DQR
DATA QUALITY REVIEW

2

Module 2
Desk review of data quality

World Health Organization

Gavi
The Vaccine Alliance

The Global Fund

JSI

MEASURE Evaluation

USAID
FROM THE AMERICAN PEOPLE

DATA QUALITY REVIEW

Module 2
Desk review of data quality

Contents

Acknowledgements

Content of the toolkit

The DQR toolkit includes guidelines and additional resources. The guidelines are presented in the three following modules. Additional resources for data collection and analysis will be made available online for downloading. Further information on additional resources are described in Module 1: Framework and metrics.

CURRENT DOCUMENT

Module 1
Framework and metrics

Module 2
Desk review of data quality

Module 3
Data verification and system assessment

Abbreviations

ANC	Antenatal care
ANC1	First antenatal care visit
ART	Antiretroviral therapy
CSPro	Census and survey processing system
DHIS 2	Web-based, open source software used by countries chiefly as their health information system for data management and monitoring of health programmes
DHS	Demographic health survey
DQR	Data quality review
DQS	Data quality self-assessment
DTP	Diphtheria-tetanus-pertussis
DTP3	Diphtheria-tetanus-pertussis three-dose vaccine
Gavi	Gavi, the Vaccine Alliance
HCT	HIV counselling and testing
HIV	Human immunodeficiency virus
HMIS	Health management information system
HSS	Health system strengthening
IPT	Intermittent preventive therapy
IPT1	First dose of intermittent preventive therapy
MCV	Measles-containing vaccine
MDR-TB	Multidrugresistant tuberculosis
MICS	Multiple indicator cluster survey
MOH	Ministry of Health
NGO	Non-governmental organization
OPD	Outpatient visit
PCV	Pneumococcal conjugate vaccine
Penta	Pentavalent vaccine
PLHIV	People living with HIV
PMTCT	Prevention of mother-to-child transmission
RDQA	Routine data quality assessment tool
RDT	Rapid diagnostic test
RR	Rifampicin-resistant
SARA	Service availability and readiness assessment
SD	Standard deviation
TB	Tuberculosis
The Global Fund	The Global Fund to Fight AIDS, Tuberculosis and Malaria
TT	Tetanus toxoid vaccine
USAID	United States Agency for International Development
WHO	World Health Organization

2.1 Overview

Desk review

The desk review of data quality does not require additional data collection. It is a review of the quality of existing data from routine information systems. The desk review is an evaluation of data quality dimensions of **completeness, internal consistency, external comparisons** and **external consistency of population data**. Normally, the desk review requires monthly or quarterly data by subnational administrative area for the most recent reporting year, and annual aggregated data for the last three reporting years, for the selected indicators.

Through analysis of the selected programme indicators, the desk review process quantifies problems of data completeness, accuracy and consistency, and thus provides valuable information on the adequacy of health-facility data to support planning and annual monitoring. WHO recommends that the desk review component of the data quality review (DQR) should be conducted annually.

The desk review has two levels of data quality assessment:

> an assessment of each indicator aggregated to the national level;

> the performance of subnational units (e.g. districts or provinces/regions) for the selected indicators.

The specified data quality metrics, which are presented for use in annual DQRs, can also be used for routine checks of data quality. Certain metrics in the annual review are not relevant to routine monitoring. However, most can be tailored to routine monitoring of data quality. At the minimum, routine checks of data quality should include examination of completeness of data (both of monthly reports and of the data elements themselves), examination of extreme values, comparison of current monthly output to historical levels for the same month, and consistency checks between related indicators.

Core indicators

The proposed core indicators were selected on the basis of their importance for programme monitoring and evaluation. They include core indicators on antenatal care, immunization, human immunodeficiency virus (HIV), tuberculosis (TB) and malaria. Table 2.1 lists the recommended core or "tracer" indicators recommended for regular DQR.

Table 2.1 Recommended core indicators for the DQR

Recommended DQR indicators		
Programme area	**Abbreviated name**	**Indicator name**
Maternal health	Antenatal care 1st visit (ANC1) coverage	Number and % of pregnant women who attended at least once during their pregnancy
Immunization	DTP3/Penta3 coverage	Number and % of children < 1 year receiving three doses of DTP/Penta vaccine
HIV	Currently on ART	Number and % of people living with HIV who are currently receiving ART
TB	TB notification rate	Number of new and relapse cases of TB that are notified per 100 000 population
Malaria	Confirmed malaria cases[1]	Confirmed malaria cases (microscopy or RDT) per 1000 persons per year

Note: ANC = antenatal care; ART = antiretroviral therapy; DTP3 = diphtheria-tetanus-pertussis three-dose vaccine; Penta = pentavalent vaccine; RDT = rapid diagnostic test; TB = tuberculosis.

While it is recommended that countries should select indicators from the core list, they may select other indicators or expand the set of indicators on the basis of their needs and the resources available. A full set of core and additional indicators is available in Annex 1.

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[1] If the number of confirmed malaria cases is not collected, total malaria cases can be substituted.

2.2 DQR desk review implementation

Preparation and implementation of the desk review

The data requirements

For the desk review, the data required for the selected indicators are monthly or quarterly data by subnational administrative area for the most recent reporting year and annual aggregated data for the last three reporting years.

Information on submitted aggregate reports and when they were received will be required in order to evaluate completeness and timeliness of reporting. Data on the number of submitted reports and the number of facilities expected to report for the three years prior to the year of analysis are required in order to evaluate the trend in reporting completeness. If information for all selected primary indicators is reported on the same forms, such as the health management information system (HMIS) form, these data will suffice for all selected indicators. If indicator values are reported on separate forms (e.g. programme-specific reporting forms), a separate analysis will be required for each set of reporting forms used for the selected indicators.

Other data requirements include denominator data for calculating coverage rates for the selected indicators and survey results (and their standard errors) from the most recent population-based survey – such as the Multiple Indicator Cluster Survey (MICS), the Demographic and Health Surveys (DHS) and immunization coverage surveys. See Annex 3 for a more detailed description of the data and formatting requirements for the desk review.

Data collection

Data for the indicators are collected from the HMIS or health programmes, depending on which source is used most frequently for programme planning, monitoring and evaluation. Because the purpose of the DQR is to evaluate the quality of routine health-facility data, support from the leadership of the Ministry of Health (MOH) is essential to acquire and evaluate the quality of HMIS or programme data. It is necessary to work closely with managers of the programme, monitoring and evaluation and HMIS to analyse the quality of facility-reported data.

Data formatting and compilation

Once data are acquired they must be formatted to facilitate the analysis, typically by creating a "flat file" in which data for facilities and/or districts are contained in rows and where indicator values by month or year are in columns (e.g. Microsoft Excel, CSV). Detailed guidance for

formatting data for the DQR is available in Annex 3. The DQR analyses can be programmed into most software applications, and they can also be conducted on paper.

After the data are formatted appropriately the analysis can proceed. Data quality metrics should be programmed into the software selected by the DQR coordinating group, with output to graphs (where appropriate), tables and lists. Metrics that identify administrative units with potential data quality issues should generate lists of those administrative units so that attempts can be made to understand the anomalies and, if possible, to correct the data. Indicators that compare trends should produce graphs showing the trend lines side-by-side for ease of comparison. Comparisons of administrative units should produce bar charts of performance by unit to facilitate understanding of their relative performance.

However, for countries that are not inclined to invest in modifying existing software to accommodate the DQR methodology, an Microsoft Excel-based tool is available from WHO for compiling and formatting data in layouts which facilitate data analysis. Once the data are entered into the standardized tool, the data quality metrics are automatically calculated, as are graphic depictions of performance.[1]

Results from the health-facility survey component of the DQR (data verification and system assessment results) should be integrated into the desk review analysis. Information on the accuracy of reporting for selected indicators will influence the confidence that policy-makers place in the reported data. Information on weaknesses or gaps in the adequacy of the reporting system can point to activities that will strengthen the system.

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[1] In addition, work is underway to incorporate many of these data quality metrics into the DHIS 2 software and to ensure that data can be extracted easily in the required format for analysis in Microsoft Excel for DHIS users.

2.3 Analysis and interpretation of desk review data

The analysis of the desk review component of the DQR has been facilitated through the use of a Microsoft Excel-based tool that can produce the standard metrics when the appropriate data are entered. This makes it easy for the user to spend more time in the analysis and interpretation of the data. More information on the Microsoft Excel tool is provided in Annex 4.

Results should be presented in tables and graphs with ample space to add interpretation of the results. Staff with an understanding of the dynamics of service delivery in the year of analysis (i.e. programme managers) should participate in the interpretation of DQR results.

Desk review analytical outputs

Illustrations of output for the DQR analysis are presented for each dimension of data quality. All these examples are taken from WHO's Microsoft Excel-based DQR tool with comments (the scripted font) inserted by the user.

Dimension 1: Completeness of reporting

Figure 2.1 shows the national-level results of analyses for completeness of district data (Indicator 1a), as well as the number and percentage of districts failing to meet the standard.[1]

Figure 2.1 Example of DQR dashboard results for completeness of reporting

Indicator 1a: National district reporting completeness rate and districts with poor completeness rate

	2014
National district reporting completeness rate	98.3%
Number of districts with completeness rate below 75%	4
Percent of districts with completeness rate below 75%	5.6%
Districts with reporting completeness rate below 75%	**District 1, District 3, District 7, District 10**

Interpretation of results – Indicator 1a

- Good reporting completeness continuing a trend upwards from recent years.
- Investigate districts with < 75% completeness for the year.
- Districts 1 and 3 had stock out of reporting forms during 2nd quarter of last year.

Indicator 1f: Consistency of reporting completeness
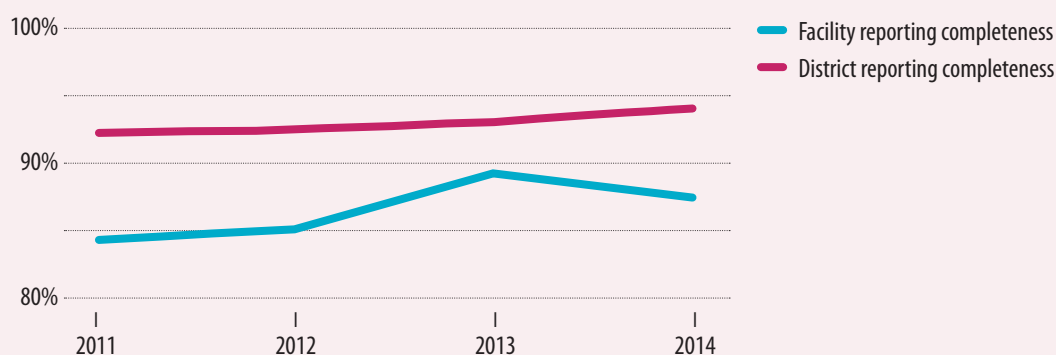
Interpretation of results – Indicator 1f

- Overall consistent high levels of reporting completeness at facility and district levels.
- District reporting is trending upwards while facility reporting declined in 2014. Look into reasons for decline – is this the start of a trend?

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[1] The Microsoft Excel-based DQR tool is configured to assess the completeness of reporting for only one reporting form (e.g. the main, monthly HMIS form). Routine reporting is typically done on multiple forms. The number of facilities expected to report and the number of copies of the form actually submitted may vary from one form to another. Users will need to use their own tool (or multiple copies of the Microsoft Excel-based DQR tool) to review the completeness of these other forms.

Dimension 2: Internal consistency of reporting data

Outliers

Figure 2.2 displays results for the identification of extreme "outliers" relative to the mean of reported values for six indicators at national and subnational levels. Outliers relative to the median of reported values are also identified in the DQR.

Figure 2.2 Example of DQR dashboard results for identification of outliers

Indicator 2a: Identification of outliers				
Indicator 2a.1: Extreme outliers (>3 standard deviation from the mean)				**2014**
Programme area and indicator	**%**	**No.**	**%**	**Name**
Maternal health – ANC 1st visit	0.2%	2	2.5%	District 2, District 7
Immunization – 3rd dose DPT-containing vaccine	0.1%	1	1.3%	District 3
HIV – Number of HIV+ persons currently on ART	0.0%			—
TB – Number of notified TB cases (all forms of TB)	0.0%			—
Malaria – Number of confirmed malaria cases reported	0.0%			—
General service statistics – total outpatient visits	0.4%	4	5.0%	District 2, District 7, District 9, District 10
Total (all indicators combined)	0.1%			

> **Interpretation of results – Indicator 2a1**
>
> - Good results given the volume of data.
> - ANC outlier in District 2 looks like a data entry error - value is 10 x greater than other monthly values reported by the district last year - call district health information officer to investigate.
> - Values in OPD could be the result of social marketing campaign conducted last year to improve health care utilization - call district health information officers in identified districts to verify the numbers.

Outliers are indicative of problems in data quality or changes in patterns of service delivery, or both. Some indicators (e.g. immunization) are expected to show variability, while others are not. The overall percentage of values that are identified as outliers is shown, as are the number and percentage of districts with extreme values. Space is provided to record interpretation of the results.

Consistency over time

Consistency over time is evaluated in order to examine the value of the current year against values reported in previous years. Depending on the expected trend of the indicator (constant, or increasing/deceasing) the value of the current year is compared to the average of the values of the three previous years (constant trend) or the value forecast[1] from the values from the preceding years (non-constant). The resulting ratio is calculated for each subnational administrative area and is compared to the national ratio. Subnational administrative areas that exceed a user-defined threshold for quality are identified for further investigation.

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[1] The forecasted value calculates what the current year should be based on the slope of the line of 3 previous years (the trend) and compares the calculated value to the real value.

In Figure 2.3, the graph (which is an example) shows service output for outpatient visits (OPD) in the current year for each subnational administrative district compared to the mean for OPD in the three preceding years for the same administrative area. Dotted lines represent the recommended or user-defined quality threshold while the solid line indicates the national-level relationship between OPD in the current year and the average for the three preceding years. Values for subnational administrative districts that exceed the threshold of quality would appear above or below the dotted lines. These areas are investigated to identify potential problems of data quality. The graph and accompanying table show that "District 3" is the only district for which OPD visits during 2014 exceeded the number of expected visits (i.e. the average of the annual number of visits during 2011–2013) by more than 33%.

Figure 2.3 Example of DQR dashboard results for consistency over time – constant trend for the indicator

2b2: Consistency of 'General Service Statistics – OPD Total Visits' over time

Year	2014
Expected trend	Constant
Compare districts to:	National result
Quality threshold	33%
National score (%)	109%
Number of districts with divergent scores	1
Percent of districts with divergent scores	8%

Names of districts with divergent scores:
District 3

National ratio = 1.09

Mean of General service statistics – OPD total visits events for preceding years (3 years max)

Trend over time: General service statistics – OPD total visits
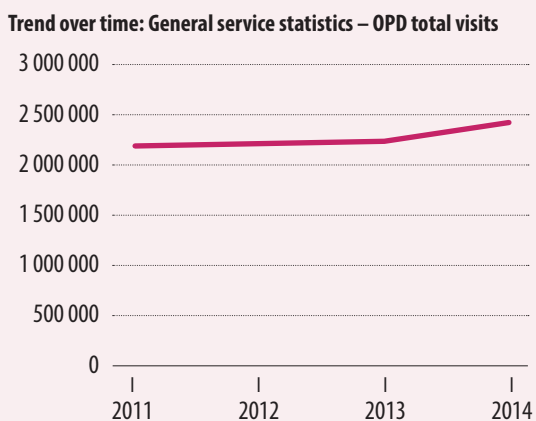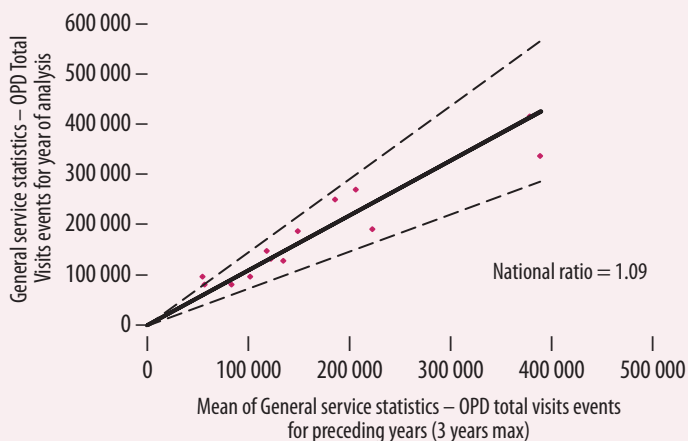
Interpretation of results – Indicator 2b2

- Overall the national ratio was 1.09 which means that the OPD visits for the current year is 9% greater than the mean of OPD visits for the past three years.

- There are 6 districts which have seem to have the mean OPD visits of the past three years that are higher than the OPD visits for the current year. Need to determine why OPD visits are lower in the current year.

- Except for 1 district, all districts had a ratio similar to the national ratio (within 33% of the national ratio).

- The district that was outside of the quality threshold had a ratio where the mean OPD visits of the past three years were higher than the OPD visit of the current year. Need to determine if this is a data quality issue or a program issue. For data quality, need to check if all the OPD data for this district has been entered. Are the visits for the past years correct? See if previous data quality checks have been done. If this is not a data quality issue need to understand potential programmatic issues that could be causing this discrepancy.

Figure 2.3a shows a comparison of the current year's value for OPD to the value forecasted on the basis of the preceding three years of values. (The graph at bottom-left indicates the actual trend in the indicator.) Subnational units are compared to the expected value: it is expected that, if the trend in reporting continues, the current year's value will be the same as, or similar to, the forecasted value for each subnational unit. Three districts had more than 120% of the expected number of OPD visits (the three dots above the upper dashed line) while two districts had fewer than 80% of the expected number of OPD visits (the two dots below the lower dashed line).

Figure 2.3a Example of DQR dashboard results for consistency over time – increasing trend for the indicator

2b3: Consistency of 'General service statistics – OPD total visits' over time

Year	2014
Expected trend	Increasing
Compare districts to:	Expected result
Quality threshold	20%
National score (%)	100%
Number of districts with divergent scores	5
Percent of districts with divergent scores	38.5%

Names of districts with divergent scores:
District 6, District 7, District 8, District 9, District 11

General service statistics – OPD total visits
Visits events for year of analysis

Forcasted General service statistics – OPD total visits value for current year based on preceding years (3 years max)

Trend over time: General service statistics – OPD total visits

Interpretation of results – Indicator 2b3

- This indicator is increasing over time (Outpatient visits are increasing – something we were expecting given social mobilization for public health services.

- Comparison of expected result (that the forecasted value is equal to the actual value for 2014) yields 5 districts with ratios that exceed the quality threhold of 20%. 3 are inferior of the quality threshold while 2 are greater.

- Errors are not systematic (e.g. all in one direction) Review district outpatient registers in affected districts to confirm reported values.

Consistency between indicators

Within Dimension 2, the consistency between related indicators is evaluated. In the example in Figure 2.4, the first antenatal care visit (ANC1) is compared to the first dose of intermittent preventive therapy (IPT1). In malaria-endemic countries, IPT should be given to all pregnant women as a part of ANC. In theory, the number of women given the first dose of IPT should be roughly equal to the number of women attending ANC for the first time. The ratio of ANC1 to IPT1 is calculated for each subnational administrative district and also for the nation as a whole. In the example in Figure 2.4, the value at national level is 114%, which means that more women began ANC than received IPT1. The subnational units with ratios over 10% greater (or 10% less) than 1 (i.e. ANC1 and IPT1 are equal) are flagged for investigation.

Figure 2.4 Example of DQR dashboard results for internal consistency between related indicators

Indicator 2c: Internal consistency - consistency between related indicators

Consistency between related indicators – Ratio of two related indicators and districts with ratios significantly different from the national ratio

2c1: Maternal health comparison: ANC 1ˢᵗ visit vs. IPT 1ˢᵗ dose

Year	2014
Expected trend	Equal
Compare districts to:	National rate
Quality threshold	10%
National score (%)	114%
Number of districts with divergent scores	2
Percent of districts with divergent scores	15.4%

Names of districts with divergent scores:
District 5, District 6

ANC 1ˢᵗ visit versus IPT 1ˢᵗ dose (Districts compared to national rate)
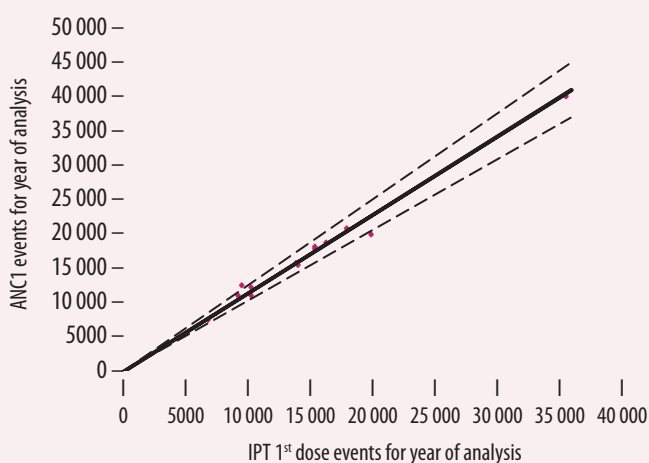
Interpretation of results – Indicator 2c1

- Data seem pretty good - only district 5 has a largely discrepant value.
- IPT seens consistently lower than ANC1 - more pregnant women should be receiving IPT.
- Stock out of fansidar in Region 2 could explain low number of IPT in Districts 5. Call DHIO in these districts to investigate.
- National rate is 114% – most districts are close to this value. District 6 is performing well relative to the other districts but is 'discrepant' relative to the national rate – no follow up needed.

External comparison with other data sources

Figure 2.5 shows results from an external comparison of HMIS data for ANC1 and the survey value of ANC coverage for the relevant year. Vertical bars represent the ANC coverage from HMIS (annual ANC values aggregated across the relevant subnational administrative areas (regions) divided by the estimated number of pregnancies for the region). The triangles represent the analogous survey indicator for the same subnational administrative regions, with error bars based on the standard error of the estimate. In Figure 2.5, Region 2 and Region 8 have survey values (and ranges of error) below the HMIS ANC coverage, indicating potential over-reporting of ANC by the HMIS. In Region 4, the HMIS estimate is less than the survey estimate, indicating potential under-reporting of ANC by the HMIS. This might be seen, for instance, with statistics from a metropolitan region where there is routine under-reporting or non-reporting of ANC services provided by private midwives.

When comparing estimates derived from HMIS data with estimates from household surveys it is important to keep in mind that surveys conducted more than 2 or 3 years previously may no longer reliably estimate coverage, especially at subnational levels. It is also important to note that statistics from household surveys are based on events that took place 12–23 months previously (in the case of immunization) and to up to four years previously (in the case of ANC and delivery care). Hence, even the most recently-published statistics from household surveys will not reliably capture changes in service delivery taking place in the last year.

Figure 2.5 External comparison of ANC1 derived from HMIS with survey values

Indicator 3a: Comparison of routine data with population-based survey values from the same period

3a1: 'ANC 1st visit' consistency ratio (ratio between the facility rates and survey rates)

Year	2014
Quality threshold	33%
National score (%)	106%
Number of regions with divergent scores	3
Percent of regions with divergent scores	30%

Names of regions with divergent scores:
Region 2, Region 4, Region 8
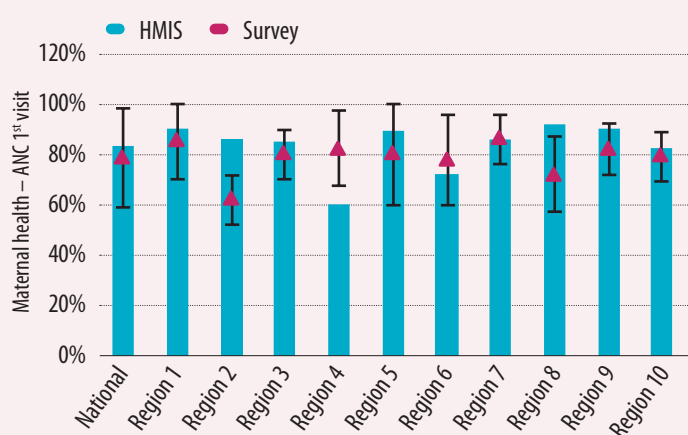
Interpretation of results – Indicator 3a1

- ANC HMIS value in Region 4 looks too low - could result from missing source documents or a failure to record service delivery. Review report forms from districts in the Region to verify the reported values.
- ANC HMIS value in regions 2 and 8 seems too high – could be double counting or duplicate reporting. Call district health information officers to investigate.

Quality of population data

Figure 2.6a shows an example of the dashboard for results of comparisons of population data. Indicator 4a shows the comparison of National Statistics Office values for live births with the United Nations population estimate for live births. The value of 0.98 indicates that the National Statistics Office value is lower than the United Nations estimate, but only slightly.

Figure 2.6a Example of DQR dashboard results for the quality of population data

Indicator 4a: Consistency with UN population projection	
	2014
Ratio of population projection of live births from the Bureau of Statistics to a UN live births projection	0.98

Interpretation of results – Indicator 4a
- Good agreement between official government estimate of live births to the UN estimate. Discrepancy could be related to growth rate used to calculate intercensal years.

Indicator 4b (see Figure 2.6b) shows the dashboard for a comparison between a health programme estimate of live births and the official government value (i.e. of the National Statistics Office). Subnational administrative districts are also evaluated (depending on the availability of the data) and discrepant subnational units are identified. In the example in Figure 2.6b, District 1, District 7 and District 12 have programme values for live births greater than the official government values for the same districts. District 5 has a programme value for live births below the official government value for that district.

Figure 2.6b Example of DQR dashboard results for comparison of estimates of live births between two sources of data

Indicator 4b: Consistency of denominator between programme data and official government population statistics

Indicator 4b1 - Comparing the official live births denominator to a programme denominator, if applicable

Year	2014
Quality threshold	10%
National score (%)	106%
Number of districts with divergent scores	4
Percent of districts with divergent scores	30%

Names of districts with divergent scores:
District 1, District 5, District 7, District 12

Programme denominator for live births (y-axis)
Official government denominator for live births (x-axis)
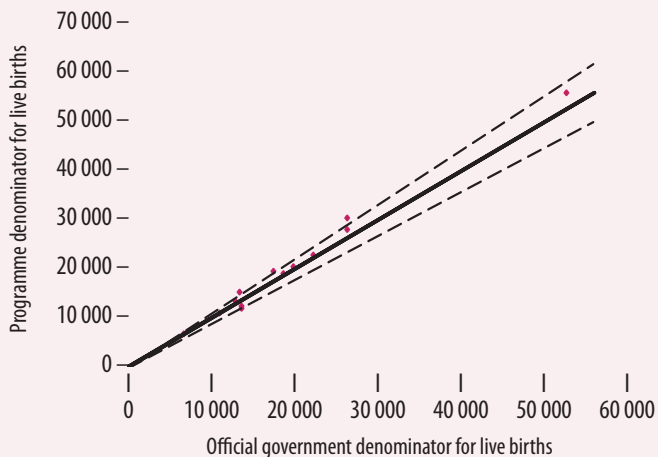
Interpretation of results – Indicator 4b1

- The programme denominators in Districts 1, 7, and 12 seem too large – and too small in District 5. Review growth rates used by programme to estimate intercensal yearly values for live births.

Annex 1: Recommended indicators

Core indicators

Recommended core of "tracer" indicators for DQR		
Programme area	Abbreviated name	Indicator name
Maternal health	Antenatal care 1st visit (ANC1) coverage	Number (%) of pregnant women who attended at least once during their pregnancy
Immunization	DTP3/Penta3 coverage	Number (%) of children < 1 year receiving three doses of DTP/Penta vaccine
HIV	Currently on ART	Number and % of people living with HIV who are currently receiving ART
TB	TB notification rate	Number of new and relapse cases of TB that are notified per 100 000 population
Malaria	Total confirmed malaria cases[1]	Confirmed malaria cases (microscopy or RDT) per 1000 persons per year

Note: ANC = antenatal care; ART = antiretroviral therapy; DTP3 = diphtheria-tetanus-pertussis three-dose vaccine; Penta = pentavalent vaccine; RDT = rapid diagnostic test.

Additional indicators

Additional DQR indicators		
Programme area	Abbreviated name	Indicator name
General	Service utilization	Number of outpatient department visits per person per year
Maternal health	Antenatal care 4th visit (ANC4)	Number (%) of women aged 15–49 years with a live birth in a given time period who received antenatal care, four times or more
	Institutional delivery coverage	Number and % of deliveries which took place in a health facility
	Postpartum care coverage	Number (%) of mothers and babies who received postpartum care within two days of childbirth (regardless of place of delivery)
	Tetanus toxoid 1st dose coverage	Number (%) of pregnant women who received the 1st dose of tetanus-toxoid vaccine
Immunization	DTP1-3/Penta1-3 coverage	Number (%) of children < 1 year receiving 1st dose, 2nd dose, 3rd dose of DTP/Penta vaccines
	MCV1 coverage	Number (%) of infants who have received at least one dose of measles-containing vaccine (MCV) by age 1 year
	PCV 1-3[2] coverage	Number (%) of children < 1 year receiving 1st dose, 2nd dose, 3rd dose of pneumococcal vaccines

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[1] If the number of confirmed malaria cases is not available, use all malaria cases.
[2] If this vaccine is not used in country, substitute with another vaccine used in the national programme.

Additional indicators, continued

Recommended DQR indicators		
Programme area	Abbreviated name	Indicator name
HIV	People living with HIV who have been diagnosed	Number (%) of people living with HIV who have been diagnosed
	HIV care coverage	Number (%) of people living with HIV who are receiving HIV care (including ART)
	PMTCT ART coverage	Number (%) of HIV-positive pregnant women who received ART during pregnancy
	ART retention	Number (%) of people living with HIV and on ART who are retained on ART 12 months after initiation (and 24, 36, 48, and 60 months)
	Viral suppression	Number (%) of people on ART who have suppressed viral load
TB	Notified cases of all forms of TB	Number of new and relapse cases of TB that are notified per 100 000 population – *Assess if quarterly case notification report blocks 1 and 2[1] are correct as per standards and benchmarks (B1.4) for paper-based systems[2]*
	TB treatment success rate	Number (%) of TB cases successfully treated (cured plus treatment completed) among TB cases notified to the national health authorities during a specified period – *Assess if quarterly treatment outcome report block 1 is correct as per standards and benchmarks (B.14) for paper-based sys-tems*
	Second-line TB treatment success rate	Number (%) of TB cases successfully treated (cured plus treatment completed) among all confirmed RR-TB/MDR-TB cases started on second-line treatment during the period of assessment
TB–HIV	Proportion of registered new and relapse TB patients with documented HIV status	Number of new and relapse TB patients who had an HIV test result recorded in the TB register, expressed as a percentage of the number registered during the reporting period
	Proportion of HIV-positive new and relapse TB patients on ART during TB treatment	Number of HIV-positive new and relapse TB patients who received ART during TB treatment expressed as a percentage of those registered during the reporting period
Malaria	Malaria diagnostic testing rate	Number (%) of all suspected malaria cases that received a parasitological test [= Number tested / (number tested + number presumed)]
	Confirmed malaria cases receiving treatment	Number (%) of confirmed malaria cases treated that received first-line antimalarial treatment according to national policy at public-sector facilities
	Malaria cases (suspected and con-firmed) receiving treatment	Number (%) of malaria cases (presumed and confirmed) that received first-line antimalarial treatment
	IPTp3	Number (%) of pregnant women attending antenatal clinics who received three or more doses of intermittent preventive treatment for malaria

Note: ANC = antenatal care; ART = antiretroviral therapy; DTP = diphtheria-tetanus-pertussis; MCV = measles-containing vaccine; MDR-TB = multidrug-resistant tuberculosis; PCV = pneumococcal conjugate vaccine; PMTCT = Prevention of mother-to-child transmission; RR = rifampicin-resistant.

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[1] Definitions and reporting framework for tuberculosis – 2013 revision. Geneva: World Health Organization; 2013 (WHO/HTM/TB/2013.2; http://apps.who.int/iris/bitstream/10665/79199/1/9789241505345_eng.pdf?ua=1, accessed 11 June 2015).
[2] Standards and benchmarks for tuberculosis surveillance and vital registration systems: checklist and user guide. Geneva: World Health Organization; 2014 (WHO/HTM/TB/2014.02; http://apps.who.int/iris/bitstream/10665/112673/1/9789241506724_eng.pdf?ua=1, accessed 11 June 2015).

Annex 2: Definitions and requirements for the calculation of metrics for the desk review of data quality

Dimension 1. Completeness and timeliness of data

This dimension measures the extent to which data that are reported through the system used for planning, monitoring and evaluation are available and adequate for these purposes. Are the data complete enough to determine whether the health programme is effective and is achieving the desired results? Are the data sufficiently recent that achievements (or gaps) indicated by the data actually reflect the current level of achievement of health indicators? The DQR methodology measures completeness of data by examining whether all entities that are supposed to report are in fact reporting. The indicators in this dimension include completeness of reporting at the health-facility level (usually the level of the first administrative unit), completeness of reporting at levels higher than the health facility (e.g. the district), and the completeness of data elements in submitted reports (i.e. identification of missing data) on programme indicators across the selected programme areas.

Data quality metric: completeness and timeliness of administrative unit reporting

Definition

Completeness of administrative unit reporting (e.g. district, regional or provincial reporting) is defined as the number of administrative unit monthly reports received divided by the total number of reports expected for a specified time period (usually one year). A completeness rate of 100% indicates that all units reported. See Box A2.1.

It is recommended that the timeliness of reporting should also be evaluated. Timeliness is defined as the number of reports from subnational administrative units submitted to the national level by the reporting deadline divided by the number of reports actually received.

Both completeness and timeliness of reporting are likely to vary by reporting form. WHO's Microsoft Excel-based DQR tool examines reporting completeness and timeliness only for a single form (e.g. the main, monthly HMIS form).

Data requirements

National:

Number of reports received at the national level from the immediately preceding subnational level (e.g. district, region or province) for the selected period.

Number of reports expected for the period.

Subnational:

Number of reports received from health facilities by month and by district for the selected period.

Number of reports expected by month and by district.

Calculation

National:

Number of administrative unit monthly reports received divided by the total number of reports expected for a specified time period. A completeness rate of 100% indicates that all units reported.

Subnational:

At the subnational level, a completeness rate is computed for each administrative unit over the specified time period. Administrative units that have a completeness rate of 75% or less are considered to have poor reporting (three or more missing reports for the year).

Box A2.1 Example of completeness of administrative unit reporting

At national level, if the country has 10 districts, the expected number of reports would be 120 reports (10 reports per month x 12 months). The actual number of reports received was 97 (shown in Table A2.1a). Therefore, the completeness rate would be 97 / 120 = 81%.

At the subnational level, the example assumes there are 10 districts that are expected to report monthly. Table A2.1a shows an example of monthly reporting by 10 districts over a period of 12 months. Five of the 10 districts (50%) have completeness reporting rates of 75% or less, while 3 out of 10 districts have 100% reporting completeness rates.

Table A2.1a District reporting example

District health offices submitting monthly reports on time are indicated with tick marks. Districts with poor reporting (i.e. completeness rate ≤ 75%) are shown in red.

	Month												Total	Completeness rate
	1	2	3	4	5	6	7	8	9	10	11	12		
District 1	✓	✓		✓		✓	✓	✓	✓		✓	✓	9	75%
District 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12	100%
District 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12	100%
District 4	✓	✓	✓	✓	✓	✓	✓		✓	✓	✓		10	83%
District 5	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	11	92%
District 6	✓	✓		✓		✓	✓	✓	✓	✓	✓		9	75%
District 7	✓	✓			✓	✓		✓	✓	✓			7	58%
District 8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	12	100%
District 9	✓		✓	✓		✓		✓		✓	✓		7	58%
District 10	✓			✓	✓	✓	✓		✓	✓		✓	8	67%
National	**10**	**8**	**6**	**8**	**7**	**10**	**8**	**8**	**9**	**9**	**8**	**6**	**97**	**81%**

Table A2.1b Example of summary results

Metric	Results
National district monthly reporting completeness rate	81%
Number (%) of districts with completeness rate below 75%	5 (50%)
Districts with completeness rate below 75%	District 1, District 6, District 7, District 9, District 10
Number (%) of districts with 100% of expected reports	3 (30%)
Districts with 100% of expected reports	District 2, District 3, District 8

Data quality metric: completeness and timeliness of facility reporting

Definition

Completeness of facility reporting is defined as the number of reports received from all health facilities nationally, divided by the total number of expected reports from all facilities that are supposed to report to the HMIS for a specified time period (usually one year). The numerator is the actual number of facilities that submit a report and the denominator is the total number of health facilities that are expected to submit a report. See Box A2.2.

Timeliness of facility reporting is defined similarly: i.e. the proportion of reports received from health facilities by subnational administrative units by the deadline for reporting.

Data requirements

Total number of reports received in the fiscal year of analysis from health facilities in the administrative level of analysis (e.g. district) – for instance, the total number of health facilities' monthly reports received for January–December 2012 by the administrative level of analysis. For timeliness, the data requirement is the number of reports received by the deadline for reporting.

The total number of health facilities by administrative level of analysis. This should include only the facilities that are expected to report to the HMIS system (or any other programme reporting system). If private facilities in a district are not expected to report to any system, they should not be included in this total count. For timeliness: the number of reports received by the deadline for reporting.

Calculation

National:

The number of reports received from all health facilities nationally, divided by the total expected reports from all facilities that are supposed to report to the HMIS for a specified time period (usually one year).

Subnational:

The facility reporting completeness rate is computed for each administrative unit over the specified time period (usually one year). The number of health facilities that submit a report is divided by the number of facilities expected to submit a report for each administrative unit. Administrative units with reporting rates of 75% or less for facilities within their administrative boundaries are considered to have poor reporting completeness.

Box A2.2 Example of completeness of facility reporting

At the national level, if a country has 1000 facilities reporting to the HMIS, the total number of expected reports for one year would be 1000 x 12 = 12 000 reports. If at the end of the year only 10 164 reports have been received (as shown in Table A2.2a below), the completeness of the facility reporting rate = 10 164 / 12 000 or 85%.

At the subnational level, facility reporting rates within each of the 10 districts are examined. Districts that have less than 80% completeness of facility reporting are shown in red. Three out of 10 districts (30%) have facility reporting rates of less than 80%. A summary of the results is shown in Table A2.2b.

Table A2.2a Facility reporting rate within districts
Districts with facility reporting rates of less than 80% are shown in red.

	Total number of facilities	Expected reports (total facilities × 12 months)	Actual number of reports received in 12 months	Facility completeness rate (%)
District 1	100	1200	1200	100%
District 2	150	1800	1140	63%
District 3	50	600	554	92%
District 4	80	960	960	100%
District 5	120	1440	1080	75%
District 6	170	2040	1920	94%
District 7	130	1560	1270	81%
District 8	100	1200	1200	100%
District 9	40	480	240	50%
District 10	60	720	600	83%
National	**1000**	**12 000**	**10 164**	**85%**

Table A2.3b Example of summary results

Metric	Results
National facility reporting completeness rate	85%
Number (%) of districts with facility reporting completeness rate below 80%	3 (30%)
Districts with completeness rate below 80%	District 2, District 5, District 9

Data quality metric: completeness of indicator data

Definition

Completeness of indicator data is measured by examining the proportion of non-zero values for specific indicators. This is achieved in two ways: 1) by measuring on reporting forms the proportion of blank cells (i.e. the cells where a specific indicator value should be recorded), and 2) by measuring the proportion of cells with a zero recorded as the value.

Missing data should be clearly differentiated from true zero values in district and facility reports. A true zero value indicates that no reportable events occurred during the specified reporting period; a missing value indicates that reportable events occurred but were not in fact reported. In many HMIS reports, missing entries are assigned a value of zero, making it impossible to distinguish between a true zero value (no events occurred) and a missing value (events occurred but were not reported). Because it is difficult to differentiate between a true zero value and a true missing value, both these criteria are assessed here. The results of these indicators must be interpreted by data managers and programme managers to ascertain whether zero values represent true zeros. See Box A2.3.

Data requirements

National:

Number of missing values for selected indicators on reports from administrative units.

Number of zero values for selected indicators on reports from administrative units.

Number of reports received from administrative units at the national level.

Subnational:

Number of health-facility reports in which no value is recorded for selected indicators in place of an expected indicator value.

Number of health-facility reports in which a zero value is recorded for selected indicators in place of an expected indicator value.

Number of health-facility reports received for the specified reporting period.[1]

Calculation

National:

Completeness of indicator data (zero) (%) is defined as the average percentage of monthly values for selected indicators combined that are not zero for the specified time period (usually one year). Thus the indicator is calculated by subtracting the percentage of values that are zeros from 100%.

Completeness of indicator data (missing) (%) is defined as the average percentage of monthly values for selected indicators combined that are non-missing for the specified time period (usually one year). Thus, the indicator is calculated by subtracting the percentage of values that are missing from 100%.

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[1] These data may not be available at national level.

Subnational:

At subnational level (e.g. district, province or region), this indicator is defined as the percentage of administrative units in which less than 90% of the monthly values are non-zero values. This percentage is calculated by summing all the zero values within an administrative unit for each selected indicator for a specified time period, and dividing by the total number of expected values for the administrative unit for the same specified time period.

The percentage of administrative units in which non-missing values account for less than 90% of monthly values on submitted reports is calculated as above.

Note that the quality threshold for this metric will vary by health programme (and possibly by country).

Box A2.3 Example of completeness of indicator data – missing values at national and subnational levels

The example in Table A2.3a below shows the percentage of missing values for ANC1. Each tick mark means that the district had a non-missing value for the month in question. When examining monthly district-level data for ANC1 over a period of one year, it is seen that, nationally, district data show that values are missing on 21 occasions. (The same procedure should be followed to calculate the percentage of zero values.)

The numerator (21) is the national total of missing values for ANC1 at district level. The denominator is the total expected number of values. With 10 districts and 12 expected monthly values for ANC1 in each district, the total expected values nationally are 120. The total percentage of missing values nationally for ANC1 is 17.5% (21 / 120). However, since we are calculating values that are not missing, the indicator is 100% - 17.5% = 82.5%.

At the subnational level, Table A2.3a shows that 5 out of 10 districts (50%) have more than 10% missing values for ANC1 within their districts.

Table A2.3a: Missing values by district for ANC1
Districts are marked in red if 10% or more of their values are missing values.

	Month												Total	Completeness rate
	1	2	3	4	5	6	7	8	9	10	11	12		
District 1	✓	✓		✓		✓	✓	✓	✓	✓	✓	✓	2	83%
District 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	100%
District 3	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	100%
District 4	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		1	92%
District 5	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	1	92%
District 6	✓	✓		✓		✓	✓	✓	✓	✓	✓		3	75%
District 7	✓	✓			✓	✓		✓	✓	✓			5	58%
District 8	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	0	100%
District 9	✓		✓	✓		✓		✓		✓	✓		5	58%
District 10	✓			✓	✓	✓	✓		✓	✓		✓	4	67%
National	**0**	**2**	**4**	**2**	**3**	**0**	**2**	**1**	**1**	**0**	**2**	**4**	**21**	**17.5%**

Table A2.3b Example of summary results

Metric	Results
National district monthly reporting completeness rate	100% - 17.5% = 82.5%
Number (%) of districts with completeness rate below 90%	5 (50%)
Districts with completeness rate below 90%	District 1, District 6, District 7, District 9, District 10
Number (%) of districts with 100% of expected reports	3 (30%)
Districts with 100% of expected reports	District 2, District 3, District 8

Dimension 2. Internal consistency of reported data

This dimension examines the plausibility of reported results for selected programme indicators based on the history of reporting of those indicators. Trends in reported data are evaluated over time (one year) to assess whether specific reported values (e.g. for a particular month or months) within the selected period are extreme in relation to the other values reported and if they are potentially indicative of data quality problems. Trends in reporting over multiple years are also evaluated in order to identify extreme or implausible values year-to-year.

Within this dimension, the results of programme indicators are compared to other indicators with which they have a predictable relationship to determine whether the expected relationship exists between the two indicators. In other words, is the observed relationship between the indicators, as reflected in the reported data, that which we would expect on the basis of our knowledge of the indicators, the health programme and the country?

This dimension also seeks to determine the accuracy of reporting for selected indicators on the basis of review of source documents (i.e. the documents in which reported events are first recorded) in order to compare reported values to a validated value. This aspect of the DQR is conducted through a health-facility assessment linked to the implementation of the DQR (see "Data verification" below).

Data quality metric: outliers in the current year

Definition

An outlier is defined as a value in a series of values that is extreme in relation to the other values in the series. Outliers can be the result of changes in programmatic activities (such as an intensified campaign) or of data quality problems. Extreme values should be identified and investigated to determine whether they are valid or if they are the result of insufficiencies in data quality. Two types of outliers are defined below: moderate outliers and extreme outliers. It is important to note, however, that moderate outliers might be plausible fluctuations in service delivery and not necessarily the result of data quality problems. Knowledge of programme data is necessary when examining and interpreting these data. It is more important to focus on extreme outliers – i.e. the values that have the most distorting effect on the statistics and which demand assertive follow-up. See Box A2.4.

Outliers can be identified by various methods, though it is recommended that one of the following two methods be used:

1. *Multiples of the standard deviation of the mean:* Values in a series greater than multiples of the standard deviation (SD) of the mean of the series of values (i.e. ± 2SD, ± 3SD, etc.) are identified as potential outliers and are evaluated for problems of data quality. Outliers identified as greater than 2SD from the mean are considered "moderate" outliers, while those identified as greater than 3SD from the mean are considered "extreme".

2. *Modified Z-score:* The Z-score of an observation refers to the number of standard deviations from the mean. A "modified Z-score" applies the median computation technique to measure the deviation and, in many cases, provides more robust statistical detection of outliers (than use of the mean). This method is useful for small samples and is more tolerant than the Z-score to extreme values. Mathematically, the modified Z-score can be written as:

$M_i = 0.6745 * (X_i - \text{Median}(X_i)) / \text{MAD}$

where MAD is defined as the median absolute deviation. MAD = *median*$(|X_i - (\widetilde{X})|)$, where $\widetilde{X}$ is the median of the series. Any number in a dataset with the absolute value of modified Z-score exceeding 3.5 is considered an outlier.[1]

Data requirements

National:
Monthly indicator values for selected indicators from administrative units reporting to the national level from HMIS reports (or database) for the selected period. Identify extreme values (outliers) by selecting one of the above methods.

Subnational:
Monthly indicator values for selected indicators from health facilities based on HMIS reports (or database) for the selected period. Identify extreme values (outliers) by selecting one of the above methods.

Calculation

National:
Moderate outliers for monthly values of a selected indicator are identified from values reported for a given period using the methods described above. The total number is divided by the expected number of values for the indicator. If the time period of analysis is one year and reporting is monthly, the total number of expected values for one indicator equals the total number of administrative units of analysis multiplied by 12. A similar calculation is performed for extreme outliers.

Subnational:
Moderate outliers: At the subnational level (e.g. district, province or region), the aim is to calculate the percentage of administrative units in which two or more of the monthly values of the selected indicator are moderate outliers (± 2–3 SD from the administrative unit mean, or a value of > 3.5 on the modified Z-score). This percentage is calculated by identifying and counting all moderate outliers within an administrative unit for the selected indicator for a specified period of time and dividing the result by the total number of expected values for the indicator in the administrative unit for the same period of time.

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[1] Iglewicz B, Hoaglin D. The ASQC basic references in quality control: statistical techniques. Volume 16: How to detect and handle outliers. Milwaukee (WI): American Society for Quality; 1993.

Extreme outliers: At the subnational level, the percentage of administrative units in which one or more of the monthly administrative unit values for the selected indicator is an extreme outlier (± 3SD from the administrative unit mean) is calculated by dividing the total number of administrative units with extreme outliers for the specified time period by the total number of administrative units.

Box A2.4 Example of outliers in the current year

Table A2.4a below shows moderate outliers for ANC1. There are 9 moderate outliers for ANC1, and these are highlighted in red. Eight of the districts have at least one occurrence of a monthly ANC1 value that is a moderate outlier.

Table A2.4a Monthly ANC1 values by district

Values in red are moderate outliers.

	Month												Total	% of values that are outliers
	1	2	3	4	5	6	7	8	9	10	11	12		
District 1	2543	2482	2492	2574	3012	2709	3019	2750	3127	2841	2725	2103	1	8.3%
District 2	1547	1340	1403	1593	2161	1729	1646	1642	1355	1581	1412	1410	1	8.3%
District 3	776	541	515	527	857	782	735	694	687	628	596	543	0	0.0%
District 4	1184	1118	1195	1228	1601	1324	1322	711	1160	1178	1084	1112	2	16.7%
District 5	1956	1773	1768	2062	2997	2056	1839	1842	2028	2002	2032	1904	1	8.3%
District 6	819	788	832	802	999	596	672	792	933	1134	810	789	1	8.3%
District 7	781	1199	981	963	818	897	853	736	2208	2734	1323	1229	1	8.3%
District 8	1382	1379	1134	1378	1417	1302	1415	1169	1369	1184	1207	1079	0	0.0%
District 9	1992	1751	1658	1823	3306	2692	2300	2218	2026	2003	1752	1753	1	8.3%
District 10	3114	2931	2956	4637	6288	4340	3788	3939	3708	4035	3738	3606	1	8.3%
National	**0**	**0**	**0**	**0**	**5**	**0**	**0**	**1**	**0**	**2**	**0**	**1**	**9**	**6.7%**

Nationally, this indicator is a percentage of values that are moderate outliers for the indicator. The numerator is the number of outliers across all administrative units (9). The denominator is the total number of expected reported values for the indicator for all the administrative units; it is calculated by multiplying the total number of units (at the level of the selected administrative unit) by the expected number of reported values for one indicator for one administrative unit. The denominator is then calculated as follows: 10 districts x 12 expected monthly reported values per district for one indicator = 120 total expected reported values. The average percentage of reported values that are moderate outliers equals (9 / 120) x 100 ≈ 7.5%.

Subnationally, the number of outliers is calculated for each district. This is done by counting the districts where there are two or more outliers (for moderate outliers) among the monthly values for the district. This is then divided by the total number of administrative units: 1 / 10 = 0.1 x 100% = 10%.

Table A2.4b Example of summary results

Metric	Results
% of district monthly values that are moderate outliers (± 2–3 SD from the district mean)	7.5%
Number and % of districts in which two or more of the monthly district values for the indicator are moderate outliers (± 2–3 SD from the district mean)	1, 10.0%

Data quality metric: consistency over time

Definition

Consistency over time (%) is defined as the average ratio of events/service outputs for the current year of analysis to the mean events/service outputs of up to three preceding years for selected indicators. Consistency over time is also measured as a comparison of the current year to the value predicted from the trend over the three preceding years for indicators or programmes with expected growth or decline. Current-year values are compared to forecasted values (the value predicted by the slope of the values of three previous years) for indicators with non-constant trend (i.e. increasing or decreasing). See Box A2.5.

This indicator shows the consistency of the values for key indicators in the most recent year compared with the mean value of the same indicator for the previous three years combined (or the forecasted value for indicators with non-constant trend). Differences in values are expected from one year to the next; however, if the differences are very large, they warrant further scrutiny. While large differences usually suggest some type of reporting error, it is also possible that the introduction of a new intervention may have contributed to a large percentage increase in indicator values from one year to the next. Hence, interpretation of the results with programme managers is critical.

Data requirements

Annual totals by subnational unit for selected indicators for the year of analysis plus the preceding three years.

Calculation

National:

At the national level this indicator is as defined above – the ratio of the current year total to the average of the preceding three years, or the current year value compared to the value forecasted from the three previous years of values for indicators with non-constant trend (i.e. increasing or decreasing).

Subnational:

Subnationally, this indicator looks at the percentage of administrative units at the selected administrative level of analysis with at least 33% difference between their ratio and the national ratio for selected indicators.

Alternatively, the subnational unit ratios can be compared to the "expected value" – i.e. equality between the current-year value and the average of the three preceding years (or forecasted value). For this comparison, the subnational unit value is compared to 1± the quality threshold. For example, if the quality threshold is set at 33%, subnational units with ratios ≥ 133% or ≤ 67% would be flagged as potential data quality problems.

Box A2.5 Example of consistency over time

First, consistency over time is examined for institutional deliveries:
National total for institutional deliveries for 2010 = 211 194
National total for institutional deliveries for 2011 = 205 863
National total for institutional deliveries for 2012 = 199 344
National total for institutional deliveries for 2013 = 220 916

The mean of 2010, 2011 and 2012 = (211 194 + 205 863 + 199 344) / 3 = 205 467.

The ratio of the current year 2013 to the mean of the past three years for ANC1 = 220 916 / 205 467 ≈ 1.08.

The average ratio of 1.08 shows that there was an overall 8% increase in the service outputs for institutional deliveries in 2013 when compared to the average service outputs for the preceding three years.

Table A2.5a Consistency trend: comparison of district ratio to national ratio
A difference of more than 33% between the district and national ratios is highlighted in red.

	2010	2011	2012	2013	Average of preceding 3 years	Ratio of current year to mean of preceding 3 years	% difference between national and district ratios
District 1	30 242	29 543	26 848	32 377	28 878	1.12	0.04
District 2	19 343	17 322	16 232	18 819	17 632	1.07	0.01
District 3	7 512	7 701	7 403	7 881	7 539	1.05	0.03
District 4	15 355	15 047	14 788	25 123	15 063	1.67	0.55
District 5	25 998	23 965	24 023	24 259	24 662	0.98	0.09
District 6	10 234	9 458	9 654	9 966	9 782	1.02	0.05
District 7	14 011	13 987	14 355	14 722	14 118	1.04	0.03
District 8	15 233	15 974	14 733	15 415	15 313	1.01	0.06
District 9	23 033	24 544	24 433	25 274	24 003	1.05	0.02
District 10	50 233	48 322	46 875	47 080	48 477	0.97	0.10
National	**211 194**	**205 863**	**199 344**	**220 916**	**205 467**	**1.08**	

Subnationally, each district should be evaluated by calculating, for institutional deliveries, the ratio of the current year (2013) to the average of the previous three years (2010–2012). For example, the ratio for District 1 is 32 377/28 878 = 1.12.

Next, the % difference between the national and district ratios is calculated for each district. Again, for District 1:

$$\left| \frac{District\ 1\ ratio - National\ ratio}{National\ ratio} \right| = \left| \frac{1.12 - 1.08}{1.08} \right| = 0.04 = 4.0\%$$

The percentage difference between the district ratio and the national ratio for institutional deliveries in District 1 is less than 33%. However, there is a difference of approximately 55% between District 4's institutional deliveries ratio and the national ratio.

To calculate this indicator subnationally, all administrative units which have ratios that differ from the country's national ratio by ± 33% or more are counted. In this example, only District 4 has a difference greater than ± 33%. Therefore, 1 out of 10 districts (10%) has a ratio that differs more than 33% from the national ratio.

Table A25b Example of summary results

Metric	Results
Average ratio of events/service outputs for the current year to the mean of events/service outputs for the three preceding years for institutional deliveries	8.0%
Number (%) of districts with at least 33% difference between the district and national ratio	1 (10%), District 4

Data quality metric: consistency between related indicators

Definition

This data quality metric examines the extent to which two related indicators follow a predictable pattern. If this pattern is not followed at the national level or for a particular subpopulation it may be indicative of data quality problems. See Box A2.6.

Consistency between two indicators is defined as the ratio between the two indicators. For some indicators, the ratio should be 1 or below; for other indicators the ratio is ≥ 1 (see Annex 1 for indicator-specific details).

Data requirements

Yearly values of selected indicators at national and subnational levels.

Calculation

National:

At the national level, this indicator is the ratio of the two selected indicators.

Subnational:

For indicators which should be roughly equal, this indicator shows the percentage of subnational administrative units that have an extreme difference (e.g. ≥ ± 10%). For indicators which should be ≥ 1, districts with ratios of < 1 should be flagged. The number and percentage of subnational units with anomalous values is calculated (the number of subnational units with anomalous values divided by the total number of subnational administrative units).

The relationship between two indicators at subnational units can also be assessed by comparing their ratio with the ratio between the two indicators at national level. In this instance the ratio percentage difference is calculated between the ratio at subnational level and the ratio at national level. Subnational units with a percentage difference greater than the specified quality threshold (e.g. ≥ 10%) are flagged for follow-up.

Box A2.6 Example of consistency between related indicators

The number of pregnant women who started in antenatal care (ANC1) each year should be approximately equal to the number of pregnant women who receive intermittent preventive therapy for malaria (IPT1) in ANC because all pregnant women should receive this prophylaxis. The ratio of ANC1 to IPT1 is calculated first at the national level and then for each district (Table A2.6a). At the national level the ratio of ANC1 to IPT1 is 154 285 / 134 341 = 1.15.

Table A2.6a % difference between ANC1 and IPT1 by district
Districts with % difference $\geq \pm$ 20% are flagged in red.

	ANC1	IPT1	Ratio of ANC1 / IPT1	District ratio / national ratio
District 1	20 995	18 080	1.16	1.01
District 2	18 923	16 422	1.15	1.00
District 3	7 682	6 978	1.10	0.96
District 4	15 669	14 151	1.11	0.97
District 5	12 663	9577	1.32	1.15
District 6	20 233	19 960	1.01	0.88
District 7	11 402	9 291	1.23	1.07
District 8	12 520	10 461	1.20	1.04
District 9	15 984	13 930	1.15	1.00
District 10	18 214	15 491	1.18	1.03
National	**154 285**	**134 341**	**1.15**	

At the subnational level we compare the subnational unit's ratio to the national ratio:

$$\frac{ANC1_{(subnational\ unit)} / IPT1_{(subnational\ unit)}}{ANC1_{(national)} / IPT1_{(national)}}$$

Any subnational unit with a value $\geq$ national ratio + specified quality threshold (e.g. 20%), or with a value $\leq$ national ratio − specified quality threshold, is flagged as a potential data quality problem.

Next we compare the subnational unit's ratio to the expected ratio:

Since all pregnant women entering ANC should receive IPT, the expected result is that the value of IPT1 should be roughly equal to the value of ANC1, or slightly less. Thus the ratio of IPT1:ANC1 should be roughly equal to 1:

$$ANC1 / IPT1 = 1$$

Any subnational unit with a value of ANC1 / IPT1 $\geq$ 1 + specified quality threshold, or $\leq$ 1 − specified quality threshold, should be flagged for follow-up.

In the example above, we see that three districts have a ratio of ANC1 to IPT1 greater than 20% (District 5, District 7 and District 8). When district ratios are compared to the national ratio, no districts surpass the quality threshold of 20%.

Table A2.6b Example of summary results

Metric	Results (comparison with expected result)	Results (comparison with national result)
National ratio of ANC1 to IPT1	1.15	1.15
Number (%) of districts with ratio of ANC1 to IPT1 of $\geq$ 20%	3 (30%)	0
Districts with ANC1:IPT1 $\geq$ 20%	District 5, District 7, District 8	None

Dimension 3. External consistency

(Agreement with other sources of data such as surveys)

The purpose of this dimension is to examine the level of agreement (i.e. external consistency) between two sources of data measuring the same health indicator. The two sources of data are 1) the data that are routinely collected and reported from the HMIS or programme-specific information system, and 2) periodic population-based surveys. Surveys are generally considered to have reliable results since the methods of conducting surveys are highly standardized; great care and expense go into ensuring high-quality implementation and estimates of health indicators. Survey results are often considered to represent the "gold standard" or true value of the indicator in the population.

The expense of surveys means that they cannot be conducted regularly, and there are limitations on the interpretation of survey results in smaller geographical areas. For these reasons, surveys alone are not adequate for routine monitoring of health-sector and programme results.

Although survey results are often considered to have a high standard, surveys are also subject to data quality problems, and if these problems are systematic the survey-based estimate of coverage may be far from the true value. In addition, surveys are based on a sample and therefore have a range of possible values (i.e. confidence interval, limits). Confidence intervals are larger if the sample is smaller, and therefore much larger at subnational levels than at national level. (Confidence intervals are often presented in the annexes of survey reports, such as the Demographic and Health Surveys, or DHS). In a comparison with routine data, the survey confidence limits must be taken into account. If the routine value lies within the range, it cannot be concluded that there is a significant difference from the survey value. Additionally, survey results may reflect past performance (often three or five years before the survey), while coverage rates based on routine data are usually for the most recent year. Thus, any comparison should be made with caution.

Data quality metric: external comparison with survey results

Definition

External comparison of selected indicators is defined as the ratio of the coverage derived from routinely reported data (e.g. HMIS) to the coverage rate derived from household survey data.

Comparison of HMIS values to health programme values for selected indicators: this metric can be calculated using the same method as the comparison of routinely reported data to survey results (e.g. comparison of HMIS estimates of immunization coverage with EPI programme estimates of immunization coverage). See Box A2.7.

Data requirements

National and subnational administrative values for selected indicators and year.

Appropriate denominators to derive coverage rates for routine data.

Analogous survey value for the same year from a recent household survey with a methodology that meets international standards for quality (e.g. MICS, DHS).

Calculation

National:

At the national level this indicator is defined as the ratio of the routine value to the survey value.

Subnational:

At the subnational level, the ratio of coverage rates is calculated for each administrative unit. Any administrative ratio that has at least a 33% difference between the two coverage rates is flagged for review. The number and percentage of administrative units with at least a 33% difference is then calculated. This comparison is possible only if the survey's coverage estimates are available for the indicator at the same administrative level. For instance, if the administrative unit of analysis is a district but survey coverage rates for the indicator are not available at the district level, the subnational comparison will not be possible at the district level. However, if provincial or regional-level survey data are available, the comparison can be made at that level, assuming that the survey was performed in the last 2–3 years

Box A2.7 Example of external comparison with survey results

If the HMIS accurately detects all ANC visits in the country (and not just those limited to the public sector) and the denominators are sound, the coverage rate for ANC1 derived from the HMIS should be similar to the ANC1 coverage rate derived from population surveys. However, the coverage rates from HMIS often differ from survey coverage rates for the same indicator.

Table A2.7a Comparison of HMIS and survey coverage rates for ANC1
Discrepancies of more than 33% between the two are highlighted in red.

	Facility coverage rate	Survey coverage rate	Ratio of facility to survey rates	Absolute % difference between HIMS and survey coverage rate
District 1	1.05	0.95	1.1	11%
District 2	0.91	0.97	0.94	6%
District 3	1.39	0.9	1.54	54%
District 4	0.76	0.95	0.8	20%
District 5	0.96	0.8	1.2	20%
District 6	0.93	0.98	0.96	5%
District 7	0.84	0.86	0.98	2%
District 8	1.1	0.98	1.13	12%
District 9	1.38	0.92	1.5	50%
District 10	0.91	0.79	1.16	15%
National	**0.98**	**0.93**	**1.05**	**5%**

At the national level:
The coverage rate from the HMIS is 98%.
The coverage rate from the most recent population-based survey is 93%.
The ratio of the two coverage rates is: 98% / 93% = 1.05
If the ratio is 1, the two coverage rates are exactly the same.
If the ratio is > 1, the HMIS coverage rate is higher than the survey coverage rate.
If the ratio is <1, the survey coverage rate is higher than the HMIS coverage rate.

The ratio of 1.05 shows that the two denominator values are fairly similar to each other, with approximately 5% difference between them.

At the subnational level, the ratio of denominators is calculated for each administrative unit. Districts with at least 33% difference between their two denominators are flagged for attention. In Table A2.7a above, District 3 and District 9 have at least 33% difference between their two ratios.

Table A2.7b Example of summary results

Metric	Results
National ANC1 coverage rates consistency ratio	1.05
Districts with ANC1 consistency ratio below 0.67 (survey coverage rate is higher)	0
Districts with ANC1 consistency ratio above 1.33 (HMIS coverage rate is higher)	2 (10%)

Dimension 4. External comparisons of population data

(Review of denominator data used to measure performance indicators)

The use of population data in the calculation of health indicators allows comparisons of results within or across geographical areas, over time, and between population subgroups. The population data for a specific indicator and a specific geographical area or population subgroup (e.g. pregnant women) serve as the denominator in the calculation of a rate or a proportion and provide context to the numerator (e.g. the number of events, patients, commodities, etc. for the health process in question). The use of population data for calculating indicators is critical to effective monitoring and evaluation of health programmes. However, in many countries the quality of population data is known to be poor. The purpose of this dimension is to determine the adequacy of the population data used in calculating health indicators. This is achieved by comparing two different sources of population estimates (for which the values are calculated differently) to assess the level of congruence between the two sources. If the two population estimates are discrepant, the coverage estimates for a given indicator can be very different even though the programmatic result is the same (i.e. the number of events). The higher the level of consistency between denominators from different sources, the more confidence can be placed in the accuracy of population projections.

Data quality metric: consistency with United Nations population projections

Definition

For this indicator, the denominator (total population of interest) used for one of the selected indicators included in the DQR is compared to United Nations population projections. Denominators that are used to calculate rates and ratios are usually derived from the census or civil registration system. Denominators from the census are usually population projections based on estimates of natural growth and migration.

Consistency with United Nations population projections is defined as the ratio between the official country projection for the number of live births or pregnant women divided by the official United Nations projection for the same population for the same year. See Box A2.8.

Consistency of denominators between programme data and official government statistics must be considered. If health programmes maintain their own population estimates, as is often the case in immunization programmes which conduct community microplanning, these programme-specific denominators can be compared with the same population estimates of the National Statistics Office using the procedure outlined here. See Box A2.9.

Data requirements

Population estimates are used as denominators for calculating rates for selected indicators. The most common denominator used for calculating ANC rates and delivery rates is the total number of live births in a specified period of time. For immunization, the most commonly used denominator is the total number of surviving infants (total live births adjusted for infant mortality), and for outpatient visits the usual denominator is the total population. Comparable denominators available from United Nations projections are births and total population.

Calculation

National:

At the national level this indicator is defined as the ratio between the official country projection (from the Census Office or National Statistics Office) and the United Nations population projection.

This quality metric is not calculated for the subnational level.

Box A2.8 Example of consistency with United Nations population projections

If the official estimate of live births for the year of analysis is 255 000 and the projected United Nations population is 200 000, the ratio of country population estimate to United Nations population projection is 255 000 / 200 000 ≈ 1.28.

This ratio shows that the country population estimate for live births is higher than the United Nations population projection for the same year.

Data quality metric: consistency of denominators – comparison of official government statistics and denominators used by health programmes

Definition

This metric measures the consistency of population estimates used for the calculation of health-system performance indicators. Population data for common indicators from official government sources (e.g. National Statistics Office) are compared to values for the same populations used by health programmes (if applicable) to determine the level of agreement between the two sources. Recommended programme indicators (and their associated denominators) used for this comparison are noted in Annex 3.

Data requirements

National:

Official government population estimates for denominators used in the calculation of rates for selected indicators for the year of analysis (live births, expected pregnancies, children under one year of age, total population).

Data for analogous subpopulations used by health programmes.

Subnational:

Subnational administrative unit population estimates for denominators used in the calculation of rates for selected indicators for the year of analysis.

Calculation

National values from official government statistics for live births, expected pregnancies, children under one year of age and total population are divided by analogous health programme values to determine agreement. Values that differ significantly (recommended 10%, but can also be defined by users) are flagged for review.

At the subnational level, this indicator is defined as the number and percentage of subnational units where there is a significant discrepancy (± 10%) between the two denominators.

Box A2.9 Example: consistency of population data

In this example focusing on live births, the subnational administrative unit values from official government sources are compared to health programme sources in order to determine agreement.

Calculate the ratio of the number of live births from official government statistics nationally for the year of analysis to the value used by the selected health programme = 0.97.

Calculate the ratio of subnational administrative unit live births in 2014 to the value used by the selected health programme (Table A2.9a).

Table A2.9a Consistency of population trend – national and subnational administrative unit ratios of official government live-birth estimates for 2014 to live-birth estimates for 2014 used by the health programme

Administrative units with a difference of ≥ 10% are indicated in red.

	Official government estimates for live births (2014)	Health programme estimates for live births (2014)	Ratio
District 1	29 855	29 351	1.02
District 2	23 398	23 032	1.02
District 3	6 893	7 420	0.93
District 4	18 832	19 938	0.94
District 5	15 032	14 844	1.01
District 6	25 023	30 141	0.83
District 7	14 983	15 004	1.00
District 8	14 556	14 960	0.97
District 9	12 973	13 054	0.99
District 10	25 233	25 283	1.00
National	**191 003**	**194 882**	**0.97**

District 6 has a difference of 0.17, or 17%.

Table A2.9b Example of summary results

Metric	Results
National ratio of official government estimate of live births to the value of live births used by the health programme	0.97
Number (%) of districts where the difference between official government live births and health programme live births is ≥ 10%	1 (10%)
Districts with a difference rate of ≥ 10%	District 6

Annex 3: Data requirements and formatting for a DQR desk review

Table A3.1 shows the data requirements for a DQR. The data requirements are based on the indicator selected.

Table A3.1 DQR data requirements

Programme	Data type		Indicator
General service statistics	Population		• Total population
	Routine		• Total outpatient visits
Maternal health	Population		• Estimated number of pregnant women • Estimated number of deliveries
	Survey	Core	• ANC1 coverage • Institutional deliveries
		In-depth	• Tetanus toxoid (TT) 1st dose
	Routine	Core	• ANC 1st visit
		In-depth	• ANC 4th visit • Institutional deliveries • IPT1 • Tetanus toxoid 1st dose • Postpartum care coverage
Immunization	Population		• Estimated number of children < 1 year ("surviving infants")
	Survey		• Estimated coverage with 3rd dose DTP-containing vaccine
	Routine	Core	• 3rd dose DTP-containing vaccine in children < 1 year
		In-depth	• 1st, 2nd, 3rd dose DTP-containing vaccine (DTP1-3/Penta1-3) • Number of children vaccinated with 1st dose of measles-containing vaccine • Doses of PCV1−3 in children < 1 year[1]
HIV	Population		• Total population • HIV prevalence to estimate population in need
	Survey	Core	• Currently on ART is not normally assessed by household surveys
		In-depth	• HIV counselling and testing during last 12 months • Pregnant women HIV-tested in ANC
	Routine	Core	• Number and % of PLHIV who are receiving HIV care (including ART services) (HIV coverage)
		In-depth	• % of HIV-positive persons on ART (or ART coverage)[2] • PMTCT ART coverage • ART retention at 12 months • Viral suppression

Table A3.1 DQR data requirements, continued

Programme	Data type		Indicator
TB	Population		• Total population
	Routine	Core	• Number of notified TB cases (all forms of TB)
		In-depth	• Number of TB cases successfully treated (all forms of TB) • Number of TB cases (new and relapse) tested for HIV • Number of HIV-positive TB patients initiated on ART • Number of MDR-TB cases detected • Number of MDR-TB cases successfully treated
Malaria	Population		• Total population
	Survey	Core	• Malaria confirmation by health facilities is not normally assessed by household surveys
		In-depth	• Proportion of pregnant women treated with 3 or more doses of IPTp • % of children with fever who took first-line antimalarial among those given any antimalarial treatment
	Routine	Core	• Number of cases of malaria confirmed by microscopy or RDT
		In-depth	• Number of malaria diagnostic tests performed (microscopy or RDT; positive or negative) • Number of confirmed malaria cases (positive microscopy or RDT) • Number of presumed malaria cases • Number of confirmed malaria cases treated • Total number of malaria cases (suspected and confirmed) treated • Number of pregnant women attending antenatal clinics treated with 3 or more doses of IPTp

Note: ANC = antenatal care; ART = antiretroviral therapy; DTP3 = diphtheria-tetanus-pertussis; IPT = intermittent preventive therapy; MDR-TB = multidrug-resistant tuberculosis; PLHIV = people living with HIV; PMTCT = Prevention of mother-to-child transmission; RDT = rapid diagnostic test.

[1] If the country has implemented vaccination with PCV, note that some countries may use this in a 2+1 schedule by which the third dose may be given at or after 12 months.

[2] Depending on the country's policies on ARV coverage – e.g. adoption of WHO's 2013 ARV guidelines recommendation of 85% of HIV-infected persons on treatment.

Formatting the data

The data from the HMIS or the health programmes should be reported monthly (or according to another periodicity) as **aggregate data for the district level**. The data should be formatted to facilitate the calculation of data quality metrics in the DQR – i.e. a flat file with one row per health facility (or district) and monthly indicator values in columns. In countries with DHIS 2, a built-in WHO data quality application, all the data formatting and analysis is done automatically and participants are presented with the results. Countries with DHIS 2 can also examine data at the health-facility level. In countries that have electronic HMIS other than DHIS, the required data should be queried to obtain the necessary format. Subsequently, it can be analysed in the automated Microsoft Excel tool included in this toolkit. For more routine data quality analysis for countries that do not have a DHIS 2, a simplified district-level version of the Microsoft Excel tool is being developed for facilities in the district.

Monthly service data

Annual data (disaggregated by month) should be provided for the fiscal year of analysis (e.g. January–December, July–June, etc.) for the selected administrative level (the recommended level of analysis is the district) for all the routine indicators listed above. All administrative units in the country should be included (for the selected level of analysis). The format of Table A3.2 can be used for each of the indicators.

Table A3.2 Format for monthly service data

Number	Administrative unit	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
1	District A												
2	District B												
3	District C												
4	District D												
5	District E												
6…	District F…												
…N	…District Z												

Service data trend information

Annual data for up to three years preceding the fiscal year of analysis should be provided for each administrative unit at the selected level of analysis for the selected programme indicators. For example, if the year of analysis is January–December 2015, annual data for 2012, 2013 and 2014 (if available) should be provided for each of the indicators. The format of Table A3.3 can be used for the trend data.

Table A3.3 Format for trend data

Number	Administrative unit	Indicator 1			Indicator 2			Indicator 3			Indicator 4		
		2012	2013	2014	2012	2013	2014	2012	2013	2014	2012	2013	2014
1	District A												
2	District B												
3	District C												
4	District D												
5	District E												
6…	District F…												
…N	…District Z												

Population data

Population data are required by the selected administrative level of analysis for specific population groups. For example, if the level of analysis is the district level, population data on the following will be required:

- total population
- number of pregnant women
- number of deliveries
- number of children under 1 year of age
- number HIV-positive.

The format of Table A3.4 can be used for the data on specific population groups.

Table A3.4 shows the format for the comparison of official government denominators (e.g. from the National Statistics Bureau) to the same denominators used by health programmes (if applicable).

Table A3.5 shows the format for denominators used to calculate population rates for the programme-level indicators used in the DQR to assess data quality. These denominators are used in Domain 3 – External Comparisons – to compare routinely-reported results to population-based survey results for the same indicators. Both the indicators in Table A3.4 and Table A3.5 are used in the DQR to evaluate data quality and the quality of denominator data.

Table A3.4 Format for data on population groups: Domain 4 – external comparison of population data

Number	Administrative unit	Denominators from official Government Statistics Bureau				Denominators used by health programmes			
		Total population	Expected pregnancies	Number of deliveries	Number of children under 1 year of age (surviving infants)	Total population	Expected pregnancies	Number of deliveries	Number of children under 1 year of age (surviving infants)
1	District A								
2	District B								
3	District C								
4	District D								
5	District E								
6…	District F…								
…N	…District Z								

Table A3.5 Format for data on population groups: Domain 3 – external consistency

Number	Administrative unit	Denominators used to calculate rates for programme-level indicators selected for DQR				
		Antenatal care 1st visit (ANC1) (expected pregnancies)	DTP3/Penta3 (surviving infants)	ART coverage (number HIV-positive)[1]	Notified cases of all forms of TB (total population)	Confirmed malaria cases (total population)
1	District A					
2	District B					
3	District C					
4	District D					
5	District E					
6…	District F…					
…N	…District Z					

[1] It may be difficult to obtain this denominator data at the district level.

Monthly HMIS or programme reports

Information is required on monthly reports submitted by health facilities to their reporting unit (usually the district), and from districts to their reporting unit, in order to calculate the completeness of reporting. Information should be provided on the following items by administrative level of analysis for the full year:

› The total number of monthly reports received from the administrative level of analysis (i.e. districts). For instance, if districts are expected to submit a report to their reporting unit each month, the actual number of reports submitted (if available) should be included.

› The total number of reports received from health facilities in the fiscal year of analysis at the administrative level of analysis (i.e. districts) – e.g. the total number of health facilities' monthly reports received for January–December 2012 by the administrative level of analysis.

› The total number of health facilities by administrative level of analysis. Only those facilities that are expected to report to the HMIS system (or any other programme reporting system) should be included. If private facilities in a district are not expected to report to any system, they should not be included in this total count.

Table A3.6 shows the format for reporting on reports received.

Table A3.6 Format for reporting on reports received

Number	Administrative unit	Total of district reports received	Total of district reports received by the deadline	Total of health facilities reporting into the HMIS	Total of health facilities' reports received	Total of health facilities' reports received by the deadline
1	District A					
2	District B					
3	District C					
4	District D					
5	District E					
6…	District F…					
…N	…District Z					

Also required are data on the number of health facilities that were expected to report in previous years.

Number	Administrative unit	Total health facilities providing services in the subdistrict			
		2011	2012	2013	2014
1	Subdistrict A				
2	Subdistrict B				
3	Subdistrict C				
4	Subdistrict D				
5	Subdistrict E				
6…	Subdistrict F…				
…N	…Subdistrict Z				

Household survey data

Formatting the data can be difficult if the data originate from a wide variety of sources. Data managers should be allowed sufficient time to produce good-quality data for the analysis since hastily-prepared data could hinder the calculation of data quality metrics.

Estimates from the most recent household survey for the selected indicators (Annex 1), with standard errors (where available) and by domain of estimation used in the survey (i.e. state/province/region), can be formatted as in Table A3.7.

Table A3.7 Format for reporting household survey data

Number	Administrative unit	Survey indicator 1		Survey indicator 4		Survey indicator 3	
		%	Standard error	%	Standard error	%	Standard error
1	Region A						
2	Region B						
3	Region C						
4	Region D						
5	Region E						
6…	Region F…						
	National						

Administrative units and data flow information

Depending on the administrative level of detail (i.e. facility, district, region) that is possible with the data available for the analysis, information will be required on the data flow from that level to the national level. If data are available for the district level and the chain of reporting is district→regional→national, information should be provided on all districts in the country, as well as on the regions to which the districts report. Table A3.8 demonstrates the desired format.

Table A3.8 Format for reporting on data flow

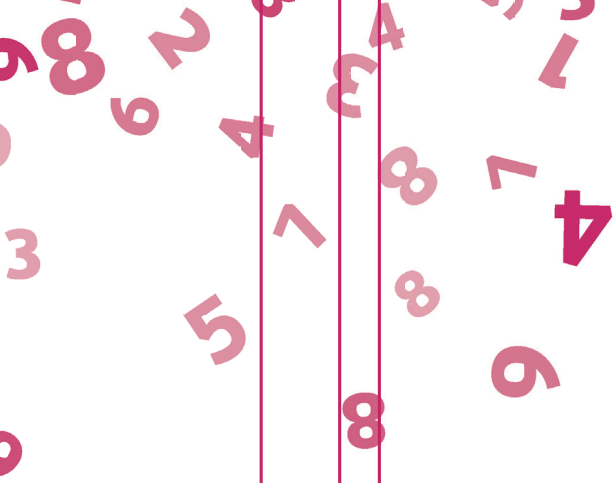| Number	Administrative level of analysis	Region to which the district reports
1	District A	Region UU
2	District B	Region UU
3	District C	Region VV
4	District D	Region VV
5	District E	Region XX
6…	District F…	Region XX
…N	…District Z	Region XX

Annex 4: Excel tool for automated data quality analysis

The data quality metrics have been included in a WHO data quality application for the DHIS software. Countries with DHIS 2 can download this app to their DHIS system. A Microsoft Excel tool has been developed to facilitate the annual data quality analysis for those countries using another software system or a paper-based system. The Microsoft Excel tool accompanies this guidance document as a separate attachment.
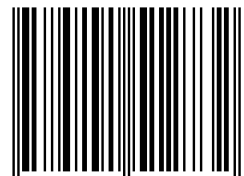
Notes

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