

Covid data analysis - Africa

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Loaded a single month of African data. Loaded the list of African countries countries-africa.csv. There are 58 countries listed here.

```
Africa <- read.delim("covid/countries-africa.csv")
head(Africa,5)
```

```
##      rank                country population          year
## 1      1                Nigeria 206,139,589          2020
## 2      2                Ethiopia 109,224,414          2018
## 3      3 Democratic Republic of the Congo 102,561,403    July 1, 2020
## 4      4                Egypt 101,334,404 December 8, 2020
## 5      5                South Africa 59,956,820 December 1, 2020
##                                source
## 1                                Worldometers[3]
## 2 UN population projections[4] [5]
## 3      National annual projection
## 4      National population clock
## 5      Official estimate
```

```
nrow(Africa)
```

```
## [1] 58
```

```
any(is.na(Africa$country))
```

```
## [1] FALSE
```

checking if any country is NA. There are 58 African countries listed in the database.

Collected all the names of covid data files into a character vector. There are 21 files with names starting with covid data.

```
vec= list.files(path = "covid/", pattern = "^covid-global", all.files = FALSE,
               full.names = FALSE, recursive = FALSE,
               ignore.case = FALSE, include.dirs = FALSE, no.. = FALSE)
vec
```

```
## [1] "covid-global_01-01-2021.csv" "covid-global_02-01-2020.csv"
## [3] "covid-global_02-01-2021.csv" "covid-global_03-01-2020.csv"
## [5] "covid-global_03-01-2021.csv" "covid-global_04-01-2020.csv"
## [7] "covid-global_04-01-2021.csv" "covid-global_05-01-2020.csv"
## [9] "covid-global_05-01-2021.csv" "covid-global_06-01-2020.csv"
## [11] "covid-global_06-01-2021.csv" "covid-global_07-01-2020.csv"
## [13] "covid-global_07-01-2021.csv" "covid-global_08-01-2020.csv"
## [15] "covid-global_08-01-2021.csv" "covid-global_09-01-2020.csv"
## [17] "covid-global_09-01-2021.csv" "covid-global_10-01-2020.csv"
## [19] "covid-global_10-01-2021.csv" "covid-global_11-01-2020.csv"
## [21] "covid-global_12-01-2020.csv"
```

```
#list.files produces a character vector so we can find the length directly.
length(vec)
```

```
## [1] 21
```

Loaded the COVID data file for October 2021. Since the global data file contains not just African countries, I just selected the African ones from the list. Unfortunately not all the names match.

```
library(tidyverse)
```

```
## -- Attaching packages ----- tidyverse 1.3.2 --
## v ggplot2 3.3.6      v purrr  0.3.5
## v tibble  3.1.8      v dplyr  1.0.10
## v tidyr   1.2.1      v stringr 1.4.1
## v readr   2.1.3      v forcats 0.5.2
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
```

```
library(dplyr)
october2021 = read.delim("covid/covid-global_10-01-2021.csv")
head(october2021)
```

```
##   FIPS Admin2 Province_State      Country_Region      Last_Update      Lat
## 1   NA              Albania  Afghanistan 2021-10-02T04:21:25Z 33.93911
## 2   NA              Albania  Albania    2021-10-02T04:21:25Z 41.15330
## 3   NA              Algeria  Algeria    2021-10-02T04:21:25Z 28.03390
## 4   NA              Andorra  Andorra    2021-10-02T04:21:25Z 42.50630
## 5   NA              Angola   Angola     2021-10-02T04:21:25Z -11.20270
## 6   NA              Antigua and Barbuda 2021-10-02T04:21:25Z 17.06080
##      Long_ Confirmed Deaths Recovered Active      Combined_Key Incident_Rate
## 1  67.70995    155191   7206      NA      NA      Afghanistan      398.6581
## 2  20.16830    170778   2705      NA      NA      Albania      5934.3248
## 3   1.65960    203517   5815      NA      NA      Algeria      464.1098
## 4   1.52180     15222    130      NA      NA      Andorra     19701.0289
## 5  17.87390     58076   1567      NA      NA      Angola      176.7040
## 6 -61.79640     3336    81      NA      NA  Antigua and Barbuda     3406.5844
## Case_Fatality_Ratio
## 1              4.6433105
```

```
## 2          1.5839277
## 3          2.8572552
## 4          0.8540271
## 5          2.6981886
## 6          2.4280576
```

```
# checking the names of the columns in Oct 2021 data
names(october2021)
```

```
## [1] "FIPS"          "Admin2"        "Province_State"
## [4] "Country_Region" "Last_Update"   "Lat"
## [7] "Long_"         "Confirmed"     "Deaths"
## [10] "Recovered"     "Active"        "Combined_Key"
## [13] "Incident_Rate" "Case_Fatality_Ratio"
```

49 countries can be found in Oct 2021 covid data from African countries list

```
library(tidyverse)
library(dplyr)
# filtering oct data based on African countries

AfricaOct2021<- october2021[october2021$Country_Region %in% Africa$country,]

# tried two methods

AfricaOct2021 <- filter(october2021,october2021$Country_Region %in% Africa$country)
head(AfricaOct2021)
```

```
##   FIPS Admin2 Province_State Country_Region      Last_Update      Lat
## 1   NA      NA              Algeria 2021-10-02T04:21:25Z 28.0339
## 2   NA      NA              Angola 2021-10-02T04:21:25Z -11.2027
## 3   NA      NA              Benin 2021-10-02T04:21:25Z  9.3077
## 4   NA      NA              Botswana 2021-10-02T04:21:25Z -22.3285
## 5   NA      NA      Burkina Faso 2021-10-02T04:21:25Z 12.2383
## 6   NA      NA              Burundi 2021-10-02T04:21:25Z -3.3731
##   Long_ Confirmed Deaths Recovered Active Combined_Key Incident_Rate
## 1  1.6596   203517   5815      NA      NA      Algeria    464.10983
## 2 17.8739    58076   1567      NA      NA      Angola     176.70397
## 3  2.3158    23890    159      NA      NA      Benin      197.06021
## 4 24.6849   179220   2368      NA      NA      Botswana   7621.11306
## 5 -1.5616    14262    184      NA      NA Burkina Faso    68.22853
## 6 29.9189    17979    38       NA      NA      Burundi    151.20117
##   Case_Fatality_Ratio
## 1          2.8572552
## 2          2.6981886
## 3          0.6655504
## 4          1.3212811
## 5          1.2901416
## 6          0.2113577
```

```
nrow(AfricaOct2021)
```

```
## [1] 49
```

The 9 countries below are not matched in covid data.

```

`%notin%` <- Negate(`%in%`)
MissingAfricanCountries <- filter(Africa,Africa$country %notin% october2021$Country_Region)
MissingAfricanCountries

```

##	rank	country	population
## 1	3	Democratic Republic of the Congo	102,561,403
## 2	16	Ivory Coast	22,671,331
## 3	39	Republic of the Congo	3,697,490
## 4	NA	Réunion (France)	840,974
## 5	NA	Western Sahara	510,713
## 6	52	Cape Verde	491,875
## 7	NA	Mayotte (France)	212,600
## 8	53	São Tomé and Príncipe	201,784
## 9	NA	Saint Helena, Ascension and Tristan da Cunha (UK)	5,633

##	year	source
## 1	July 1, 2020	National annual projection
## 2	May 15, 2014	Preliminary 2014 census result
## 3	April 28, 2007	2007 census result
## 4	January 1, 2013	Official estimate
## 5	September 2, 2014	Preliminary 2014 census result
## 6	June 16, 2010	Final 2010 census result[permanent dead link]
## 7	August 21, 2012	2012 census result
## 8	2018	Official estimate
## 9	June 2016	2016 census result

We should care more about these countries as their population is higher than the smaller islands. If these countries are ignored, the number of cases and deaths due to covid in Africa could be miscalculated entirely. The data we would be using further would not stay accurate.

Next, find how are the names of these three countries (Two Congos and Ivory Coast) written in the covid data. After looking through the Oct 2021 data's list of countries, I found that these 3 countries are written as Congo (Kinshasa), Congo (Brazzaville) and Cote d'Ivoire.

```

names<-october2021 %>% filter(str_detect(october2021$Country_Region, "^Congo|^Cote"))
names

```

##	FIPS	Admin2	Province_State	Country_Region	Last_Update	Lat
## 1	NA			Congo (Brazzaville)	2021-10-02T04:21:25Z	-0.2280
## 2	NA			Congo (Kinshasa)	2021-10-02T04:21:25Z	-4.0383
## 3	NA			Cote d'Ivoire	2021-10-02T04:21:25Z	7.5400

##	Long_	Confirmed	Deaths	Recovered	Active	Combined_Key	Incident_Rate
## 1	15.8277	14359	197	NA	NA	Congo (Brazzaville)	260.21676
## 2	21.7587	56997	1084	NA	NA	Congo (Kinshasa)	63.64014
## 3	-5.5471	60335	631	NA	NA	Cote d'Ivoire	228.72989

##	Case_Fatality_Ratio
## 1	1.371962
## 2	1.901854
## 3	1.045827

I replaced Ivory Coast in the list of African countries with Cote d'Ivoire, Democratic Republic of the Congo with Congo (Kinshasa) and Republic of the Congo with Congo (Brazzaville).

```
Africa$country[Africa$country == 'Ivory Coast'] <- "Cote d'Ivoire"
Africa$country[Africa$country == 'Democratic Republic of the Congo'] <- "Congo (Kinshasa)"
Africa$country[Africa$country == 'Republic of the Congo'] <- "Congo (Brazzaville)"
head(Africa)
```

```
##      rank      country population      year
## 1      1      Nigeria 206,139,589      2020
## 2      2      Ethiopia 109,224,414      2018
## 3      3 Congo (Kinshasa) 102,561,403      July 1, 2020
## 4      4      Egypt 101,334,404 December 8, 2020
## 5      5      South Africa 59,956,820 December 1, 2020
## 6      6      Tanzania 59,734,218      2020
##
##      source
## 1      Worldometers[3]
## 2 UN population projections[4][5]
## 3      National annual projection
## 4      National population clock
## 5      Official estimate
## 6      Worldometers
```

I am only left with "Réunion (France)", "Western Sahara", "Cape Verde", "Mayotte (France)", "São Tomé

```
~%notin%` <- Negate(~%in%`)
MissingAfricanCountries <- filter(Africa, Africa$country %notin% october2021$Country_Region)
MissingAfricanCountries
```

```
##      rank      country population
## 1      NA      Réunion (France) 840,974
## 2      NA      Western Sahara 510,713
## 3      52      Cape Verde 491,875
## 4      NA      Mayotte (France) 212,600
## 5      53      São Tomé and Príncipe 201,784
## 6      NA Saint Helena, Ascension and Tristan da Cunha (UK) 5,633
##
##      year      source
## 1      January 1, 2013      Official estimate
## 2      September 2, 2014      Preliminary 2014 census result
## 3      June 16, 2010 Final 2010 census result[permanent dead link]
## 4      August 21, 2012      2012 census result
## 5      2018      Official estimate
## 6      June 2016      2016 census result
```

The file name is written as “covid-global___.csv.bz2”, and date always “01” in these files. Extracting the date part from the first file name as Date object.

Answer: Removing the date part of file “covid-global_01-01-2021.csv.bz2” and storing it in a object of date type.

```
filename="covid-global_01-01-2021.csv.bz2"
filename=gsub("^[_]*_", "", filename)
filename=gsub("\\\\.\\.", "", filename)
filename
```

```
## [1] "01-01-2021"
```

```
firstDate= as.Date(filename, "%m-%d-%Y")
firstDate
```

```
## [1] "2021-01-01"
```

```
class(firstDate)
```

```
## [1] "Date"
```

Now I merge all the data files into one.

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

```
##
```

```
## Attaching package: 'lubridate'
```

```
## The following objects are masked from 'package:base':
```

```
##
```

```
##      date, intersect, setdiff, union
```

```
#creating a merged df by binding data from each file after performing processes to extract date, select
```

```
mergedDf<-NULL
```

```
for (item in vec) {
```

```
  df <- read.delim(paste0("covid/", item))
```

```
  item=gsub("^[_]*_", "", item)
```

```
  item=gsub("\\.\\.\\.\\.", "", item)
```

```
  firstDate= as.Date(item, "%m-%d-%Y")
```

```
  df$year=year(firstDate)
```

```
  df$month=month(firstDate)
```

```
  selectedDf=df%>%select(starts_with("Country"),Deaths, year, month)
```

```
  selectedDf=selectedDf%>%rename(country=starts_with("Country"))
```

```
  mergedDf=rbind(mergedDf,selectedDf)
```

```
}
```

```
mergedDf<- mergedDf[mergedDf$country %in% Africa$country,]
```

```
head(mergedDf)
```

```
##      country Deaths year month
## 3      Algeria  2762 2021     1
## 5        Angola   405 2021     1
## 37         Benin    44 2021     1
## 41      Botswana   42 2021     1
## 71 Burkina Faso   85 2021     1
## 73        Burundi    2 2021     1
```

```
nrow(mergedDf)
```

```
## [1] 986
```

Extracted the population size from the dataset of African countries.

```
AfricaPopulationDf= Africa%>%select(country,population)
head(AfricaPopulationDf)
```

```
##           country population
## 1      Nigeria 206,139,589
## 2      Ethiopia 109,224,414
## 3 Congo (Kinshasa) 102,561,403
## 4         Egypt 101,334,404
## 5   South Africa  59,956,820
## 6      Tanzania  59,734,218
```

For each country, computed the death rate: number of deaths per 1M population.

```
#Merging AfricanPopulationDf with Africa's covid data
combinedDf=merge(mergedDf,AfricaPopulationDf,by.x="country", by.y="country", all=TRUE)
combinedDf$population <- as.numeric(gsub(",", "",combinedDf$population))
combinedDf$deathRate<-(combinedDf$Deaths*100000)/as.numeric(combinedDf$population)
head(combinedDf)
```

```
## country Deaths year month population deathRate
## 1 Algeria  2762 2021     1  43000420  6.423193
## 2 Algeria  5302 2021     9  43000420 12.330112
## 3 Algeria  3261 2021     5  43000420  7.583647
## 4 Algeria  1518 2020     9  43000420  3.530198
## 5 Algeria   453 2020     5  43000420  1.053478
## 6 Algeria  4291 2021     8  43000420  9.978972
```

Analyzing which 10 countries have the largest death rate? (As of the latest date in the data, Oct 1st, 2021).

```
topTen=combinedDf[order(combinedDf$deathRate, decreasing = TRUE), ]
topTen=topTen%>%filter(topTen$year=="2021" & topTen$month=="10")
head(topTen,10)
```

```
##           country Deaths year month population deathRate
## 1      Tunisia  24901 2021     10  10982754 226.72820
## 2      Namibia   3514 2021     10   2280700 154.07550
## 3 South Africa  87705 2021     10  59956820 146.28027
## 4 Seychelles    112 2021     10    90945 123.15136
## 5 Botswana     2368 2021     10   2024904 116.94382
## 6 Eswatini     1223 2021     10   1119375 109.25740
## 7 Libya        4664 2021     10   5298152  88.03069
## 8 Morocco     14290 2021     10  37034729  38.58540
## 9 Zimbabwe     4624 2021     10  13061239  35.40246
## 10 Lesotho      633 2021     10   2007201  31.53645
```

```
topTenCountries=head(topTen$country,10)
topTenCountries
```

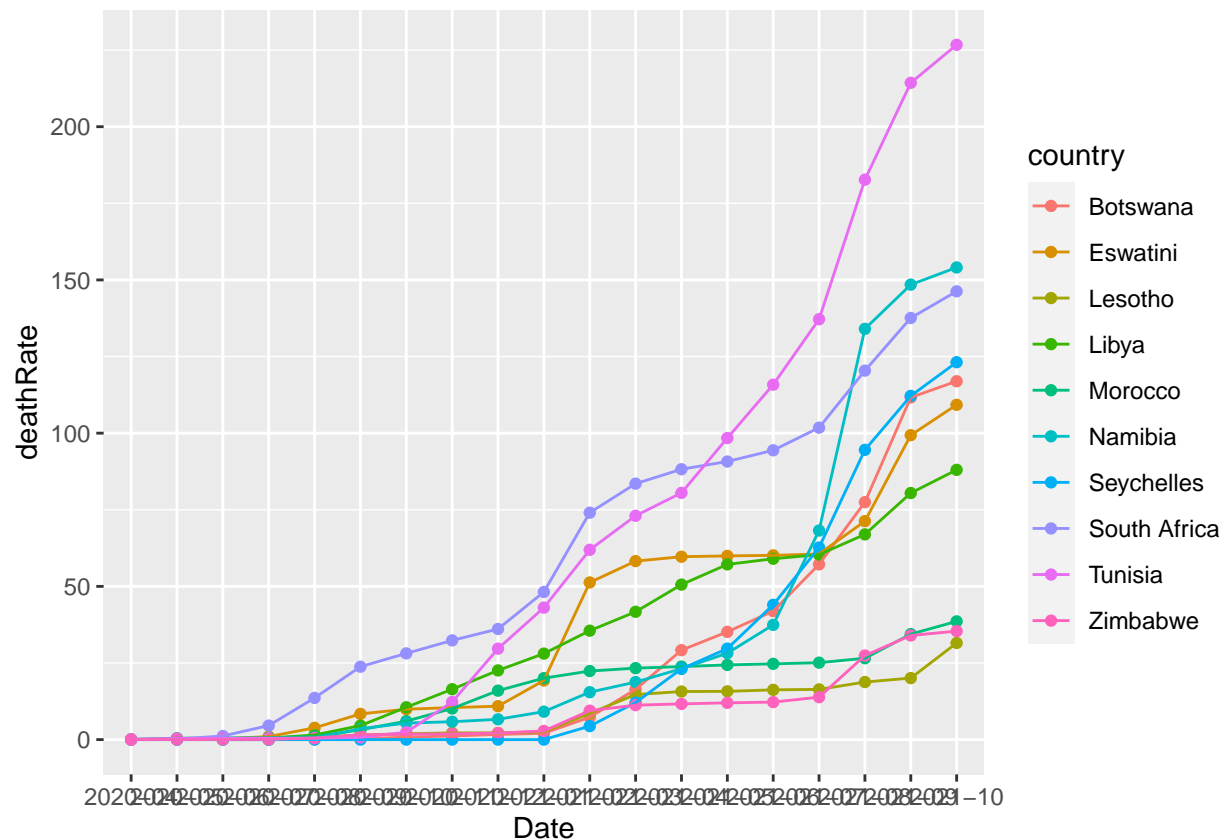
```
## [1] "Tunisia"      "Namibia"      "South Africa" "Seychelles"   "Botswana"
## [6] "Eswatini"     "Libya"        "Morocco"      "Zimbabwe"     "Lesotho"
```

Plotting the growth in death rate in these 10 countries over time.

```
dfToVisualize= combinedDf[combinedDf$country %in% topTenCountries,]
dfToVisualize=within(dfToVisualize, Date <- sprintf("%d-%02d", year, month))
head(dfToVisualize)
```

```
##      country Deaths year month population  deathRate   Date
## 59 Botswana     42  2021     1    2024904  2.07417241 2021-01
## 60 Botswana    712  2021     5    2024904 35.16216077 2021-05
## 61 Botswana      1  2020     6    2024904  0.04938506 2020-06
## 62 Botswana   1158  2021     7    2024904 57.18789632 2021-07
## 63 Botswana      6  2020     9    2024904  0.29631034 2020-09
## 64 Botswana   1569  2021     8    2024904 77.48515485 2021-08
```

```
ggplot(dfToVisualize, aes(x=Date, y=deathRate, fill=country, group=country)) + geom_point(aes(color = country))
```



Computing the number of new monthly deaths (per 1M population) and displaying it on a similar plot.

```
#correcting the order of data for using lag
dfToVisualize=dfToVisualize[order(dfToVisualize$country, dfToVisualize$Date),]
#calculating the difference in the deaths per month, grouped by country
dfToVisualize$monthly_Deaths <- ave(dfToVisualize$Deaths, factor(dfToVisualize$country), FUN=function(x){
  head(dfToVisualize)
```



```
##      country Deaths year month population  deathRate    Date monthly_Deaths
## 71 Botswana      1 2020      4    2024904 0.04938506 2020-04             NA
## 65 Botswana      1 2020      5    2024904 0.04938506 2020-05             0
## 61 Botswana      1 2020      6    2024904 0.04938506 2020-06             0
## 77 Botswana      1 2020      7    2024904 0.04938506 2020-07             0
## 69 Botswana      2 2020      8    2024904 0.09877011 2020-08             1
## 63 Botswana      6 2020      9    2024904 0.29631034 2020-09             4
```

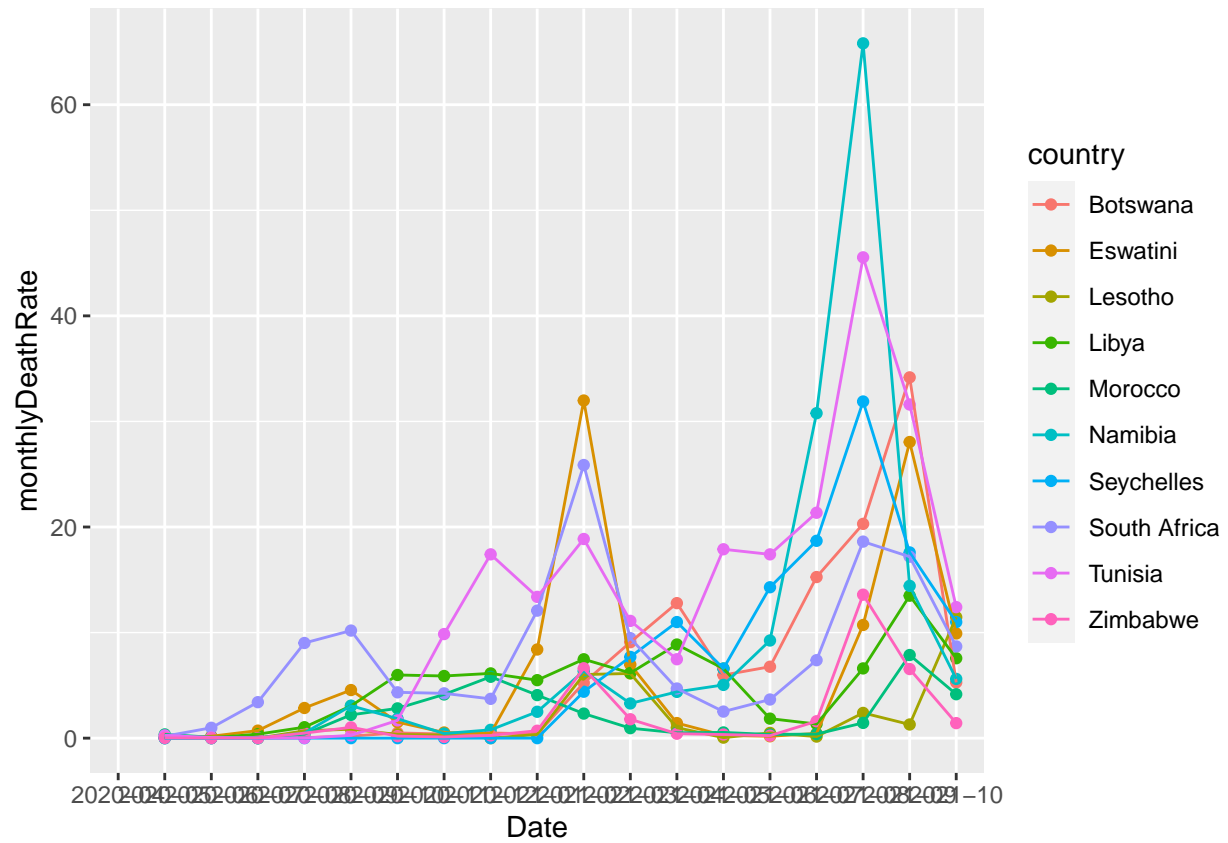
```
# now that we have monthly deaths, we can calculate monthly death rate and append that column to the df
dfToVisualize$monthlyDeathRate=dfToVisualize$monthly_Deaths*100000/dfToVisualize$population
head(dfToVisualize)
```

```
##      country Deaths year month population  deathRate    Date monthly_Deaths
## 71 Botswana      1 2020      4    2024904 0.04938506 2020-04             NA
## 65 Botswana      1 2020      5    2024904 0.04938506 2020-05             0
## 61 Botswana      1 2020      6    2024904 0.04938506 2020-06             0
## 77 Botswana      1 2020      7    2024904 0.04938506 2020-07             0
## 69 Botswana      2 2020      8    2024904 0.09877011 2020-08             1
## 63 Botswana      6 2020      9    2024904 0.29631034 2020-09             4
##      monthlyDeathRate
## 71                  NA
## 65      0.000000000
## 61      0.000000000
## 77      0.000000000
## 69      0.04938506
## 63      0.19754023
```

```
# now we display this data
ggplot(dfToVisualize, aes(x=Date, y=monthlyDeathRate, fill=country, group=country)) + geom_point(aes(col=country))
```

```
## Warning: Removed 10 rows containing missing values (geom_point).
```

```
## Warning: Removed 10 row(s) containing missing values (geom_path).
```



Namibia experienced the highest peak in the new monthly deaths. It was in 2020-08 (Aug-2020). I can see three waves of covid in the graph.