, incomplete reporting is an indication of a lower service provision and *k* is between 0 and 1 (Maina et al. 2017).

F. **Discussions with health facility staff and vaccinators performing outreach are usually helpful to inform interpretation**. For example, staff may say that their targets are too high and that they feel pressure to report more vaccinations than children exist. In settings where programme data (doses given) are being used for next year's targets, this can contribute to denominator inflation. On the other hand, local staff may express that their target is too low, resulting in frequent vaccine stock-outs.

- If there is disagreement between facility estimates with sum of estimates from lower levels, why?
- How do facilities calculate their targets?
- How were special populations or "outsiders" included in the estimate?

Review of outreach data is also important. The number of people vaccinated in outreach and trends (e.g., outreach coverage for 3-5 years) should be reviewed to adjust estimates and potentially change the number or locations of outreach sites.

Other checks that can be performed are to review the consistency of electronic or written annual microplans with reported monthly target data. If the method for determining microplan target estimates is noted, discussing what is done in practice can also be informative. Discussing how special populations and children seeking care at the facility but living outside the catchment area ("outsiders") are accounted for can also be informative. Another check is to confirm that sum of denominators for units within the catchment area equal the catchment estimate.

For urban and peri-urban facilities, it may be useful to organize discussions between neighboring facilities (e.g., one that delivers babies with one that does not). Discussions can include where catchment populations actually start vaccination and where they continue services. Some peri-urban facilities, for example, never reach their denominator because local populations get vaccinations in the urban area or private sector.

DEVELOP an action plan

After examining multiple data sources, summarize the key findings concerning denominators. Next, consider whether the findings from the denominator triangulation lead to actionable recommendations to improve the denominators in your area. Based on your understanding of the issues, develop simple key messages and potential actions for each level. Providing examples of issues and why it is important would be helpful to support your message. This may be known based on contextual information (such as evidence on demographic trends in the area, or having migrant workers' camps), or discussions with local staff.

- Can actions be taken based on the denominator triangulation findings?
- Is decision of higher authority needed to change the target?

This guide does not provide step-by-step method for how to improve denominator accuracy. However, approaches are covered in WHO Denominator guide and summarized in the box below.

Improving Denominators

- Choose an alternative target population estimate (see ranked order of data source reliability on p. 6)
    - Estimate births for future years using growth rates, if needed (i.e., not needed for census projections already accounting for growth)
    - Consider completeness of your estimate and adjust for left-outs (for programme data and birth registration data)
- Prorate for estimates for lower levels based on known commodity (e.g., vaccine doses given)
- Calculate surviving infants for lower levels from births

There are no "magic bullets" to fix denominators in the short-term. Consider the availability of resources and staff in charge of programme implementation when developing potential action items. Actions can be prioritized based on what is feasible for the short-term versus long-term, based on what will take more time to address. Consider the implications of any large changes to targets, e.g., potential vaccine stock outs. If issues related to training needs or data quality issues arise, opportunities to conduct supportive supervision might be relevant. Your action plan may also include conducting regular triangulation analyses in the future.

Denominators are often outside of the control of the immunization programme. If you decide you would like to change the denominator based on your analysis, discuss the rationale with higher level supervisor with decision making authority, including the ministry of health and national statistics office. If changes are made to the annual microplan, include the source of denominator and any changes made with a description of the rationale. If using a different data source or estimation methods for programme targets isn't possible, two sets of target estimates might be used: official figures for reporting purposes and operational figures for planning and implementation purposes. This should be discussed with local decision-makers to determine the best way forward.

Example: Taking Action

Country Z has highly unreliable EPI target estimates at the sub-national level resulting in inaccurate coverage estimates and frequent vaccine-preventable disease outbreaks, including recent vaccine-derived polio and measles outbreaks. After reviewing existing data, the programme concluded that routine immunization microplanning was mostly based on vaccine utilization data and significantly underestimated programme target populations.

The country had recently conducted consecutive rounds of supplementary immunization activities (SIAs). The programme decided to use microplan data from these SIAs to adjust population figures for routine immunization. Since SIAs enabled closer contact with communities, mobilization and higher demand, they allowed adjustment upward of target population for microplanning. Local staff were able to use these population figures use for operational planning purposes, while using official EPI estimates for reporting purposes.

Resources

WHO. Assessing and improving the accuracy of target population estimates for immunization coverage (2015 draft): https://www.who.int/immunization/monitoring_surveillance/data/Denominator_guide.pdf?ua=1

WHO. Handbook on the use, collection, and improvement of immunization data (June 2018 draft): https://www.dropbox.com/s/8ivdiu0g5xvnlbc/handbook.pdf?dl=1
[Updated version available by request at vpdata@who.int]

Analysis and use of health facility data: Guidance for Programme Managers (February 2018 working document) Available at: https://www.who.int/healthinfo/tools_data_analysis_routine_facility/en/

WHO. Data Quality Review (DQR) Toolkit (2019). Available at: https://www.who.int/healthinfo/tools_data_analysis/dqr_modules/en/

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PAHO. Tools for monitoring the coverage of integrated public health interventions: Vaccination and deworming of soil-transmitted helminthiasis (2017). Available at: http://iris.paho.org/xmlui/handle/123456789/34510

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Maternal and Child Survival Program (MCSP) Mozambique Program Brief: Addressing the Denominator Conundrum for Maternal and Child Health Programs: a New Methodology https://www.mcsprogram.org/wp-content/uploads/dlm_uploads/2019/01/MCSP-MZ-Brief-TargetPopulationMethodology.pdf

Stashko. Assessing the quality and accuracy of national immunization program reported target population estimates from 2000 to 2016. PLoS One. 2019 Jul 9;14(7):e0216933. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0216933

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Reaching Every District (RED) strategy: https://www.who.int/immunization/programmes_systems/service_delivery/red/en/

WHO. Training for Mid-Level Managers (MLM): https://www.who.int/immunization/documents/mlm/en/

WHO. Immunization in Practice: A practical guide for health staff: https://www.who.int/immunization/documents/mlm/en/

WHO Regional Office for Europe. Tailoring Immunization Programmes (TIP): www.euro.who.int/tip

WHO Effective communication of immunization data: www.euro.who.int/datacommunication

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