Secondary data modules

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Preface

Vector control constitutes a major component of malaria control and elimination strategies. WHO recommends using insecticide-treated nets (ITNs) and/ or indoor residual spraying (IRS) for malaria vector control in most areas at risk of malaria as appropriate. These interventions may be supplemented by other interventions such as larval source management (LSM) depending on the setting and available resources.

In the first module, we will discuss the main vector control interventions, i.e., LLIN and IRS, in more detail. The second module deals with data from the Demographic and Health Survey (DHS) program.

1 Insecticide treated nets

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Insecticide-treated bed nets (ITNs) are a form of personal protection that can reduce the risk of malaria illness, severe disease, and death. In community-wide trials in several African settings, ITNs reduced the death of children under 5 years from all causes by about 20%. ITNs repel, kill, or sterilize mosquitoes that come into contact with the insecticides or other active ingredients impregnated on the netting material. ITNs also have a community effect where members of the community (not just those who sleep under a net) may have some protection when a large proportion of the community uses ITNs. The effectiveness of ITNs diminishes over time due to physical damage, deteriorating chemical integrity, or bio-efficacy (i.e., through the development of insecticide resistance). Long-lasting insecticidal net (LLIN) is a special type of ITN that stays effective for a longer time (~ 3 years) before replacement, without a need for reimpregnation with insecticide.

2 ITN distribution data

For seceral decades, ITNs and LLINs have been delivered to malaria-endemic countries through various global or local initiatives and programs. National Malaria Control Programs (NMCPs) in endemic countries coordinate the distribution of bed nets to target populations. In most countries, ITN distributions are mainly carried out in two formats:

- **Mass ITN campaign**: is a cost-effective way of rapidly achieving high and equitable vector control coverages. ITN campaigns are done once every few years targeting all or a cohort of population at each round (usually districts but can be at lower administrative units too), They aim to provide a proportion of the population in the target districts with new ITNs at a regular interval (ideally every 3 years).
- **Routine programs**: Routine antenatal and immunization services program provides a cost-effective means to reach out to communities at a higher risk of malaria transmission including children and mothers. Programs keep stocks of ITNs which they dispense to beneficiaries along with their routine services.

  Most NMEPs compile data on the number of ITNs distributed at the district level or sub-district levels on annual basis. In recent years, ITN distribution data have been incorporated into the DHIS-2 system improving their accessibility. Access to this data (usually through the NMEPs) ensures data is used in analytics and modeling related works.

2.1 Working with LLIN data from NMEP

2.1.1 Mass LLIN distribution data

In this exercise, we will look at an example of mock data for sample districts in Ethiopia. Note that the data we use in this exercise is made up and may not have any use outside this exercise. This exercise assumes the LLIN data and accompanying population figures have been cleaned and verified for consistency and completeness.

First, let us load the necessary libraries.

```r
library(tidyverse)
```

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.2     v tibble    3.3.0
v lubridate 1.9.4     v tidyr     1.3.1
v purrr     1.0.4
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becom
```

```r
library(lubridate)
```

We will read data on mass campaign LLIN distribution obtained from NMEP to support our analysis. We will further read the corresponding population data for each district.

```r
mass_llin_dist<- read_csv("data/llin_mass_2017_2020.csv")
```

```
Rows: 300 Columns: 7
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (3): region, zone, district
dbl (4): llin_2017, llin_2018, llin_2019, llin_2020

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
population<- read_csv("data/pop_2017_2020.csv")
```

```
Rows: 300 Columns: 7
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (3): region, zone, district
dbl (4): pop_2017, pop_2018, pop_2019, pop_2020

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

We can visualize and verify if our data is consistent with the expectation. To do that we join the LLIN distribution datasets with the corresponding population data.

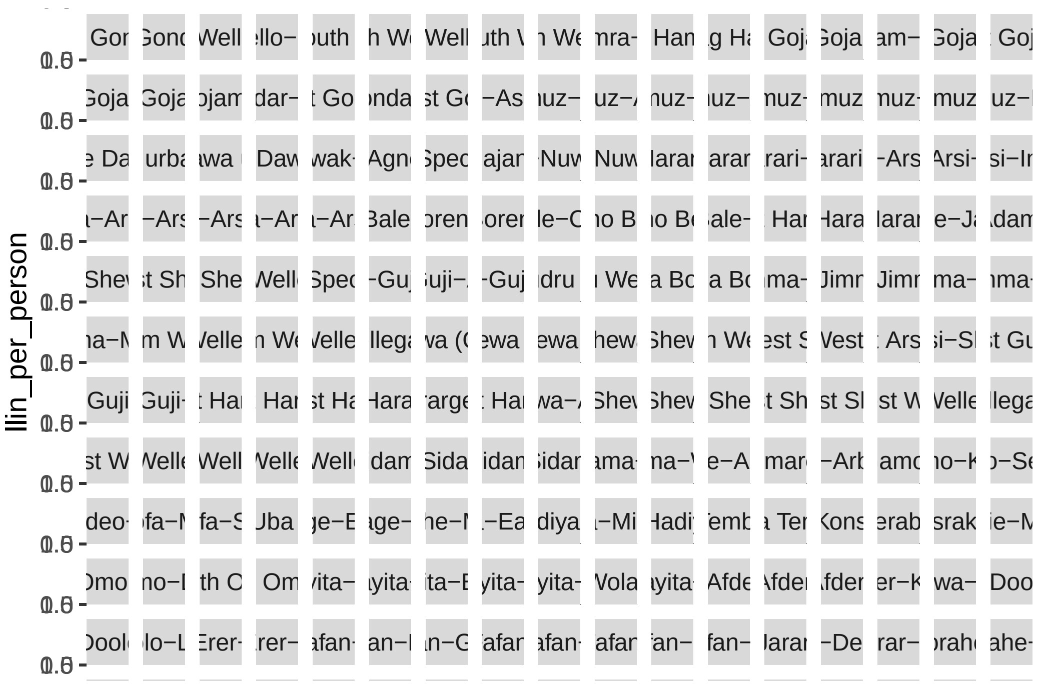
The following script does that by (a) converting the datasets into long format (b) joining them based on geographic units and years, and (c) generating LLINs per population (as an indicator of access to LLIN).

```r
### convert mass LLIN data into long format
mass_llin_long<-
  mass_llin_dist |>
  pivot_longer(cols = contains("llin"),
               names_to = "year_txt",
               values_to = "llin") |>
  mutate(year = as.numeric(substr(year_txt,6,9))) |>
  dplyr::select(-year_txt)

### convert population data into long format
population_long<- population |>
  pivot_longer(cols = contains("pop"),
               names_to = "year_txt",
               values_to = "pop")|>
  mutate(year = as.numeric(substr(year_txt,5,8))) |>
  dplyr::select(-year_txt)

### join the two and generate llin per person
  mllin_pop = mass_llin_long |>
  left_join(population_long,
            by = c("region",
                   "zone",
                   "district",
                   "year")) |>
    mutate(llin_per_person  = llin/pop)


### visualize
mllin_pop|>
    filter(llin_per_person>0) |>
    ggplot(aes(x=year, y = llin_per_person)) +
    facet_wrap (~ paste0(region, "-", zone, "-", district)) +
    geom_point()
```



```r
ggsave(filename = "plots/llin_mass.tiff",
       width = 8, height = 10, compression = "lzw")
```

Mass distributions often assume two persons would use a single LLIN. In other words, 100% coverage would be achieved if a district gets LLIN about half its population. Thus, it would be somewhat curious if a district reports LLIN per person greater than 0.5, and even more suspicious if they report figures greater than 1. Note that the data quality issues can come from one or both of the two data sets used, mass LLIN and the population denominator.

Exercise 1: How many districts in the above example reported LLIN per person values greater than 1 in any year?

2.1.2 Routine LLIN distribution data

In this exercise, we will look at an example of mock routine LLIN distribution data for the sample districts. This exercise assumes the LLIN data and accompanying population figures have been cleaned and verified for consistency and completeness.

First, let us load the necessary libraries.

```r
library(tidyverse)
library(lubridate)
```

We will read data on LLIN distribution through routine programs (EPI and ANC). We will further read the corresponding population data for each district.

```r
routine_llin_dist<- read_csv("data/llin_routine_2017_2020.csv")
```

```
Rows: 1200 Columns: 12
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (3): region, zone, district
dbl (9): year, llins_epi_u6m, llins_epi_611m, llins_epi_1223m, llins_epi_245...

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```r
population<- read_csv("data/pop_2017_2020.csv")
```

```
Rows: 300 Columns: 7
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (3): region, zone, district
dbl (4): pop_2017, pop_2018, pop_2019, pop_2020

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

We can visualize and verify if our data is consistent with the expectation. To do that we join the LLIN distribution datasets with the corresponding population data.

The following script does that by (a) converting the datasets into long format (b) joining them based on geographic units and years, and (c) generating LLINs per estimated population under five years old by assuming U5 population is roughly a fifth of the overall population.

```r
### convert routine LLIN data into long format
routine_llin_long<- routine_llin_dist |>
  pivot_longer(cols = contains("llin"),
               names_to = "program",
               values_to = "llin")
```

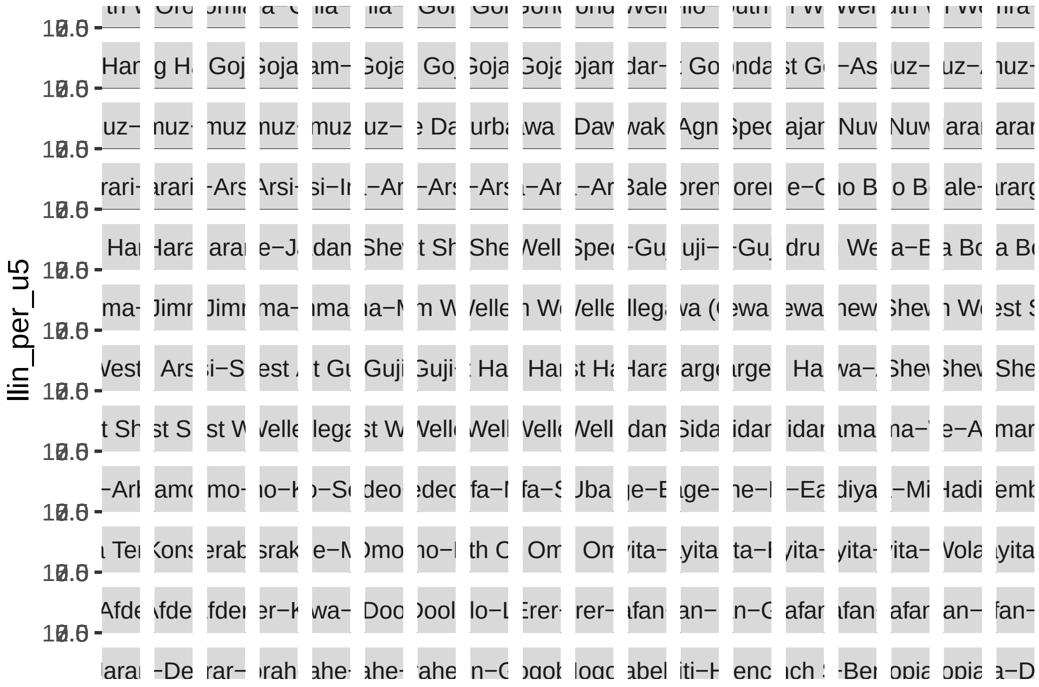
```
### convert population data into long format
population_long<- population |>
  pivot_longer(cols = contains("pop"),
               names_to = "year_txt",
               values_to = "pop") |>
  mutate(year = as.numeric(substr(year_txt,5,8))) |>
  dplyr::select(-year_txt)


### join the two and generate llin per person

rllin_pop <-   routine_llin_long |>
  left_join(population_long,
            by = c("region",
                   "zone",
                   "district",
                   "year")) |>
  group_by(region, zone, district, year) |>
  summarise(rllin = sum(llin, na.rm=T),
            population = mean(pop)) |>
  ungroup() |>
  mutate(llin_per_u5  = rllin/population * 5)  # assuming U5 a fifth of pop.
```

```
`summarise()` has grouped output by 'region', 'zone', 'district'. You can
override using the `.groups` argument.
```

```
## visualize
rllin_pop|>
  ggplot(aes(x=year,
             y = llin_per_u5)) +
  facet_wrap (~ paste0(region, "-",
                       zone, "-", district)) +
  geom_point()
```



```
ggsave(filename = "plots/llin_routine.tiff",
       width = 8, height = 10, compression = "lzw")
```

Unlike mass distributions, routine LLINs are distributed without consideration of the size of the population targeted. Rather, they are handed out during the visits by members of the population. However, we can have a broad assumption such as that the number of LLINs dispensed may not exceed the n time the population of under-five-year-old children. Data points flagged in this manner can also be subject to further scrutiny as part of the data cleaning process.

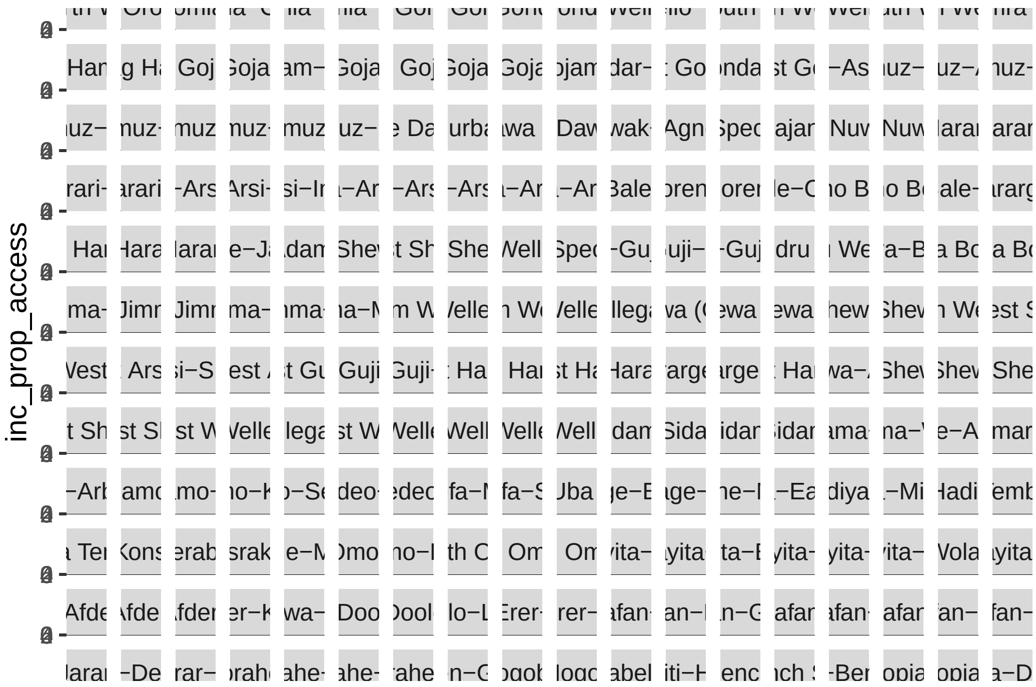
Exercise 2: How many districts in the above example reported routine LLIN per U5 population values greater than 5 in any year?

2.1.3 Access to LLIN at the population level

Following LLIN distributions LLIN access as a result of the distribution in the year can be easily estimated. In the next script, we will bring both mass campaign and routine LLIN distribution data together and generate estimates of access to LLIN. In calculating access to LLIN at the population level, will assume one LLIN serves an average of 1.8 individuals in the population.

```r
### increment to the proportion with access to LLIN
llin_access<- mllin_pop |>
  left_join(rllin_pop,
            by = c("region", "zone", "district", "year")) |>
  mutate(total_llin = llin + rllin) |>
  mutate(llin_per_person = total_llin/population) |>
  mutate(inc_prop_access = llin_per_person*1.8) |>
  dplyr::select(region, zone, district, year, total_llin, llin_per_person,
                 inc_prop_access)

## visualize
llin_access|>
  ggplot(aes(x=year, y = inc_prop_access)) +
  facet_wrap (~ paste0(region, "-", zone, "-", district)) +
  geom_point()
```



```r
ggsave(filename = "plots/llin_access_increment.tiff",
       width = 8, height = 10, compression = "lzw")
```

Since access to LLIN is given in percentages, we can assume a maximum of 1, and districts with values beyond that may be flagged for further checking of their data.

Exercise 3: How many districts in the above example reported increment to proportion with access to LLIN of greater than 100% (>1.0) ?

3 Demographic and Health Survey

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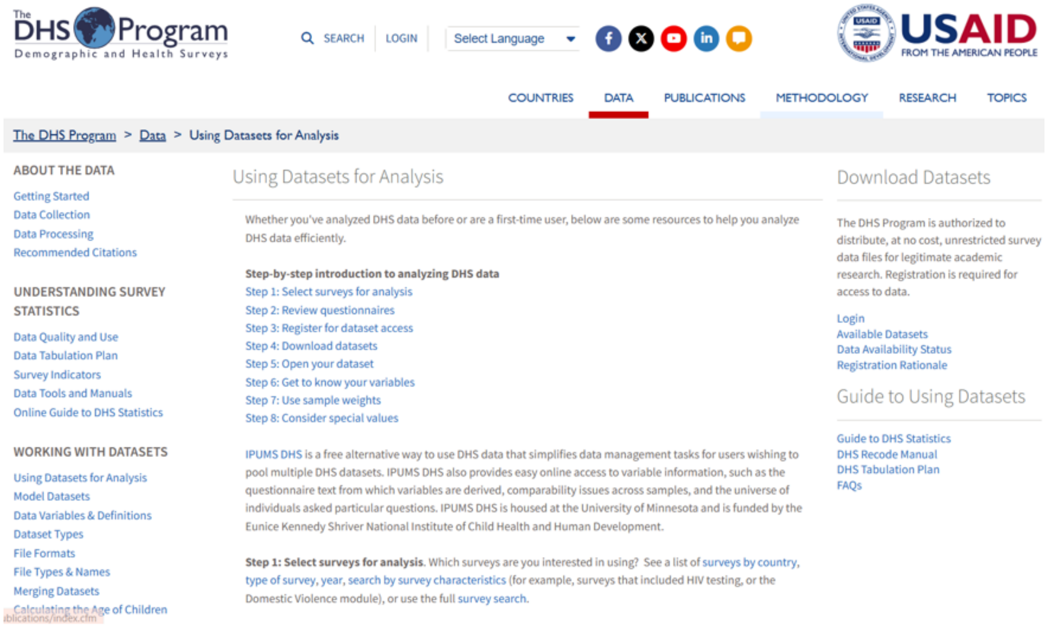
The Demographic and Health Surveys (DHS) program collects data on health-related indicators at regular intervals (averaging five years) in many malaria-endemic countries. The DHS collects rare survey data on malaria indicators, including ITN ownership, ITN usage, indoor residual spraying coverage, treatment coverage, treatment-seeking rates, vaccination coverage in the expanded program on immunization (EPI), antenatal care coverage, among others.

This module will cover downloading and working with DHS data available under the *rdhs* package in R.

4 Registering with DHS

All data at the DHS are freely available. However, before you can download data, you must register as a DHS data user. You can register at this [other-links].



Using Datasets for Analysis

Whether you've analyzed DHS data before or are a first-time user, below are some resources to help you analyze DHS data efficiently.

Step-by-step introduction to analyzing DHS data

Step 1: Select surveys for analysis
Step 2: Review questionnaires
Step 3: Register for dataset access
Step 4: Download datasets
Step 5: Open your dataset
Step 6: Get to know your variables
Step 7: Use sample weights
Step 8: Consider special values

IPUMS DHS is a free alternative way to use DHS data that simplifies data management tasks for users wishing to pool multiple DHS datasets. IPUMS DHS also provides easy online access to variable information, such as the questionnaire text from which variables are derived, comparability issues across samples, and the universe of individuals asked particular questions. IPUMS DHS is housed at the University of Minnesota and is funded by the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

Step 1: Select surveys for analysis. Which surveys are you interested in using? See a list of surveys by country, type of survey, year, search by survey characteristics (for example, surveys that included HIV testing, or the Domestic Violence module), or use the full survey search.

Download Datasets

The DHS Program is authorized to distribute, at no cost, unrestricted survey data files for legitimate academic research. Registration is required for access to data.

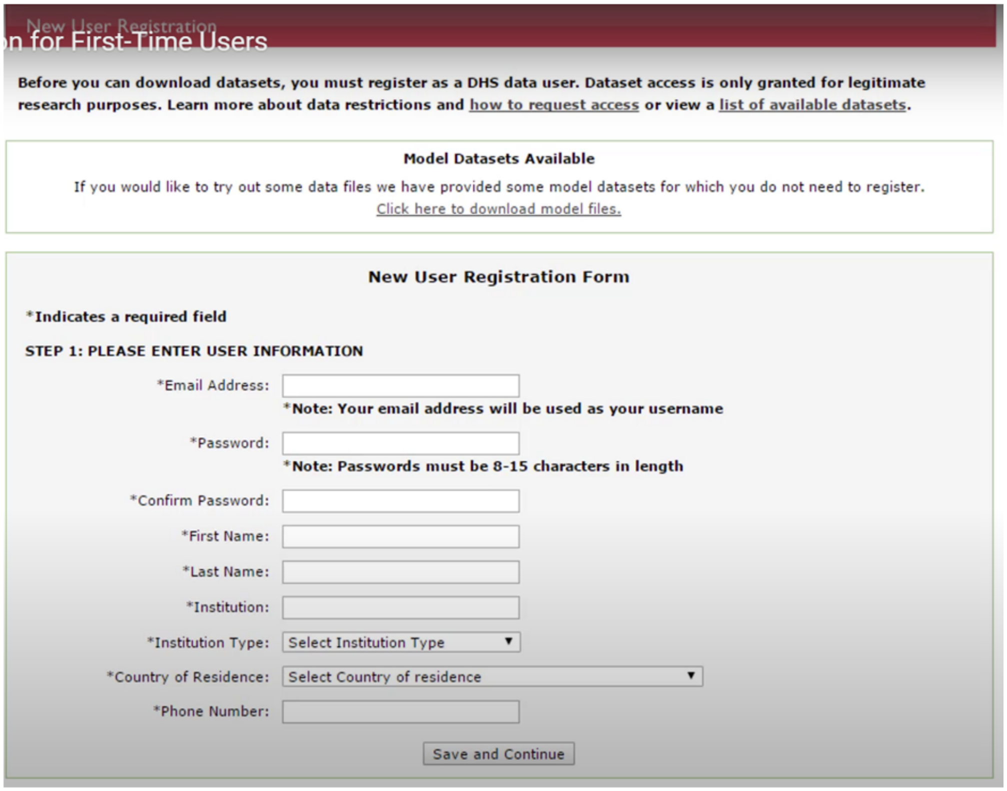
Login
Available Datasets
Data Availability Status
Registration Rationale

Guide to Using Datasets

Guide to DHS Statistics
DHS Recode Manual
DHS Tabulation Plan
FAQs

Figure 1: DHS users need to register at this website

In the *Step-by-step introduction to analyzing data* section, you can select *Step 3: Register for dataset access* to get more information on how to register.



New User Registration

n for First-Time Users

Before you can download datasets, you must register as a DHS data user. Dataset access is only granted for legitimate research purposes. Learn more about data restrictions and how to request access or view a list of available datasets.

Model Datasets Available

If you would like to try out some data files we have provided some model datasets for which you do not need to register.
Click here to download model files.

New User Registration Form

***Indicates a required field**

STEP 1: PLEASE ENTER USER INFORMATION

*Email Address:

***Note: Your email address will be used as your username**

*Password:

***Note: Passwords must be 8-15 characters in length**

*Confirm Password:

*First Name:

*Last Name:

*Institution:

*Institution Type: Select Institution Type ▼

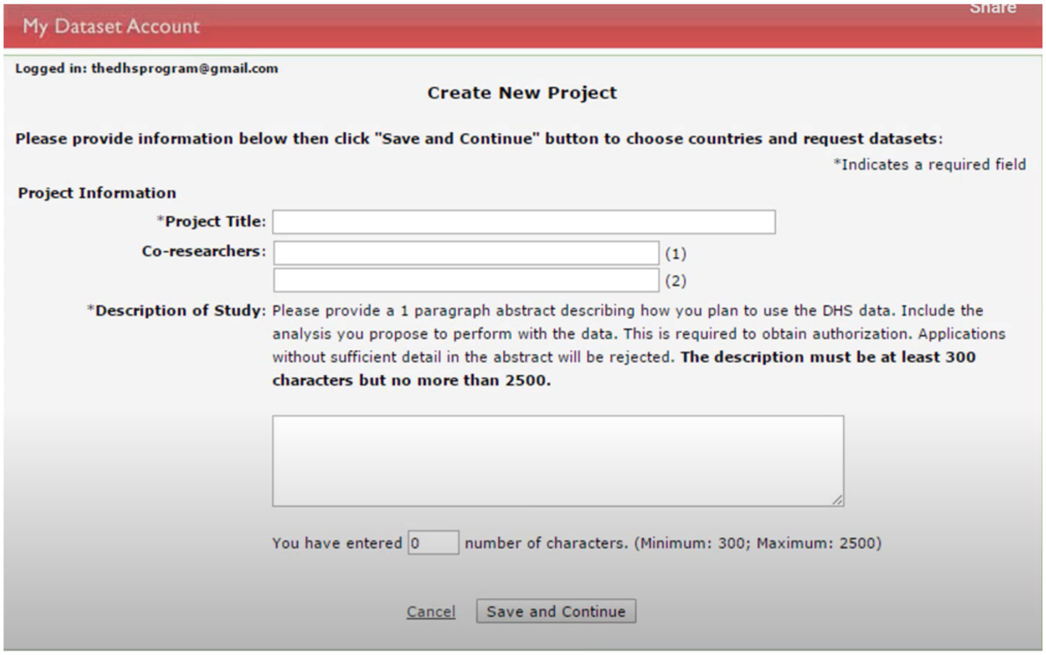
*Country of Residence: Select Country of residence ▼

*Phone Number:

Figure 2: Step 1 of the user registration process

You will need to provide your email and a password which you will use to access DHS data. Your email address also serves as your username. You will also need to provide information on the project you will use the data for. This includes the title, co-researchers, and a description of the study. For our demonstration, we will provide the following information:

- **Project Title**: *Malaria control data analysis support*
- **Co-researcher**: *Name of yout collaborator*
- **Description of the study**: *The Malaria control data analytics support project will work with malaria control programs in Africa to strengthen their data-driven decision-making process. Particularly, we aim to answer questions related to alignment of program-based data with that from survey data, such as the DHS. We will use visualization and statistical tools to answer these questions.*



Logged in: thedhsprogram@gmail.com

Create New Project

Please provide information below then click "Save and Continue" button to choose countries and request datasets:

*Indicates a required field

Project Information

***Project Title:**

Co-researchers: (1)

(2)

***Description of Study:** Please provide a 1 paragraph abstract describing how you plan to use the DHS data. Include the analysis you propose to perform with the data. This is required to obtain authorization. Applications without sufficient detail in the abstract will be rejected. **The description must be at least 300 characters but no more than 2500.**

You have entered 0 number of characters. (Minimum: 300; Maximum: 2500)

Figure 3: Step 2 of the user registration process

The country/ countries you will download data for may or may not need to be identified, depending on the project. In this exercise, we will select the Democratic Republic of Congo (DRC) as the country and *Sub-Saharan Africa* as the region of interest. You can choose as many countries as you want, but make sure the list of countries you select corresponds to the overall objective of the project stated in the *Description of Study* section.

Once approved, which usually takes 24-48 hours, you will be granted access to the data

5 Exploring the DHS repository

Once you have a DHS account, you can access DHS data using the R package *rdhs*. In this section, we will describe the organization of DHS data in the online DHS archive, accessible through the *rdhs* package. We will then demonstrate downloading DHS data for DRC.

We begin by installing the *rdhs* package in R and loading the necessary packages.

```
-- Attaching core tidyverse packages ------------------------ tidyverse 2.0.0 --
v dplyr     1.1.4     v readr     2.1.5
v forcats   1.0.0     v stringr   1.5.1
v ggplot2   3.5.2     v tibble    3.3.0
v lubridate 1.9.4     v tidyr     1.3.1
v purrr     1.0.4
-- Conflicts ------------------------------------------ tidyverse_conflicts() --
x dplyr::filter() masks stats::filter()
x dplyr::lag()    masks stats::lag()
i Use the conflicted package (<http://conflicted.r-lib.org/>) to force all conflicts to becom

Attaching package: 'janitor'


The following objects are masked from 'package:stats':

    chisq.test, fisher.test


Thank you for using rdhs. If you are using rdhs regularly
or for automated tasks, please register for your own API key by
emailing api@dhsprogram.com.

More info at <https://api.dhsprogram.com/#/introdevelop.html>
```

The *rdhs* package has functions that facilitate exploring the DHS repository.

5.1 Survey characteristics

To explore what survey types reside in the DHS repository, we can use the *dhs_survey_characteristics()* function. Not all DHS surveys are related to malaria, and only a few are specific to malaria. You can find out by filtering those that have “malaria” in their names. This function provides high-level information on the types of data gathered by the DHS.

```r
# capture all data on survey characteristics
sc<- dhs_survey_characteristics()
```

```
Writing your configuration to:
   -> C:\Users\jmillar\AppData\Local\Temp\RtmpgFqdkJ/rdhs/rdhs.json
```

```
You have not granted permision to rdhs to write outside of
your temporary directory. As a result any datasets or API
calls will not be saved after you close this R sessiton.
To cache your results please use set_rdhs_config()
```

```r
# filter those that have 'malaria' in their names
mal_sc<-  dhs_survey_characteristics() |>
  dplyr::filter(grepl("Malaria", SurveyCharacteristicName))

head(mal_sc)
```

```
  SurveyCharacteristicID        SurveyCharacteristicName
1                     96                     Malaria DBS
2                     90              Malaria microscopy
3                    124              Malaria microscopy
4                    119 Malaria microscopy - thin smear
5                     57               Malaria questions
6                     89                     Malaria RDT
```

5.2 Surveys

We can go further and explore what country-specific surveys are included in the repository by using the function dhs_surveys(). The DHS program conducts malaria indicator surveys (MISs) in addition to the regular DHS. MIS is separate from DHS by its *SurveyType* attribute in the *dhs_surveys* data set.

```r
# capture all surveya
srv<- dhs_surveys ()

# summarize by survey type
table(srv$SurveyType)
```

```
AIS DHS MIS
 11 313  39
```

```r
# capture MIS surveys by the year of release and country name
srv_mis<- dhs_surveys(returnFields =
                        c("ReleaseDate", "CountryName","SurveyType")) |>
  filter(SurveyType == "MIS")

head(srv_mis)
```

```
  ReleaseDate SurveyType  CountryName
1  2008-02-27        MIS       Angola
2  2012-01-24        MIS       Angola
3  2015-10-16        MIS Burkina Faso
4  2019-07-08        MIS Burkina Faso
5  2013-09-03        MIS      Burundi
6  2023-10-27        MIS     Cameroon
```

```r
# display all DHS and MIS surveys released in the year 2018
dhs_surveys(returnFields =
                        c("ReleaseDate", "CountryName","SurveyType")) |>
  filter(SurveyType %in% c("MIS", "DHS")) |>
  filter(year(ReleaseDate)==2018)
```

```
   ReleaseDate SurveyType CountryName
1   2018-04-05        DHS     Burundi
2   2018-08-21        DHS       Haiti
3   2018-01-11        DHS       India
4   2018-04-25        MIS      Malawi
5   2018-10-03        DHS Philippines
6   2018-09-07        MIS      Rwanda
7   2018-09-28        DHS     Senegal
8   2018-12-14        DHS  Tajikistan
```

```
9   2018-10-22        MIS    Tanzania
10  2018-04-10        DHS Timor-Leste
11  2018-08-08        MIS        Togo
12  2018-07-30        DHS      Turkey
13  2018-07-30        DHS      Turkey
14  2018-03-12        DHS      Uganda
```

5.3 Countries

We can explore which countries have data in the DHS repository by using the dhs_countries() function. Notice what country code each country is assigned. We will use these two-letter country codes to download data in our examples.

```
# capture all countries
countries<- dhs_countries()

# capture country codes and names
country_ids<- dhs_countries(returnFields=c("DHS_countryCode", "CountryName"))

head(country_ids)
```

```
  DHS_CountryCode CountryName
1              AF Afghanistan
2              AL     Albania
3              AO      Angola
4              AM     Armenia
5              AZ  Azerbaijan
6              BD  Bangladesh
```

Notice that the country codes for CAR, DRC, Ethiopia, Gambi, Nigeria, Senegal, and Zambia are “CF”, “CD”, “ET”, “GM”, “NG”, “SN”, and “ZM”, respectively.

5.4 Indicators

DHS (and MIS) include thousands of indicators whose data you can download These indicators are described in the data dictionary which can be explored using the *dhs_indicators()* function.

```
#capture the list of indicators
ind<- dhs_indicators()
names(ind)
```

```
 [1] "Definition"               "NumberScale"
 [3] "IndicatorType"            "MeasurementType"
 [5] "IsQuickStat"              "ShortName"
 [7] "IndicatorId"              "Level1"
 [9] "IndicatorTotalId"         "Level2"
[11] "Level3"                   "SDRID"
[13] "IndicatorOldId"           "TagIds"
[15] "DenominatorWeightedId"    "Label"
[17] "IndicatorOrder"           "Denominator"
[19] "QuickStatOrder"           "IndicatorSpecial1Id"
[21] "DenominatorUnweightedId" "IndicatorSpecial2Id"
```

```
#capture the list of indicators by their label and ID
indicators <- dhs_indicators(returnFields=c("IndicatorId", "Label"))

head(indicators)
```

```
    IndicatorId                                   Label
1 FE_FRTR_W_A10 Age specific fertility rate: 10-14
2 FE_FRTR_W_A15 Age specific fertility rate: 15-19
3 FE_FRTR_W_A20 Age specific fertility rate: 20-24
4 FE_FRTR_W_A25 Age specific fertility rate: 25-29
5 FE_FRTR_W_A30 Age specific fertility rate: 30-34
6 FE_FRTR_W_A35 Age specific fertility rate: 35-39
```

5.5 Datasets

Downloading DHS data involves data retrieval from hundreds of files. The repository is organized into thousands of datasets, each identified by its file name. The datasets are stored in different formats, including SPCC, flat ASCII data, Stata data, etc. The fileType indicates the the datasets organization including births recode, household members recode, household recode, provider, verbal autopsy, etc. rdhs uses acronyms to represent these file types. For instance ‘PR’ is used to represent person (household member) recode.

```
# capture all datasets
dset<- dhs_datasets()

# capture all datasets by country name, year, file format, and file type.
datasets<- dhs_datasets(returnFields=c("SurveyType,", "CountryName", "SurveyYear", "FileForma

# capture all datasets related to household member recode
person_datasets<- dhs_datasets(fileType ="PR")
```

6 Downloading DHS data

While downloading DHS data involves retrieval of data from corresponding datasets, in *rdhs* we have the option of downloading data either specified by the datasets, or a compilation of all data for a specific country.

At this stage, we need to sign into the DHS repository using the DHS username and password we have created. We will use the project we had registered in the registration section. The process to sign in involves using the function *set_rdhs_config*().

```
$email
NULL

$project
NULL

$password
NULL

$cache_path
[1] "C:\\Users\\jmillar\\AppData\\Local\\Temp\\RtmpgFqdkJ/rdhs"

$config_path
[1] "C:\\Users\\jmillar\\AppData\\Local\\Temp\\RtmpgFqdkJ/rdhs/rdhs.json"

$global
[1] TRUE

$verbose_download
[1] FALSE

$verbose_setup
[1] TRUE

$timeout
[1] 30
```

```
$data_frame
function (x)
x
<bytecode: 0x000001bf3065da78>
<environment: namespace:base>

$project_choice
NULL

$data_frame_nice
[1] "as.data.frame"

attr(,"class")
[1] "rdhs_config"
```

#this configuration statement enables you to login to your DHS account

set_rdhs_config(email = [“your email”]

project = “Malaria Data Fellowship Program”,

config_path = “rdhs.json”,

global = FALSE)

To comply with CRAN, this function will also ask you for your permission to write to files outside your temporary directory, and you must type out the filename for the config_path - “rdhs.json”. The path to your config is saved between sessions so you only have to set this once. With your credentials set, all API requests will be cached within the cache_path directory provided so that these can be returned when working remotely or with a poor internet connection. You can also check your configuration by using the get_rdhs_config().

6.1 Downloading a specific dataset

Let us assume we want to download RDT prevalence from all surveys conducted since 2005 in DRC. This can be done by selecting the surveys conducted since 2025 in DRC, and specifying the file format and file type.

- Malaria RDT is organized into the survey characteristics named Malaria RDT (surveyCharacteristicsId = 89)
- Data on RDT prevalence is located in the dataset organized into household members thus will be in household members recode data type (PR).
- The file type will be flat ASCII (FL)

```
# filter the surveys for the DRC (country code CD) and malaria RDT (id=89)
# since 2005
this_survey <- dhs_surveys(
  countryIds = c("CD"),
  surveyCharacteristicIds = 89,
  surveyYearStart = 2005)

# zoom into the datasets with data on household member recode
this_dataset <- dhs_datasets(
  surveyIds = this_survey,
  fileFormat = "FL",
  fileType = "PR")

# dowload the data from DHS repository
# at this stage the system will verify our login information

# commented out because of a bug at the DHS website
 # downloads <- get_datasets(this_dataset$FileName)
```

6.2 Downloading all data for a country

Another approach to downloading DHS data is using the rdhs repository in R. This repository has archived historical DHS surveys for all countries , which can access in R. The following script access all DHS data for DRC conducted since 2005 broken down by provinces.

```
# capture all indicators in DHS
indicators <- dhs_indicators(returnFields=c("IndicatorId", "Label"))

# capture data on all indicators for the DRC since 2005
# broken down by subnationally (province level)
cd_all_dhs<- dhs_data(countryIds = "CD",
                      indicatorIds = indicators$IndicatorID,
                      surveyYearStart = 2005 ,
                      breakdown = "subnational")
```

7 Visualization of DHS data

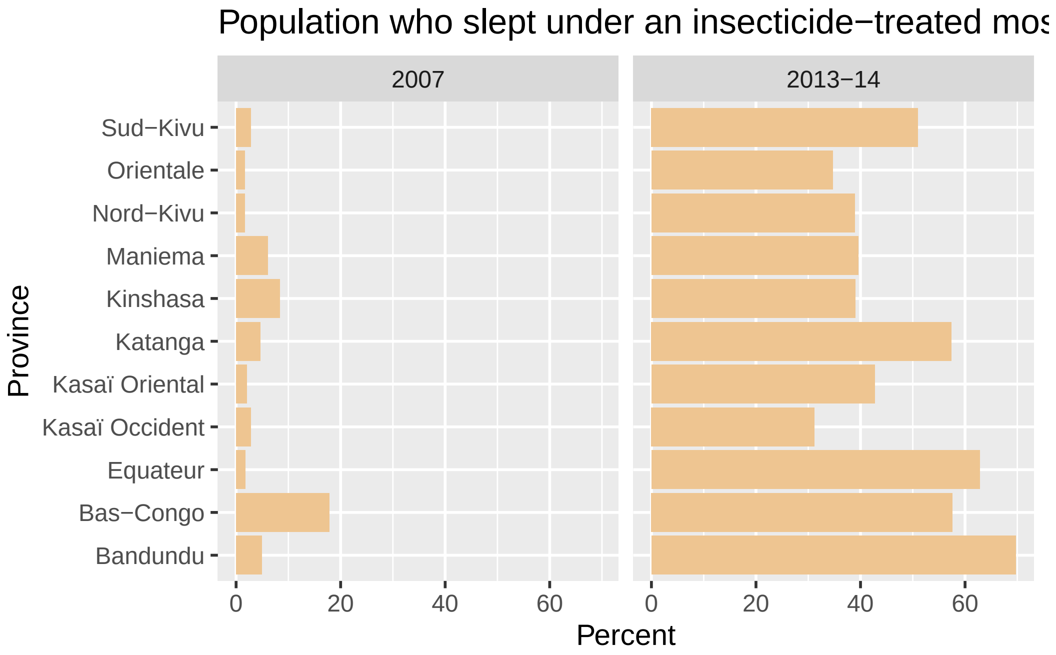
In the next section, we will exercise visualizing DHS data for indicators related to vaccination and access to long lasting insecticide nets (LLINs).

7.0.1 LLIN usage

The DHS indicators for LLIN usage is '*Population who slept under an insecticide-treated mosquito net (ITN) last night'*. The following script extracts data specific to this indicator and creates a column plot showing the LLIN usage proportions at the province level for each of the survey years.

```r
## indicator/s of interest = LLIN usage (all age)
ind<- "Population who slept under an insecticide-treated mosquito net (ITN) last night"

## a column plot for each surveys and provinces
cd_all_dhs |>
  filter(Indicator %in% ind) |>
janitor::clean_names() |>
  rename(province=characteristic_label) |>
  ggplot(aes(x=province, y = value)) +
  facet_wrap(~survey_year_label) +
  geom_col(position = "dodge", linewidth = 1.2, fill = "burlywood2") +
  coord_flip() +
  labs(y="Percent", x = "Province",
       title = ind)
```



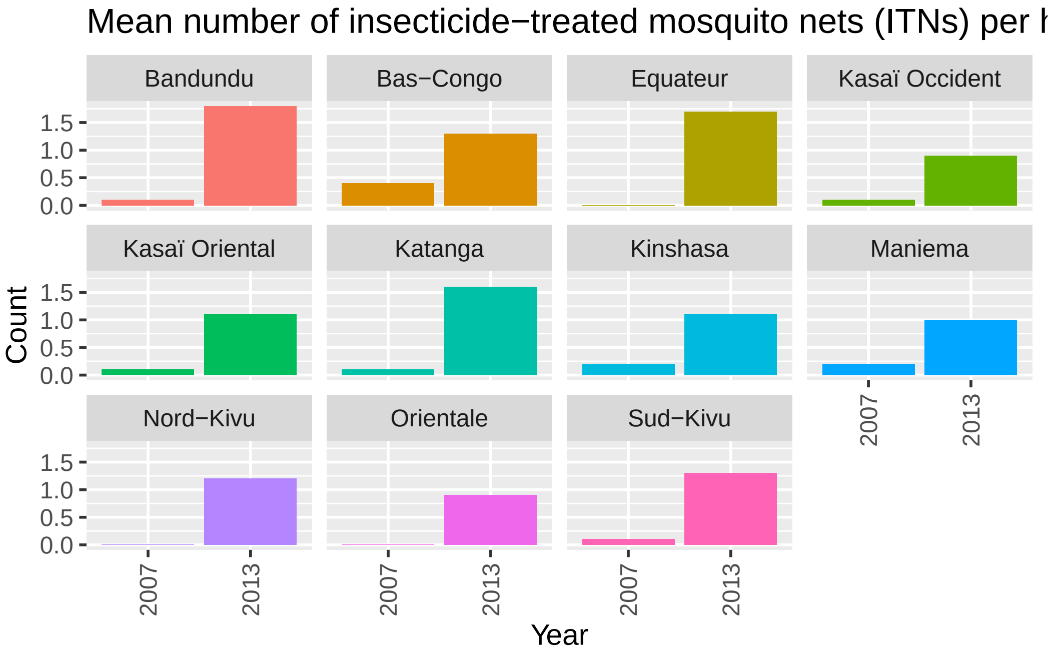
7.0.2 LLIN ownership

The DHS indicators for LLIN ownership is '*Mean number of long-lasting insecticide-treated mosquito nets (LLINs) per household*'. The following script extracts data specific to this indicator and creates a column plot showing household level LLIN ownership by province for each of the surveys in DRC.

```
## indicator/s of interest = ITN per household
ind<- "Mean number of insecticide-treated mosquito nets (ITNs) per household"

## a bar plot for each surveys and provinces
cd_all_dhs |>
  filter(Indicator %in% ind) |>
  janitor::clean_names() |>
  rename(province=characteristic_label) |>
  mutate(year = as.numeric(substr(survey_year_label,1,4))) |>
  ggplot(aes(x= as.factor(year), y = value, group = province)) +
  facet_wrap(~province) +
  geom_col(position = "dodge", size = .4, aes(fill = province)) +
  labs(y="Count", x = "Year",
       title = ind) +
  theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1),
        legend.position = "none")
```

```
Warning: Using `size` aesthetic for lines was deprecated in ggplot2 3.4.0.
i Please use `linewidth` instead.
```

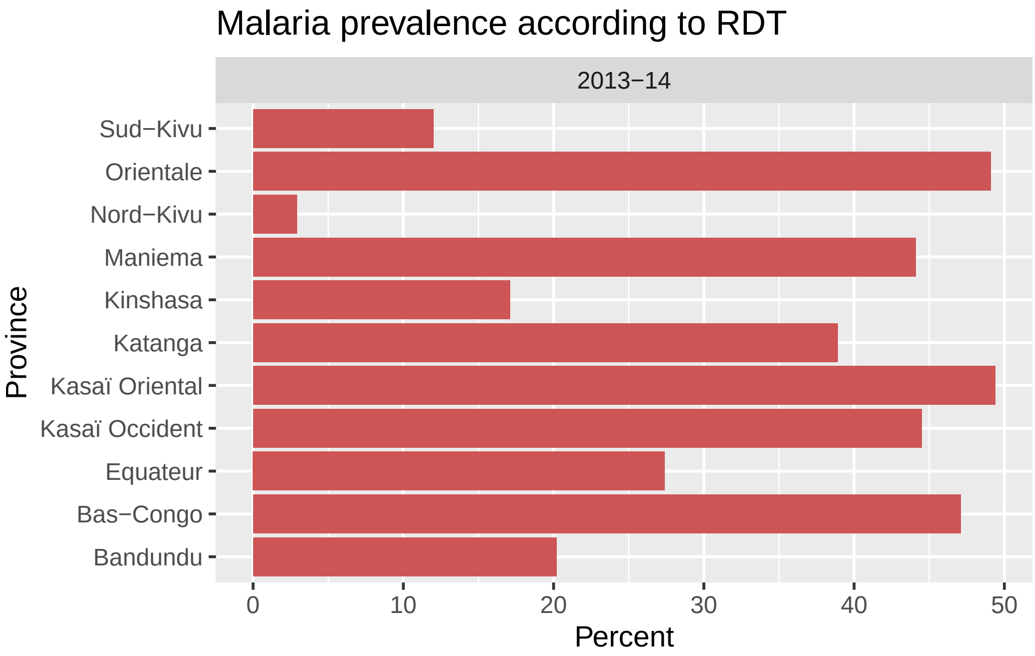


7.0.3 RDT prevalence

The DHS indicators for the prevalence of malaria among children under-five years old children is ‘*Malaria prevalence according to RDT*’. The following script extracts data specific to this indicator and creates a column plot showing province level RDT based prevalence of malaria among children.

```
#indicator/s of interest = ITN per household
ind<- "Malaria prevalence according to RDT"

## a column plot for each surveys and provinces
cd_all_dhs |>
  filter(Indicator %in% ind) |>
    janitor::clean_names() |>
  rename(province=characteristic_label) |>
  ggplot(aes(x=province, y = value)) +
  facet_wrap(~survey_year_label) +
  geom_col(position = "dodge", size = 1.2, fill = "indianred3") +
  coord_flip() +
  labs(y="Percent", x = "Province",
       title = ind)
```

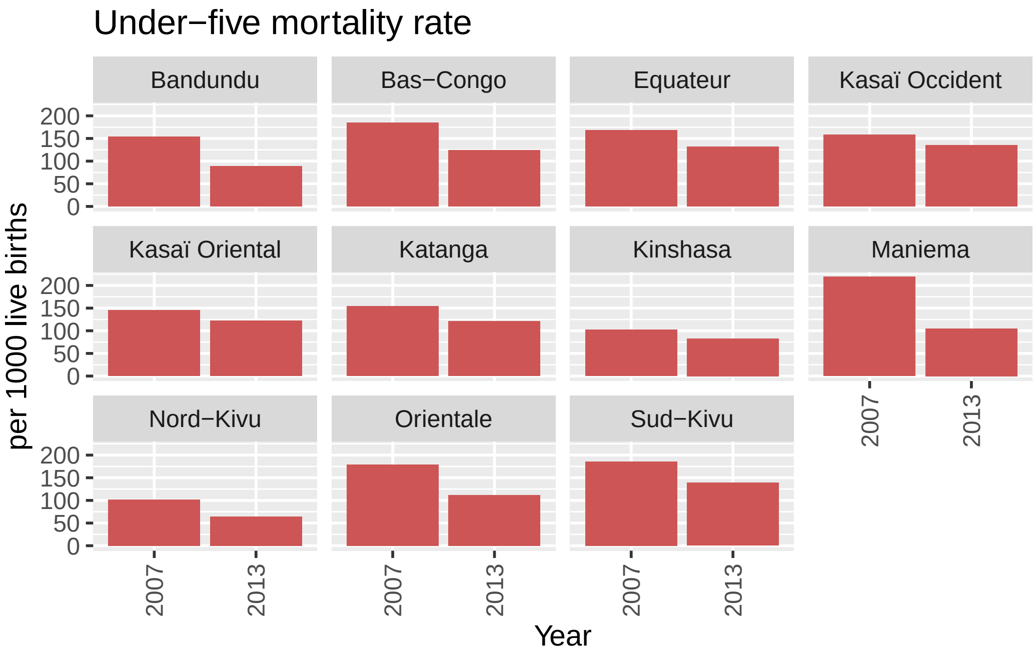


7.0.4 Under five mortality

The DHS indicators for the prevalence of malaria among children under-five years old children is '*Under-five mortality rate*'. The following script extracts data specific to this indicator and creates a bar plot showing under five mortality rates by surveys at province level.

```
#indicator/s of interest = U5 mortality
ind<- "Under-five mortality rate"

## a bar plot for each surveys and provinces
  cd_all_dhs |>
  filter(Indicator %in% ind) |>
    janitor::clean_names() |>
    rename(province=characteristic_label) |>
    mutate(year = as.numeric(substr(survey_year_label,1,4))) |>
    ggplot(aes(x= as.factor(year), y = value, group = province)) +
    facet_wrap(~province) +
    geom_col(position = "dodge", size = .4, fill = "indianred3") +
    labs(y="per 1000 live births", x = "Year",
       title = ind) +
    theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1),
          legend.position = "none")
```



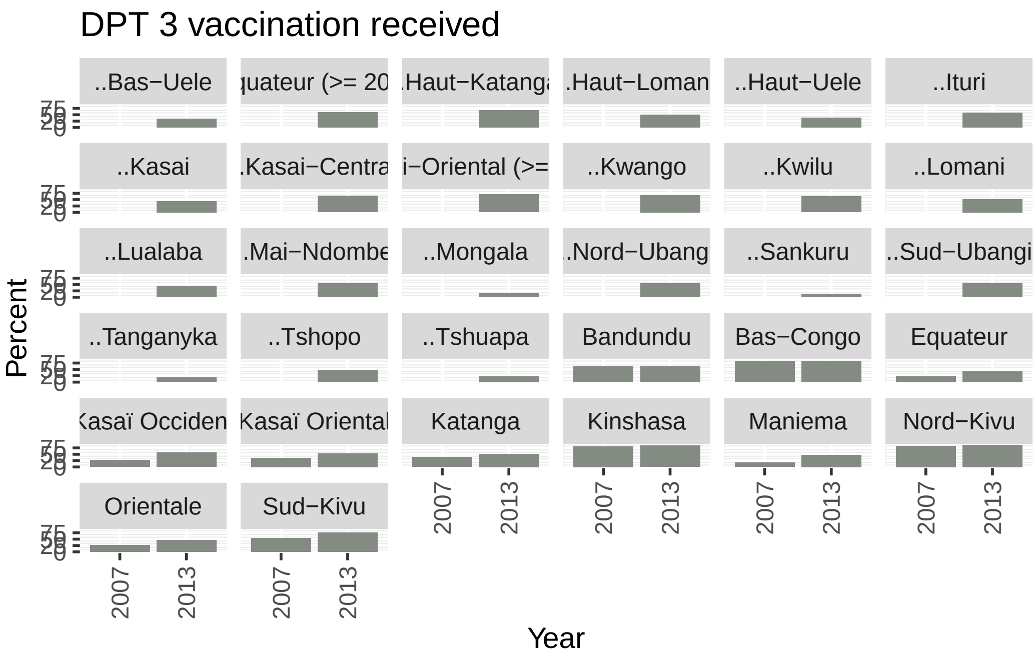
7.0.5 DPT3 coverage

The DHS indicators for the coverage of third dose of DPT based on vaccination card among children aged 12-23 months old is ‘DPT 3 vaccination received’. The following script extracts data specific to this indicator and creates a bar plot showing coverage of DPT-3 s at province level.

```
#indicator/s of interest = DPT 3 coverage
ind<- "DPT 3 vaccination received"

## a bar plot for each surveys and provinces
cd_all_dhs |>
```

```
 filter(Indicator %in% ind) |>
janitor::clean_names() |>
rename(province=characteristic_label) |>
mutate(year = as.numeric(substr(survey_year_label,1,4))) |>
ggplot(aes(x= as.factor(year), y = value, group = province)) +
facet_wrap(~province) +
geom_col(position = "dodge", size = .4, fill = "honeydew4") +
labs(y="Percent", x = "Year",
     title = ind) +
theme(axis.text.x = element_text(angle = 90, vjust = 0.5, hjust=1),
      legend.position = "none")
```


DPT 3 vaccination received
..Bas−Uele
quateur (>= 20
.Haut−Katanga
.Haut−Loman
..Haut−Uele
..Ituri
..Kasai
.Kasai−Centra
i−Oriental (>=
..Kwango
..Kwilu
..Lomani
..Lualaba
.Mai−Ndombe
..Mongala
.Nord−Ubang
..Sankuru
..Sud−Ubangi
..Tanganyka
..Tshopo
..Tshuapa
Bandundu
Bas−Congo
Equateur
Kasaï Occiden
Kasaï Oriental
Katanga
Kinshasa
Maniema
Nord−Kivu
Orientale
Sud−Kivu
Percent
Year