Exploratory Data Analysis

1 Personal Information

Name: Alexandra de Nooy
Student ID: 14581728
Email: alexandra.de.nooy@student.uva.nl or denooy.alex@gmail.com
Submitted on: 22/03/2023
Github link:

2 Data Context

This exploratory data analysis is conducted usinf R and RStudio. There are two main sets of data to be considered, linked to the two main sections of the project.

The first set of data represents the baseline or standard of care output runs produced by the existing patient pathway model. For the baseline there are 15 data output files (in csv format). Multiple files had been generated to account for model stochasticity, with the results of each simulation being based on a different set of random probabilities. The data files have a consistent structure and represent the population of indiviudals who move through the TB diagnostic patient pathway. In this, each column represents either a patient disease status or a point in the patient pathway that the indiviudal may or may not have reached.

The second data set consists of TB burden estimates for Kenya produced by the World Heath Organization as well as the accompanying data dictionary. The estimates cover a range of data variables and their estimated values between the years 2000 and 2022. Several key variables include estimates on TB incidence (new cases), notifications (diagnoses) and deaths. Estimates are also provided for different groups of individuals (for example HIV postive patients) and for different tpes of TB.

3 Data Description: Baseline TB model

4 Data Description: WHO Tuberculosis Data

4.1 Load and merge WHO TB burden data and data dictionary

```r
#Path to directory
basePath="/Users/adenooy/Library/CloudStorage/OneDrive-Personal/UVA/Thesis/MSc-Thesis/"

#Load data dictionary
datadict=read.csv(paste(basePath,"data/dynamic/TB_data_dictionary_2024-01-30.csv",sep=""))
colnames(datadict)
```

```
## [1] "variable_name" "dataset"       "code_list"     "definition"
```

```
print(datadict[1:3,])
```

```
##     variable_name dataset code_list
## 1 budget_cpp_dstb  Budget          
## 2  budget_cpp_mdr  Budget          
## 3  budget_cpp_tpt  Budget          
##                                                                                                           
## 1 Average cost of drugs budgeted per patient for drug-susceptible TB treatment, excluding buffer stoc
## 2              Average cost of drugs budgeted per patient for MDR-TB treatment, excluding buffer stoc
## 3      Average cost of drugs budgeted per patient for  TB preventive treatment, excluding buffer stoc
```

```
#Load TB data
tb_estimates=read_excel(paste(basePath,"data/dynamic/kenya_tb_burden.xlsx",sep=""))
colnames(tb_estimates)
```

```
##  [1] "country"                  "iso2"                    
##  [3] "iso3"                     "iso_numeric"             
##  [5] "g_whoregion"              "year"                    
##  [7] "e_pop_num"                "e_inc_100k"              
##  [9] "e_inc_100k_lo"            "e_inc_100k_hi"           
## [11] "e_inc_num"                "e_inc_num_lo"            
## [13] "e_inc_num_hi"             "e_tbhiv_prct"            
## [15] "e_tbhiv_prct_lo"          "e_tbhiv_prct_hi"         
## [17] "e_inc_tbhiv_100k"         "e_inc_tbhiv_100k_lo"     
## [19] "e_inc_tbhiv_100k_hi"      "e_inc_tbhiv_num"         
## [21] "e_inc_tbhiv_num_lo"       "e_inc_tbhiv_num_hi"      
## [23] "e_mort_exc_tbhiv_100k"    "e_mort_exc_tbhiv_100k_lo"
## [25] "e_mort_exc_tbhiv_100k_hi" "e_mort_exc_tbhiv_num"    
## [27] "e_mort_exc_tbhiv_num_lo"  "e_mort_exc_tbhiv_num_hi" 
## [29] "e_mort_tbhiv_100k"        "e_mort_tbhiv_100k_lo"    
## [31] "e_mort_tbhiv_100k_hi"     "e_mort_tbhiv_num"        
## [33] "e_mort_tbhiv_num_lo"      "e_mort_tbhiv_num_hi"     
## [35] "e_mort_100k"              "e_mort_100k_lo"          
## [37] "e_mort_100k_hi"           "e_mort_num"              
## [39] "e_mort_num_lo"            "e_mort_num_hi"           
## [41] "cfr"                      "cfr_lo"                  
## [43] "cfr_hi"                   "cfr_pct"                 
## [45] "cfr_pct_lo"               "cfr_pct_hi"              
## [47] "c_newinc_100k"            "c_cdr"                   
## [49] "c_cdr_lo"                 "c_cdr_hi"
```

```
print(tb_estimates[1:3,])
```

```
## # A tibble: 3 x 50
##   country iso2  iso3  iso_numeric g_whor~1  year e_pop~2 e_inc~3 e_inc~4 e_inc~5
##   <chr>   <chr> <chr>       <dbl> <chr>    <dbl>   <dbl>   <dbl>   <dbl>   <dbl>
## 1 Kenya   KE    KEN           404 AFR       2000  3.09e7     451     182     839
## 2 Kenya   KE    KEN           404 AFR       2001  3.18e7     499     178     982
## 3 Kenya   KE    KEN           404 AFR       2002  3.28e7     534     174    1090
## # ... with 40 more variables: e_inc_num <dbl>, e_inc_num_lo <dbl>,
## #   e_inc_num_hi <dbl>, e_tbhiv_prct <dbl>, e_tbhiv_prct_lo <dbl>,
## #   e_tbhiv_prct_hi <dbl>, e_inc_tbhiv_100k <dbl>, e_inc_tbhiv_100k_lo <dbl>,
## #   e_inc_tbhiv_100k_hi <dbl>, e_inc_tbhiv_num <dbl>, e_inc_tbhiv_num_lo <dbl>,
## #   e_inc_tbhiv_num_hi <dbl>, e_mort_exc_tbhiv_100k <dbl>,
## #   e_mort_exc_tbhiv_100k_lo <dbl>, e_mort_exc_tbhiv_100k_hi <dbl>,
## #   e_mort_exc_tbhiv_num <dbl>, e_mort_exc_tbhiv_num_lo <dbl>, ...
```

```
#Merge tb data with data dictionary
tbData=tb_estimates %>% gather("variable_name","value",7:50) %>% left_join(datadict)
```

```
## Joining, by = "variable_name"
```

```
#remove unnecessary regional columns, blank code_list column
tbData=subset(tbData, select = -c(iso2,iso3,iso_numeric,g_whoregion,code_list) )
print(tbData[1:5,])
```

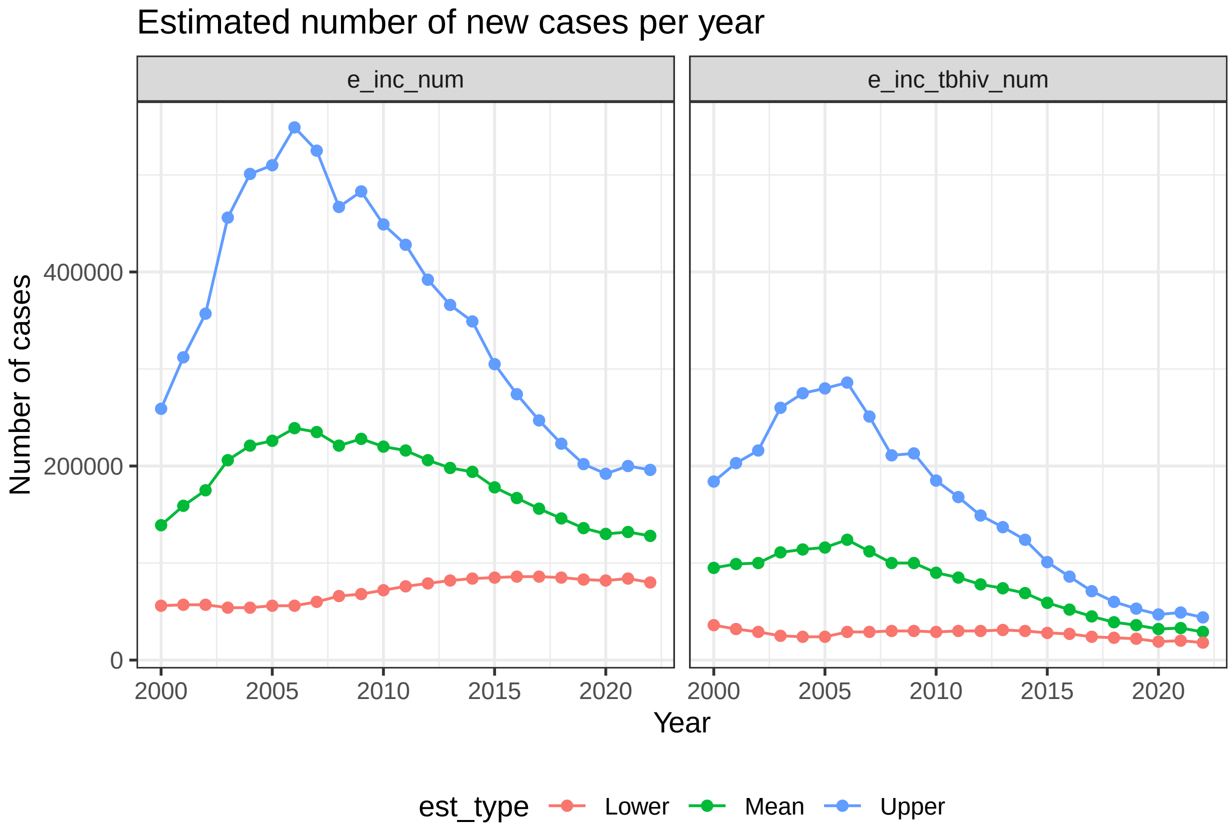
```
## # A tibble: 5 x 6
##   country  year variable_name    value dataset   definition
##   <chr>   <dbl> <chr>            <dbl> <chr>     <chr>
## 1 Kenya    2000 e_pop_num     30851606 Estimates Estimated total population num~
## 2 Kenya    2001 e_pop_num     31800343 Estimates Estimated total population num~
## 3 Kenya    2002 e_pop_num     32779823 Estimates Estimated total population num~
## 4 Kenya    2003 e_pop_num     33767122 Estimates Estimated total population num~
## 5 Kenya    2004 e_pop_num     34791836 Estimates Estimated total population num~
```

4.2 Exploring new incident infections (all infections and HIV)

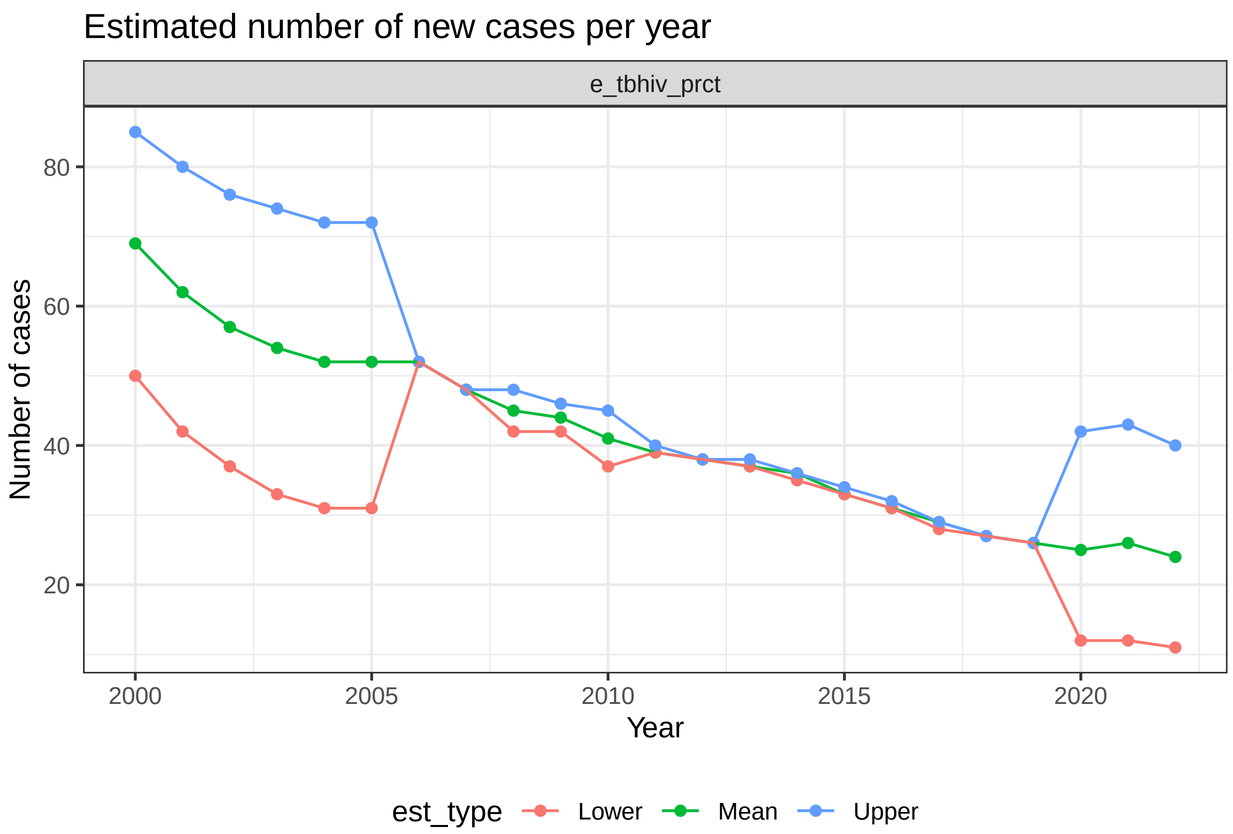
Incident infections are the number of estimated people being infected with TB each year. The number of new infections is an estimate and is different from the number of reported cases or diagnoses - which is reliant on the identification, testing and treating of people with TB. This data represent a key element in the transmisison model and it is important in understanding the past dynamics of TB in kenya and provides an idea on the current trend.

HIV is an important factor to consider, given that Kenya has relatively high HIV/TB coinfection and because HIV impacts the likelihood of contracting TB, becoming infectious or of becoming severely ill.

```
#select relevant variables related to incidence
inc_data= tbData %>% filter(variable_name %in% c("e_inc_num","e_inc_num_lo","e_inc_num_hi")) %>% mutate
hiv_inc=tbData %>% filter(variable_name%in% c("e_inc_tbhiv_num","e_inc_tbhiv_num_lo","e_inc_tbhiv_num_hi
hiv_perc_inc=tbData %>% filter(variable_name%in% c("e_tbhiv_prct","e_tbhiv_prct_lo","e_tbhiv_prct_hi"))

#label upper, lower and mean estimates
all_inc=rbind(inc_data,hiv_inc)
all_inc$est_type="Mean"
all_inc$est_type[grepl("_lo",all_inc$variable_name,fixed=TRUE)==TRUE]="Lower"
all_inc$est_type[grepl("_hi",all_inc$variable_name,fixed=TRUE)==TRUE]="Upper"

hiv_perc_inc$est_type="Mean"
hiv_perc_inc$est_type[grepl("_lo",hiv_perc_inc$variable_name,fixed=TRUE)==TRUE]="Lower"
hiv_perc_inc$est_type[grepl("_hi",hiv_perc_inc$variable_name,fixed=TRUE)==TRUE]="Upper"

#Incident cases (all and HIV)
ggplot(all_inc,aes(x=year,y=value,group=variable_name,color=est_type))+geom_point()+
  geom_line()+theme_bw()+xlab("Year")+ylab("Number of cases")+
  labs(title="Estimated number of new cases per year")+theme(legend.position = "bottom")+facet_wrap(.~va
```



```r
#Percentage of new cases HIV positive
ggplot(hiv_perc_inc,aes(x=year,y=value,group=variable_name,color=est_type))+geom_point()+
  geom_line()+theme_bw()+xlab("Year")+ylab("Number of cases")+
  labs(title="Estimated number of new cases per year")+theme(legend.position = "bottom")+facet_wrap(.~va
```


Estimated number of new cases per year
e_tbhiv_prct
Number of cases
80
60
40
20
2000
2005
2010
2015
2020
Year
est_type
Lower
Mean
Upper