Country Analysis Meeting (CAM) 2025 - Analysis Guide

Jun 16, 2025

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Welcome

Overview of the Countdown to 2030

The Countdown to 2030 for Women's, Children's and Adolescents' Health (The Countdown) initiative is a global collaboration involving academics from national, regional, and international institutions, UN agencies, the World Bank, and civil society organizations. The initiative tracks progress in Reproductive, Maternal, Newborn, Child, and Adolescent Health and Nutrition (RMNCAH+N), fostering advocacy and accountability through rigorous data analysis.

Key objectives include:

- Strengthening country-led data analysis and monitoring
- Fostering innovation and evidence generation through multi-country collaboration
- Enhancing global measurement and monitoring Improving policy and program communication

For more on Countdown to 2030 initiative, visit: The Countdown website

About the `cd2030.rmncah` R Package

The cd2030.rmncah R package and Shiny App were developed to support evidence generation and analysis of RMNCAH indicators.

Key features include: User-friendly interface for data management and analysis Tools for visualization and statistical summarization Automated report generation

Acknowledgments

The Countdown acknowledges and appreciates the contribution of the following individual in developing the Stata codes that form the backbone of the `cd2030.rmncah` R package and Shiny App:

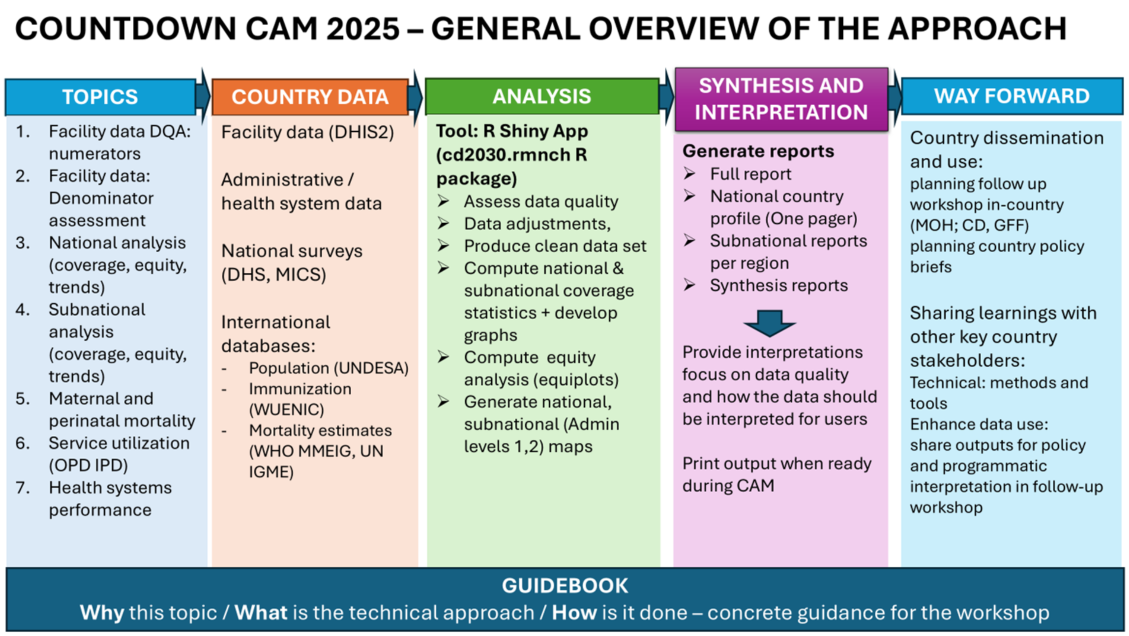
Part I

About this Guide

1 CD2030 CAM Approach

The CD2030 for Women's, Children's and Adolescents' Health, GFF, UNICEF, WHO, WAHO and other partners are collaborating to strengthen country-led progress and performance reviews, such as annual health sector reviews and midterm reviews of investment cases. This guidebook is for Countdown country analytical teams to develop a set of national and subnational estimates for key RMNCAH-N indicators, including equity, using five-year time series of routine data and survey results.

Much attention is paid to obtaining a clean data set with the necessary corrections and adjustments for known biases. Service coverage and equity, maternal and perinatal mortality, and health service utilization and systems performance are the main subjects, with a focus on monitoring national and sub-national targets, as well as global targets. The figure below shows the general overview of the CAM approach



1.1 Organization of the Guidebook

This guidebook is organized into seven sections, each focusing on a specific area of data analysis related to reproductive, maternal, newborn, child and adolescent health and nutrition (RMNCAH-N). The guidebook provides a comprehensive approach to analyzing routine health data and survey results, with an emphasis on data quality, coverage, equity, and health systems performance. The seven data analysis sections in this guidebook are:

1. Section 1: Health facility data quality assessment
2. Section 2: National Analyses (Coverage & Equity)
3. Section 3: Subnational analysis (Coverage & Inequality)
4. Section 4: Maternal mortality, stillbirths and neonatal mortality
5. Section5: Curative health services utilization for sick children
6. Section 6: Health systems progress and performance
7. Section 7: Planning ahead for data use

These sections are designed to be used in a modular way, allowing countries to select the topics that are most relevant to their context and data availability.

Each section has:

- **Why/Rationale -** the scientific basis for the analysis;
- **Approach**- a step-by-step guide on how to conduct the analysis; and the
- **Implementation -** the use of the R Shiny App for data visualization and interpretation.

1.2 Data Sources

The Countdown CAM approach uses a variety of data sources, including:

- **Health facility data**: Routine health data collected from health facilities, including service coverage, health systems performance, and health service utilization.
- **Surveys**: Nationally representative surveys, such as the Demographic and Health Surveys (DHS) and Multiple Indicator Cluster Surveys (MICS), which provide data on health indicators, equity, and health service utilization.
- **Administrative data**: Data collected by government agencies, such as vital registration systems and health management information systems (HMIS), which provide information on health outcomes and service delivery.
- **Other data sources**: Other relevant data sources, such as census data, population estimates, and health financing data, which provide additional context for the analysis.

1.3 Expected outputs

- **Synthesis/poster reports** (.pdf, .doc files)
- **Full country report** (national/sub-national) (.pdf, .doc files) - to be downloaded in sections from the Shiny App and compiled into a full report with analysis outputs and interpretations.
- **Country analytical reproducible files** (.rds files)
- **Adjusted and or summarized data files** (.csv. .dta, xlsx files)

Country analytical reproducible files (.rds files) are the final output of the analysis, which can be used for further analysis and visualization. These files contain the cleaned and processed data, country specific analysis parameters as well as the results of the analysis, including coverage, equity, and health systems performance indicators.

2 Getting started

In the past, Countdown to 2030 (CD2030) analyses were conducted using Stata, relying on a series of `.do` files. These scripts have since been translated into an R package — **cd2030.rmncah** — and integrated into a user-friendly Shiny App. This application enables health data users to load data, conduct data quality assessments (DQA), perform analyses, and generate insightful outputs using pre-designed report templates.

The tool facilitates in-depth inspection of data quality and supports subnational analysis (up to the administrative level 2) for various indicators related to data quality and RMNCAH outcomes.

2.1 Software requirements

To use this innovative digital health analytics tool, the following are required:

- Install the latest versions of **R** and **RStudio**
- Install the **cd2030.rmncah** R package latest version-noted by the superscript suffix in the name of the App

  Ensure access to all required (datasets) and (parameters)
- Install **RTools** (for Windows users, to support package compilation)

2.2 Installing R and RStudio

To begin working in R, it is necessary to install both R and RStudio. R is the underlying programming language, while RStudio provides a user-friendly interface that simplifies the development and execution of R scripts. Both are freely available and widely supported across platforms.

Note: R and RStudio are not the same. R is the programming language, while RStudio is an integrated development environment (IDE) that makes working with R easier.

To ensure smooth installation and functionality, it is recommended to install **R** first, followed by **RStudio**. This order is important as RStudio relies on R to function properly.

2.2.1 Step 1: Download and Install R

R is distributed via The Comprehensive R Archive Network (CRAN). Select your operating system from the homepage: Windows, Mac, or Linux.

Windows

1. Navigate to ***Download R for Windows*** and select the "base" option.
2. Click the first link (e.g., "Download R x.x.x for Windows") to download the installer.
3. Run the installer and follow the prompts. ***Administrator privileges may be required***.
4. R will be installed in your system's Program Files, with a shortcut added to the Start menu.

Mac

1. Click ***Download R for Mac*** on the CRAN homepage.
2. Download the latest release package and run the installer.
3. The default installation settings are typically sufficient. You may be prompted to enter your system password.

Note

R is not a graphical software application but a programming environment. It is best used in conjunction with RStudio, which provides a consistent and user-friendly interface across operating systems.

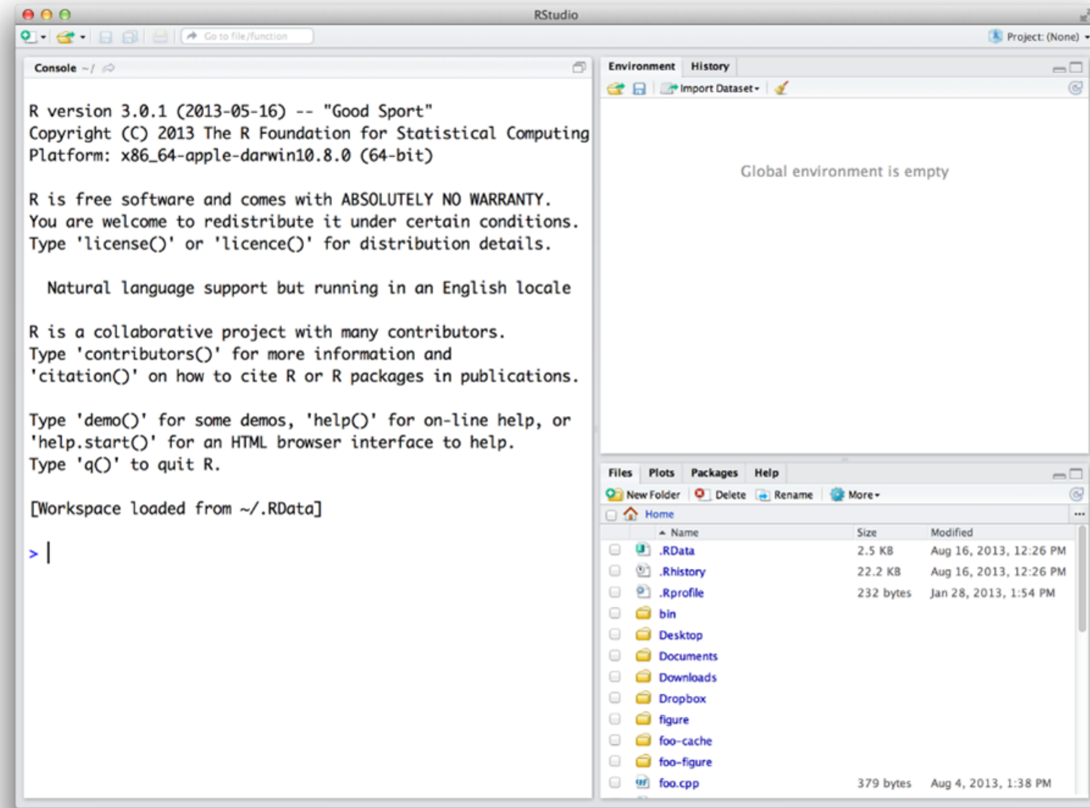
2.2.2 Step 2: Download and Install RStudio

RStudio is an integrated development environment (IDE) designed for R. It features a script editor, console, graphics viewer, and additional tools for package management, debugging, and file organization.

Download RStudio from Posit Website

Do I still need to download R? Even if you use RStudio, you'll still need to download R to your computer. RStudio helps you use the version of R that lives on your computer, but it doesn't come with a version of R on its own.

After installation, launch RStudio and begin interacting with R through its console and script windows.



2.3 Installing the CD2030 RMNCAH package

After installing R and RStudio, you may proceed with installing the Countdown2030 RMNCAH application, which is hosted on GitHub under the repository `cd2030.rnncah`. The application is implemented as an R package and supports interactive dashboard generation via Shiny.

2.3.1 Installation via R Console

Stable Version

```r
if (!requireNamespace("devtools", quietly = TRUE))
  install.packages("devtools")
devtools::install_github("aphrcwaro/cd2030.rmncah@v1.0.0")
```

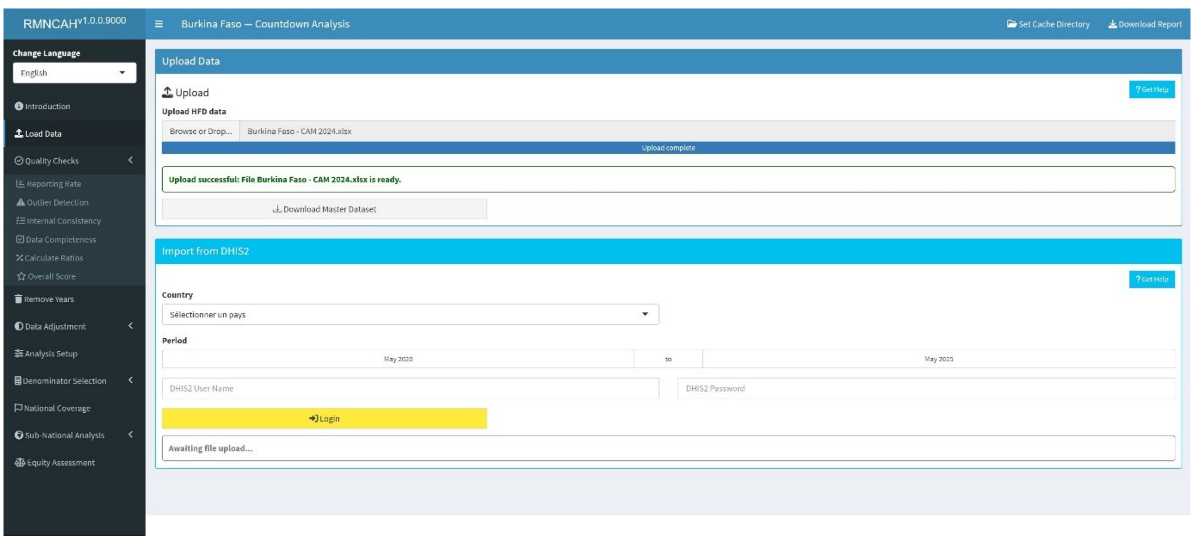
Development Version

```r
if (!requireNamespace("devtools", quietly = TRUE))
  install.packages("devtools")
  devtools::install_github("aphrcwaro/cd2030.rmncah")
```

2.3.2 Launching the Application

```r
library(cd2030.rmncah)
dashboard()
```

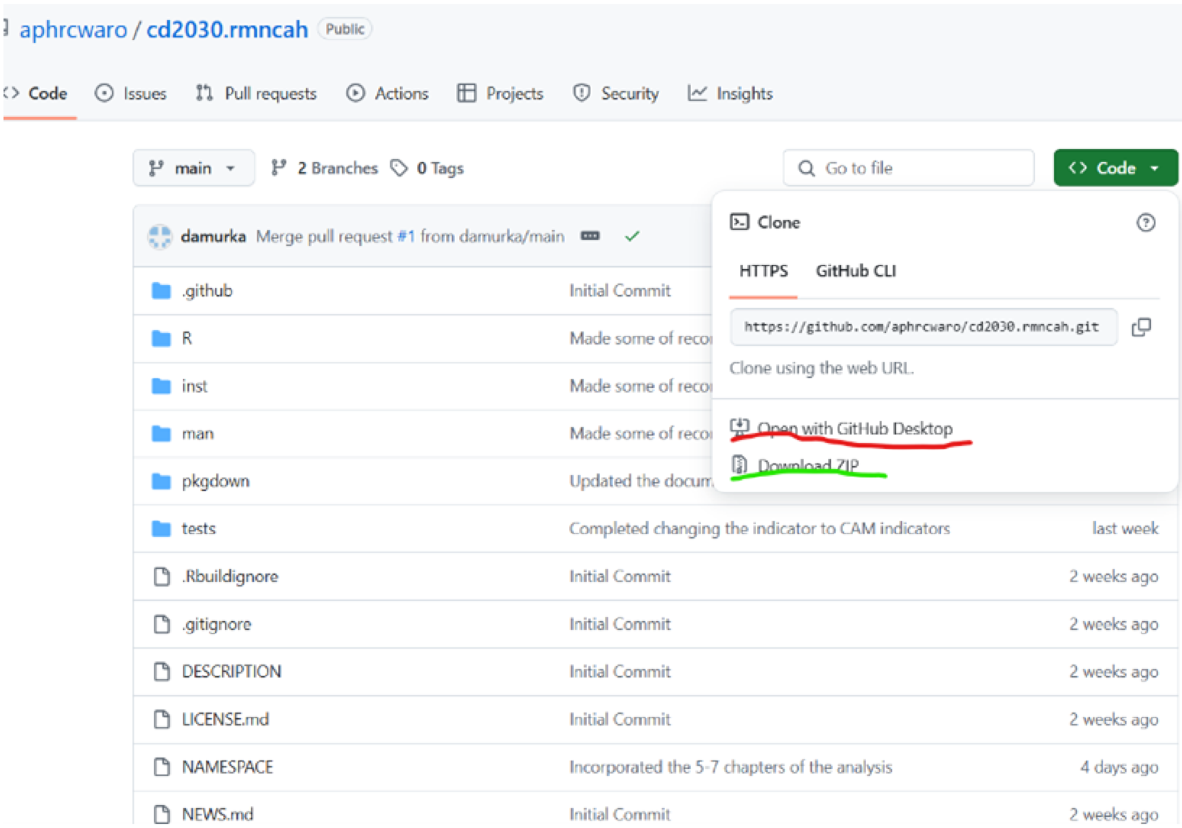
The Shiny dashboard will launch automatically in your default web browser.

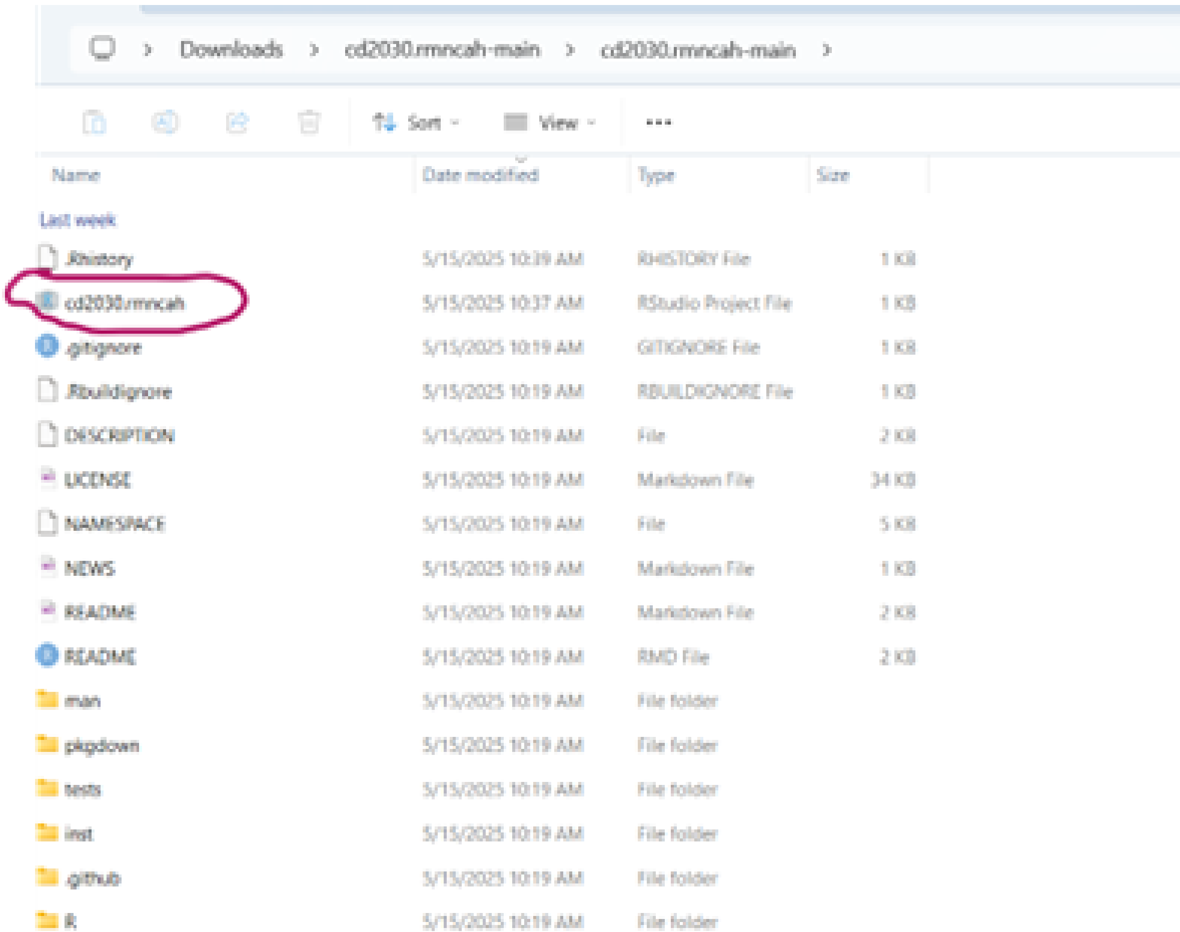


2.3.3 Alternative Installation via GitHub Desktop or Git or direct download

Advanced users with GitHub accounts may prefer to clone the repository directly. This method allows for:

- Version control
- Contribution to the codebase
- Inspection of the package structure
- Once cloned, open the .Rproj file in RStudio to set the working directory.





To install and run:

```r
library(cd2030.rmncah)
dashboard()
```

2.3.4 `RTools` for Windows

To compile packages from source, especially development versions, RTools must be installed. Ensure the Rtools selected corresponds and is compatibile with your installed R version.:

- **R 4.2.0** → Rtools42
- **R 4.4.0** → Rtools44
- **R 4.5.0** → Rtools45

Rtools can be downloaded from CRAN

2.4 Data requirements

2.4.1 Datasets required

To run the analysis efficiently, each country team will require to have a folder containing the following datasets:

1. Health facility data (.xlsx file)
2. UN Estimates
3. Survey data
4. UN mortality data
5. FPET data

These datasets will be provided to the country teams by the Countdown2030 team prior to the workshop.

2.4.2 Country specific analysis parameters

The following (parameters) will be required to run the analysis

3 App Features

3.1 Overview of App Features

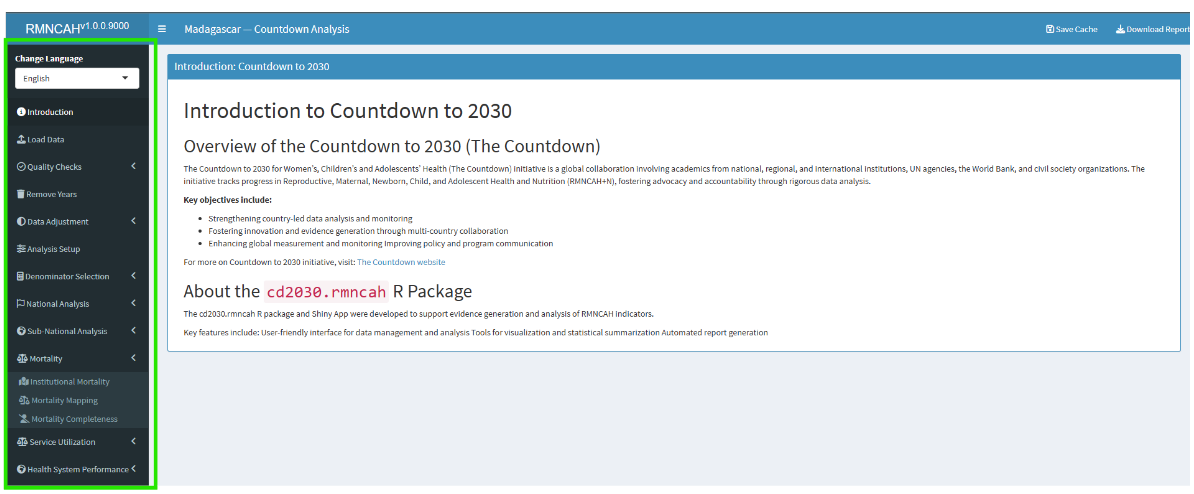
This section details the main components of the **cd2030.rmncah** Shiny App interface: the **Title Bar**, **Sidebar**, and **Main Panel (Body Content)**. Understanding these elements will help you navigate and use the app more effectively.

3.2 Title Bar

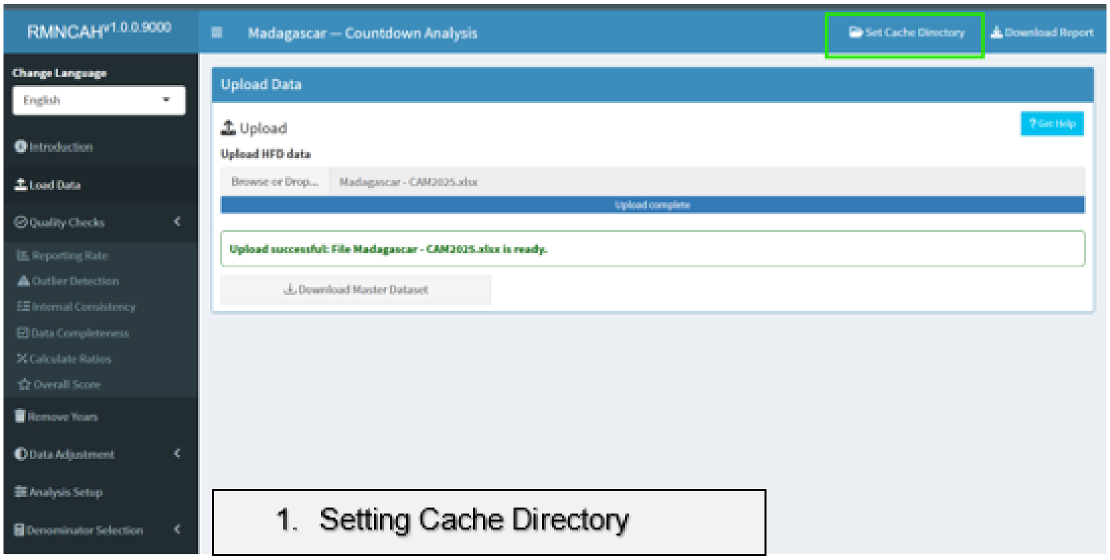
The Title Bar, located at the top of the app, provides key information controls. The elements of the Title Bar, such as "Set Cache Directory/Save Cache" and "Download Report," are only displayed after data has been loaded.

3.2.1 Key Elements of the Title Bar

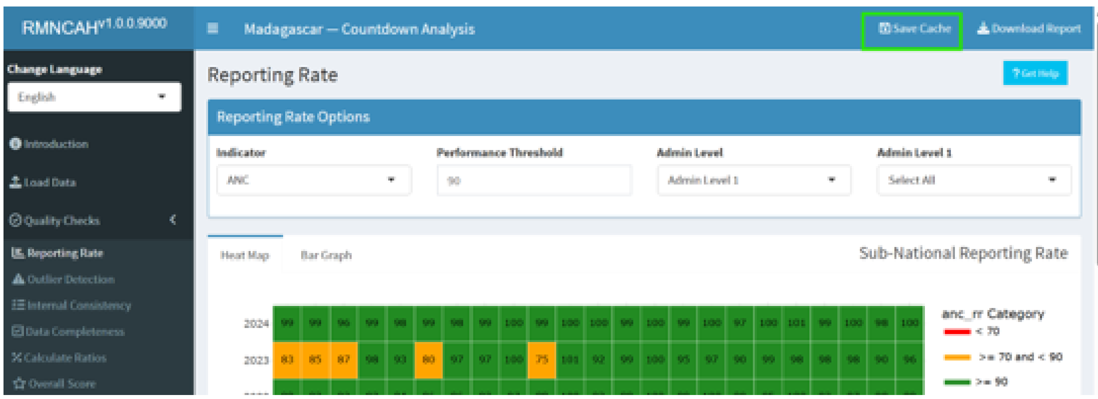
1. **Contextual Information**: Displays the current analysis context, such as the country of analysis (e.g., "Madagascar - Countdown Analysis").



2. **Cache Management**



1. Setting Cache Directory



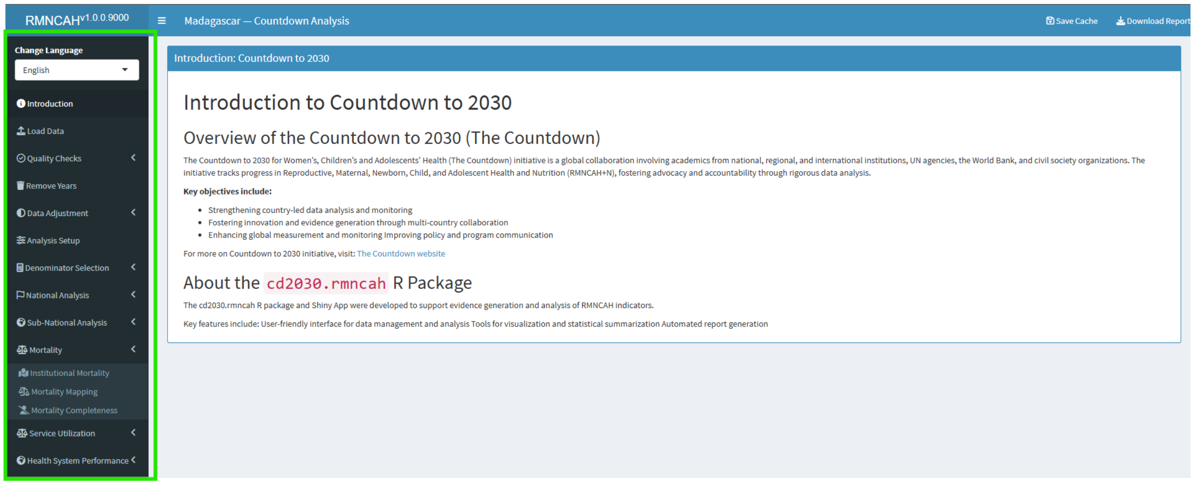
2. Saving/updating Cache file

- **Set Cache Directory:** This button allows you to specify a directory for saving intermediate results and progress.
- **Save Cache:** This button allows you to save the progress of your analysis. This is useful for large analyses or for resuming a session later.
- NB:
  - The Cache button is enabled only once valid data has been uploaded into the App
  - Changing the file path of the Cache mid analysis would require you to set the cache again, losing any saved progress after the last save.

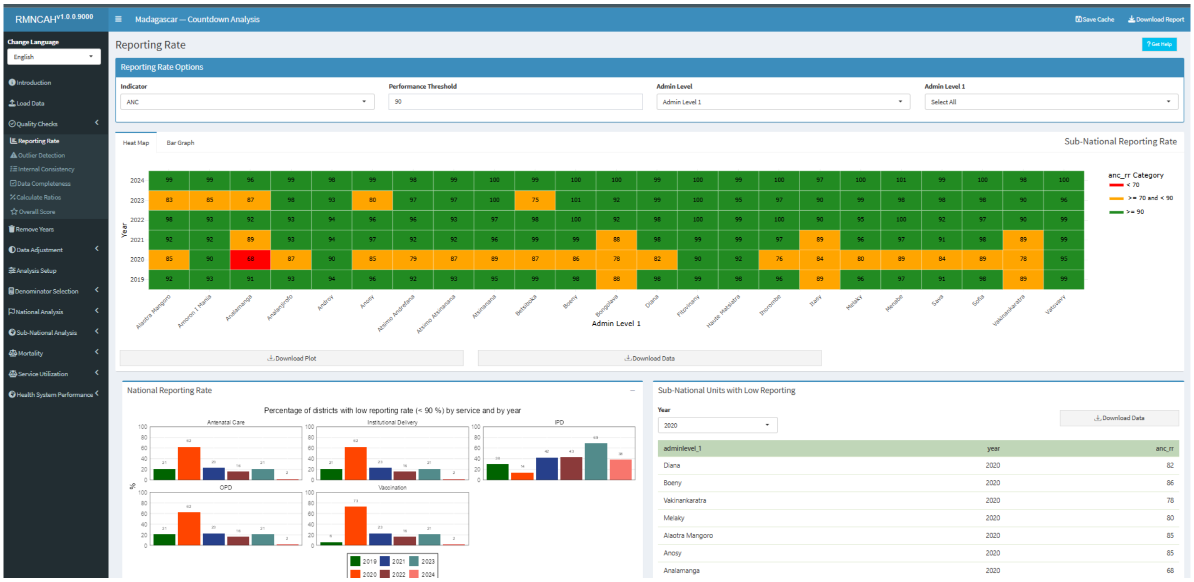
3.3 Sidebar

The Sidebar is located on the left side of the app and contains the main navigation elements.It provides navigation through the analysis workflow. The sections are arranged sequentially to guide you through the process.

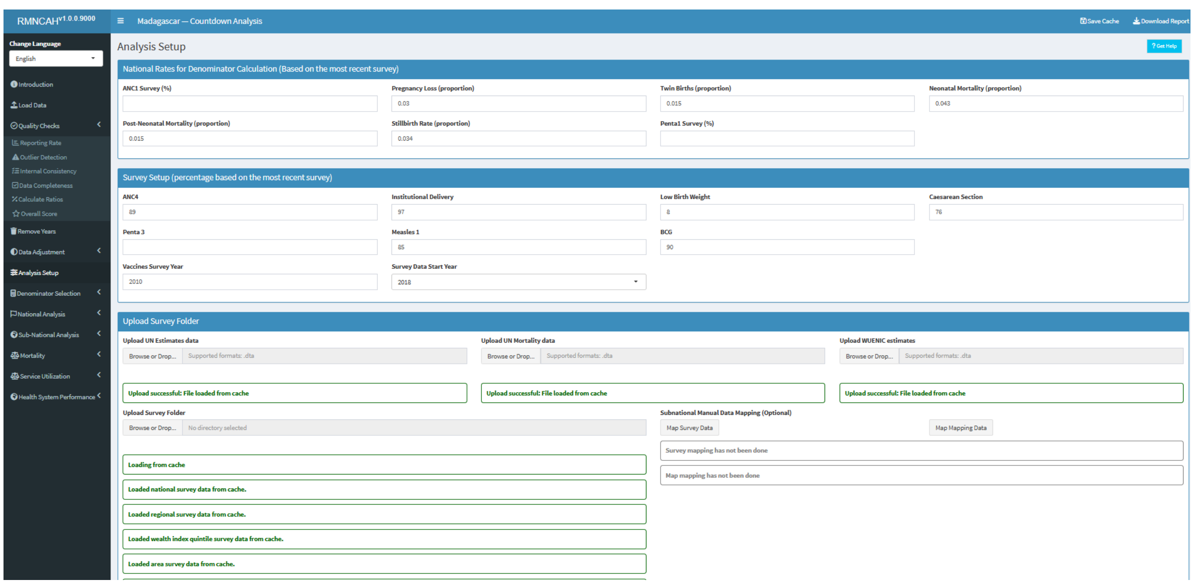
3.3.1 Sidebar Navigation



1. **Introduction**: Provides a brief overview of the app's purpose and functionality.
2. **Load Data**: Allows you to upload and manage your datasets (e.g. Health Facility Datasets, Master datasets, and cache file).
3. **Data Quality**: Provides tools for assessing the quality of your data, including checks for missing values and inconsistencies. Subsections include:
    - Reporting Rate
    - Outlier Detection
    - Consistency Check
    - Data Completeness
    - Calculate Ratios
    - Overall Score



4. **Analysis Set-up**: Allows you to configure the analysis by selecting the data sources (UN Estimates, WUENIC estimates, and survey data). It also allows you to map the sub-national survey and mapping data to the uploaded data.



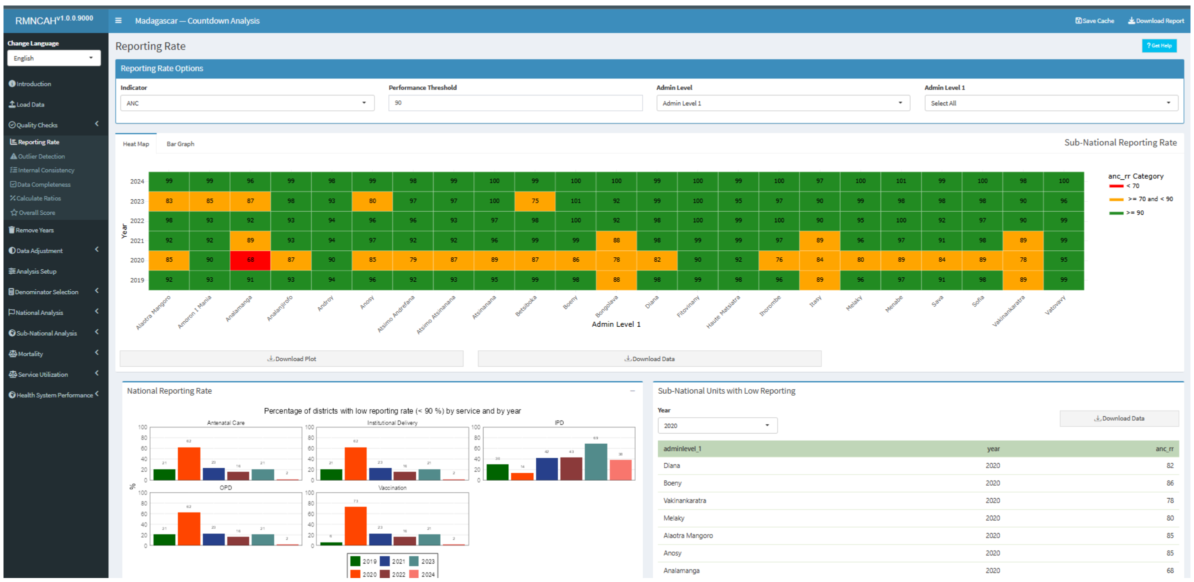
5. **National Analysis**: Provides tools for analyzing national-level data, including coverage and equity analysis.
6. **Sub-National Analysis:** For all sub-national analyses
7. **Mortality Analysis:** For all mortality analyses
8. **Service Utilization:** ForCurative health services utilization for sick children analyses
9. **Health System Performance:** Health systems progress and performance analysis

3.4 Main Panel(Body Content)

The main panel is the central workspace where the analysis result, visualizations, and interactive elements are displayed.

3.4.1 Key Elements of the Main Panel

1. **Page Title**: Displays the current module or analysis step (e.g., "Reporting Rate").



2. **Action Buttons**: Provides context-specific actions:

   - **Download Report**: Helps you to download two reports: **Synthesis report** and the **Subnational one paper report**
   - **Generate Report**: Downloads a report specific to the analysis section.

     NB: This button is green in colour and only appears in the sections where the user can download the section reports.
   - **Get Help**: Provides context-specific help and documentation for the current page.
   - **Download Plot / Download Data:** Allows the user to download the displayed output and the data associated with the output, respectively.

4 Loading Health facility data

This section explains how to structure and upload data into the app, ensuring compatibility with the **Countdown Health facility data format**

Please note that should you update your data during the workshop, ensure it is in the correct format before uploading to avoid errors.

4.1 Supported File Formats

The app supports uploading the following file types:

- `.xls`, `.xlsx` (Excel files)- The raw health facility dataset in the **Countdown format**
- `.dta` (Stata files) - Master dataset downloaded from the app after validation/adjustment
- `.rds` (R Cached datafile) - The file containing the preloaded dataset, user adjustments and analysis parameters that has been > saved in the Cache directory. This will be the last saved file.

4.2 How to Upload Data

Step 1: Prepare Your data file

Ensure your data is cleaned and structured according to the **The Countdown Health facility data format** by:

- Using the provided **HFD Standardized Template** to format your data correctly.
- Saving the file in a supported format: `.xls`, `.xlsx`, `.dta`, or `.rds`.

Step 2: Upload the File

1. Navigate to the `Upload Data` section of the app.

2. **Drag and drop** your file into the upload box, or click `Browse` > to select it manually in your directory.
3. For subsequent re-uploads (after the initial uploading of the `.xls`, `.xlsx`, `.dta` files and saving your progress in .rds file using the `Save Cache` button), do not re-upload the `.xls`, `.xlsx`, or `.dta` but the saved `.rds` file if you want to retain any changes made in your analytical files
4. The app will validate your file against the **Countdown format**.
   - If successful, a confirmation message will appear: ***"Upload successful: Your file is ready for analysis."***
   - If errors are detected, an error message will indicate the issue.

4.3 Common Errors and How to Fix Them

Error Message	Cause	Solution
"Unsupported file format"	File type not supported	Save your file as .xls, .xlsx, .dta, or .rds.
"The following required columns are missing from the data: opv1"	Missing essential columns in the data	Add the missing column(s) to your dataset and ensure their values are valid.
"The following sheets are missing: Service_data_1, Service_data_2, Service_data_3, Reporting_completeness, Population_data, Admin_data"	Missing one or more required sheets in the file	Add the missing sheets to your file and ensure they conform to the template.
"Sheet Service_data_3 is empty"	The sheet exists but contains no data	Populate the sheet with valid data or remove the empty sheet.
"Key Columns"month" missing in Service_data_3"	A key column district, year, or month, is missing from the specified sheet	Add the missing column(s) to the sheet and ensure the data is structured correctly.
"Column name month must not be duplicated. Use .name_repair to specify repair."	Duplicate column names in the dataset	Ensure all column names are unique. Rename or remove duplicate columns.

Note*: If a key column (district, year, or month) is missing data in a row, that row will be excluded from the resulting dataset.*

4.4 Tips for a Successful Upload

- Always use the latest **The Countdown Health facility data format** > template to structure your data.
- Double-check column names, formats, and content before uploading.
- Save your file in a supported format and ensure it is UTF-8 encoded

Part II

Data Quality Assessment

5 Numerators Assessment

5.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Routinely reported health facility data are an important data source for health indicators at facility and population level. The data are reported by health facilities on events such as immunizations given, or live births attended. As with any data, quality is an issue. Data needs to be checked to consider completeness of reporting by health facilities, identify extreme outliers and internal consistency. A standard reporting method for data quality allows assessment of progress over time.

Approach: Description of analytical steps

The analysis of the monthly data by district for 2019-2024 is used to assess annual data quality using the following standard indicators: *Reporting completeness*, *Outlier detection*,*Internal Consistency Data completeness*, *Ratios calculation*, *Overall quality score*

Implementation: Conducting analysis in the Shiny App

5.2 DQA Metrics calculation and interpretation

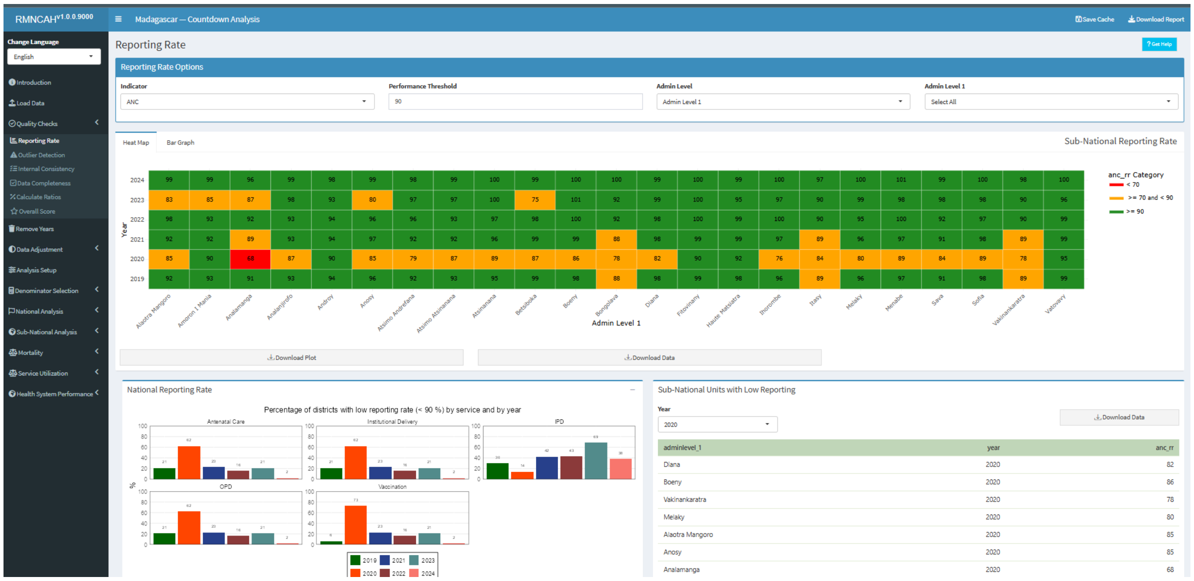
5.2.1 Reporting Completeness

Indicator	Numerator	Denominator
1a	N of monthly facility reports received	Total N of facility rep
1b	N of districts with at least 90% monthly reporting completeness in a year	Total N of districts
1c	N of districts with no missing values for any of the 4 forms in a year	Total N of districts

Statistics for 1a and 1b are based on the mean of 4 reporting forms (ANC, delivery, immunization, OPD)

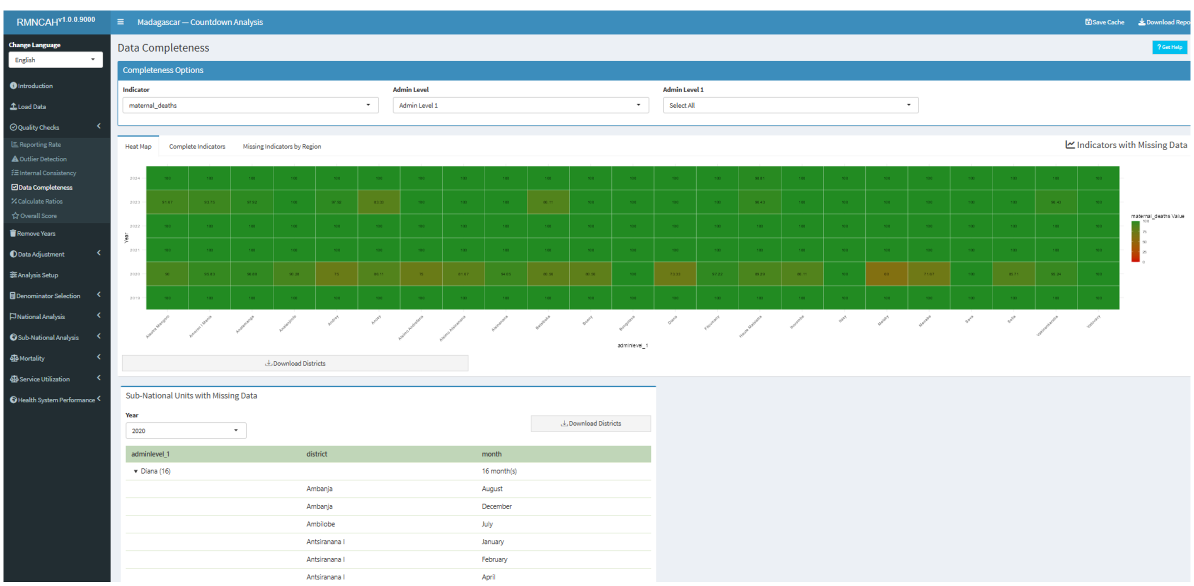
Within the Shiny App, you can select the indicator of interest, the reporting rate cutoff point (performance Threshold)- the default value has been set at 90% reporting rate.

You can also choose the level of you analysis (Admin Level (Regions) or District level). Below is an output for ANC reporting rate at the Admin Level 1.



The app will also produce a report with the results of the data quality assessment, including the numerators and denominators for each indicator, as well as the overall data quality score.

5.2.2 Data Completeness

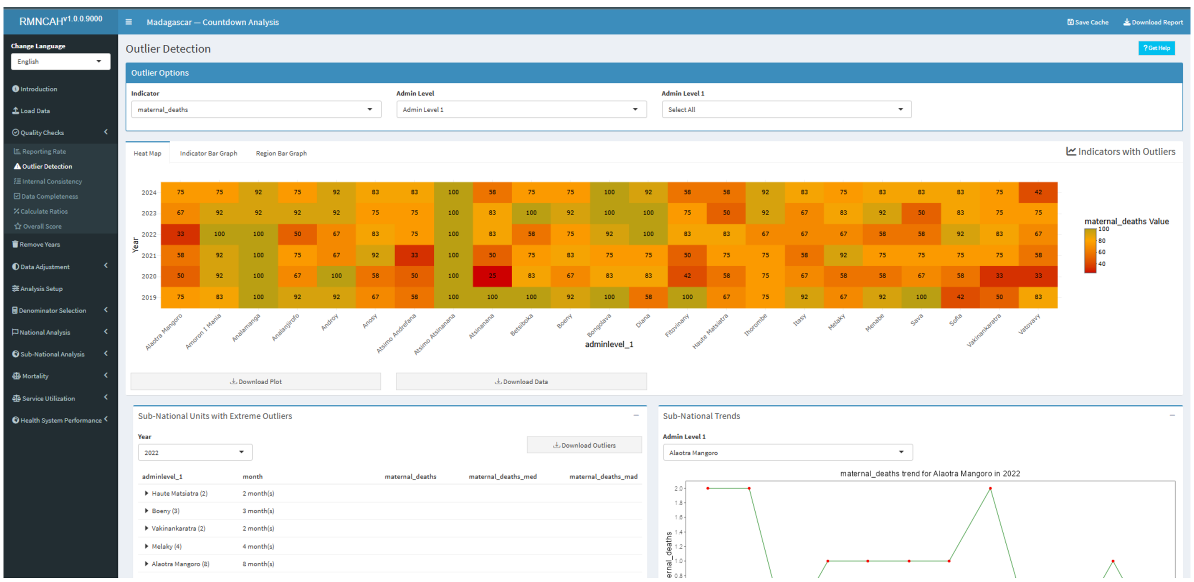


5.2.3 Outlier Detection

		E
Indicator	Numerator	Denominator
2a	N of monthly values that are not extreme outliers in a specific year	Total N of monthly values (
2b	N of districts with no extreme outliers in a specific year	Total N of districts

Outliers are identified statistically; definitions may vary depending on methods used.

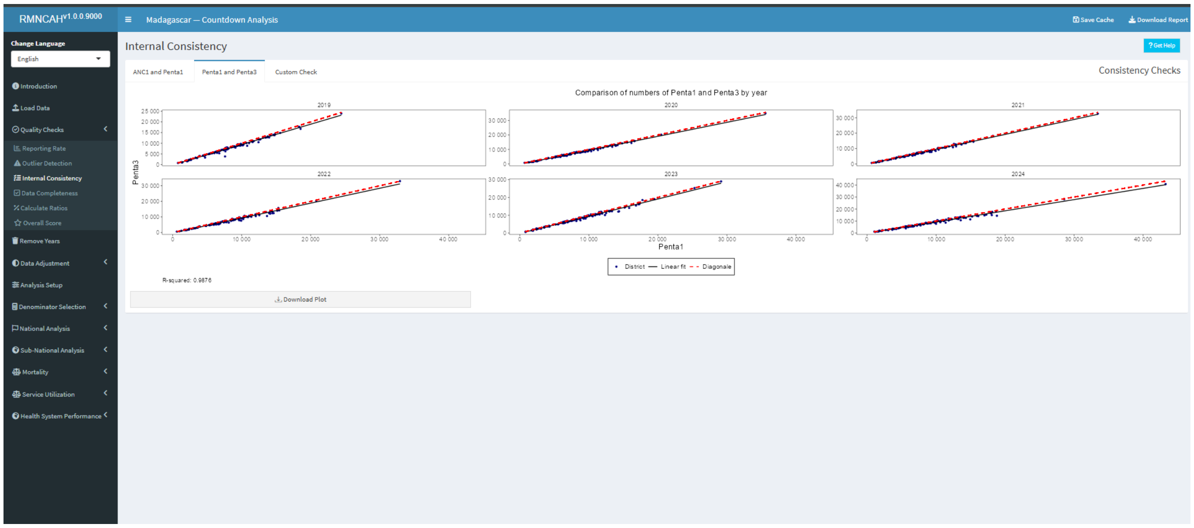
The Shiny App allows users to visually investigate which sub-national units have outliers and for which months. This way, they can factor in their country context in determining whether indeed it is a data quality issue or not.



5.2.4 Internal Consistency

			Consistency of Annual
Indicator	Numerator	Denominator	Interpretation
3a	N of ANC1 reported	N of penta1 reported	National ratio withi
3b	N of penta1 reported	N of penta3 reported	National ratio withi
3c	N of districts with ratios within the expected range	Total N of districts	For districts there is
3d	N of districts within the expected range	Total N of districts	For districts there is

There is often an inconsistency between antenatal and immunization data, even though we can argue that the two should be consistent. To examine the association between ANC1 and penta1 is particularly informative.



To compute and interpret indicators 3a and 3b the following considerations need to be made:

ANC1 to penta1 ratio

We can compute an expected ratio ANC1 to penta1 based on assumptions about mortality between early to mid pregnancy and early infancy and survey data on coverage of ANC1 and penta1 in the population:

- Consider the mortality between the first ANC visit and the first pentavalent vaccination.

  Assuming that ANC1 takes place at about 20 weeks or 4-5 months of pregnancy and penta1 at 6-8 weeks postpartum, we assume a pregnancy loss (abortion) after the ANC1 visit of 3%, a stillbirth rate of 2%, a twinning rate of 1.5% and neonatal mortality rate before the penta1 of 3% then the difference between the numbers of ANC1 and penta1 should be:

  $$1 - 0.03 - 0.02 + 0.015 - 0.03 = 0.935$$

  This corresponds with a ANC1 to penta1 ratio of

  $$1/0.935 = 1.07$$

- Actual population coverage of ANC1 and penta1 will also need to be considered, using the surveys.

The expected ratio (the number of ANC1/ number of penta1 in facilities) is 1.07 * (ANC1 coverage in the survey/penta1 coverage in the survey). If coverage for ANC1 and penta1 are the same, then the ratio is

$$1.07(1.07 \times 1/1)$$

But if, for example, the last survey shows that ANC1 coverage was 90% and penta1 coverage was 95%, then the expected ratio becomes \1.07 * (.90/.95) = 1.01*.

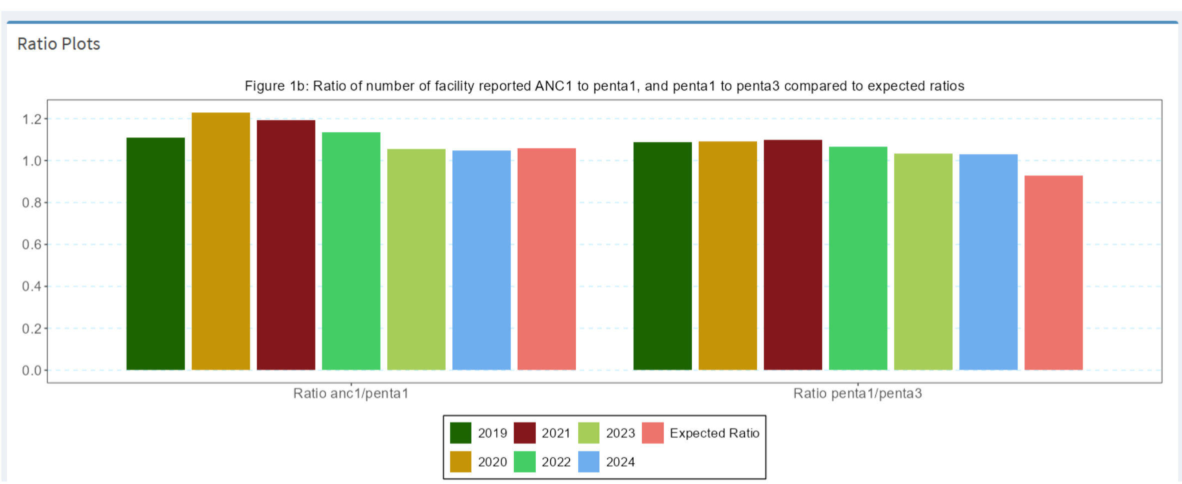
- For the national ANC1 to penta1 ratio a range of plus or minus 0.05 outside this computed ratio is considered acceptable. If the ratio is outside this range, this should be flagged, and possible explanations discussed.

Penta1 to penta3 ratio

We can compute an expected penta1 to penta3 ratio based on the most recent survey:

- The main factor determining the penta1 to penta3 ratio, which are recommended at 6 and at 14 weeks of age, is the actual drop-out rate between penta1 and penta3, as mortality plays a limited role.
- Population coverage rates from the latest survey are used to determine the expected penta1 to penta3 ratio in the facility data. For instance, if penta1 coverage is 95% and penta3 coverage is 85%, we expect that ratio to be 0.95/0.85 = 1.12.
- Also, here a range of plus or minus 0.05 is considered acceptable for the assessment of the facility data.

The Figure below produced in the ShinyApp shows the ratios for all six years (2019-2024) and the expected value. It will be important to reflect on large differences (e.g., more than 0.10 or 10%.).

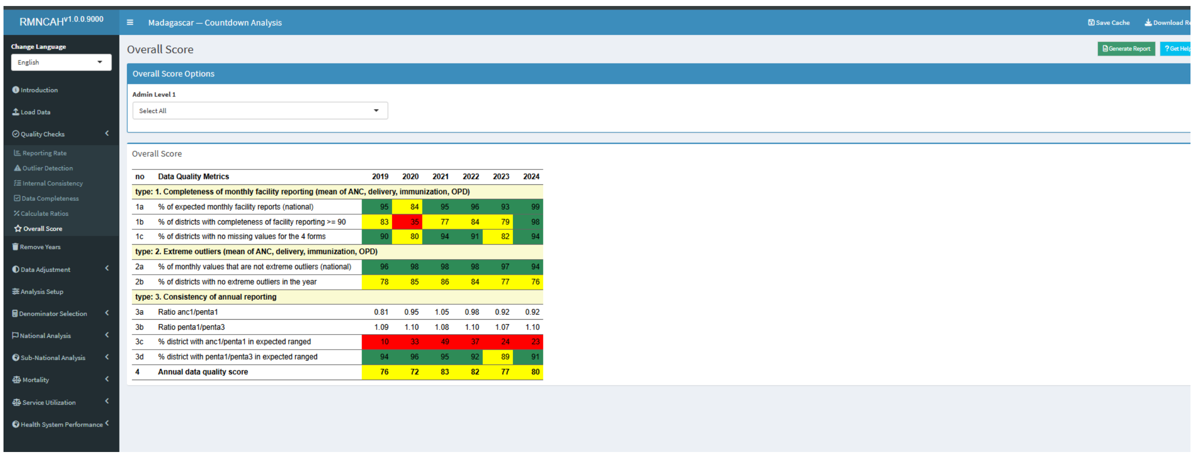


5.2.5 Overall DQA Score

In this section, the overall DQA score is calculated by considering the mean scores within some preselected data quality metrics as below.

Summary of Performance			
Indicator	Numerator	Denominator	Interpretation
			Annual data quality score (mean 1a, 1b, 2a, 2b, 3c, 3d)

The app will automatically compute the overall data quality score based on the metrics described above. It is in this section that the first section report is downloaded capturing the key DQA indicators as shown below.



5.2.6 DQA Report and interpretation

The first report - DQA - is generated using the `Generate Report` button.

The interpretation for this section should seek to answer the following questions:

- Is there a data quality pattern by year for which there is an explanation? (include the explanation)
- Are there certain regions or other sub-national units that are particularly problematic?
- Are there certain reporting forms or services (e.g., antenatal care, labour and delivery, immunization) that are problematic?
- Is there good consistency between reported numbers of ANC1 and penta1?

[1] An extreme outlier is defined as a monthly value that is 5 times the median absolute deviation (MAD) from the monthly median value for a particular year.

6 Numerator adjustments

6.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

The completeness of reporting may affect the analysis, especially if completeness is low or varies between years. Extreme outliers, such as an accidental extra zero in a number, can have a large impact, especially on subnational numbers. Following the assessments, several steps are necessary to obtain a clean data set for analysis. This implies adjusting for incomplete reporting and correcting for extreme outliers.

Approach: Description of analytical steps

If we do not consider reporting completeness that means we assume all non-reporting facilities provided zero services, which is not likely to be true. Adjustments depend on how much services (e.g., pregnancy care, vaccinations) were provided at non-reporting facilities compared to those that reported. The adjustment factor k - defined as the ratio of the volume of services provided by non-reporting facilities to the volume of services provided by reporting facilities - is used to adjust the reported numbers for incomplete reporting.

6.2 Numerator Adjustment

To account for incomplete reporting, the reported number of events can be adjusted using completeness and facility reporting ratio, with the following formula:

$$N_{\text{adjusted}} = N_{\text{reported}} + N_{\text{reported}} \times \left(\frac{1}{c} - 1\right) \times k$$

Where:

- N_{adjusted}: Total number of events adjusted for incomplete reporting
- N_{reported}: Number of events reported
- (c): Reporting completeness (e.g., proportion of facilities that reported)
- (k): Adjustment factor to account for lower service volume in non-reporting facilities

As a default value, we use $k = 0.25$, which means the non-reporting facilities provided services but only at a volume which was a quarter of the reporting health facilities.

The factor k can be different for different services. For instance, if private facility reporting is poor but they are in the national system and they provide a considerable number of deliveries, k maybe greater than 0.25 or even as high as 1.0.

The following k-values are used depending on the reporting used to adjust the reported numbers for incomplete reporting:

- $k = 0$ - No services in non-reporting facilities (default k-value)
- $k = 0.25$ - Some services, but much lower than reporting facilities
- $k = 0.50$ - Half the rate compared to reporting facilities
- $k = 0.75$ - Nearly as much as reporting facilities
- $k = 1.0$ - Same rate of services as reporting facilities

If the facility reporting rate is below 75%, it becomes more difficult to impute district data. Therefore, no adjustments are made if reporting is lower than 75%. In that case, further analysis to determine coverage with the facility data is not considered sufficiently reliable.

Extreme outliers, as defined in the previous section, will be corrected by imputing the median monthly value of the same year. The table summarizes the adjustments.

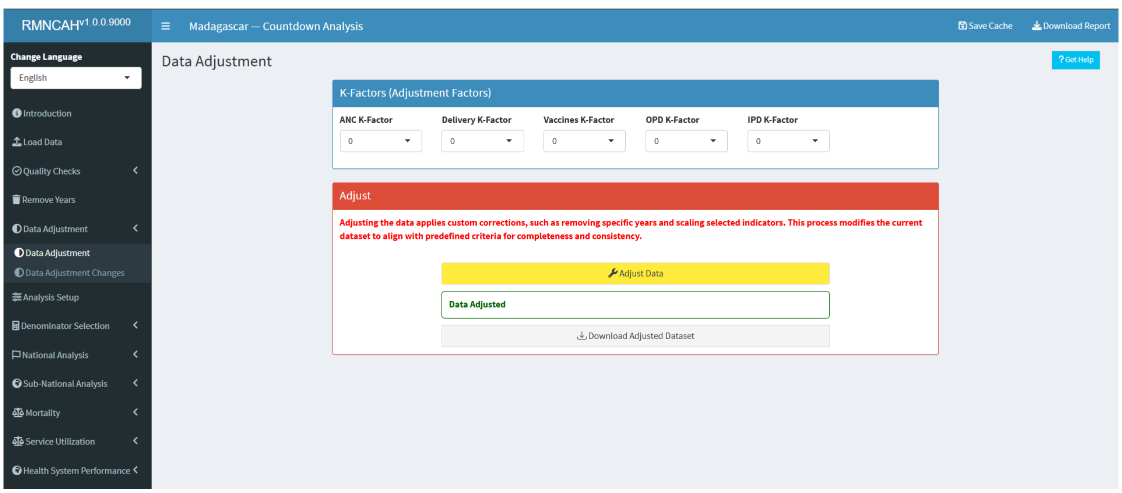
Table 2: Summary of adjustments made to the raw health facility data in preparation of a clean data set for the endline analysis

Problem	**Action**	**Adjustment**
Low reporting rates: identifying low rates that were adjusted	If below 75% (default), data were imputed	Median monthly value for the district year was imputed for the month with low reporting
Incomplete reporting by districts, variable over time, affecting trend assessment	If reporting rates were >=75% and <= 100% default), an assumption was made about the volume of services provided by the non-reporting facilities	Adjustment factor k value was used to adjust for incomplete reporting k default value 0.25 (replace if different value used; state if used for all reporting forms or different k factors between forms)

Problem	Action	Adjustment
Extreme outliers can greatly affect coverage trend assessments	If a monthly value was greater or smaller than 5 times the median absolute deviation (MAD) from district monthly median value, an adjustment was made	Extreme monthly outliers are corrected and given the district median value for the same year
Missing values	If there is a missing value, data were imputed	District median monthly value for the year was imputed for the month with missing value

6.3 Implementation: Conducting analysis in the Shiny App

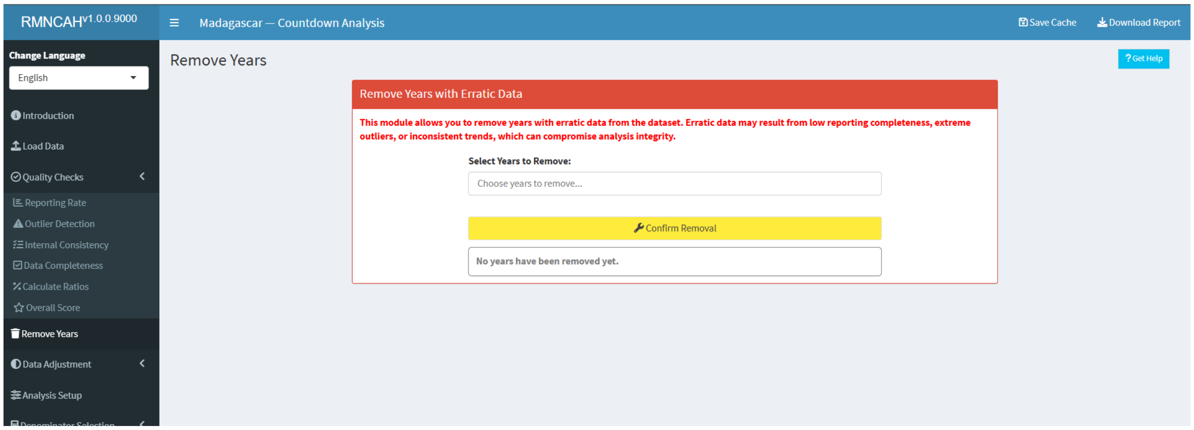
- The outputs for this analysis can be obtained through the **Data adjustment** section of the Shiny App.
- Select the $k - factor$ that is deemed appropriate given your country context.



6.3.1 Remove Years

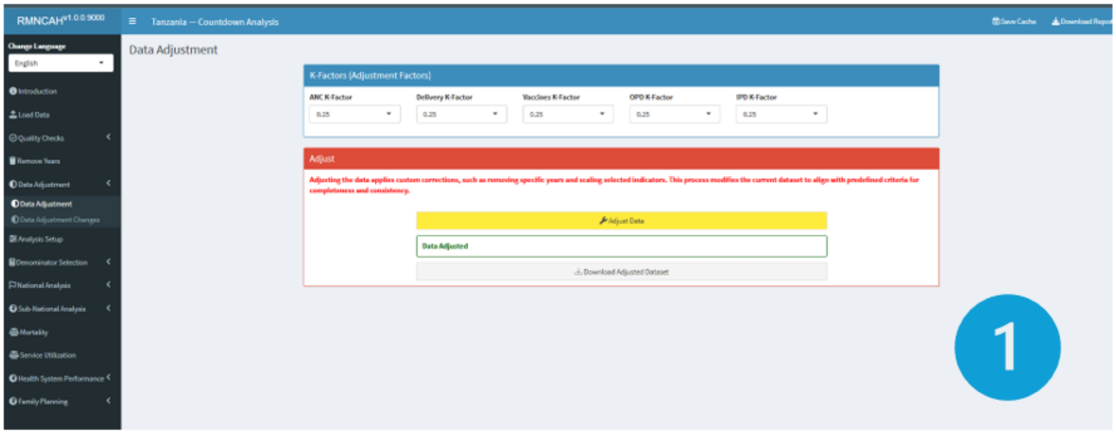
The ***`Remove Years`*** section allows you to remove any years with no data or whose data has been determined to not be fit for analysis by the country team due to quality issues.

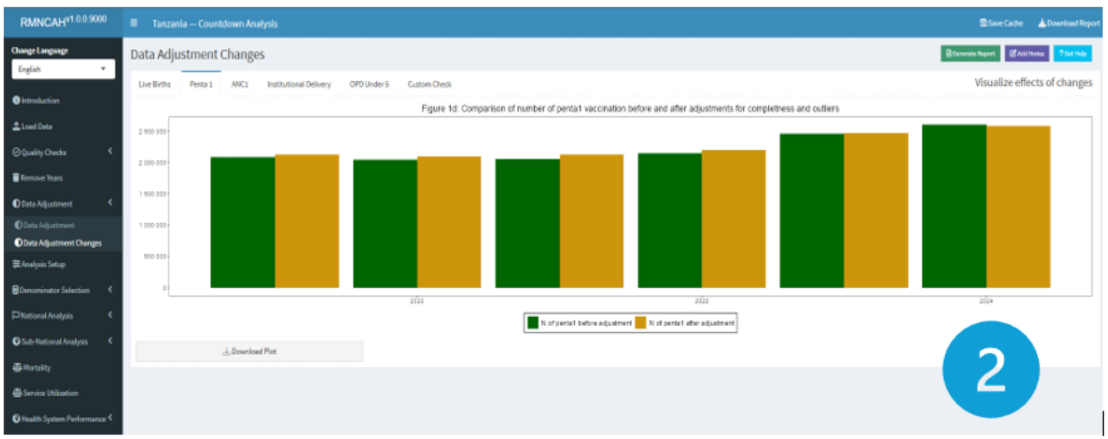
It is recommended to be used in instances where the data quality is poor, or the country teams have sufficient, contextual information that renders the said year(s)' data unreliable/inaccurate.This will ensure that the analysis is based on reliable data.



6.3.2 Adjustment outputs

- This Section produces a master adjusted dataset (`.dta`) ready for analysis and plots for different indicators showing data adjustment changes. In the image below, we can see the adjustment output after making no adjustment to the data ($k = 0$).





6.3.3 Report

- The interpretation should include the selected adjustment factor (factor k) that was used to adjust for incomplete reporting (if necessary, by service). If the default factor is used, then report this and explain what this means for the reader.
- Report the percent change that the adjustment made in reported numbers of institutional deliveries and in penta1 (average of the 6-year period);
- You may want to :
  - Highlight the year with the greatest impact of the adjustment if there is one;
  - Interpret if the impact of the adjustment on coverage rates is large or small;
  - Make the same description and interpretations for penta1 vaccinations.

7 Denominator Assessment and selection

7.1 Rationale, Approach and Implementation

Rationale: Scientific basis for the analysis

Service coverage is defined as the population who received the service divided by the population who need the services (also referred to as target population). The numerators of coverage statistics (e.g., number of live births in health facilities) are derived from the health facility data and need to be adjusted as shown in the previous section. The denominator of the coverage statistics (e.g., number of live births in the population) needs to be estimated for national and sub-national levels (regions/provinces and districts).

Approach: Description of analytical steps

The objective of the health facility denominator analysis is twofold:

1. First, we assess the quality of the population projections in DHIS2 by comparison with the UN projections and the internal consistency.
2. Then, we assess the performance of multiple denominators options for the computation of population-based service coverage indicators from the health facility data.

This should lead to a final decision on denominators that are used for the analyses of population-based coverage indicators based on health facility data.

Each indicator has its own denominator, as shown in the table below.

Table 3: Selected indicators with numerators and denominators

Indicators	Numerator	Denominator
SERVICE UTILIZATION		
Outpatient visits, children under 5, per year (N)	N of OPD visits for under-5	Total mid-year population under 5
Inpatient admissions, children under 5, per year (N)	N of admissions for under-5	Total mid-year population under 5
PREVENTIVE INTERVENTIONS		

Indicators	Numerator	Denominator
% of pregnant women with 4 antenatal care visits	N of women with ANC 4th visit	Total N of pregnant women in the whole population
% of live births in health facilities	N of live births in health facilities	Total N of live births in the whole population
% of infants receiving 3 doses of pentavalent vaccine	N of infants receiving 3 doses	N of infants eligible for 3 doses of the vaccine
CURATIVE INTERVENTIONS		
% of children under 5 with malaria who receive ACT	N of children under 5 with malaria receiving ACT	Total N of children who had malaria in the last year
% of deliveries that were by C-section (population)	N of C-sections reported	Total N of deliveries in the population
% of deliveries that were by C-section (institutional)	N of C-sections reported	Total N of deliveries in health facilities
MORTALITY		
Institutional maternal mortality ratio	N of maternal deaths in health facilities	Total number of live births in health facilities
Stillbirth rate	N of stillbirths in health facilities	Total N of births in health facilities
Neonatal mortality before discharge	N of neonatal deaths before discharge (after birth)	Total N of live births in the health facilities
FAMILY PLANNING (FP)		
Ratio FP visits to women of reproductive age	N of FP new and revisits	Total N of women 15-49 years
Estimated modern use of contraceptives	Couple years of protection	Total N of women 15-49 years
FP coverage (demand satisfied)	N of women using modern methods	Total N of women in need of FP

7.1.1 Part 1: Quality Assesment of Population projections in DHIS2

In the first part, we assess the **quality of the DHIS2 population projections** at national level:

- **Check the internal consistency of the DHIS2 population growth over time:**

Compute the population growth rate:

$$\text{Pop growth} = \frac{\text{Pop}_{2024} - \text{Pop}_{2023}}{\text{Pop}_{2023}},$$

then the crude birth rates (defined as the number of live births in DHIS2 projections per 1,000 population). We expect both rates to be consistent over time (e.g., less than 2 per 1,000 difference between years).

- **Compare the population data in DHIS2 with the UN population projections at the national level:**

Differences may occur, but large discrepancies suggest issues with DHIS2 population projections. The comparison is done for four indicators. Abnormal values are flagged:

1. **Population size:**
   A relative difference between DHIS2 and UN-projected population size greater than 5% should be considered a data quality issue with the DHOS2 projections.

$$\text{Relative difference} = \left\| \frac{\text{Pop\_DHIS2} - \text{Pop\_UN}}{\text{Pop\_UN}} \right\|$$

2. **Population growth during 2023–2024:**
   Annual growth is computed using the natural logarithm as below.

Interpretation: A difference greater than 0.3% (absolute) between DHIS2 and UN estimates is concerning.

$$\ln\left(\frac{\text{Pop}_{2024}}{\text{Pop}_{2023}}\right)$$

1. **Crude birth rate (CBR):**

Defined as the number of live births per 1,000 population. We compare the DHIS2 CBR for 2023 with the UN estimate of the CBR for the same year.

Interpretation: If the difference is greater than 5 per 1,000 population, the DHIS2 may be problematic.

DHIS2 CBR is defined as:

$$\text{CBR} = \frac{\text{Total Projected livebirths}}{\text{Total Population}} \times 1000$$

Interpretation: A difference greater than 5 per 1,000 population compared to the UN estimate suggests a data quality issue.

4. **Crude death rate (CDR):**

   Defined as the number of deaths per 1,000 population. It is the difference between the CBR and the population growth if thereis no major out- or in-migration.

   We compute the CDR from the DHIS2 projections as shown in the equation below

   Interpretation: A **negative CDR** or a **CDR < 5 per 1,000** indicates inconsistency and potential data problems.

$$\text{CDR} = \text{CBR} - \text{Population growth rate} \quad \text{(both expressed per 1,000 population)}$$

7.1.2 Part 2: Best Denominator Selection

The second part is to select the best performing denominator for population coverage estimates with facility data. First, we compare the results for different denominators at the national level.

For the national level, we evaluate 4 denominator methods. The first two are projection methods (DHIS2 estimate and UN estimate), and the additional two are facility data- based methods (***ANC1-derived*** and ***penta1-derived*** denominators).

Note:

- For the sub-national level, no UN projections are available, so we will use 3 methods only.

The maternal and newborn health denominators are closely related and can be computed from each other by making assumptions.

Starting with pregnancies, the number of live births is closely associated with the number of pregnancies, which are usually identified within the health system at the first antenatal visit which in most countries is around 4-5 months of pregnancy (according to the surveys). Country specific values are preferred where available and can be obtained from the WHO website. The default global assumptions are as follows:

- Pregnancy loss between 4 and 7 months (28 weeks of pregnancy): 3%.
- Stillbirths or pregnancy loss between 28 weeks and birth: 2%.
- Twinning rate: 1.5%. These first three steps give the number of live births computed from pregnancies.
- Neonatal mortality: 3% (or 30 per 1,000 live births).
- Post neonatal mortality (between 1-11 months): 2.4% (or 24 per 1,000 live births).

The selection of the best performing denominator method is based on a comparison of the performance of the DHIS2 projection and facility-data derived methods for two indicators: ***institutional live births*** and ***penta3***. The gold standard is the population coverage rates from a recent survey, for a year as close as possible. The absolute difference between survey and facility-based coverage at national and sub-national levels is used to select the best performing indicator. (This can also be expressed as the number of standard errors from the survey value but this requires including the standard errors from the surveys - the results will be the same).

7.1.3 Facility data derived denominators

The basic idea is that if the coverage of an indicator is high (e.g., over 90%), then the number of events reported by health facilities has to be close to the target population. In other words, the denominators or target population can be derived from the numbers in DHIS2. The best candidate indicators for this approach are ANC1 and DPT/penta1 (BCG also possible in some countries if re-vaccinations are recorded separately).

This approach requires the following:

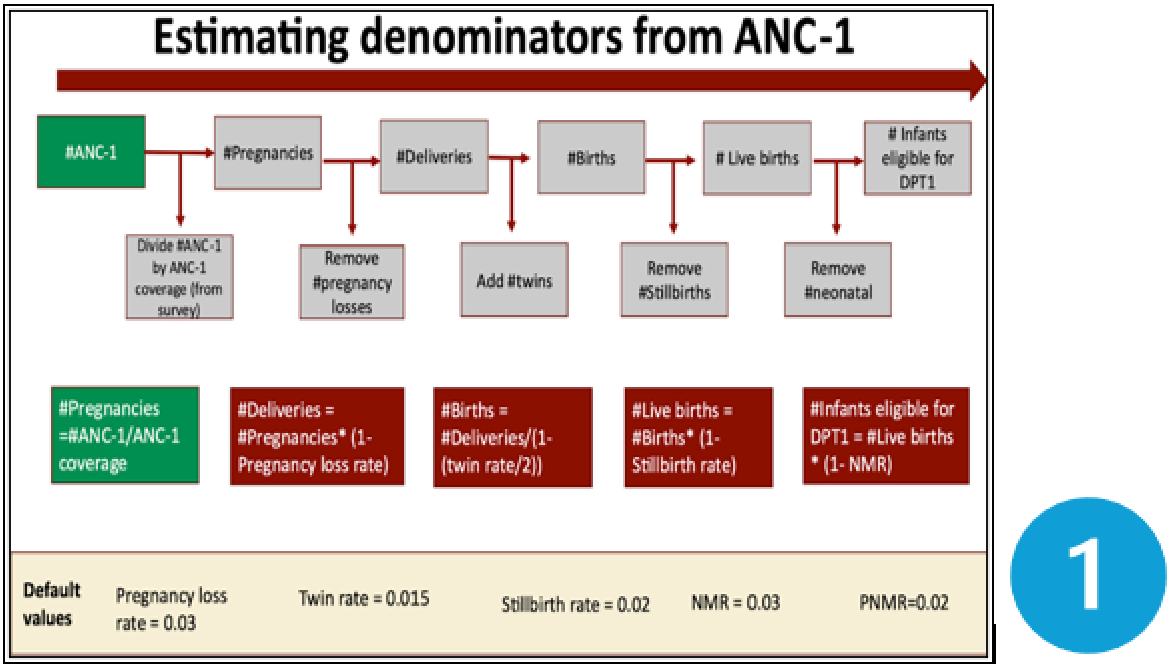
A recent population-based survey is used to obtain an estimate of population level coverage of ANC1 or penta1. For example, ANC1 coverage is 95% of pregnant women.

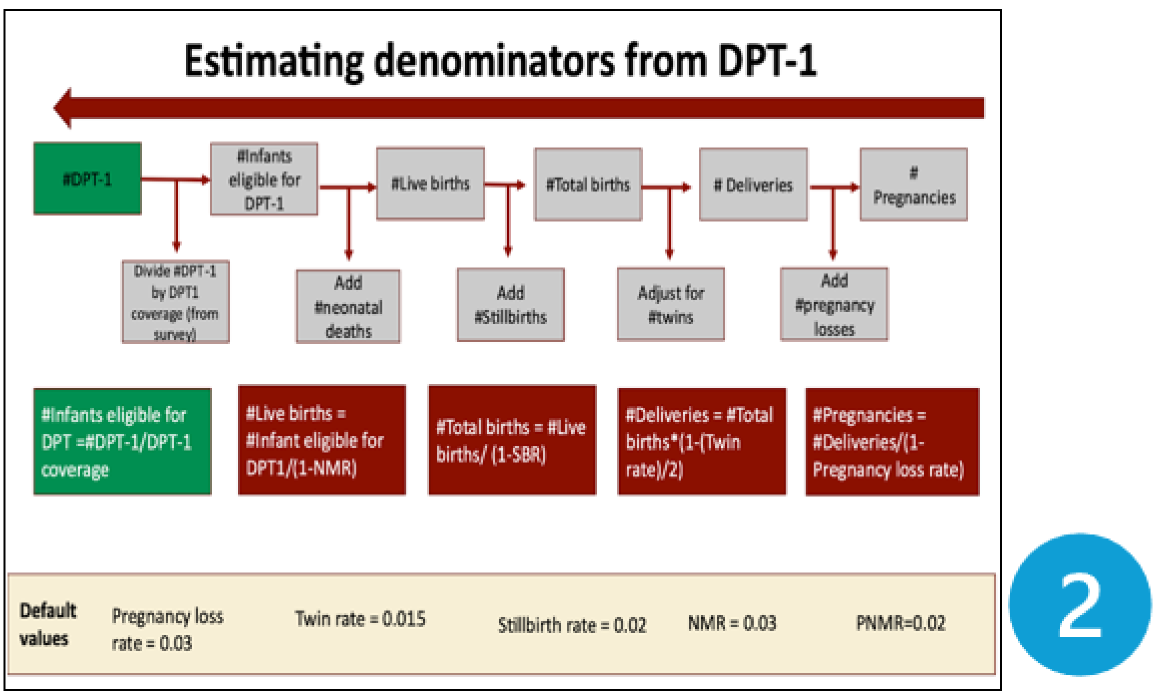
The DHIS2 data on the number of ANC1 and penta1 visits need to be considered complete and accurate (after adjustments / cleaning the data). For example, 100,000 ANC1 visits were reported.

If this is the case, then we only need to add the percentage that has not used the services (according to the survey results) to get the target population. For example, if ANC1 coverage from survey is 95% and the number of ANC1 visits from DHIS2 for the year is 100,000, the total number of pregnant women is: $ 100,000 / 0.95 = 105,263 $

The same approach can be used for DPT1 or penta1. The survey coverage is the percent of children 12-23 months who received DPT1/penta1, the facility data are the number of infants who received DPT1/penta1 vaccination. For example, if survey coverage is 92%, and there were 100,000 vaccinations given, then the $ Denominator= 100,000 / 0.92 = 108,696. $

The number of live births can be obtained from ANC1 and DPT1 by making assumptions about pregnancy loss (abortion after the first ANC visit, stillbirths), twinning rates, and neonatal mortality. These steps are shown in the Figure below.


Estimating denominators from ANC-1
#ANC-1
#Pregnancies
#Deliveries
#Births
Live births
Infants eligible for DPT1
Divide #ANC-1 by ANC-1 coverage (from survey)
Remove #pregnancy losses
Add #twins
Remove #Stillbirths
Remove #neonatal
#Pregnancies =#ANC-1/ANC-1 coverage
#Deliveries = #Pregnancies* (1- Pregnancy loss rate)
#Births = #Deliveries/(1-(twin rate/2))
#Live births = #Births* (1- Stillbirth rate)
#Infants eligible for DPT1 = #Live births * (1- NMR)
Default values
Pregnancy loss rate = 0.03
Twin rate = 0.015
Stillbirth rate = 0.02
NMR = 0.03
PNMR=0.02
1


Estimating denominators from DPT-1
#DPT-1
#Infants eligible for DPT-1
#Live births
#Total births
Deliveries
Pregnancies
Divide #DPT-1 by DPT1 coverage (from survey)
Add #neonatal deaths
Add #Stillbirths
Adjust for #twins
Add #pregnancy losses
#Infants eligible for DPT =#DPT-1/DPT-1 coverage
#Live births = #Infant eligible for DPT1/(1-NMR)
#Total births = #Live births/ (1-SBR)
#Deliveries = #Total births*(1-(Twin rate)/2)
#Pregnancies = #Deliveries/(1- Pregnancy loss rate)
Default values
Pregnancy loss rate = 0.03
Twin rate = 0.015
Stillbirth rate = 0.02
NMR = 0.03
PNMR=0.02
2

An example of ANC1:

- Above we computed 105,263 pregnant women in the population
- at 3% abortion, this implies 105,263 * (1-.0.03) = 102,454 deliveries
- at 1.5% twinning rate this implies 102,454 / (1-(0.015/2)) = 103,229 births
- at 2% stillbirth rate this implies 103,229 * (1-0.02) = 101,164 live births
- at 3% neonatal mortality this implies 101,164 * (1-0.03) = 98,129 children eligible for DPT1/penta1.

7.2 Implementation in the Shiny App

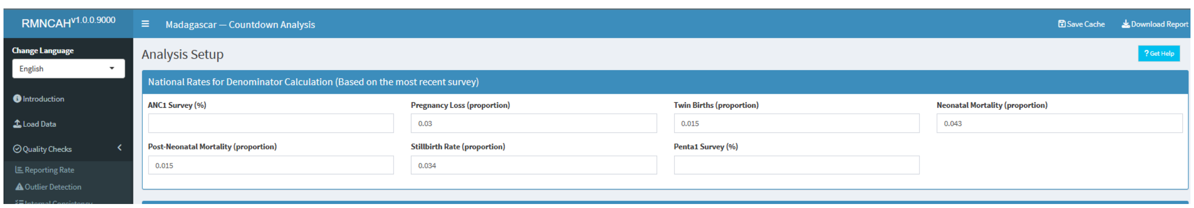
Shiny App

To get outputs for this analysis first, one need to set up their analysis by inputting key information at the **Analysis Set up** section in the Shiny App.

7.2.1 Analysis set up

The parameters required are as shown in the figure below and they are:

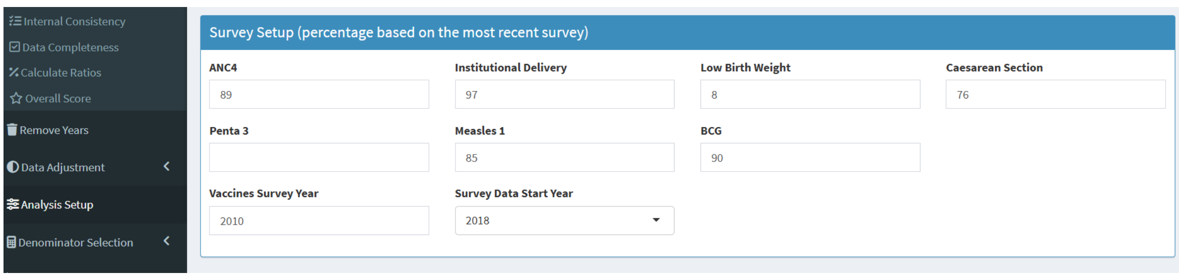
1. **National mortality rates - based on the most recent survey**



1. **ANC1 Survey(%)** - Percentage of women aged 15–49 with a live birth who received at least one antenatal care (ANC) visit during their last pregnancy. (Example: If 940 out of 1,000 women had at least one ANC visit, the ANC1 coverage is 94%.)
2. **Pregnancy Loss (proportion)** - Proportion of pregnancies that ended in miscarriage, abortion, or stillbirth out of all reported pregnancy outcomes. (Example: If 80 of 1,000 pregnancies ended in loss, the proportion is 0.08)
3. **Twin Births (proportion)** - Proportion of live births that are twins out of all live births. (Example: If 30 out of 1,500 live births were twins (i.e., 15 twin pairs), the proportion is 0.02)

4. **Neonatal Mortality (proportion)** - Proportion of live births that die within the first 28 days of life out of all live births. (Example: If 20 out of 1,000 live births died within the first 28 days, the proportion is 0.02)
5. **Post Neonatal Mortality (proportion)** - Proportion of live births that die between 28 days and 11 months of life out of all live births. (Example: If 15 out of 1,000 live births died between 28 days and 11 months, the proportion is 0.015)
6. **Stillbirth Rate (proportion)** - Proportion of pregnancies that ended in stillbirth out of all reported pregnancy outcomes. (Example: If 10 out of 1,000 pregnancies ended in stillbirth, the proportion is 0.01)
7. **Penta 1 Survey (%)** - Percentage of infants aged 12–23 months who received the first dose of pentavalent vaccine.(Example: If 920 out of 1,000 infants received the first dose, the Penta 1 coverage is 92%.)

- **Survey coverage based percentages (based on the most recent survey)**



1. **ANC4** -Percentage of women aged 15–49 with a live birth who received four or more antenatal care visits during their last pregnancy. (Example: If 680 out of 1,000 women had 4 ANC visits, ANC4 coverage is 68%.)
2. **Institutional delivery** - Percentage of live births that occurred in a health facility. (Example: If 850 out of 1,000 live births were in a health facility, the institutional delivery coverage is 85%.)
3. **Lowbirth weight** - Percentage of live births that were low birth weight (less than 2,500 grams). (Example: If 100 out of 1,000 live births were low birth weight, the low birth weight coverage is 10%.)
4. **Caesarean section** - Percentage of live births that were delivered by caesarean section. (Example: If 150 out of 1,000 live births were by C-section, the C-section coverage is 15%.)
5. **Penta 3** - Percentage of infants aged 12–23 months who received the third dose of pentavalent vaccine. (Example: If 850 out of 1,000 infants received the third dose, the Penta 3 coverage is 85%.)

6. **Measles1** - Percentage of infants aged 12–23 months who received the first dose of measles vaccine. (Example: If 900 out of 1,000 infants received the first dose, the Measles1 coverage is 90%.)
7. **BCG** - Percentage of infants aged 12–23 months who received the Bacillus Calmette-Guérin (BCG) vaccine. (Example: If 950 out of 1,000 infants received the BCG vaccine, the BCG coverage is 95%.)
8. **Vaccines survey year** - The calendar year in which the survey was conducted and from which vaccine coverage estimates (e.g., BCG, Penta1/3, Measles1) are drawn. (Example: If the survey was conducted in 2022, that is the vaccine survey year).
9. **Survey data start year** - The calendar year from which the survey data starts. This is used to determine the time period for which the survey data is relevant. Ideally, it is recommended to use the two most recent surveys for this analysis.(Example: If a country has survey data for 2008, 2013, 2018 and 2023; the Survey data start should be 2018 (two most recent)).

- **Survey datasets**

In addition to setting these parameters, you will be required to upload the following survey datasets (in addition to the health facility data loaded at the beginning of the analysis session).

```
::: {.cell layout-align="center"}
::: {.cell-output-display}
![](../images/1-dqa-survey_upload.png){fig-align='center' width=100%}
:::
:::
```

```
1.  UN Estimates data
2.  UN Mortality data
3.  WUENIC estimates data
4.  Survey data (uploaded as a folder)
5.  FPET data
6.  Public/Private share data (uploaded as a folder)
```

7.2.2 Denominator assessment

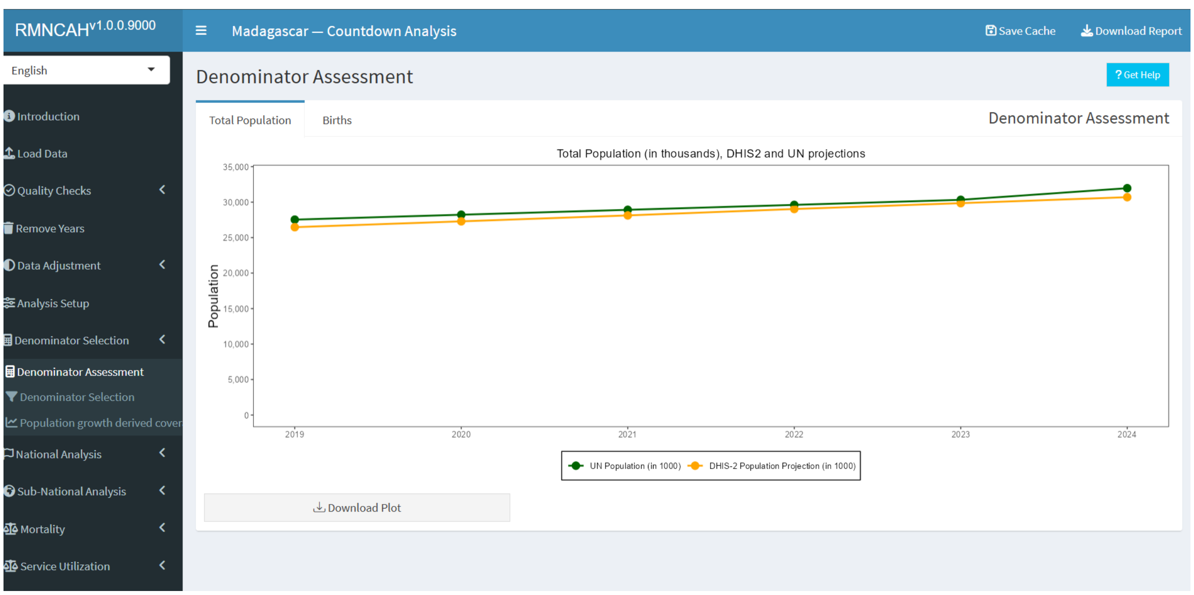
The first part is to assess the accuracy and consistency of the projected population numbers in the DHIS-2 by comparing them to external sources.

Interpretation:

The interpretation should focus on the extent to which the DHIS2 projections are considered robust which is the case when:

- The DHIS2 total population projection is consistent over time with regular population growth
- The DHIS2 total live birth projection is consistent over time (regular trend)
- The projected numbers of total population and live births are close to the UN population projection
- The DHIS2 population projections are consistent with UN estimates for crude birth rate and crude death rate.

The second part is to compare results from the different methods - both at the national and sub-national levels.



Interpretation:

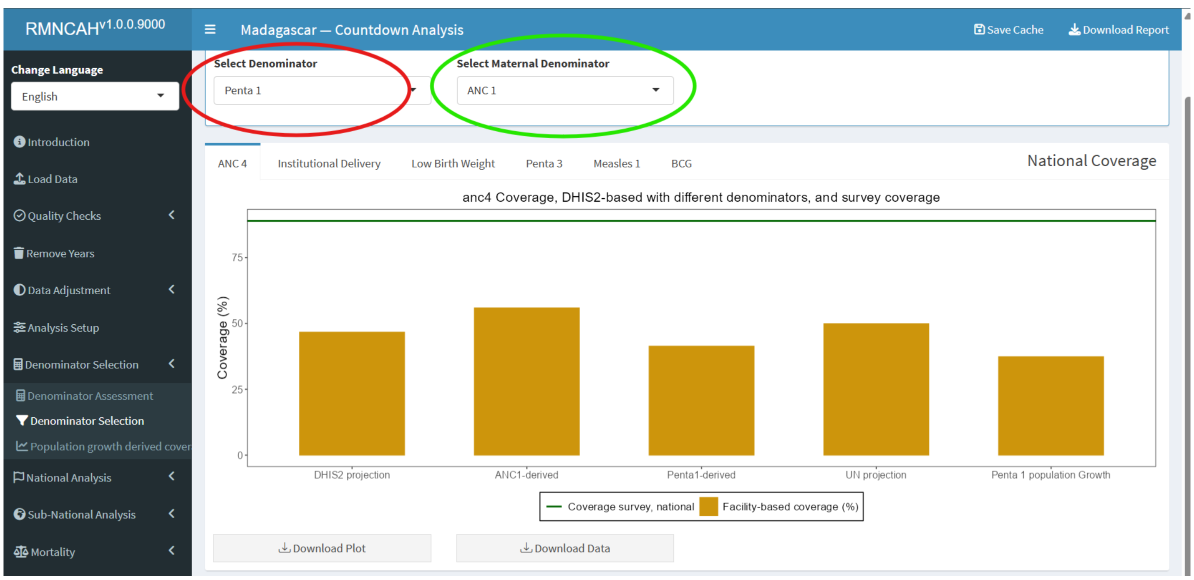
The interpretation should focus on the extent to which the DHIS2 projections are considered robust which is the case when:

- The DHIS2 total population projection is consistent over time with regular population growth
- The DHIS2 total live birth projection is consistent over time (regular trend)
- The projected numbers of total population and live births are close to the UN population projection
- The DHIS2 population projections are consistent with UN estimates for crude birth rate and crude death rate.

The second part is to compare results from the different methods - both at the national and sub-national levels

7.2.3 Denominator selection

The final step is to select the best performing denominator for the coverage analyses with health facility data. The results on the national gap and the median sub-national gap should be taken into account to make that choice.



The best methods have the smallest gaps with the survey results.

Note

- Ideally, one method is selected but it is also possible to select one denominator method for the MNH coverage indicators (ANC, delivery, PNC) and another method for the immunization coverage analyses (see highlighted section in the graph above). It will be

important to clearly state the chosen denominator. Please ensure this information is saved within your cached `.RDS` file.
- The selected denominators (for both maternal and immunization indicators) will be used in the subsequent analysis. The highlighted tabs are the only places you can change your chosen denominator(s)

Interpretation:

The interpretation should describe, based on the graphs:

- Which denominator methods performed best at the national level for the two indicators?
- Which denominator performed best at the sub-national level for the two indicators?
- What selection is made for the indicators in the coverage analyses?

Part III

National Analyses

8 Coverage

8.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Coverage of interventions is a critical and direct output of health systems. Regular tracking of coverage at national and sub-national levels has become the mainstay of monitoring progress in national health plans and international initiatives. Reproductive, maternal, newborn, child and adolescent health indicators with targets are the most common indicators of national health plans and global monitoring. Both health facility data and household surveys can provide coverage statistics, and an integrated analytical approach is desirable.

Approach: Description of analytical steps

Many coverage indicators can be estimated in both surveys and from health facility data. Both are critical pieces of information and need to be considered in conjunction with each other. The Table below lists the indicators, for antenatal and delivery care and child immunization, considered in the health facility data analysis in the workshop, including the variable names (in R) in the first column.

Name (in R)	Indicator title	Survey denominator	Facility data denominator
Antenatal care			
anc1	Antenatal care at least one or more visits among all pregnant women (%)	Women aged 15-49 years with a live birth in the last 2 years	Estimated livebirths as denominator
anc_1 trimester	Antenatal care 1+ visits in 1st trimester of pregnancy among all pregnant women (%)		
anc4	Antenatal care 4+ visits among all pregnant women (%)		

Name (in R)	Indicator title	Survey denominator	Facility data denominator
ipt2 ipt3	Intermittent preventive therapy for malaria - 2nd dose / 3^{rd} dose during pregnancy among all pregnant women (%)		
ifa90	Iron folic acid supplementation given (90 days supply) during pregnancy among all pregnant women (%)		
hiv_test	HIV test conducted among pregnant women (%)	Not available (in some survey reports)	
syph ilis_test	Syphilis test conducted among pregnant women (%)		
Delivery care			
instd eliver-ies	Institutional live births among all live births	Live births in the last 2 years	Estimated livebirths as denominator.
sba	Skilled birth attendance		
low_bweight	Low birth weight (below 2500 grams) among all live births		
c-section	C-section among all live births		
pnc48h	Postnatal care within 48 hours		
Immunization			
bcg	BCG vaccination to infants	Children 12-23 months	N of surviving infants (beyond neonatal period)
penta1	Penta vaccine - 1st dose to infants	Children 12-23 months	
penta3	Penta vaccine - 3rd dose to infants	Children 12-23 months	
measles1	Measles vaccine - 1st dose (to infants)	Children 12-23 months	N of surviving infants (beyond post-NN period)
measles2	Measles vaccine - 1st dose (older children)	Children 24-35 months	N of surviving infants (beyond postneonatal period) (or age 1)

The facility data can be used to generate annual coverage estimates, and the coverage results should be compared and interpreted alongside the results from recent surveys. The analysis results will include both coverage estimates.

Implementation: Conducting analysis in the Shiny App

8.1.1 Antenatal care (ANC)

Most countries have at least one ANC indicator with a target in the national plan. The global ENAP/EPMM coverage targets for 2025 are: globally, at least 90% of pregnant women with 4 or more ANC care visits, and 90% of countries with at least 70% coverage. There are several ANC indicators that capture:

- *contact with health services* during pregnancy (ANC 1st visit, ANC 4 or more visits, ANC first visit in first trimester). ANC1 is often considered an indicator of basic access to health services. It is high in most countries, and in many instances, the numbers of ANC1 visits in the routine health facility data can provide a better denominator for the ANC and delivery indicators than population projections (see section 2 on denominators).
- *contents of services* provided (intermittent preventive therapy (IPT2 or IPT3) against malaria, HIV testing, syphilis testing and iron-folic acid (IFA) supplementation (at least 90 tablets given to the pregnant woman)). Some countries will not have policies for all of these diagnostic or therapeutic interventions during pregnancy (e.g., no IPT if no malaria risk).

For most indicators, the surveys also provide coverage estimates for the national level, with 95% confidence intervals. For most coverage indicators the data refer to a period before the survey: e.g., institutional birth coverage for the live births in the two years preceding the survey. This means that the midpoint of the coverage estimate lies one year before the survey.

An example of two graphs for ANC, based on facility and survey data, is shown below, showing both good concordance between the facility-based and survey results for coverage of ANC first visit in the first trimester and poor concordance in case of ANC4 visits. In the latter case, it is evident that ANC4 is overreported in the facility data as coverage is much higher than the survey and unlikely to be high (over 90% during 2021-23 and even 101% in 2023). Poor recording and reporting of ANC 4th visits in the DHIS2 data is likely the main cause.

Sometimes, an indicator may reach an unlikely high coverage at the national level, say over 125%. This may be because the data quality of the numerator of the coverage indicator is poor, the denominator is wrong, or the intervention is given and recorded more than once during pregnancy. An example is IFA supplementation. In that case, the computation of coverage is not useful. It is better to express it differently. For instance, if coverage is 200%, it is better to compute the average number of courses of 90 IFA tablets that a pregnant woman received (in this case 2.0 per pregnant woman in the population).[1]

Figure 8.1: Subnational Coverage Inequality for ANC4

8.1.2 Delivery care

All countries have at least one delivery care indicator with a target in the national plan. The global ENAP/EPMM coverage target for 2025 is at least 90% global average coverage, and 90% of countries at least 80% coverage of skilled birth attendance (SBA). For postnatal care (PNC) within 2 days the global coverage target is 80% and the 90% of countries with at least 60% coverage.

Institutional (live) birth coverage and SBA are closely related, as almost all deliveries with a skilled attendant occur in health facilities. From the analytical point of view, institutional birth coverage is preferred because it is a more objective measure and avoids issues with the definition of what constitutes skilled birth. SBA is often preferred from the health care perspective, as it includes an element of quality: obviously, an institutional delivery without skilled attendance is not desirable, and in some countries home SBA may be part of the health care delivery strategy. attendance. Either indicator works well to capture delivery care.

Caesarean section is a live saving intervention and an important indicator. A general rule of thumb is, put forward by WHO, that in a population the need for Caesarean section is in the range of 10-15% of all deliveries. If the Caesarean section rate is below 10%, that means that there is unmet need. If the Caesarean section rate is over 10-15%, that implies that there most likely overuse of Caesarean section. It may however also imply that there is still unmet need among certain population groups (e.g. the poorest women or rural women) in combination with overuse in other subgroups of the population (such as urban and richer women).

[1] Surveys can provide coverage of IFA supplementation, as here the unit of data analysis is individual pregnant women.

Postnatal care (PNC) within 48 hours is provided to the mother/women and newborn. Country systems may have different ways of recording the type of PNC and also surveys are known to have data issues with PNC for the mother or the baby.[2] Some countries use multiple definitions of timing of the PNC visit (e.g., within the first week).

Low birthweight is a critical indicator of neonatal health. It is most meaningful if the distinction between prematurity and small-for-gestational age is made, but most facility reporting systems and most surveys do not have such data. All babies are supposed to have been weighed right after birth and the percent of newborns weighing less than 2500 grams is usually reported in the DHIS2 system. As general guidance for the interpretation of the data, low birthweight prevalence in sub-Saharan Africa was estimated at 13.9% (95% credibility interval: 12.4-15.7%) for 2020.[3]

8.1.3 Immunization

Immunization coverage indicators are included in virtually every country's health sector monitoring plan. A general target is at least 90% coverage for essential vaccines given in childhood and adolescence.

For the national coverage analyses, the focus is on **BCG**, first and third doses of penta/DTP (penta1 or DTP1 and penta3 or DTP3), and first and second doses of measles vaccine, often given in combination with rubella vaccine. *BCG and penta/DTP vaccinations* are recommended to be given at birth (BCG), 6 weeks (penta1) and 14 weeks (penta3). For facility data, the number of vaccinations given to infants is used and the denominator is the number of eligible children in the population, which is approximated as live births minus neonatal deaths. Survey data generally provide vaccination coverage among children 12-23 months (may also include the age at which the vaccination was given - mostly before the first birthday).[4]

The first dose of measles vaccine is generally recommended at age 9 months. For the facility data, the recording and reporting usually separate measles given to children under 1 year and children 1 year and older, though the quality of recording and reporting for the age group may vary (there may be a tendency to record measles vaccinations after 12 months as given to infants). Here, we use children who have survived the first year of life (live births minus neonatal deaths minus postneonatal deaths) as the denominator for measuring vaccination coverage. The second dose of measles uses children aged 24-35 months as denominator. This can be estimated as live births minus neonatal deaths = 2* postneonatal deaths).

[2] Amouzou A, Hazel E, Vaz L, Sanni Y, Moran A. Discordance in postnatal care between mothers and newborns: Measurement artifact or missed opportunity? J Glob Health. 2020 Jun;10(1):010505.

[3] Okwaraji YB, et al. National, regional, and global estimates of low birthweight in 2020, with trends from 2000: a systematic analysis. Lancet. 2024 Mar 16;403(10431):1071-1080.

[4] Therefore, the survey data on immunization roughly refer to the program performance in the year before the survey

WHO and UNICEF work with countries to produce annual estimates of immunization coverage based on all data sources. The national estimates, called WUENIC, are published and available for 2020-2024. These time trends are included in the analysis outputs, to compare the 2019-2024 annual estimates of the facility data produced in the workshop and the survey results.

8.1.4 Family planning

The family planning coverage estimates are derived from a collaboration of the Countdown with Track20. Track20 has developed an advanced estimation tool called Family Planning Estimation Tool (FPET) which focuses on three indicators: modern contraceptive use, unmet need for modern contraceptives and demand satisfied with modern methods. The three indicators are closely related since demand is satisfied (this is the true coverage indicator) = use of modern contraceptives / (unmet need + use of modern contraceptives).

FPET uses statistical modelling that incorporates all available data from surveys and may also use estimates obtained from facility data if the quality is sufficient.[5] FPET allows for various types of survey data to be integrated into the estimates and fits a line that pulls from the trends. This utilizes the strength of multiple data points and minimizes the risk of comparing different surveys.

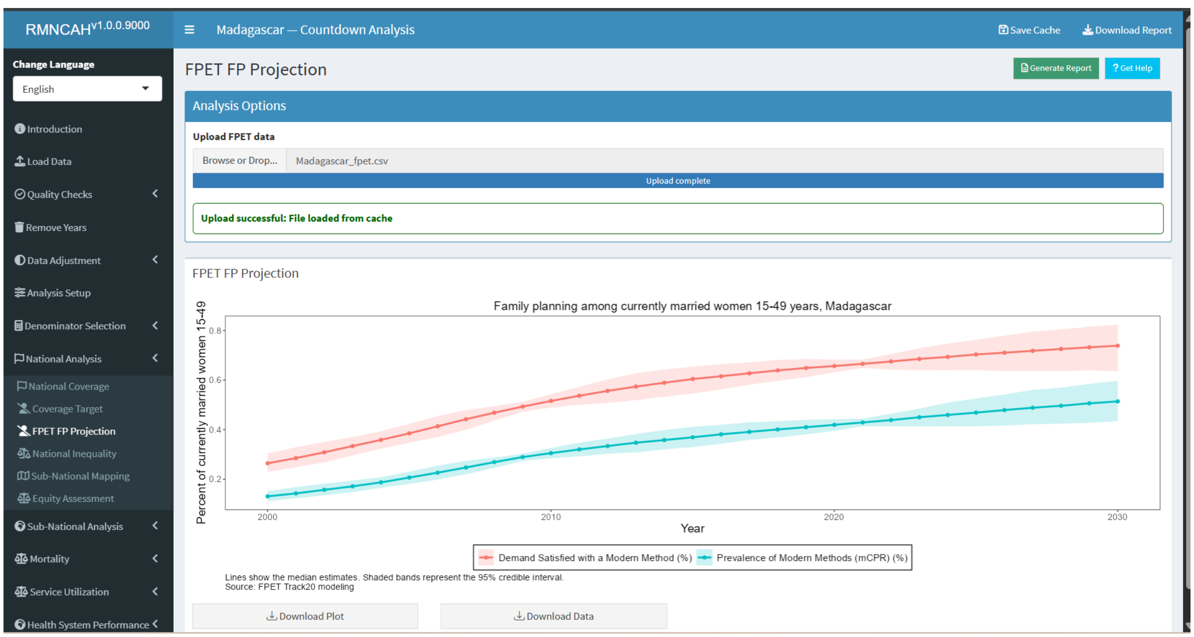


Figure 8.2: FP among currently married women 15-49 years

[5] https://www.track20.org/pages/data_analysis/publications/methodological/family_planning_estimation_tool.php

9 National Inequality

9.1 National Inequality (MADM)

9.1.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Sub-national analysis of health intervention coverage is essential for advancing universal health coverage (UHC), which aims to ensure equitable access to quality health services for all populations. National averages often mask critical disparities that exist across regions, districts, or population subgroups.

Monitoring sub-national data helps identify geographical areas where coverage is low, signaling potential inequities in health service access and prompting targeted interventions. This is particularly important for drawing attention to populations who are left behind and ensuring resources are directed where they are most needed.

Approach: Description of analytical steps

Here we calculate **Median Absolute Deviation from the Median (MADM)** to quantify spread in coverage in districts within an admin1 level , compared with the coverage at the said Admin1 subnational unit.

The key statistical measures for sub-national inequalities are:

- MADM: median absolute distance from the median. This measure gives an indication on whether the country has been successful in reducing inequalities between sub-national units.
- Percent of sub-national units with coverage above a specific target or threshold: this indicator provides information on the extent to which a country has been successful in reaching universal coverage at the sub-national level.

Summary of district and regional performance

Progress towards international and national targets can be measured by computing the percentage of regions and districts that have achieved these targets. The goal is for all regions and districts to have met the target. Higher percentages mean less inequality.

Implementation: Conducting analysis in the Shiny App

Navigate to the **National Analysis =>National Inequality** and inspect the plotted regional and district results by year, with the median absolute distance from the median (MADM, see screenshot below), as the summary measure to assess if inequalities have reduced.

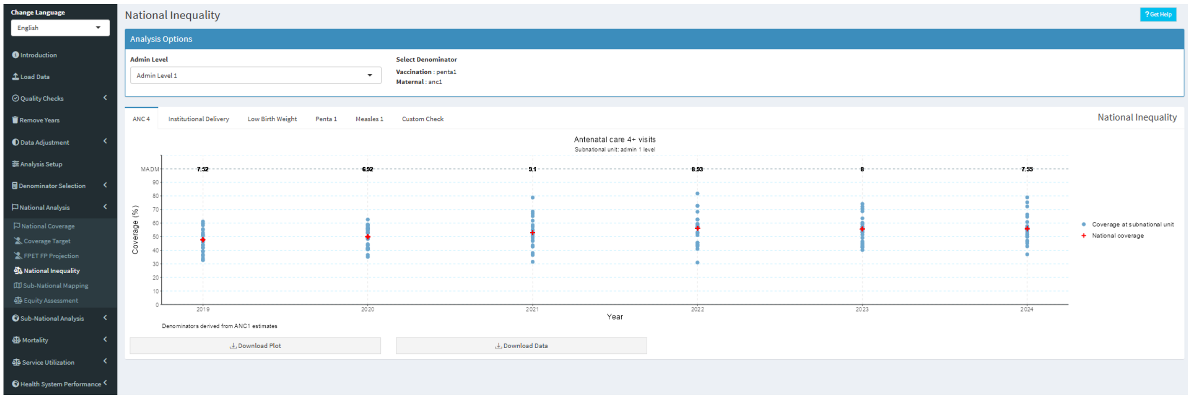


Figure 9.1: Subnational Coverage Inequality for ANC4

Interpretation:

10 Global Coverage Targets

10.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Reducing geographic inequality is essential for equitable health systems and achieving the SDGs. Subnational inequalities reveal inconsistencies in service delivery and highlight systemic barriers to healthcare access. Tracking inequality indicators helps assess whether health systems are becoming more equitable and whether targeted interventions are working.

Approach: Description of analytical steps

Here we calculate **Median Absolute Deviation from the Median (MADM)** to quantify spread in coverage in districts within an admin1 level , compared with the coverage at the said Admin1 sub-national unit.

The key statistical measures for sub-national inequalities are:

- MADM: median absolute distance from the median. This measure gives an indication on whether the country has been successful in reducing inequalities between sub-national units.
- Percent of sub-national units with coverage above a specific target or threshold: this indicator provides information on the extent to which a country has been successful in reaching universal coverage at the sub-national level.

Summary of district and regional performance

Progress towards international and national targets can be measured by computing the percentage of regions and districts that have achieved these targets. The goal is for all regions and districts to have met the target. Higher percentages mean less inequality.

10.2 Implementation: Conducting analysis in the Shiny App

Navigate to the **Subnational Analysis** tab =>**Subnational Inequality** and inspect the plotted regional and district results by year, with the median absolute distance from the median (MADM, see screenshot below), as the summary measure to assess if inequalities have reduced.

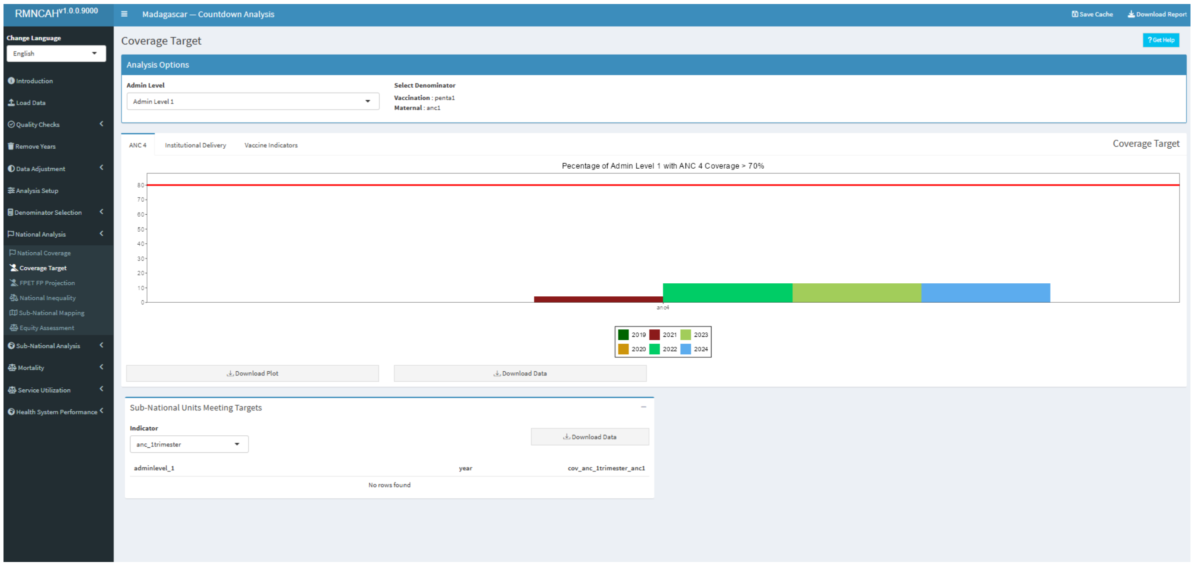


Figure 10.1: Subnational Coverage Inequality for ANC4

11 Sub-national Mapping

11.1 National and sub-national mapping of health service coverage

12 Equity Assessment (Equiplots)

12.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Household surveys provide critical information on inequalities. Our focus is on three major dimensions of inequality: area of residence, wealth and education.

For area of residence, we focus on urban/rural areas, for wealth, we use household wealth quintiles and for education we focus on education of the mother. Equiplots are used to assess whether the country has made progress since 2010 in reducing the poor rich gap or the gap between women with no education or low education and women with higher education.

For wealth quintiles, it can be assessed what the type of inequality is, as all categories are of the same size:

1) If the richest are well ahead of all other wealth quintiles, this is top inequality and is sometimes also referred to as mass deprivation (only the rich escape)
2) If the coverage differences are equidistant, this is a linear pattern where the increasing household wealth is linearly associated with higher coverage
3) If the poorest are left behind, this is called bottom inequality, and means marginalization of the poorest. Each pattern requires a different strategy of health programming and targeting.

12.2 Interpretation of equiplots

The interpretation should focus on whether inequalities have reduced over time and to what extent global targets for coverage have been met. Consider your audience/s and what key messages and insights you want to get across.

The following questions should guide and be answered by the interpretation:

1) What is the level of inequality in the most recent data point?
2) How have inequalities changed over time?
3) Is there any inequality pattern that can be observed?
4) What will be the best approaches to reduce inequalities?

Implementation: Conducting analysis in the Shiny App

This will be analysed within the **National analyses ->Equity Assessment** section in the Shiny App

You expect to see output as below

Figure 12.1: Penta3 coverage Inequality by Wealth, Area and Maternal education

Part IV

Sub-national Analyses

13 Coverage

14 Sub-national Coverage

14.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Sub-national analysis of health intervention coverage is essential for advancing universal health coverage (UHC), which aims to ensure equitable access to quality health services for all populations. National averages often mask critical disparities that exist across regions, districts, or population subgroups.

Monitoring sub-national data helps identify geographical areas where coverage is low, signaling potential inequities in health service access and prompting targeted interventions. This is particularly important for drawing attention to populations who are left behind and ensuring resources are directed where they are most needed.

Approach: Description of analytical steps

The focus here is to assess the coverage estimates (e.g., ANC4, institutional deliveries, Penta3) at Admin1 and Admin2 levels using the best performing denominator for the coverage computations, as decided from the analysis in section 2 on denominators.

There will be more "noise" in the sub-national data with improbably high or low coverage rates, compared to the national analyses, and more so in the district analyses than in the regional (admin1) analyses. This is because district analyses are affected by small numbers (more fluctuations which may be random or due to data quality issues) and by the health service utilization patterns by women and children. For instance, a municipal district may get more deliveries than an adjacent rural district because of the location of the hospitals in the municipal district.

Implementation: Conducting analysis in the Shiny App

Navigate to the **Subnational Analysis** tab **->Subnational Coverage** and select the admin level of interest (Region (Admin Level1) or District. Then select the indicator of interest from the key indicators (ANC4, Institutional deliveries, Low Birth Weight, Penta 1 and Measles 1. You can also use the **Custom Check** tab to select any other indicator of interest.

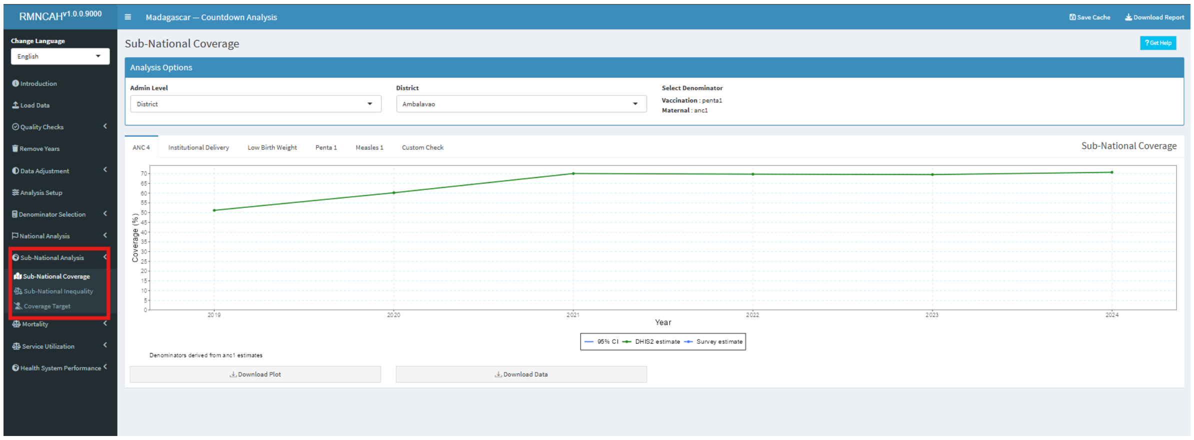


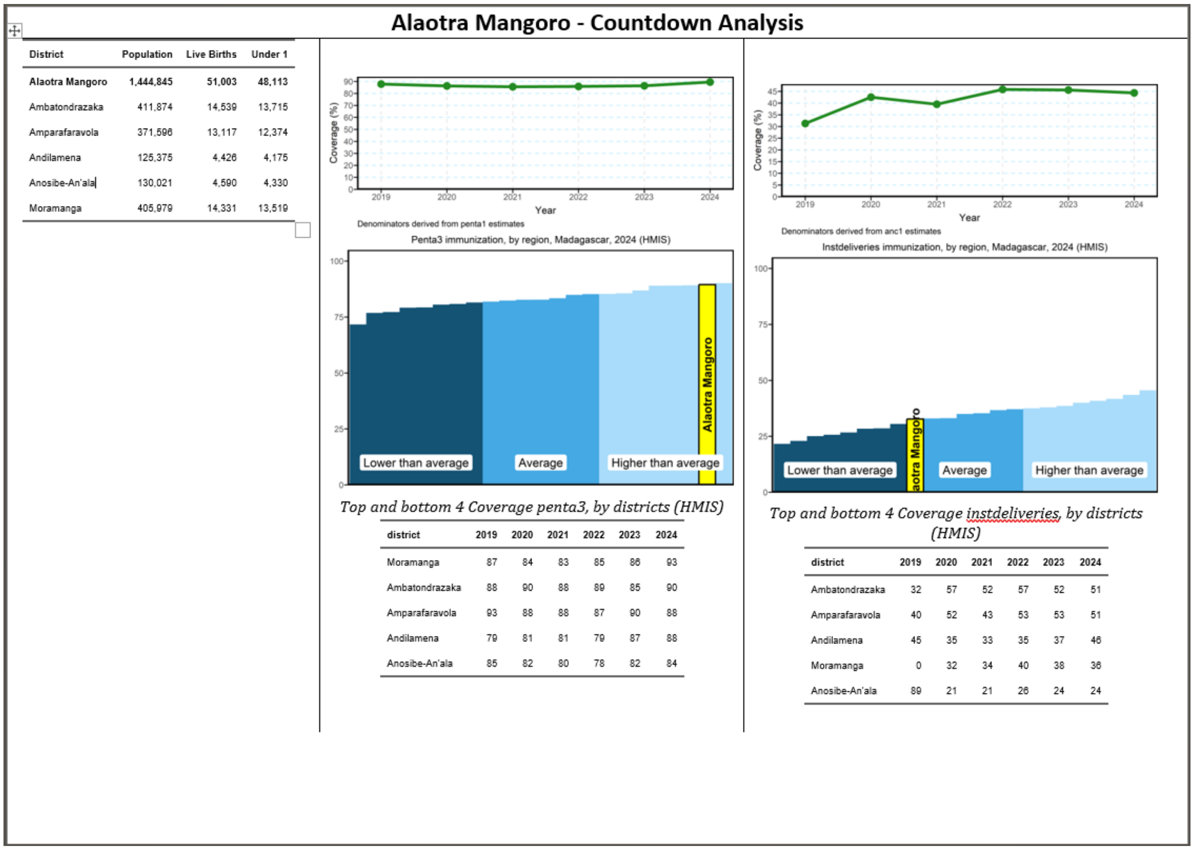
Figure 14.1: Subnational coverage

14.2 Sub-national statistical summaries (One pager)

The aim is to produce a one-pager for each admin1 unit (generally region, province or county) that contains the regional information as well as a summary of the districts within the region. We refer to this as the regional sub-national statistical summary.

The following components are included:

- Summary of key demographic information for the region and the districts: table with expected number of births in 2024 according to the DHIS2 projections and according to the preferred denominators derived from the health facility data (based on ANC1 for live births, and on penta1 for immunization indicators).
- Line graphs with the trend in coverage of institutional deliveries and penta3 vaccination that include the best estimates for 2020-2024 based on the health facility data, as well as the estimates from the most recent surveys (from 2015) for the same indicators (with confidence intervals if possible).
- Bar graphs that compare the 2024 coverage situation in the region compared to all other regions, and puts the region into the lowest, middle or upper third of regions in terms of coverage. This is done for both institutional deliveries and penta3 vaccination.
- Table that summarizes the coverage for institutional deliveries and penta3 vaccination in 2024 by district.
- Other indicators can be used as prioritized by the country (e.g., ANC4, measles1).



District	Population	Live Births	Under 1
Alaotra Mangoro	**1,444,845**	**51,003**	**48,113**
Ambatondrazaka	411,874	14,539	13,715
Amparafaravola	371,596	13,117	12,374
Andilamena	125,375	4,426	4,175
Anosibe-An'ala	130,021	4,590	4,330
Moramanga	405,979	14,331	13,519

Top and bottom 4 Coverage penta3, by districts (HMIS)

district	2019	2020	2021	2022	2023	2024
Moramanga	87	84	83	85	86	93
Ambatondrazaka	88	90	88	89	85	90
Amparafaravola	93	88	88	87	90	88
Andilamena	79	81	81	79	87	88
Anosibe-An'ala	85	82	80	78	82	84

Top and bottom 4 Coverage instdeliveries, by districts (HMIS)

district	2019	2020	2021	2022	2023	2024
Ambatondrazaka	32	57	52	57	52	51
Amparafaravola	40	52	43	53	53	51
Andilamena	45	35	33	35	37	46
Moramanga	0	32	34	40	38	36
Anosibe-An'ala	89	21	21	26	24	24

Figure 14.2: Percentage of districts in Alaotra Mangoro

To summarize the coverage situation according to the health facility statistics for 2024 can be done for the regional level and shown on a map. A composite coverage index is computed as an average in seven mother and child health indicators: ***ANC4****,* ***institutional live birth coverage****,* ***SBA****,* ***IPT2****,* ***postnatal care****,* ***pentavalent vaccine 3rd dosage*** *and* ***measles 1*** *vaccination coverage. Equal weight is given to all indicators.*

15 Inequality

15.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Reducing geographic inequality is essential for equitable health systems and achieving the SDGs. Subnational inequalities reveal inconsistencies in service delivery and highlight systemic barriers to healthcare access. Tracking inequality indicators helps assess whether health systems are becoming more equitable and whether targeted interventions are working.

Approach: Description of analytical steps

Here we calculate **Median Absolute Deviation from the Median (MADM)** to quantify spread in coverage in districts within an admin1 level , compared with the coverage at the said Admin1 subnational unit.

The key statistical measures for sub-national inequalities are:

- MADM: median absolute distance from the median. This measure gives an indication on whether the country has been successful in reducing inequalities between sub-national units.
- Percent of sub-national units with coverage above a specific target or threshold: this indicator provides information on the extent to which a country has been successful in reaching universal coverage at the sub-national level.

Summary of district and regional performance

Progress towards international and national targets can be measured by computing the percentage of regions and districts that have achieved these targets. The goal is for all regions and districts to have met the target. Higher percentages mean less inequality.

15.2 Implementation: Conducting analysis in the Shiny App

Navigate to the **Subnational Analysis** tab =>**Subnational Inequality** and inspect the plotted regional and district results by year, with the median absolute distance from the median (MADM, see screenshot below), as the summary measure to assess if inequalities have reduced.

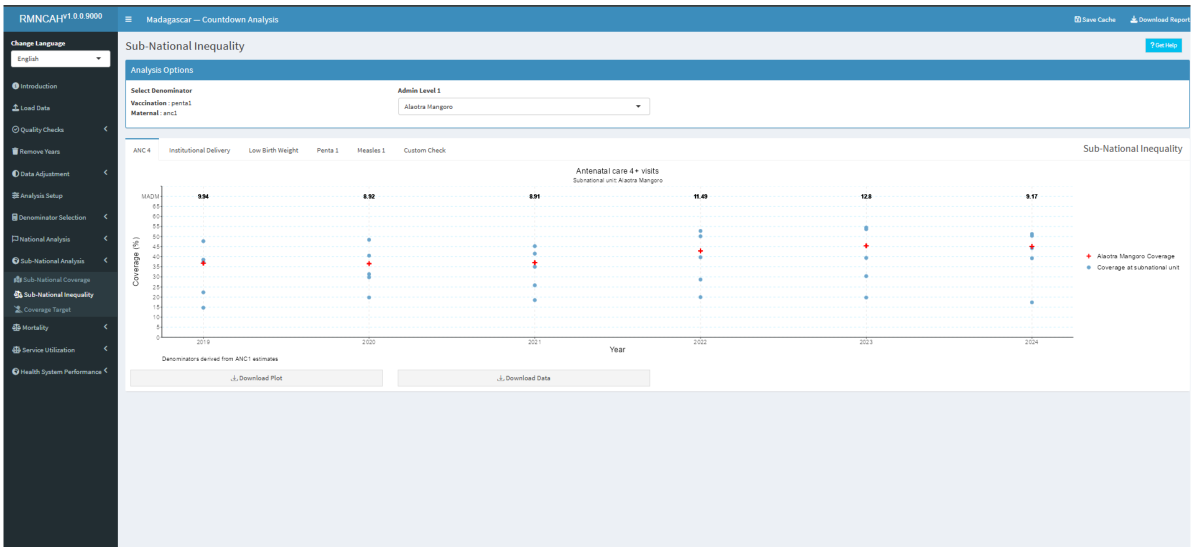


Figure 15.1: Subnational Coverage Inequality for ANC4

16 Global coverage targets

16.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Reducing geographic inequality is essential for equitable health systems and achieving the SDGs. Subnational inequalities reveal inconsistencies in service delivery and highlight systemic barriers to healthcare access. Tracking inequality indicators helps assess whether health systems are becoming more equitable and whether targeted interventions are working.

Approach: Description of analytical steps

Here we calculate **Median Absolute Deviation from the Median (MADM)** to quantify spread in coverage in districts within an admin1 level , compared with the coverage at the said Admin1 subnational unit.

The key statistical measures for sub-national inequalities are:

- MADM: median absolute distance from the median. This measure gives an indication on whether the country has been successful in reducing inequalities between sub-national units.
- Percent of sub-national units with coverage above a specific target or threshold: this indicator provides information on the extent to which a country has been successful in reaching universal coverage at the sub-national level.

Summary of district and regional performance

Progress towards international and national targets can be measured by computing the percentage of regions and districts that have achieved these targets. The goal is for all regions and districts to have met the target. Higher percentages mean less inequality.

16.2 Implementation: Conducting analysis in the Shiny App

Navigate to the **Subnational Analysis** tab =>**Subnational Inequality** and inspect the plotted regional and district results by year, with the median absolute distance from the median (MADM, see screenshot below), as the summary measure to assess if inequalities have reduced.

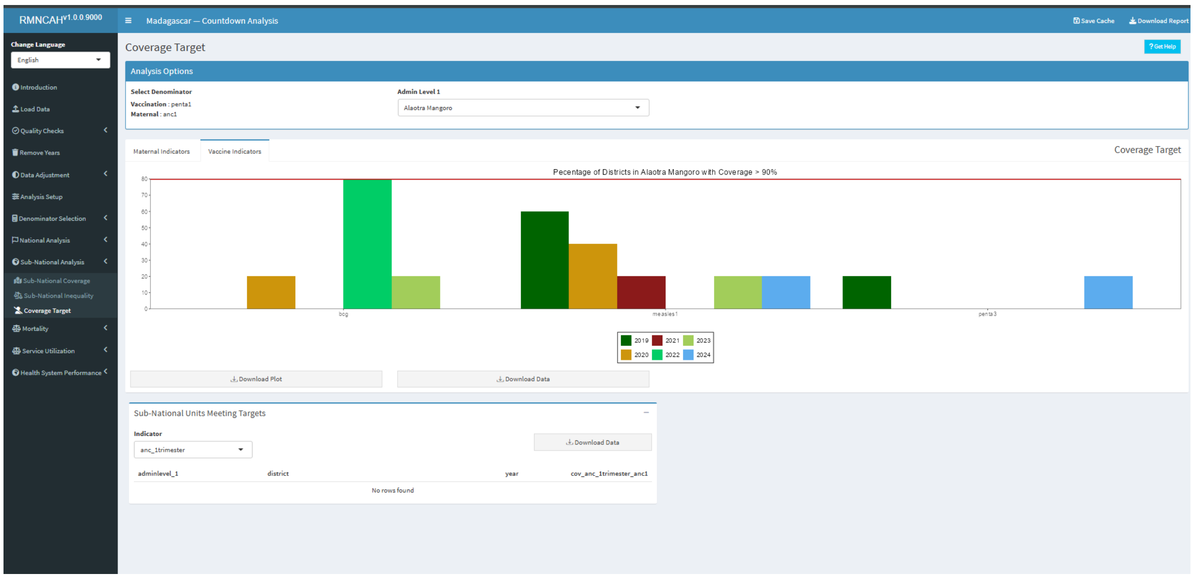


Figure 16.1: Subnational Coverage Inequality for ANC4

Part V

Mortality

17 Institutional Mortality

17.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

Maternal and perinatal mortality in health facilities are critical indicators of the quality of care (institutional mortality). Institutional maternal mortality is one of the key indicators proposed to monitor progress. Facility-based mortality statistics can also be a critical input into the estimation of population levels of mortality.

Reporting of maternal deaths, stillbirths, and early neonatal deaths (before discharge) may occur through the routine reporting system (DHIS2, aggregate or individual level) or be part of a maternal and perinatal death surveillance and response system (MPDSR).

Population mortality statistics (maternal mortality ratio, stillbirth rates, neonatal mortality rates) rely on household surveys and censuses, with major limitations, especially for maternal mortality and stillbirths. A promising development is the major increase in health facility deliveries observed in many countries.

Especially if coverage of births in health facilities is high (e.g., over 75%), the facility-based statistics will become a useful input into the estimation of population levels of mortality. The main challenge with mortality data from health facilities is under-reporting of deaths. Maternal deaths do not only occur during birth, but also in pregnancy and post-partum.

Reporting of stillbirth deaths requires well maintained maternity registers, but also cross-checks to the operation theatre registers for cases of Caesarean section. If that is not the case, deaths may not be recorded in the maternity register, and not reported into the national system. In addition, maternal deaths occurring in other hospital wards are more likely to be missed, such as deaths associated with abortion, or post-discharge due to sepsis and other causes. Neonatal deaths after discharge, which is often within 24 hours, are also more likely to be missed.

A critical step is a systematic assessment of data quality issues, which forms the basis for, if possible, adjustments, and more importantly should guide efforts to improve reporting quality.

Approach: Description of analytical steps

The definitions for institutional, community and population maternal mortality and for stillbirths are:

Indicator	Numerator	Denominator
Institutional maternal mortality ratio (iMMR)	Number of maternal deaths in health facilities[1]	Number of live births in health facilities * 100,000
Population maternal mortality (MMR)	Number of maternal deaths in the population	Number of live births in the population * 100,000
Community maternal mortality ratio (comer)	Number of maternal deaths in the community	Number of live births in the community * 100,000
Institutional stillbirth rate (iSBR)	Number of stillbirths in health facilities[2]	Number of births in health facilities * 1,000
Population stillbirth rate (SBR)	Number of stillbirths in the population	Number of births in the population * 1,000
Community stillbirth rate (cSBR)	Number of stillbirths in the community	Number of births in the community * 1,000
Neonatal mortality (before discharge)	Number of neonatal deaths before discharge	Number of live births in health facilities * 1000

17.2 Data Analysis Components:

Data analysis has the following components:

iMMR and iSBR review

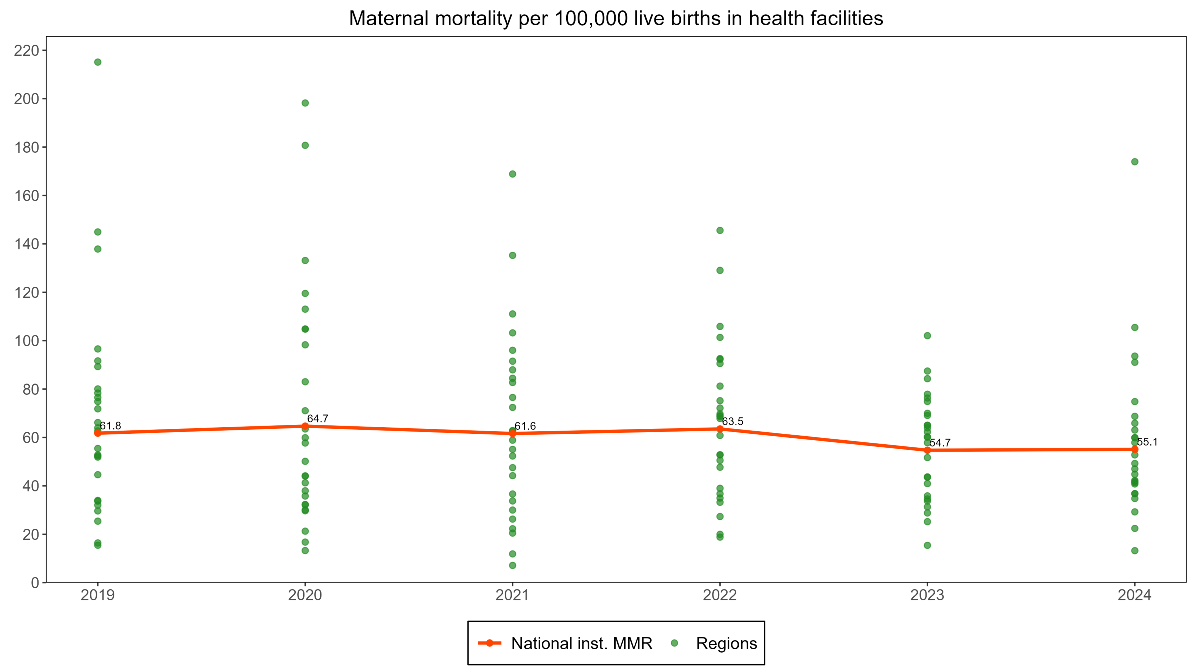
The annual mortality rates are computed using the unadjusted data on reported deaths and births/live births in health facilities. We do not adjust for reporting rates and outliers (as is done for other interventions) because it is difficult to adjust maternal deaths and stillbirths, where the number of deaths is small and fluctuating.[3] It is however advisable to check the data for any extreme outliers in the annual data (e.g., numbers of deaths that clearly indicate data entry errors) and replace these with the average of the surrounding years.

The figure below displays the institutional maternal mortality per 100,000 live births for regions (dots) and for the country as a whole (line and annual values) by year.

[1]Maternal death is defined as any cause related to or aggravated by pregnancy or its management (excluding accidental or incidental causes) during pregnancy and childbirth or within 42 days of termination of pregnancy, irrespective of the duration and site of the pregnancy

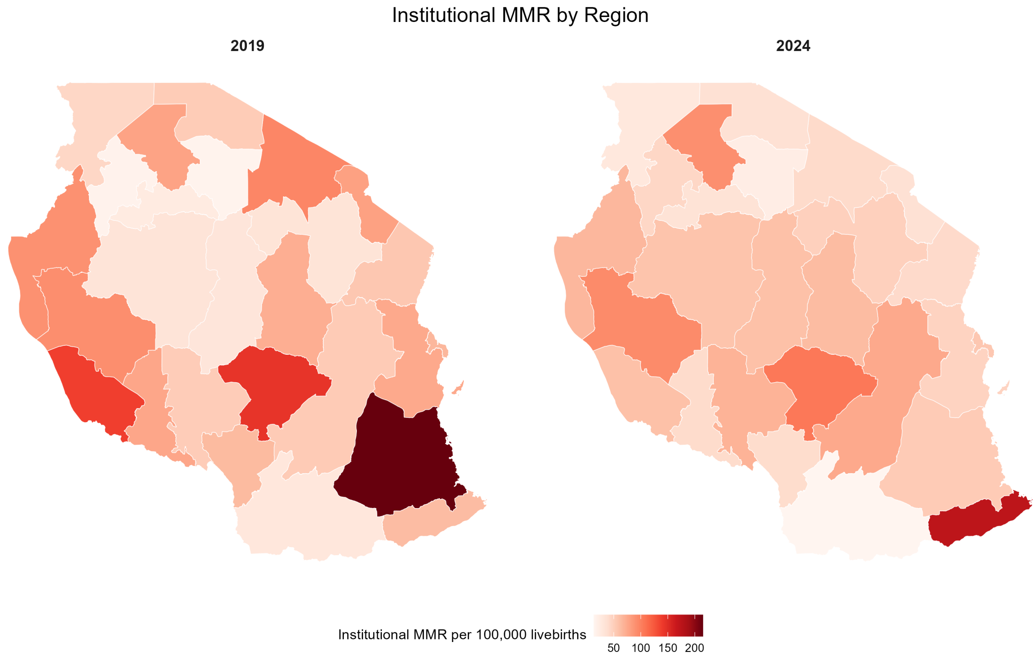
[2]A baby who dies after 28 weeks of pregnancy, but before or during birth, is classified as a stillbirth. Often the distinction is made between ante-partum (macerated) and intrapartum (fresh) stillbirths.

[3]It is however good to inspect the data and consider extreme outliers (more than 3 standard deviations from the annual, or more than 5 times the median absolute deviation – see data quality section.



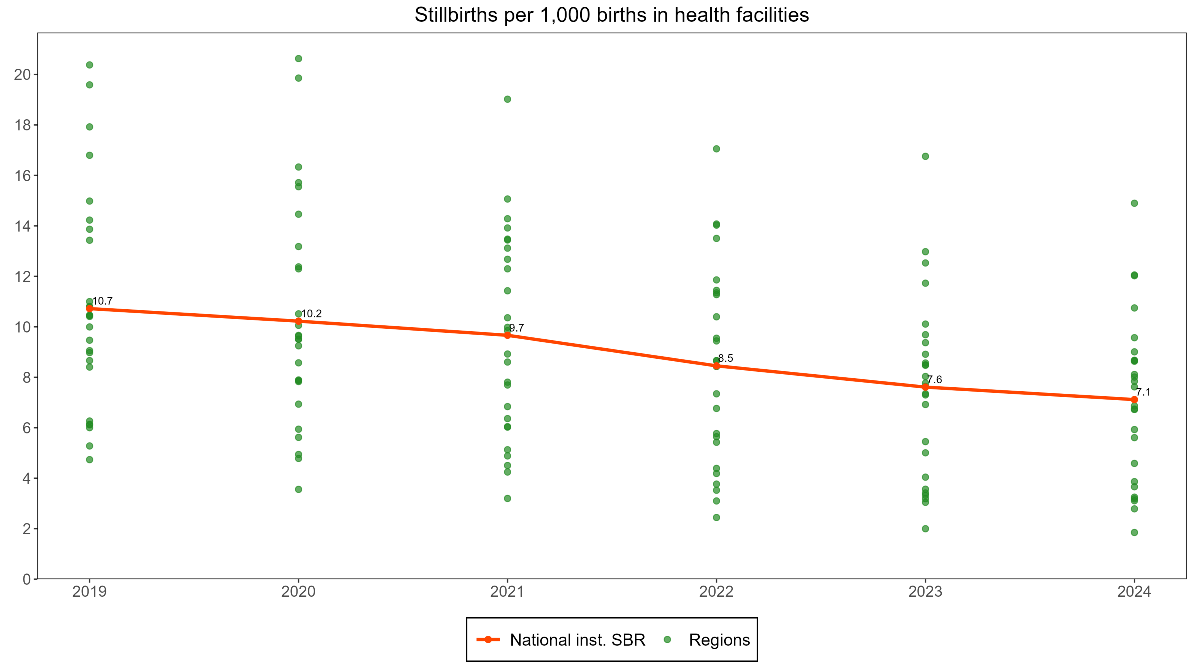
Several considerations need to be made:

- Are there any extreme outliers on the high side which may be due to major data errors which need correction?
- How many regions have implausibly low iMMR which is arbitrarily defined as less than 25 per 100,000 live births (25 is two times the MMR in high-income countries of 12.5); are these more advanced regions where mortality is expected to be lower, or are there less-developed regions with low mortality, which could be an indication of major under-reporting of deaths.
- A map with the iMMR by region/province would be a useful addition to guide the interpretation of the data, especially focusing on potential data quality issues.



The figure below presents the stillbirth rate per 1,000 births for regions and the country, using the same format as for maternal mortality. The interpretation should explain:

- How many regions have implausibly low iSBR which is defined as less than 6 per 1,000 births (which is two times the SBR in high income countries)?
- Are these more advanced regions where mortality is expected to be lower, or is this a sign of major under-reporting of deaths in less-developed regions of the country.



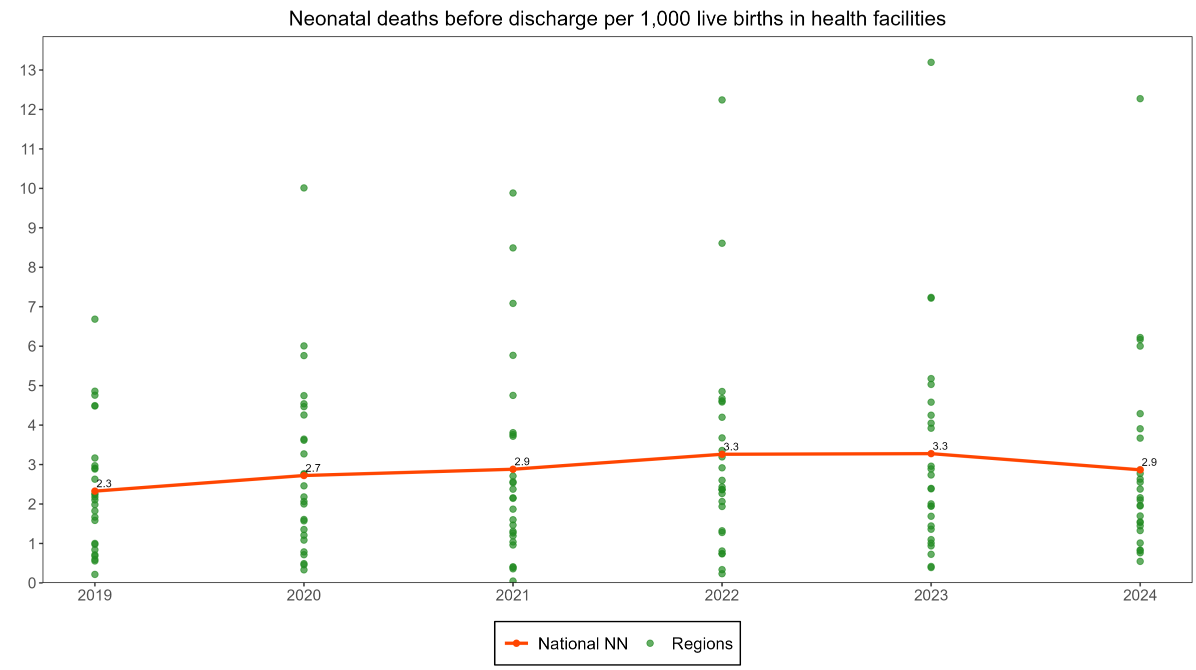
In addition, the institutional mortality levels can be compared to the most recent mortality estimates for the population. These population estimates could be coming from a recent national survey or census, or we can use the UN estimates for maternal mortality (for 2020) and stillbirth rates (for 2021).

This is to obtain an idea of the difference between the institutional mortality and the population mortality. Interpretation should seek to explain:

- How far is the iMMR (or iSBR) from the UN estimates of the population mortality, including the uncertainty range of the global estimates: this difference will be used further to assess the data quality.

The institutional neonatal mortality rates (per 1,000 live births) based on reported neonatal deaths may also be graphed similar to iMMR and iSBR, but have to be interpreted with additional caution. Almost all babies stay at least 24 hours after delivery in the hospital but after that many are discharged and the observation time in health facilities is variable. Therefore, the statistic is mostly referred to as neonatal deaths before discharge per 1,000 live births, which includes day 1, some deaths on day 2, fewer deaths on day 3 etc.

A rough guide to assess reporting completeness is that expected mortality of neonatal deaths before discharge in health facilities should be at least half of neonatal mortality in the population. So for instance, if population neonatal mortality is 20 per 1,000 live births, we expect institutional neonatal mortality at least 10 per 1,000 live births in the health facilities.



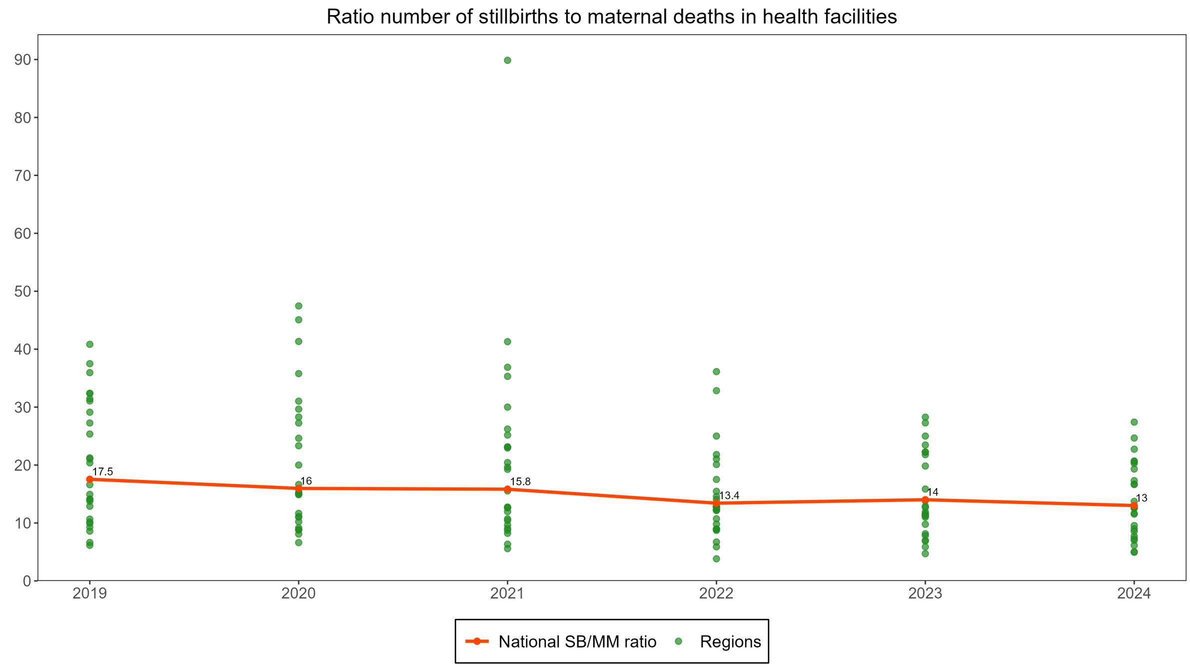
17.3 Data Quality metrics

- ***Ratio stillbirth to maternal deaths in the health facility data at national level***

We expect maternal mortality and stillbirth to be positively correlated given the commonalities in causes. Based on a review of the global estimates, historical data, and health facility studies, we expect the ratio of stillbirth to maternal death to be in the range of 5 to 25 for countries in sub-Saharan Africa. We compute the ratio as the number of reported stillbirths divided by the number of reported maternal deaths in DHIS2 or MPDSR, in a specific time period (usually a year) and raise a "data quality flag" if the ratio is outside the 5-25 range.

Interpretation:

- If the ratio is lower than 5: under-reporting of stillbirths is likely greater than under-reporting of maternal deaths
- If the ratio is equal or greater than 25: under-reporting of maternal deaths is likely to be the main issue, under-reporting of stillbirth less serious than for maternal deaths.
- If the ratio is between 5 and 25: under-reporting of maternal deaths and under-reporting of stillbirths are both possible, or reporting of both is of good quality (this requires that the level is also in the expected range - component 1).



- ***Consistency of institutional MMR with estimated population MMR and community MMR***

The completeness of reporting by health facilities can be estimated by comparing the reported iMMR based on facility data with an expected iMMR. The population MMR, community MMR and institutional MMR should be consistent. There will be variation in the community to institutional MMR between populations, but it is not likely that, for instance, the community MMR is 1,000 when the institutional MMR is 100.

We compute an expected MMR in health facilities based on assumptions about:

- MMR in the whole population (including community and institutional deaths): For example, the lower bound, median, upper bounds of global estimates for each country (2023 UN estimates) could be used, or the results from a recent survey.
- Ratio of community to institutional maternal mortality: We use assumptions ranging from 1.0 (where we assume community MMR is the same as iMMR) to 2.0 and 3.0 (cMMR is 2 or 3 times higher than iMMR).[4] For each country, one should consider what this ratio could be which may depend on the proportion of births in health facilities. There is some evidence that the community to institutional ratio increases as institutional birth rates increases, as well as the observed percent of births in health facilities.

[4]The assumptions on the range of ratios for community to institutional MMR were selected based on studies that measured both institutional and population mortality estimates (or had information about the percent of all maternal deaths that occurred at health facilities and the percent of deliveries that took place at health facilities.

The population MMR is the sum of the institutional and community MMR, weighted by the percent of births occurring in facilities. For instance, if the institutional MMR is 100 and the community MMR is 200, and 75% of births are in health facilities, then the population MMR equals

$$0.75 * 100 + 0.25 * 200 = 125 per 100,000$$

live births. This can be expressed in the following formula:

$M_p = P_i * M_i + (1 - P_i) * M_c$

Where;

- M_p = maternal mortality ratio in the population;
- M_i = institutional maternal mortality ratio;
- M_c= maternal mortality ratio in the community;
- P_i the proportion of live births in institution

Here, we have (1) iMMR from the DHIS2 data and (2) population mortality from the UN estimates, and can compute the community MMR as

$$(125 - 0.75 * 100)/(1 - 0.25) = 200$$

, or

$$M_c = \frac{(M_p - P_i * M_i)}{(1 - P_i)}$$

In the example, the ratio community to institutional mortality

$$(Mc/Mi)$$

equals 200 / 100 = 2, in other words the community mortality is two times higher than the institutional mortality.

We can now compute the expected MMR based on 1) an estimate of population MMR 2) the ratio Mc/Mi. For instance, if 75% delivers in health facilities, the population MMR is 200 and the ratio (M_c/M_i) is 2, then the expected institutional MMR is

$$(200/(2 - (2 - 1) * 0.75) = 200/1.25 = 160 per 100,000$$

live births. (and the community MMR is

$$320$$

).

In a formula:[5]

Expected

$$Mi = Mp/(Mc/Mi - -(Mc/Mi) - 1) * Pi))$$

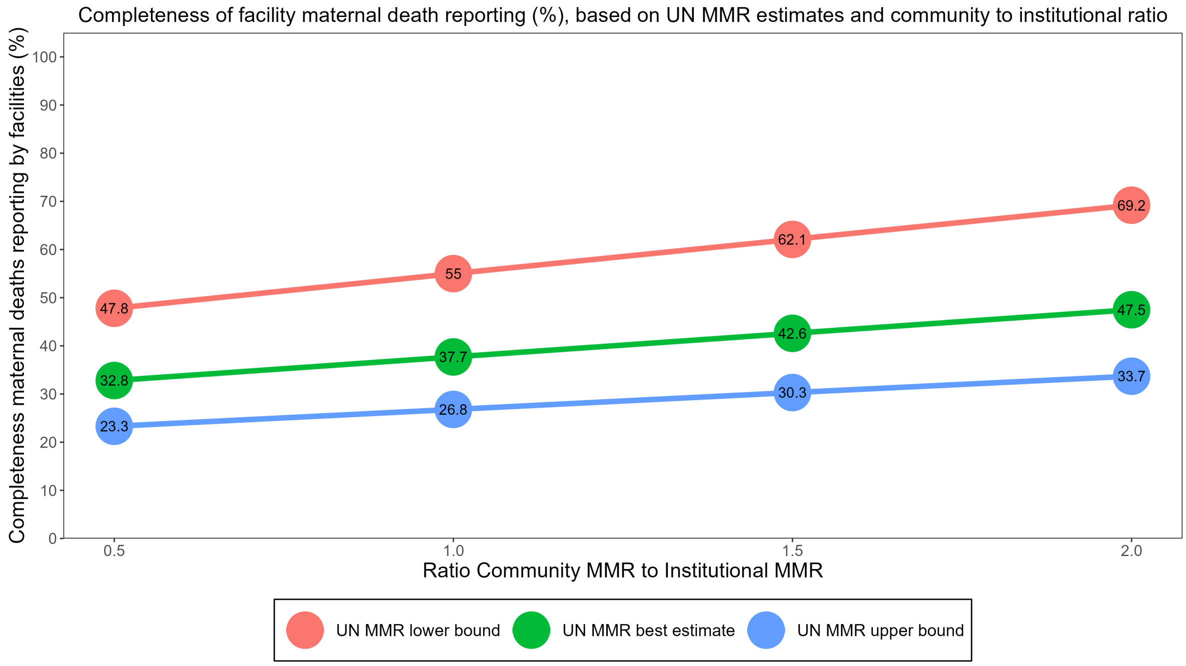
Finally, the completeness of facility reporting is reported iMMR (e.g. based on DHIS2) divided by the expected iMMR. For instance, if the reported MMR was 100 and the expected MMR 160, then the level of completeness of reporting is

$$100/160 * 100$$

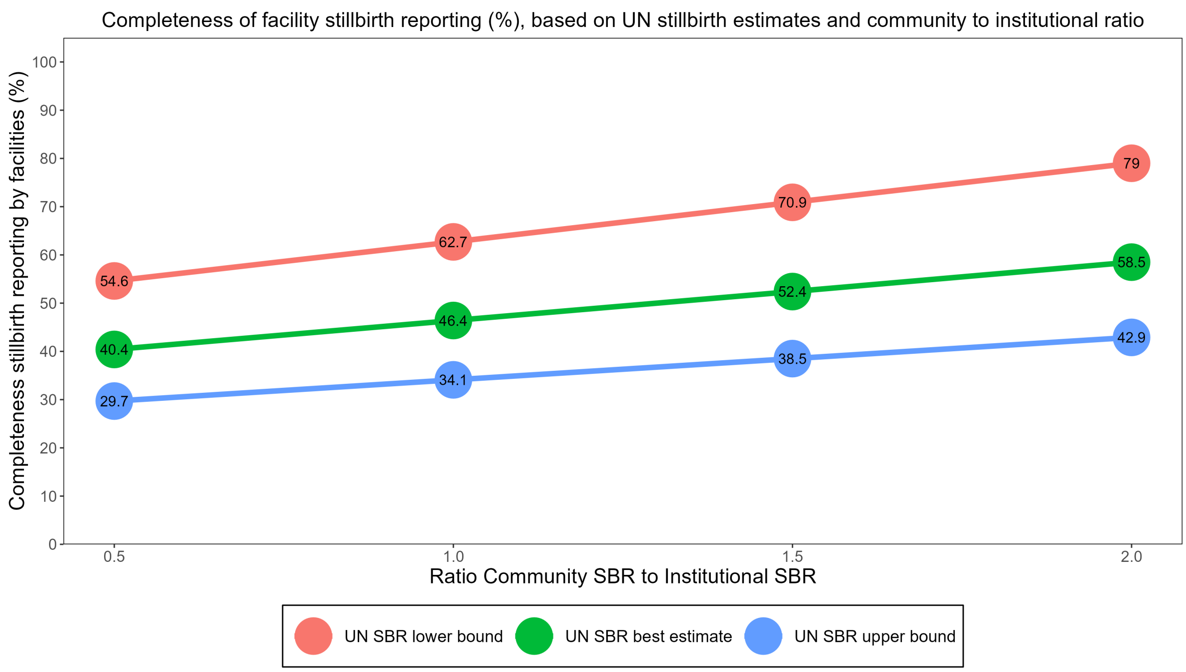
Below is an example of the estimated completeness of facility reporting of maternal deaths using different scenarios. The figure shows the results on completeness of reporting with three levels of population MMR (lower bound, median or best estimate, upper bound) and three community to institutional mortality ratios (0.5-2.5), shown on the X-axis.

Not all scenarios are equally relevant to each country. For instance, if there is evidence that the population MMR is lower than the UN median, pick the scenario with the lowest MMR (the blue line). If it is considered that community MMR could be 1.5-2.0 times higher than institutional MMR, then the completeness estimate is 59-64%. The choices are arbitrary, but it is useful to consider if the range of estimates of completeness of facility reporting can be narrowed down by using the most plausible scenario. As default values, the ratios of 1.0, 2.0 and 3.0 are used.

[5] An important factor affecting MMR estimates from health facilities, especially if the data are gathered through MPDSR, is that many deaths occur outside of the maternity ward (upon re-admission). If the DHIS2 is based on the reporting of all cause-specific deaths in health facilities, and the maternal death is correctly classified, this is not an issue.



A similar approach can be used for stillbirths using all births instead of live births. The UN global stillbirth estimates for 2021 with uncertainty ranges can be used (lower and upper bound are 90% uncertainty intervals from the model). There is little research on the community to institutional stillbirth ratio (partly because community level stillbirth reporting is more uncertain) but it is likely that the ratios are lower than for maternal mortality, as institutional mortality levels are much higher for stillbirth rates than for MMR. A range of 0.5-1.5 may be used for the estimation of the level of completeness of facility reporting.



Completeness of facility stillbirth reporting (%), based on UN stillbirth estimates and community to institutional ratio
Completeness stillbirth reporting by facilities (%)
100
90
80
70
60
50
40
30
20
10
0
54.6
62.7
70.9
79
40.4
46.4
52.4
58.5
29.7
34.1
38.5
42.9
0.5
1.0
1.5
2.0
Ratio Community SBR to Institutional SBR
UN SBR lower bound
UN SBR best estimate
UN SBR upper bound

18

Part VI

Service Utilization

19 Curative health services utilization for sick children

19.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

There is only limited information about curative service utilization, even though diarrhoea and pneumonia are leading causes of death in children. Service utilization statistics on care-seeking behaviour among children with recent illnesses (diarrhoea, acute respiratory infection, or fever in the last 2 weeks) is usually obtained from household surveys, relying on mother's recall.

Health facility data on outpatient (OPD) visits is an indicator of access to curative services: **less than one visit per person is often considered an indicator of poor access**. Similarly, data on hospital admissions is an indicator of access to services, while hospital mortality (case fatality) is an indicator of the quality of care.

Approach: Description of analytical steps

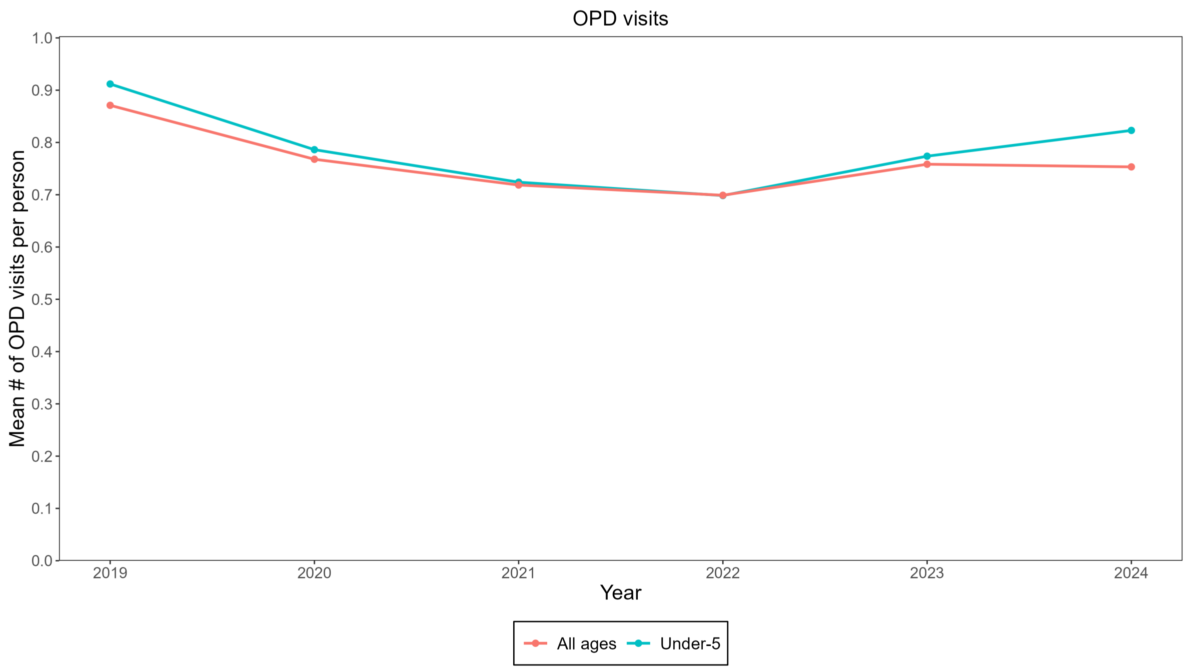
The data on OPD visits should include new and re-visits. Data are usually reported for under-5 years and 5 years and older. As with data on maternal and newborn care and immunization, the data quality is assessed, and adjustments are made for completeness of reporting and extreme outliers are corrected. The adjusted clean data are used for analysis at national and subnational levels.

19.1.1 Outpatient service utilization

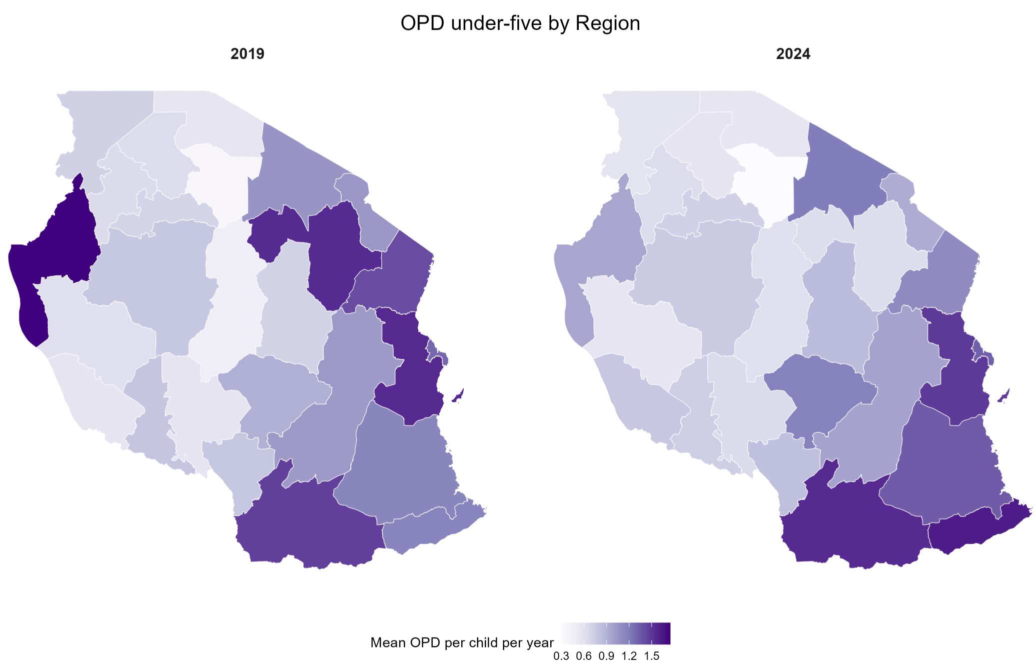
The data on outpatient visits should include both new and re-visits.

Mean number of OPD visits per child per year:

- The numerator is the adjusted number of under-5 OPD visits in a year and the denominator is the total number of children under-5 which is taken from the DHIS2 projections. We do not expect this statistic to change much between years (less than 0.2 visits per child per year). A gradual increase suggests either improvements in access to OPD services or a greater disease burden for children. There is no fixed cut-off, but if the attendance is less than 1 visit per year per child, access to services is likely an issue. The OPD statistics are computed for the national and regional/provincial levels.



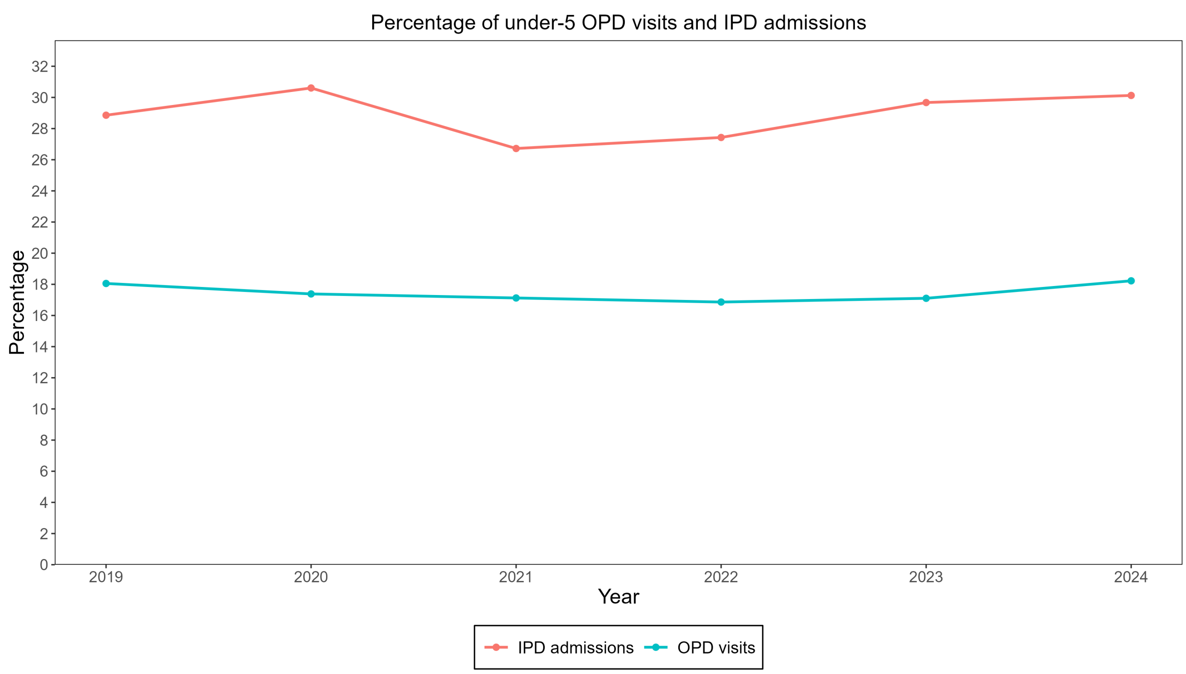
- A map with OPD use by region or province can reveal important sub-national differences.



- OPD interpretations considerations:
  - What can be said about the data quality for OPD visits? Is there consistency of reported numbers between years?
  - What is the number of OPD visits per child per year during 2019-2023, is it increasing?
  - Is it lower than 1 visit per year, which is considered indicative of low access?
  - What can be said about the OPD visits per child per year by region/province in 2023? How large is the difference between top and bottom regions?

Percent of OPD visits that are children under five years

The percentage commonly lies between 15-45% of all visits that are under-fives. In high fertility countries (e.g., total fertility rate > 4) we expect a higher percentage (e.g., over 30%) than in lower fertility countries. If the percent lies outside this range, there may be a data quality problem. Furthermore, if the percent changes much between years (e.g. more than 5 percentage points) then there may also be a data quality issue.



19.1.2 Inpatient service utilization

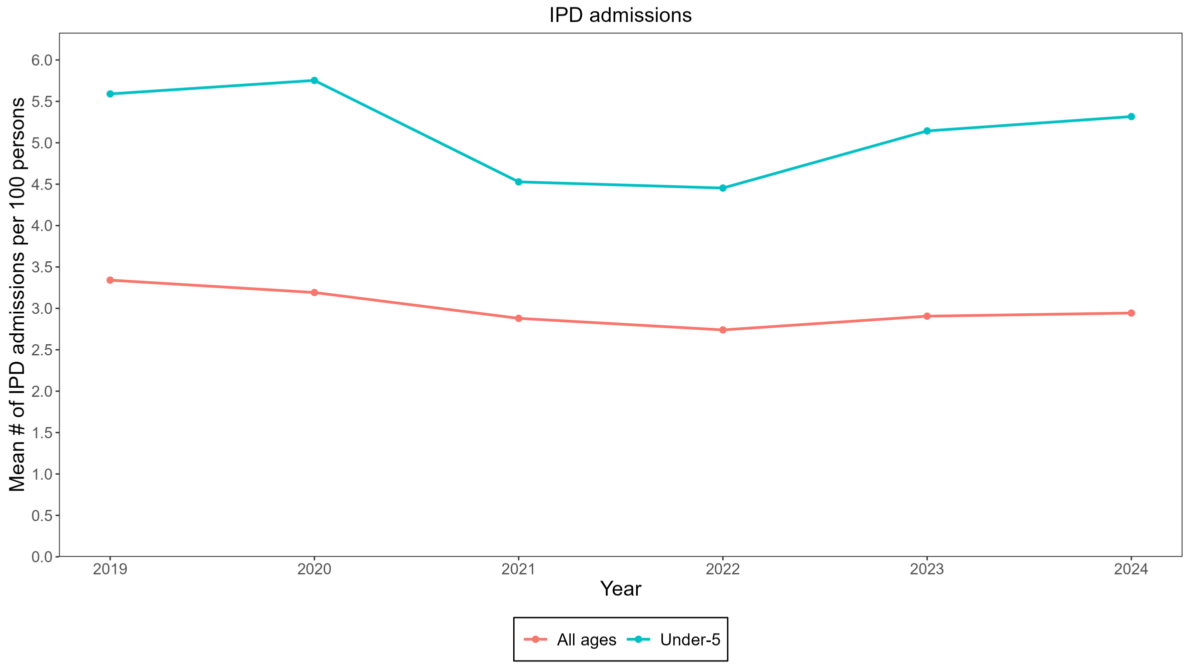
The data on hospital admissions (or discharges + deaths) include new and re-admissions. Data are usually reported for under-5 and 5 years and over. Some countries report discharges rather than admissions which would be the preferred data (discharges = admissions – deaths).

A review of completeness of reporting and the presence of extreme outliers is used to assess data quality. Reporting rates of hospitals (and other facilities with in-patient services) may be more difficult to assess than for other services. Therefore, the decision to adjust for incomplete reporting also depends on the judgement by the country teams regarding the quality of the reporting rate for in-patient services.

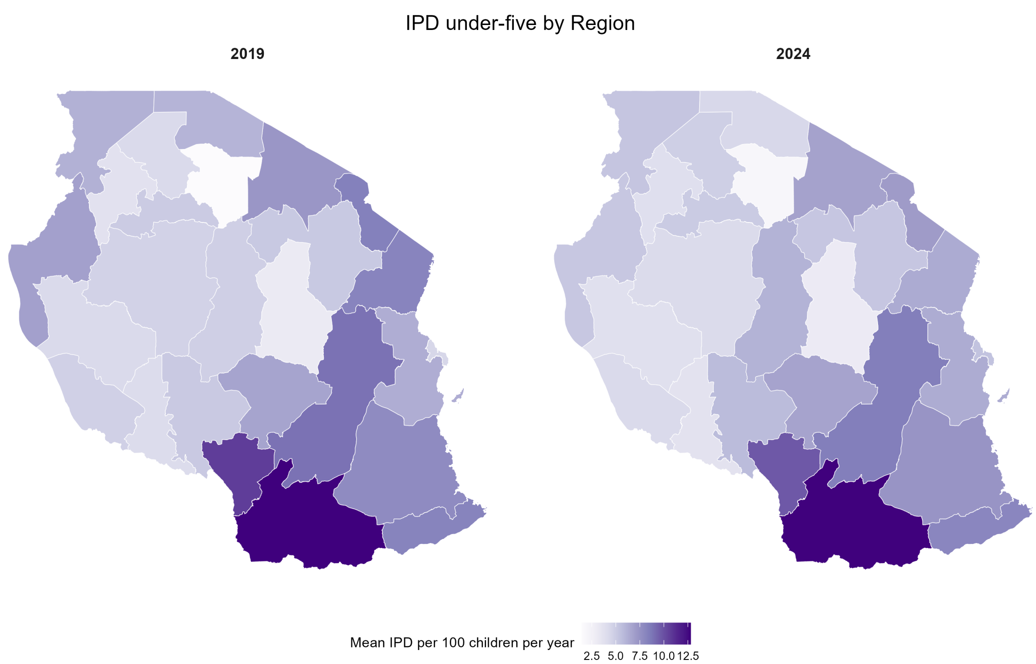
Also, extreme outliers may be more common for monthly admissions because of poor reporting, and adjustments need to be made cautiously. It is recommended to assess both the unadjusted and adjusted results.

Number of admissions per 100 children under-5 per year:

- This is an indicator of access. A low value, e.g., less than 2 admissions per 100 children under-5 per year, is indicative of low access to services. The median for countries in sub-Saharan Africa for 2018-2022 was 4.5 admissions per year. Also here, we do not expect the indicator to change much per year: e.g. a change of 1 or more admissions per 100 children between years is unlikely, unless a specific explanation can be found (such as an epidemic).
-



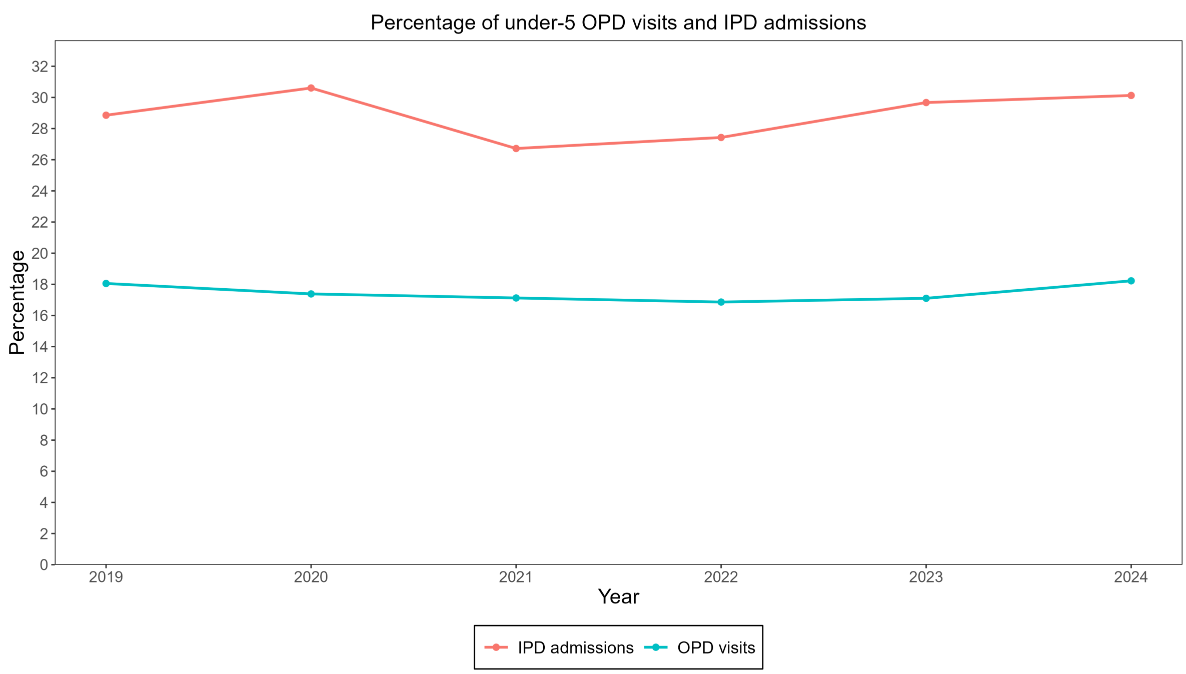
- A map with IPD admissions among under-five use by region or province can reveal important sub-national differences.



- IPD interpretations considerations:
  - Is there consistency of reported numbers of admissions / admission rates over time?
  - What is the number of admissions per 100 children under 5 per year during 2019-2023?
  - Trend - Is it low or high? What can be said about admissions per 100 children under-5 per year by region/province in 2023?

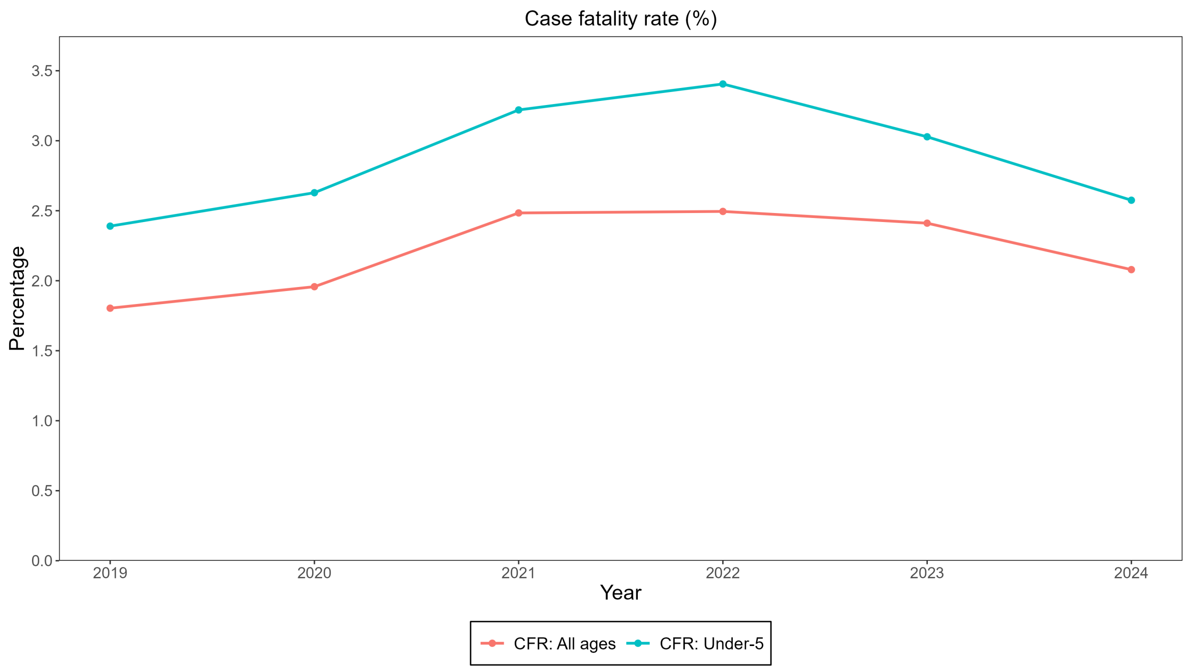
Percent of admissions that are children under five:

This is an indicator of data quality. The percentage commonly lies between 10-40% of all admissions that are under-fives. If the percentage lies outside this range, there may be a data quality problem or an exceptional situation. Furthermore, if the percent changes much between years (e.g. more than 5 percentage points), then there may also be a data quality issue.



Case fatality rate:

An indicator of the quality of care, defined as the number of children who die in hospital divided by the total number admitted (discharges + deaths). This should be done using the unadjusted data, as we do not adjust: neither the numbers of deaths nor the number of admissions. The case fatality rate is considered an indicator of the quality of care. The lower the mortality in health facilities, the better the quality of care.


Case fatality rate (%)
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Percentage
2019
2020
2021
2022
2023
2024
Year
CFR: All ages
CFR: Under-5

Part VII

Health System Perfomance

20 Health Systems Performance

20.1 Introduction

This section focuses on analyzing health systems performance, including the availability and quality of health services, health workforce, and health financing. The analysis aims to identify gaps and challenges in the health system that may affect the delivery of reproductive, maternal, newborn, child and adolescent health and nutrition (RMNCAH-N) services.

It has the following subsections:

- Health system inputs (national and subnational)
- Health system outputs (national and subnational)
- Private sector and RMNCAH-N services

20.2 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

The assessment of the burden of disease, the coverage, quality and equity of interventions and the inputs of the health system should guide policy making and targeting of programmes. Subnational analyses are critical: districts and regions/provinces are key units of the health systems and their service delivery. One element of the assessment is a basic assessment of the health system inputs in terms of financing, health workforce and infrastructure and outputs of the system in terms of service utilization and coverage.

Approach: Description of analytical steps

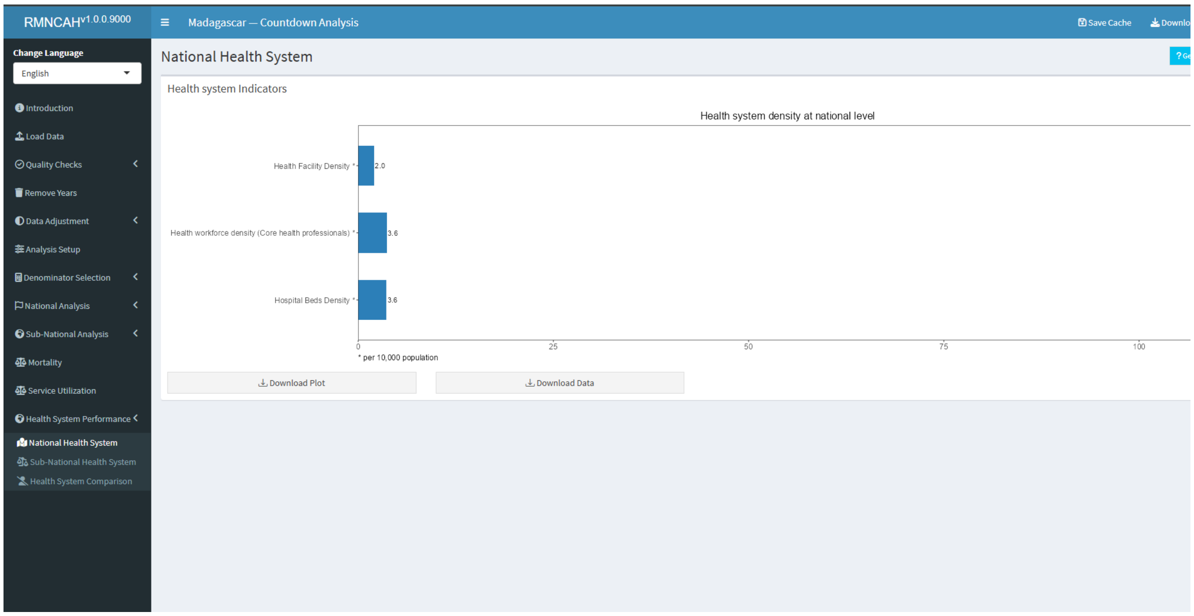
The focus is on a basic comparison of health system outputs (coverage of interventions) with system inputs (infrastructure, workforce, financing) at the sub-national level (admin1). More complex methods such as efficiency analyses, frontier analysis, considering socioeconomic level of development and other factors are beyond the scope of this section of the analysis.

This section focuses on analyzing health systems performance, including the availability and quality of health services, health workforce, and health financing. The analysis aims to identify gaps and challenges in the health system that may affect the delivery of reproductive, maternal, newborn, child and adolescent health and nutrition (RMNCAH-N) services.

It has the following subsections:

- Health system inputs (national and subnational)
- Health system outputs (national and subnational)
- Private sector and RMNCAH-N services

The analysis for these subsections is conducted within the Health System Performance section of the Shiny App as shown here:



21 Health systems inputs

21.1 Health systems inputs

First, the assessment focuses on the quality of data for the health system indicators at national and sub-national levels. For selected indicators, the assessment should focus on:

1. 1) comparison with global data for selected indicators (national level only)
2. 2) plausibility of indicator values by subnational units – major outliers? Improbable patterns?
3. In addition, it is useful to explore the associations of the health system indicators with each other (e.g. workforce and beds), if only to detect inconsistencies by admin1 (province, region, county).
4. It is also useful to assess the association of the health system performance between different administrative levels (e.g., admin 1 and district) to detect outliers or inconsistencies.

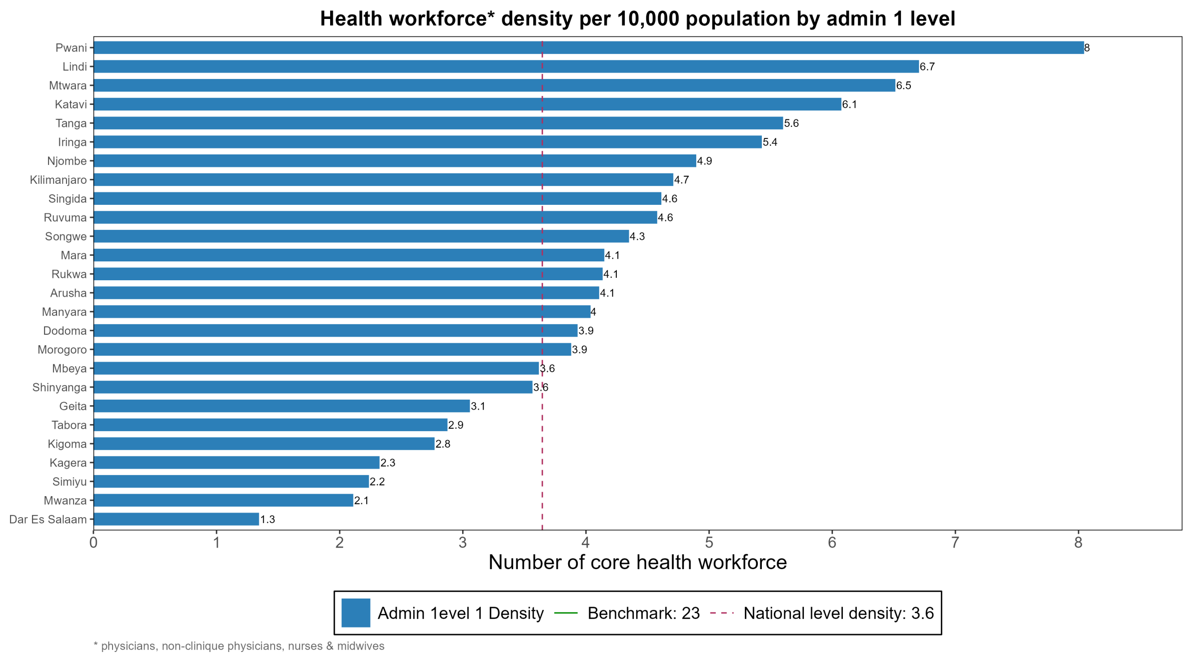
Health financing:

Health financing indicators at the district or admin1 levels are difficult to obtain and are often limited to budget and not expenditures. The data also tends to be limited to government resources and may miss on other sources of financing. (*These data are not used here, but if available, the financial data should be used to assess health system inputs.)*

Core health professionals per 10,000 population:

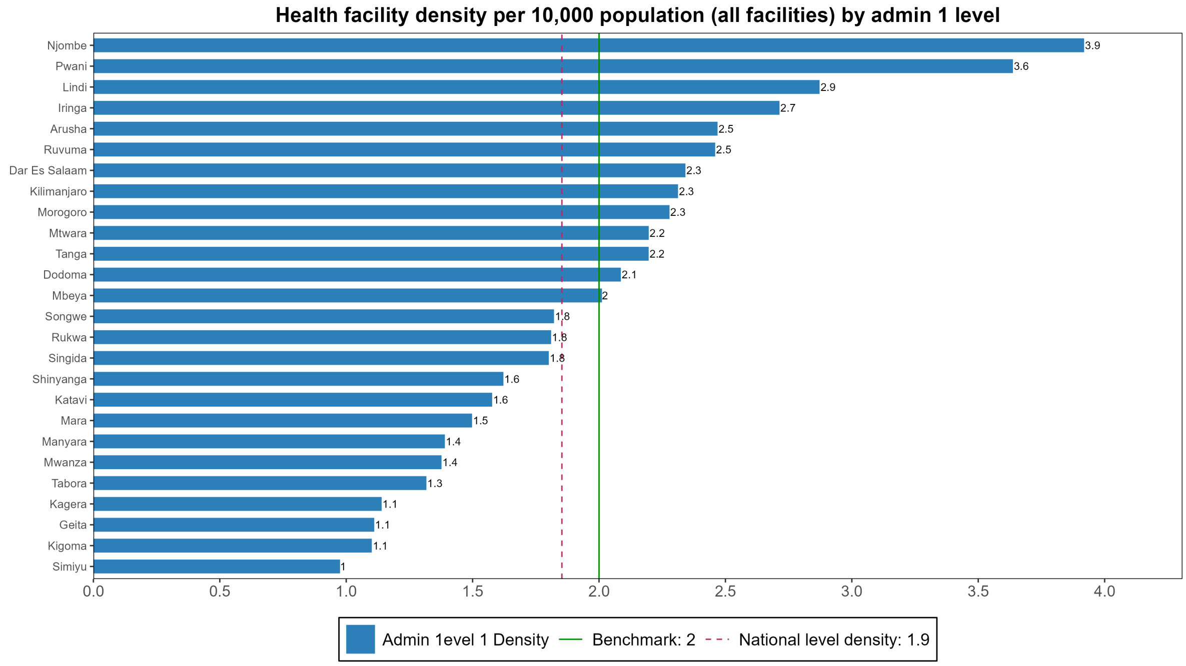
Health workforce indicators are often of poor quality and not easy to obtain. The main indicator is the number of core health professionals per 10,000 population. These include physicians, non-physician clinicians (depending on the country, but often with surgical skills and multiple years of training but no academic degree), nurses and midwives.

In 2006, WHO suggested that at least 23 core health professionals were needed to make major progress in reducing maternal and child mortality with high skilled birth attendance. More recently, higher thresholds have been used: at least 44.5 per 10,000 population to achieve universal health coverage.



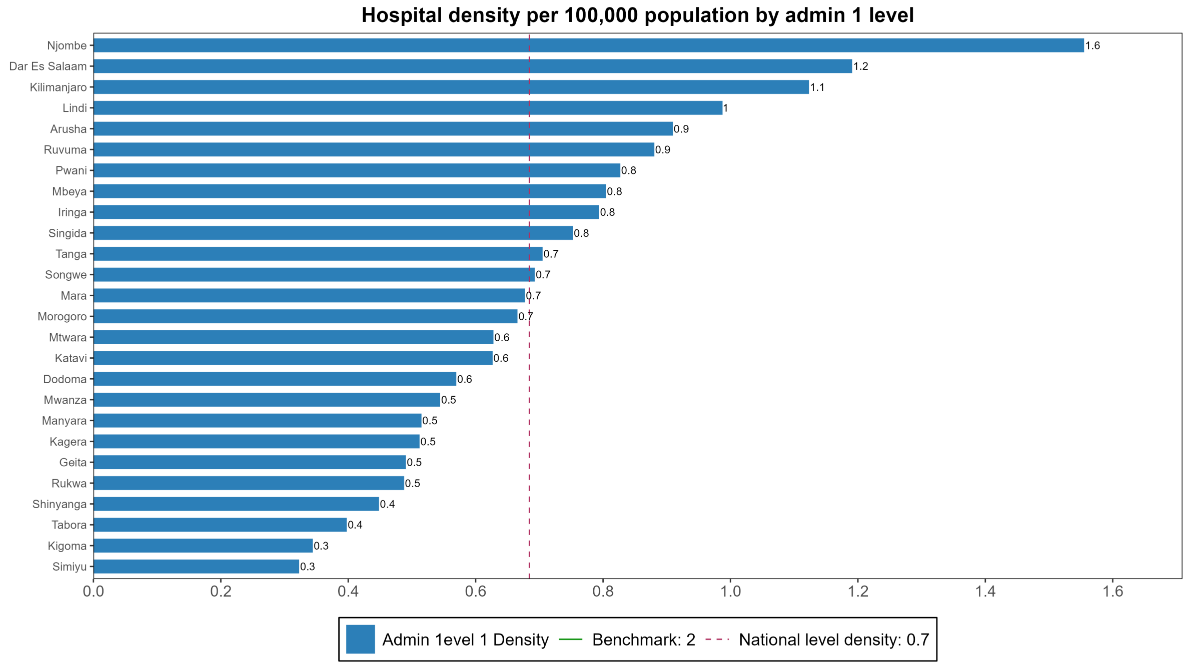
Number of health facilities per 10,000 population:

Health infrastructure is another useful indicator, including all hospitals, health centers and lower level health facilities such as health posts and dispensaries. Both private and public sectors should be included. The number of health facilities per 10,000 population is a crude indicator as it mixes small and large facilities (2 per 10,000 could be used as an indicative number, where less than 2 is considered low).



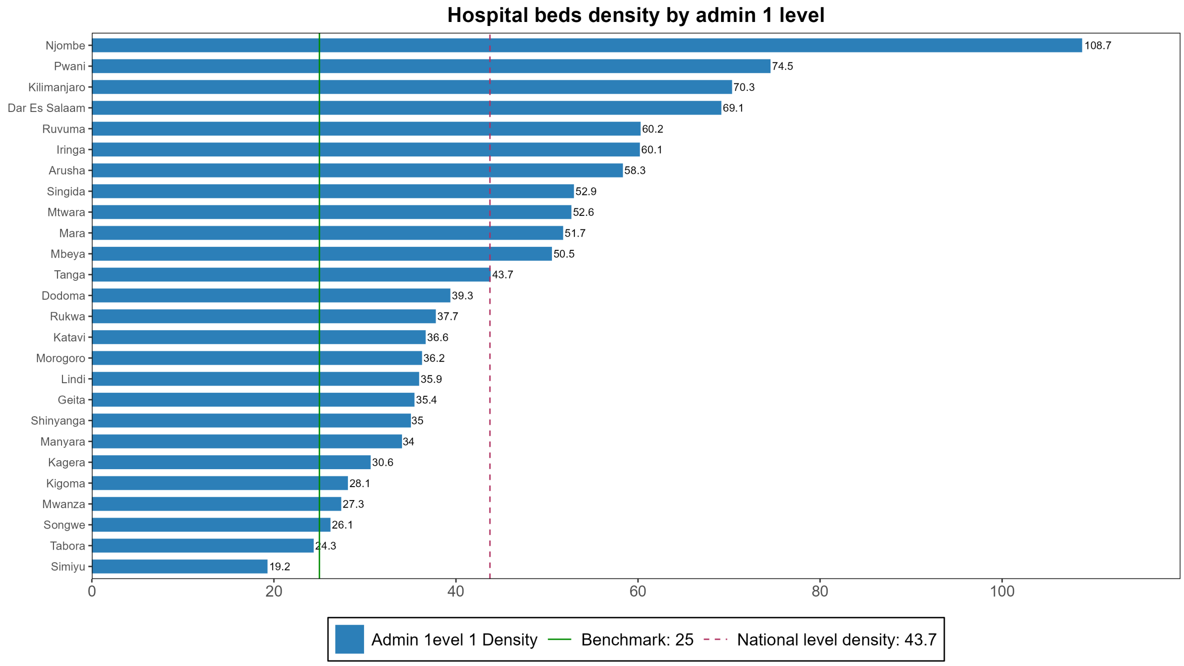
Number of hospitals per 100,000 population :

Additional insights into the infrastructure for in-patient services can be obtained by computing the number of hospitals per 100,000 population.



Inpatient bed density per 10,000 population:

Additional indicator for health infrastructure, computed as the number of inpatient beds in all health facilities per 10,000 population.


Hospital beds density by admin 1 level
Njombe
Pwani
Kilimanjaro
Dar Es Salaam
Ruvuma
Iringa
Arusha
Singida
Mtwara
Mara
Mbeya
Tanga
Dodoma
Rukwa
Katavi
Morogoro
Lindi
Geita
Shinyanga
Manyara
Kagera
Kigoma
Mwanza
Songwe
Tabora
Simiyu
108.7
74.5
70.3
69.1
60.2
60.1
58.3
52.9
52.6
51.7
50.5
43.7
39.3
37.7
36.6
36.2
35.9
35.4
35
34
30.6
28.1
27.3
26.1
24.3
19.2
0
20
40
60
80
100
Admin 1evel 1 Density
Benchmark: 25
National level density: 43.7

22 Health systems outputs by inputs

22.1 Health systems outputs by inputs at the subnational level

The second part of the analysis explores the association between health system inputs and service utilization and coverage by sub-national units (admin1).

The following can be examined:

1. ***Association between hospital density (per 100,000) and admission rates for children under 5 and beds per 10,000 population and admission rates for children under 5, by admin1.***

- We expect that regions with lower hospital density have lower admission rates for children, and those with higher density have higher admission rates. This would show as a positive slope of a linear regression line, as below.

  Insert screenshot (6-ipd_use)

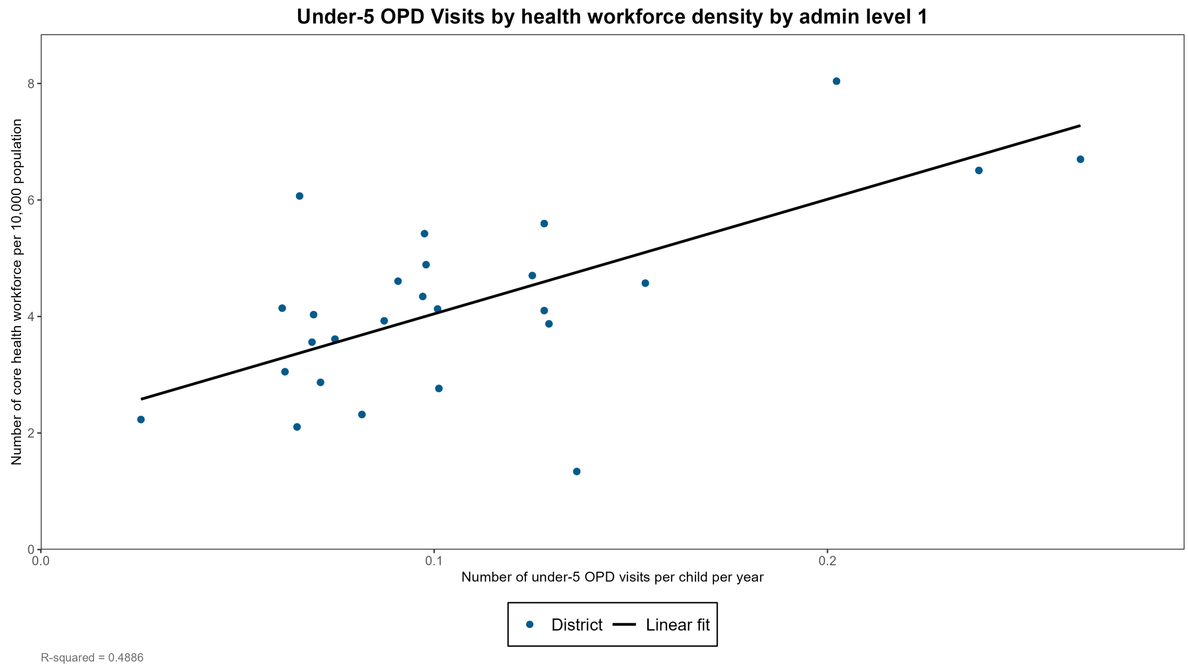
- There may be major outliers. For instance, regions with low density and high admission rates: this may be because:

  - Hospital density is under-reported by these regions
  - Hospitals in the low density regions have very high admission and bed occupancy rates
  - Hospital admission are over-reported in these regions.

  The interpretation should be based on knowledge of the actual situation in the regions.

2. ***Association between health workforce (core health professionals per 10,000) and outpatient visits among children under 5, by region***

- We expect that regions with lower health workforce density have lower OPD utilization rates for children, and those with higher density have higher admission rates. This would show as a positive slope of a linear regression line, as in the figure below.



1. There may be major outliers, for instance, regions with low health workforce density and high OPD utilization rates. This may be because:

   - Health workforce density is under-reported by these regions
   - Health workers have a very high workload in these regions
   - Health workforce density is over-reported in these regions (less likely).

   The interpretation should be based on knowledge of the actual situation in the regions.

   3. ***Association between health workforce (core health professionals per 10,000) and institutional live birth coverage, by region***

- For delivery coverage, data by region from either a recent household survey or the most recent DHIS2 data derived estimate can be used.
- We expect that regions with lower health workforce density have lower institutional delivery rates for children, and those with higher density have higher rates. This would show as the positive slope of a linear regression line.

  The considerations for the interpretation are the same as above.

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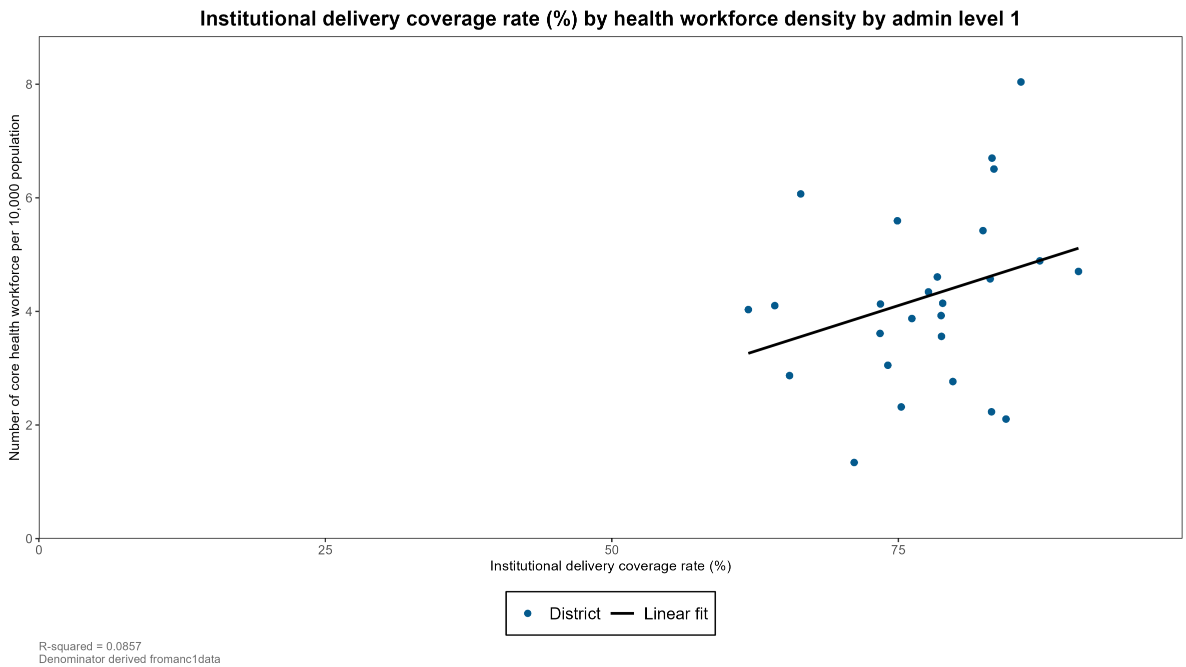

Institutional delivery coverage rate (%) by health workforce density by admin level 1
Number of core health workforce per 10,000 population
0
2
4
6
8
0
25
50
75
Institutional delivery coverage rate (%)
District
Linear fit
R-squared = 0.0857
Denominator derived fromanc1data

23 Private sector and RMNCH services

23.1 Private sector share analysis

23.1.1 Rationale, Approach and implementation

Rationale: Scientific basis for the analysis

The private sector plays a significant role in delivering RMNCH (Reproductive, Maternal, Newborn, and Child Health) services, although its contribution varies both between and within countries. While routine health facility data are intended to capture private sector service delivery—such as the number of deliveries or family planning visits—this information is often incomplete, as reporting from private facilities tends to be less consistent than from public ones. Ideally, all private facilities should be included in the master facility list, but this is frequently not the case.

To estimate the private sector's contribution more accurately, survey data such as those from DHS and MICS can be used. These surveys include questions about the source of health services, distinguishing between public and private providers.

Approach: Description of analytical steps

In this analysis, we use three key indicators to assess the private sector's role at the national level and disaggregated by urban and rural residence.

The three indicators are:

1. **Deliveries**: Percent of live births occurring in health facilities among all live births in the last two years, by public private; with the share that is private
2. **Surgical interventions**: Percent of C-sections that occur in health facilities among all live births in the last two years, by public private; with the share that is private
3. **Curative care for children**: Percent of children under-five who have sought care for fever, acute respiratory illness or diarrhoea in the last two weeks before the interview, by public private; with the share that is private

It is generally expected that women and children in urban areas rely more on privately provided services than those in rural areas.

There are, however, two caveats to the interpretation:

- Rural women may use private services located in urban areas, which means that the percentage of women / children is overestimated for rural residents.
- The distinction between private-for-profit and non-profit private facilities is not made in this analysis. Each country uses a different classification and naming convention, and also for the survey respondent this distinction is difficult to make.

Implementation: Conducting analysis in the Shiny App

This can be analyzed using the Health System Performance tab ->

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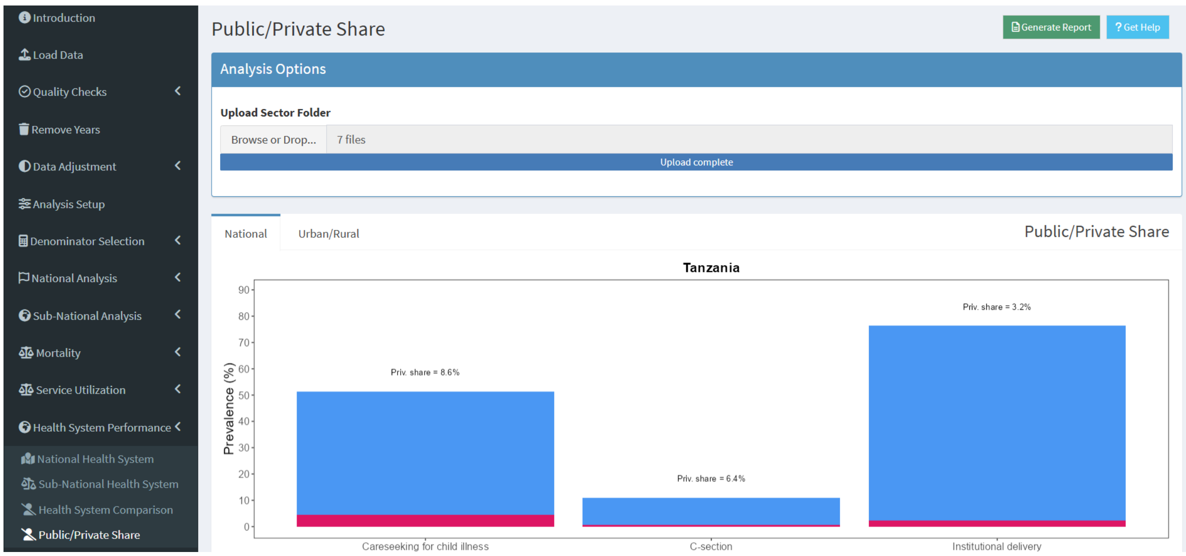

24 Planning Ahead

The objective of the final session of the workshop is to identify concrete actions to take forward the work you have completed. As you have been preparing and interpretating your analyses, you have been encouraged to think about the full cycle of data-driven decision-making. (See diagram below.) This starts with identifying the data users and understanding the questions or issues they aim to address, and then preparing the findings, interpretation and insights that would be most useful for addressing those questions or issues. Information products and dissemination strategies should be tailored to align with users' preferences and should be supplemented with support to decision-makers in utilizing the analysis and following up on agreed actions. This requires ongoing engagement between data providers and users to understand needs and to learn what is most useful in responding to those needs.

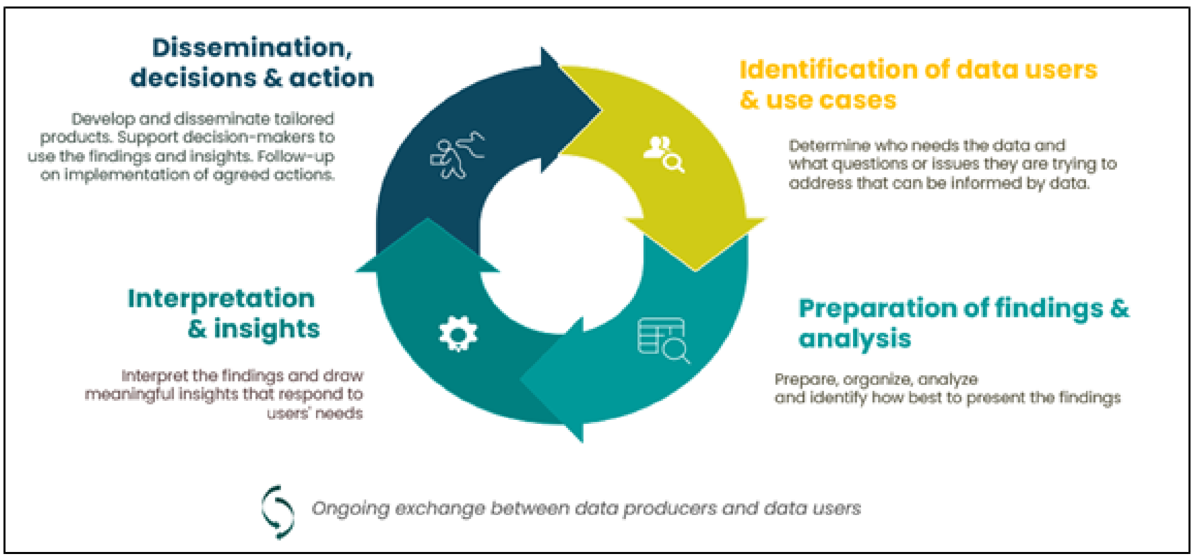

Figure 24.1: Diagram. Cycle of data-drive decision-making

As you prepare your plans, consider your use cases and audiences, as well as the platforms and meetings that could be leveraged to reach these audiences. It will be important to do more than just share the analysis as a one-off event, so think about how to feed into routine forums where data and analyses are used, and decisions are taken. A primary use will be contributing to routine reviews of progress and performance led by the Ministry of Health, such as analytical reports for annual reviews or for global reporting on RMNCAH-N.

Consider also how this will connect with your Countdown country collaboration and existing plans to build capacity for RMNCAH data analysis and use. For instance, if you are having working sessions with your target audiences to share the findings, you could also use this as an opportunity to explore some of the concepts learned during the workshop and to strengthen competencies to interpret the analyses and identify opportunities for action (see further suggestions below). If you have participated in CAM workshops in previous years, reflect on what has worked well so far and whether there are new use cases, audiences or dissemination approaches you could explore, drawing on your experiences and those of other countries.

Purpose of the activity	Examples
Supporting data use and action	• Present **findings, interpretation and key insights** to the country platform and technical workings groups for them to review and interpret. Support them to identify **opportunities to take action based on data and evidence - for example,** address gender or geographic inequities, test pilots with implementation research or evaluation, advocate for policy change or resources, etc. • Include analysis as **part of evidence base to inform the development of new RMNCAH-N strategy**, a **mid-term review** and an **evaluation,** where any of these are underway. • Produce **an article or analytical brief for targeted audiences** with key learning, takeaways, and proposed actions following the workshop, as an entry point for follow-up.
Building capacity	• Carry out **cascade training** at national and district levels on the **concepts, interpretation, and use** of specific analyses, through the country Countdown collaboration. • Hold sessions to sensitize **national bureau of statistics staff** on Countdown methodology to build ownership. • Share the concepts and findings of **health facility data quality assessment** with **HMIS and M&E staff** to build their understanding and as an opportunity for strengthening routine systems for data quality. • Build HMIS and M&E staff capacity to understand the **relevance of gender and equity-related** indicators and analyses. • Build capacity of staff to incorporate **some of the new analytical techniques** and **approaches** into dashboards, policy briefs, statistical reports, etc.

Identifying needs for further analysis	• Identify opportunities for **implementation research** to **address bottlenecks or to inform potential scale-up/replication of successes** based on findings from the analysis. • Identify opportunities for further research or analysis in order to **better understand trends in gender and inequity** that were observed in the analysis and to inform options for action.