Week 4 In-Class: Exploratory Data Analysis

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```
#Check final data variables
finaldata <- read.csv(here("Data", "finaldata.csv"), header = TRUE)
names(finaldata)
```

```
 [1] "country_name"       "ISO"                "region"
 [4] "Year"               "gdp1000"            "OECD"
 [7] "OECD2023"           "popdens"            "urban"
[10] "agedep"             "male_edu"           "temp"
[13] "rainfall1000"       "totdeath"           "armconf1"
[16] "Infant_Mortality"   "Neonatal_Mortality" "Under5_Mortality"
[19] "Maternal_Mortality" "drought"            "earthquake"
```

```
#Check observations from Canada

finaldata %>%
dplyr::filter(country_name == "Canada")
```

```
   country_name ISO           region Year  gdp1000 OECD OECD2023  popdens
1        Canada CAN Northern America 2000 24.27100    1        1 66.19704
2        Canada CAN Northern America 2001 23.82206    1        1 66.45361
3        Canada CAN Northern America 2002 24.25534    1        1 66.71112
4        Canada CAN Northern America 2003 28.30046    1        1 66.96384
5        Canada CAN Northern America 2004 32.14368    1        1 67.21715
6        Canada CAN Northern America 2005 36.38251    1        1 67.47283
7        Canada CAN Northern America 2006 40.50406    1        1 67.73674
8        Canada CAN Northern America 2007 44.65990    1        1 67.99444
9        Canada CAN Northern America 2008 46.71051    1        1 68.25765
10       Canada CAN Northern America 2009 40.87631    1        1 68.53354
11       Canada CAN Northern America 2010 47.56208    1        1 68.80739
12       Canada CAN Northern America 2011 52.22370    1        1 69.04842
13       Canada CAN Northern America 2012 52.66909    1        1 69.27604
```

```
14       Canada CAN Northern America 2013 52.63517    1        1 69.50772
15       Canada CAN Northern America 2014 50.95600    1        1 69.76876
16       Canada CAN Northern America 2015 43.59614    1        1 69.98853
17       Canada CAN Northern America 2016 42.31560    1        1 70.21484
18       Canada CAN Northern America 2017 45.12943    1        1 70.40863
19       Canada CAN Northern America 2018 46.54864    1        1 70.63614
20       Canada CAN Northern America 2019 46.32867    1        1 70.83794
      urban   agedep male_edu     temp rainfall1000 totdeath armconf1
1  56.14335 46.34463 12.30281 5.486244    0.9971559       11        0
2  56.40270 45.89632 12.35258 6.469105    0.8644873       23        0
3  56.67093 45.46660 12.40182 5.979147    0.9460938        1        0
4  56.94365 45.07468 12.45053 5.416964    1.0189234        0        0
5  57.20020 44.67374 12.49870 5.556961    1.0008237        0        0
6  57.41671 44.26641 12.54635 6.187472    1.0367199        0        0
7  57.59143 43.96370 12.59349 6.895084    1.0917386        0        0
8  57.75691 43.83612 12.64015 5.900051    1.0134091        0        0
9  57.97905 43.85426 12.68634 5.650118    1.0693435        0        0
10 58.24228 43.94937 12.73207 5.398867    0.9928497        0        0
11 58.52809 44.13587 12.77735 6.781766    1.0379754        0        0
12 58.81437 44.53578 12.82218 6.269133    1.1343442        0        0
13 59.05573 45.18393 12.86660 7.249497    0.9747708        0        0
14 59.19713 45.95404 12.91059 5.954381    1.0282075        0        0
15 59.30361 46.75493 12.95414 5.584650    1.0377695        0        0
16 59.42627 47.59164 12.99723 6.436884    0.9632446        0        0
17 59.50521 48.41410 13.03988 7.184514    0.9677826        0        0
18 59.59325 49.14806 13.08210 6.539669    1.0995322        0        0
19 59.68433 49.80166 13.12388 6.539677    1.0991469        0        0
20 59.75984 50.47739 13.16522 6.539633    1.0987523        0        0
   Infant_Mortality Neonatal_Mortality Under5_Mortality Maternal_Mortality
1               5.3                3.8              6.2                 9
2               5.3                3.8              6.2                10
3               5.3                3.9              6.2                10
4               5.3                3.9              6.2                10
5               5.3                3.9              6.1                10
6               5.2                3.9              6.1                11
7               5.2                3.9              6.0                11
8               5.1                3.8              6.0                11
9               5.1                3.8              5.9                12
10              5.0                3.8              5.8                12
11              5.0                3.8              5.7                11
12              4.9                3.7              5.7                11
13              4.9                3.7              5.6                11
14              4.8                3.6              5.5                11
```

```
15              4.7               3.6              5.4                11
16              4.7               3.6              5.4                11
17              4.6               3.5              5.3                10
18              4.6               3.4              5.2                10
19              4.5               3.3              5.1                NA
20              4.4               3.3              5.1                NA
   drought earthquake
1        0          0
2        0          0
3        0          0
4        0          0
5        0          0
6        0          0
7        0          0
8        0          0
9        0          0
10       0          0
11       0          0
12       0          0
13       0          0
14       0          0
15       0          0
16       0          0
17       0          0
18       0          0
19       0          0
20       0          0
```

```
#Check observations from Ecuador

finaldata %>%
dplyr::filter(country_name == "Ecuador")
```

```
   country_name ISO                          region Year  gdp1000 OECD OECD2023
1       Ecuador ECU Latin America and the Caribbean 2000 1.451531    0        0
2       Ecuador ECU Latin America and the Caribbean 2001 1.904814    0        0
3       Ecuador ECU Latin America and the Caribbean 2002 2.184209    0        0
4       Ecuador ECU Latin America and the Caribbean 2003 2.438344    0        0
5       Ecuador ECU Latin America and the Caribbean 2004 2.703566    0        0
6       Ecuador ECU Latin America and the Caribbean 2005 3.014310    0        0
7       Ecuador ECU Latin America and the Caribbean 2006 3.340841    0        0
8       Ecuador ECU Latin America and the Caribbean 2007 3.579032    0        0
```

9	Ecuador	ECU	Latin America and the Caribbean	2008	4.260433	0	0		
10	Ecuador	ECU	Latin America and the Caribbean	2009	4.240703	0	0		
11	Ecuador	ECU	Latin America and the Caribbean	2010	4.640246	0	0		
12	Ecuador	ECU	Latin America and the Caribbean	2011	5.202656	0	0		
13	Ecuador	ECU	Latin America and the Caribbean	2012	5.678456	0	0		
14	Ecuador	ECU	Latin America and the Caribbean	2013	6.050355	0	0		
15	Ecuador	ECU	Latin America and the Caribbean	2014	6.374631	0	0		
16	Ecuador	ECU	Latin America and the Caribbean	2015	6.130587	0	0		
17	Ecuador	ECU	Latin America and the Caribbean	2016	6.079089	0	0		
18	Ecuador	ECU	Latin America and the Caribbean	2017	6.246404	0	0		
19	Ecuador	ECU	Latin America and the Caribbean	2018	6.321349	0	0		
20	Ecuador	ECU	Latin America and the Caribbean	2019	6.233258	0	0		

	popdens	urban	agedep	male_edu	temp	rainfall1000	totdeath	armconf1
1	23.27432	36.19963	67.44216	7.738627	19.54855	1.4201653	0	0
2	23.39372	36.67994	66.57356	7.843942	19.66622	1.1667746	0	0
3	23.52087	37.08903	65.65488	7.949449	20.24695	1.4577981	2	0
4	23.58358	37.23792	64.71472	8.055240	20.05016	1.5781807	0	0
5	38.43743	37.39268	63.78049	8.161433	20.10136	1.0683450	26	1
6	38.55361	37.36968	62.86530	8.268176	19.88163	0.8555447	0	0
7	38.65018	37.47567	61.97042	8.375587	20.07087	1.1114502	0	0
8	38.76505	37.68172	61.11422	8.483729	19.49536	1.0899082	0	0
9	38.83977	37.67445	60.31015	8.592603	19.85711	1.6184816	0	0
10	38.92613	37.39437	59.55262	8.702180	20.39298	1.0870796	25	1
11	39.03066	37.26838	58.83793	8.812409	20.11160	1.7045703	0	0
12	39.09586	37.61553	58.16553	8.923172	19.86633	1.4518388	0	0
13	39.13343	38.00733	57.51051	9.034284	20.19000	1.7520003	0	0
14	39.18619	38.22511	56.84804	9.145523	19.85177	1.3735605	0	0
15	39.27871	38.12421	56.17001	9.256679	20.42252	1.2572257	0	0
16	39.38824	38.15633	55.46511	9.367582	20.95595	1.7284273	0	0
17	39.46201	38.45745	54.73369	9.478071	20.77476	1.3168761	0	0
18	39.53609	38.65993	53.99096	9.587993	20.53262	1.9544485	0	0
19	39.58380	38.87253	53.12249	9.697221	20.53714	1.9573265	0	0
20	39.75109	39.05144	52.29278	9.805670	20.54169	1.9602443	0	0

	Infant_Mortality	Neonatal_Mortality	Under5_Mortality	Maternal_Mortality
1	24.7	14.1	29.5	122
2	23.4	13.4	28.0	117
3	22.4	12.7	26.6	110
4	21.5	12.1	25.4	100
5	20.7	11.6	24.4	94
6	19.9	11.1	23.5	94
7	19.2	10.6	22.6	90
8	18.5	10.2	21.7	85
9	17.7	9.7	20.8	82

```
10             17.0                9.3             19.9                 80
11             16.3                8.9             19.0                 78
12             15.6                8.5             18.1                 76
13             14.9                8.1             17.3                 71
14             14.3                7.8             16.6                 67
15             13.7                7.5             15.9                 65
16             13.2                7.3             15.4                 63
17             12.8                7.1             14.8                 61
18             12.4                6.9             14.4                 59
19             12.0                6.9             13.9                 NA
20             11.6                6.8             13.4                 NA
   drought earthquake
1        0          0
2        0          0
3        0          0
4        0          0
5        0          0
6        0          0
7        0          0
8        0          0
9        0          0
10       1          0
11       0          0
12       0          0
13       0          0
14       1          0
15       0          1
16       0          0
17       0          1
18       0          0
19       0          0
20       0          1
```

```
summary(finaldata)
```

```
 country_name           ISO               region              Year
 Length:3720        Length:3720        Length:3720        Min.   :2000
 Class :character   Class :character   Class :character   1st Qu.:2005
 Mode  :character   Mode  :character   Mode  :character   Median :2010
                                                          Mean   :2010
                                                          3rd Qu.:2014
                                                          Max.   :2019
```

```
   gdp1000              OECD          OECD2023         popdens
Min.   :  0.1105   Min.   :0.000   Min.   :0.0000   Min.   : 0.00
1st Qu.:  1.2383   1st Qu.:0.000   1st Qu.:0.0000   1st Qu.:14.79
Median :  4.0719   Median :0.000   Median :0.0000   Median :27.52
Mean   : 11.4917   Mean   :0.171   Mean   :0.1882   Mean   :30.57
3rd Qu.: 13.1531   3rd Qu.:0.000   3rd Qu.:0.0000   3rd Qu.:40.72
Max.   :123.6787   Max.   :1.000   Max.   :1.0000   Max.   :99.86
NA's   :62                                          NA's   :20
    urban             agedep          male_edu          temp
Min.   : 0.1025   Min.   : 16.17   Min.   : 1.067   Min.   :-2.405
1st Qu.:17.2872   1st Qu.: 47.94   1st Qu.: 5.904   1st Qu.:12.928
Median :30.2535   Median : 55.51   Median : 8.368   Median :21.958
Mean   :30.6948   Mean   : 61.94   Mean   : 8.258   Mean   :19.625
3rd Qu.:41.6558   3rd Qu.: 77.11   3rd Qu.:10.849   3rd Qu.:25.869
Max.   :93.4135   Max.   :111.48   Max.   :14.441   Max.   :29.676
NA's   :20                         NA's   :20       NA's   :20
 rainfall1000        totdeath          armconf1      Infant_Mortality
Min.   :0.01993   Min.   :    0.0   Min.   :0.0000   Min.   :  1.60
1st Qu.:0.59146   1st Qu.:    0.0   1st Qu.:0.0000   1st Qu.:  7.60
Median :1.01288   Median :    0.0   Median :0.0000   Median : 18.90
Mean   :1.20216   Mean   :  361.1   Mean   :0.1892   Mean   : 28.90
3rd Qu.:1.68706   3rd Qu.:    2.0   3rd Qu.:0.0000   3rd Qu.: 44.52
Max.   :4.71081   Max.   :78644.0   Max.   :1.0000   Max.   :138.10
NA's   :20                                           NA's   :20
Neonatal_Mortality Under5_Mortality Maternal_Mortality    drought
Min.   : 0.80      Min.   :  2.00   Min.   :   2.0     Min.   :0.00000
1st Qu.: 4.90      1st Qu.:  9.00   1st Qu.:  17.0     1st Qu.:0.00000
Median :12.10      Median : 22.20   Median :  66.0     Median :0.00000
Mean   :16.18      Mean   : 40.50   Mean   : 210.6     Mean   :0.08737
3rd Qu.:25.32      3rd Qu.: 61.33   3rd Qu.: 299.8     3rd Qu.:0.00000
Max.   :60.90      Max.   :224.90   Max.   :2480.0     Max.   :1.00000
NA's   :20         NA's   :20       NA's   :426
  earthquake
Min.   :0.00000
1st Qu.:0.00000
Median :0.00000
Mean   :0.08333
3rd Qu.:0.00000
Max.   :1.00000
```

```r
#missing data
sapply(finaldata, function(x) sum(is.na(x)))
```

```
      country_name                ISO             region               Year
                 0                  0                  0                  0
           gdp1000               OECD          OECD2023            popdens
                62                  0                  0                 20
             urban             agedep           male_edu               temp
                20                  0                 20                 20
      rainfall1000           totdeath           armconf1   Infant_Mortality
                20                  0                  0                 20
Neonatal_Mortality   Under5_Mortality Maternal_Mortality           drought
                20                 20                426                  0
        earthquake
                 0
```

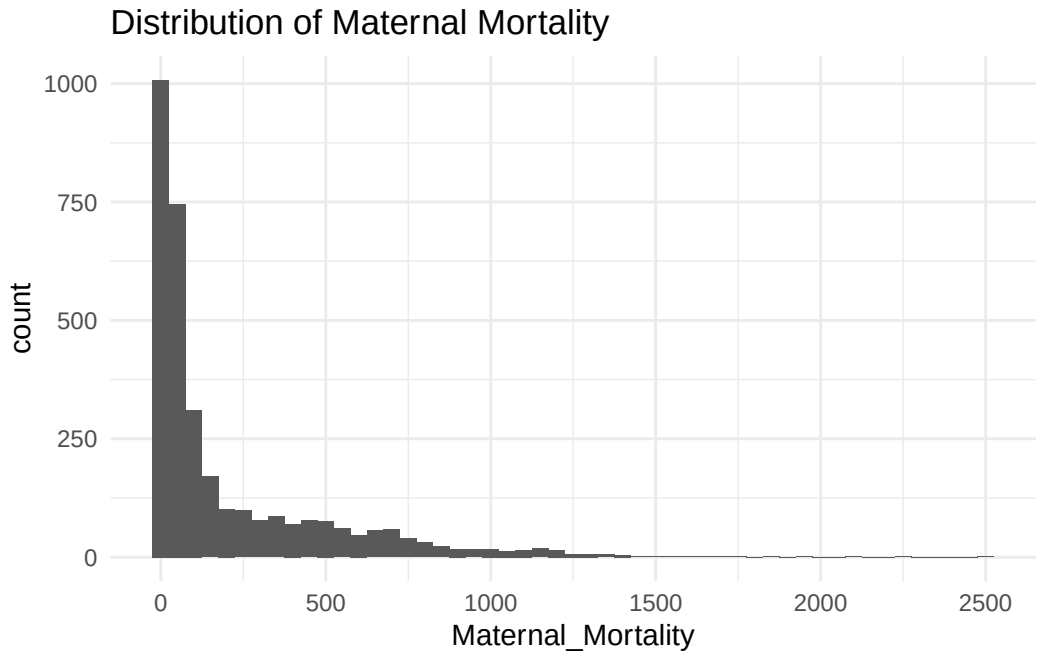
```r
#Identify countries with 20 missing values

missing_summary <- finaldata %>%
    select(country_name, ISO, Year,
           popdens, urban, male_edu, temp,
           rainfall1000, Infant_Mortality,
           Neonatal_Mortality, Under5_Mortality) %>%
    mutate(popdens_missing = is.na(popdens),
           urban_missing = is.na(urban),
           male_edu_missing = is.na(male_edu),
           temp_missing = is.na(temp),
           rainfall1000_missing = is.na(rainfall1000),
           Infant_Mortality_missing = is.na(Infant_Mortality),
           Neonatal_Mortality_missing = is.na(Neonatal_Mortality),
           Under5_Mortality_missing = is.na(Under5_Mortality)) %>%
    filter(popdens_missing | urban_missing | male_edu_missing |
           temp_missing | rainfall1000_missing |
           Infant_Mortality_missing | Neonatal_Mortality_missing |
           Under5_Mortality_missing) %>%
    select(country_name, ISO, Year,
           popdens_missing, urban_missing,
           male_edu_missing, temp_missing,
           rainfall1000_missing, Infant_Mortality_missing,
           Neonatal_Mortality_missing, Under5_Mortality_missing)
```

Missing data identified for all the variables. 20 missing values for each of the following variables: popdens, urban, male_edu, temp, rainfall1000, infant mortality, neonatal mortality, under5 mortality. In comparison, the variable gdp1000 has 62 missing values and maternal mortality has 426 missing values.

On further investigation, Cote d'Ivoire is the country with 20 missing values for the following variables: popdens, urban, male_edu, temp, & rainfall1000 from year 2000 to 2019. Puerto Rico is missing 20 values for infant, neonatal & under5 mortality from years 2000 to 2019.

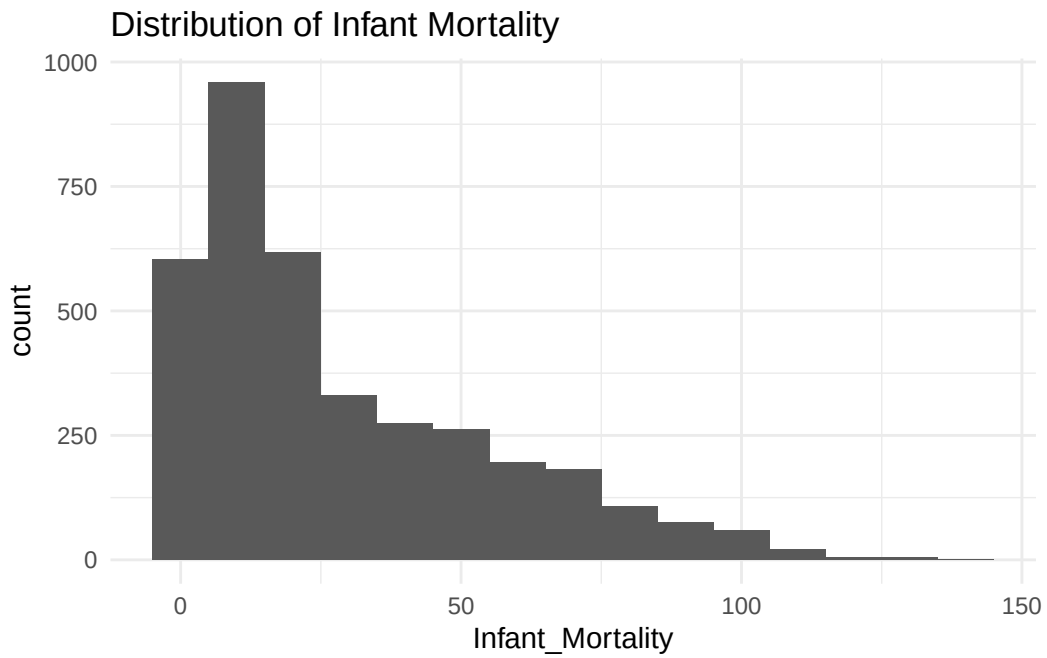
```
#Visualize distributions of mortality rates

ggplot(finaldata, aes(x=Maternal_Mortality)) +
  geom_histogram(binwidth=50) +
  theme_minimal() +
  labs(title="Distribution of Maternal Mortality")
```

```
Warning: Removed 426 rows containing non-finite outside the scale range
(`stat_bin()`).
```



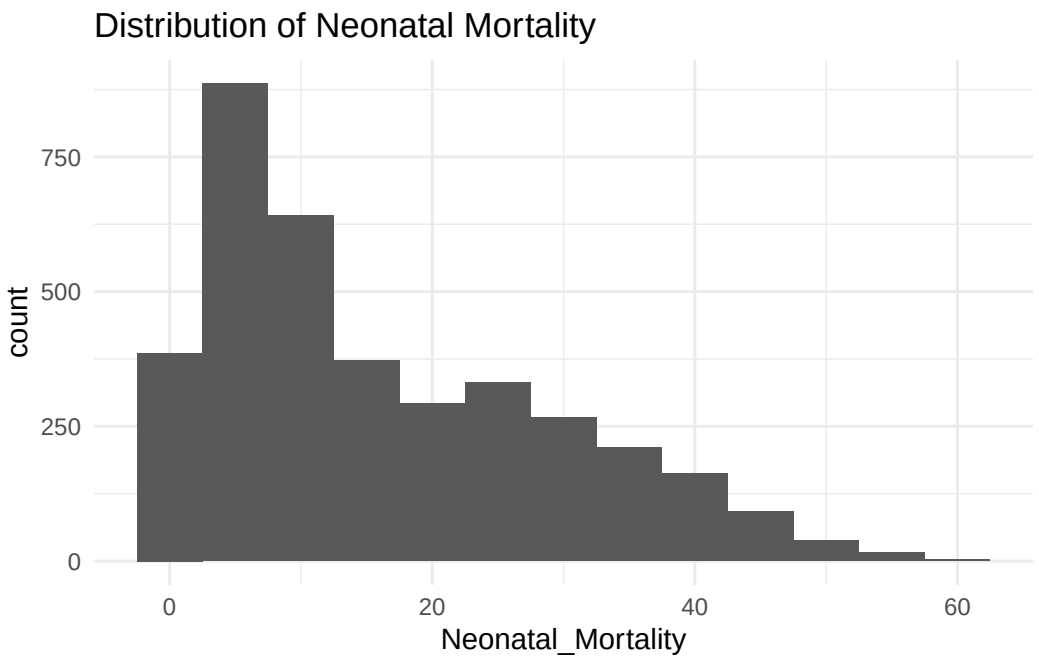

```
ggplot(finaldata, aes(x=Infant_Mortality)) +
  geom_histogram(binwidth=10) +
  theme_minimal() +
  labs(title="Distribution of Infant Mortality")
```

```
Warning: Removed 20 rows containing non-finite outside the scale range
(`stat_bin()`).
```



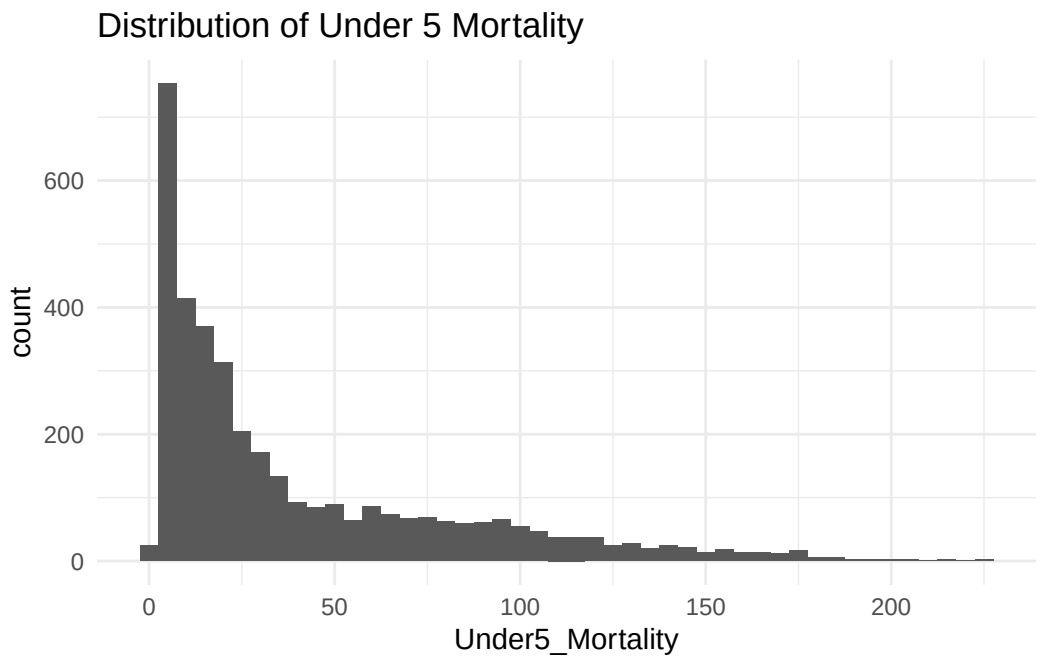

```
ggplot(finaldata, aes(x=Neonatal_Mortality)) +
  geom_histogram(binwidth=5) +
  theme_minimal() +
  labs(title="Distribution of Neonatal Mortality")
```

```
Warning: Removed 20 rows containing non-finite outside the scale range
(`stat_bin()`).
```



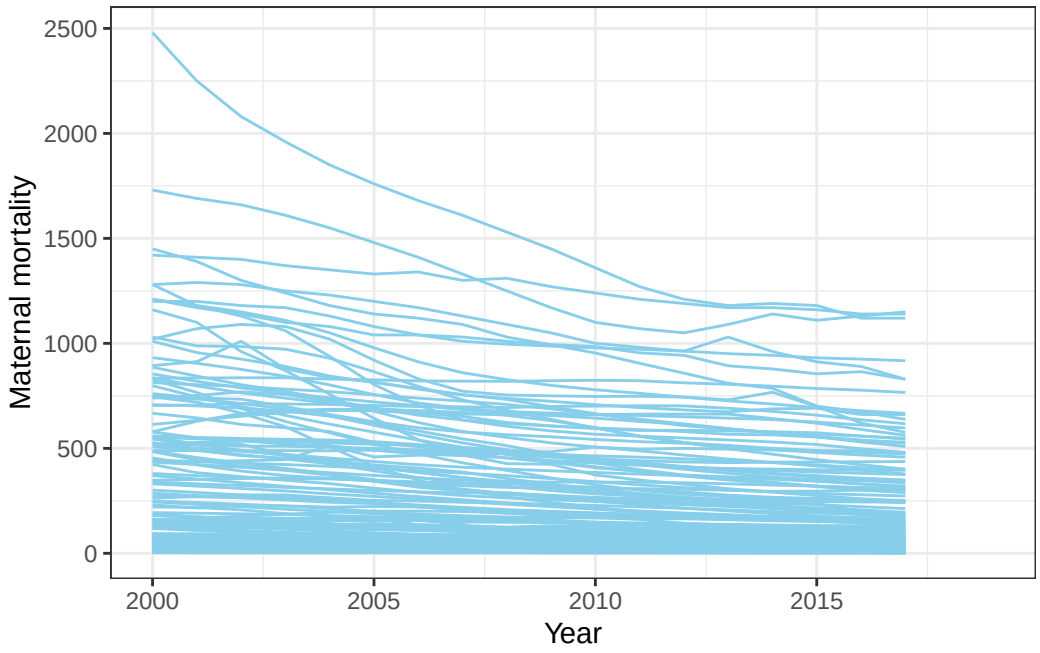

```
ggplot(finaldata, aes(x=Under5_Mortality)) +
  geom_histogram(binwidth=5) +
  theme_minimal() +
  labs(title="Distribution of Under 5 Mortality")
```

```
Warning: Removed 20 rows containing non-finite outside the scale range
(`stat_bin()`).
```



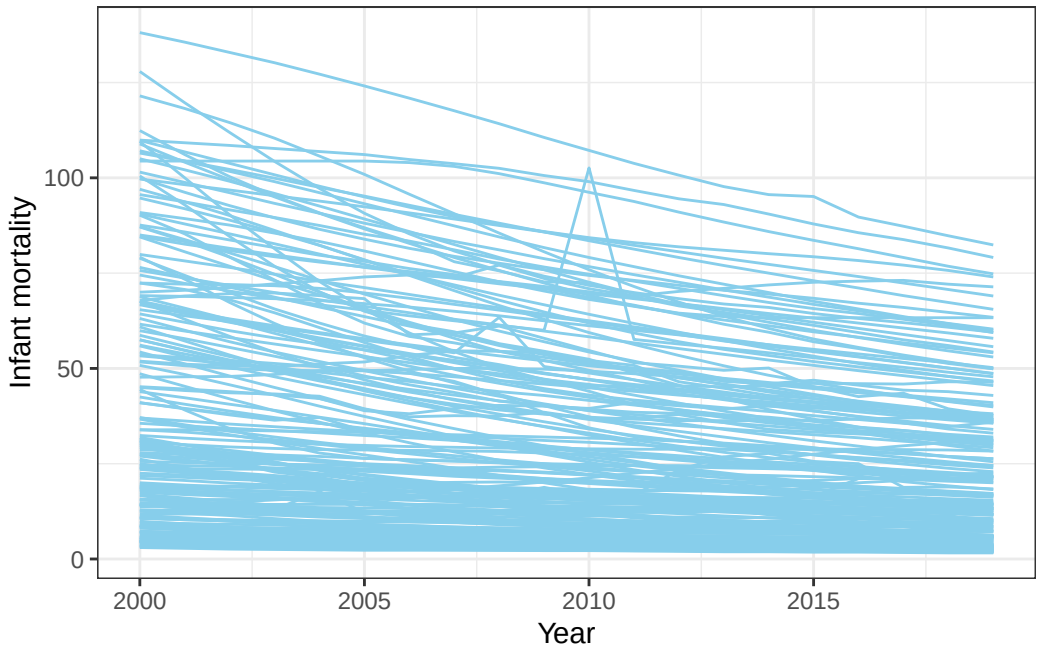

```
#Visualize mortality trends 2000-2019

#Maternal Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Maternal_Mortality, group = ISO)) +
  geom_line(color = "skyblue") +
  xlim(c(2000,2019)) +
  labs(y = "Maternal mortality", x = "Year") +
  theme_bw()
```

```
Warning: Removed 426 rows containing missing values or values outside the scale range
(`geom_line()`).
```



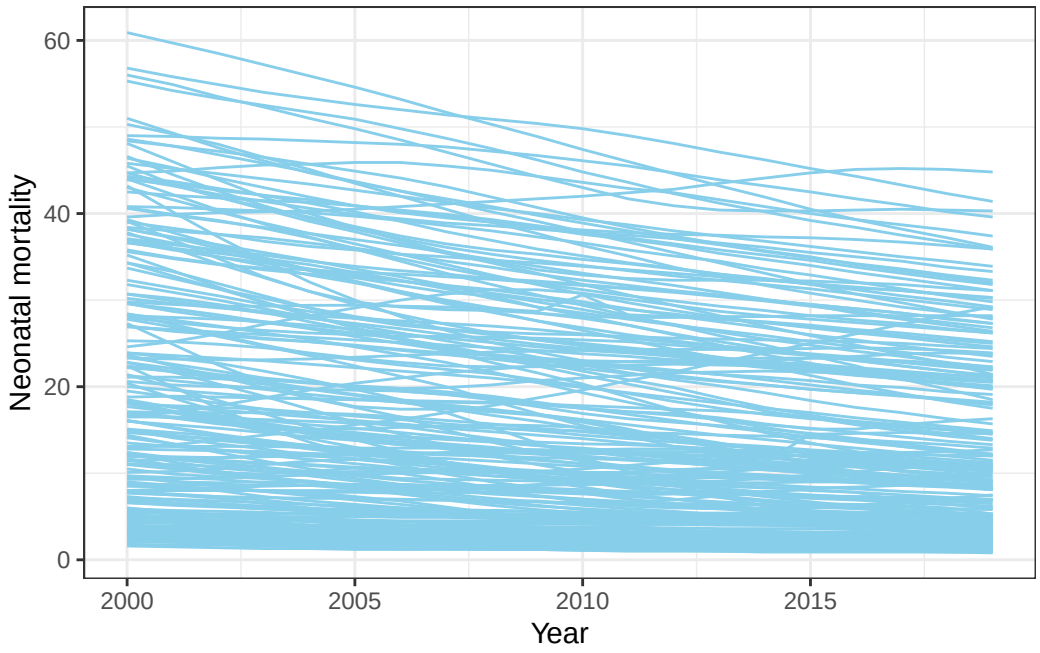

```
#Infant Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Infant_Mortality, group = ISO)) +
  geom_line(color = "skyblue") +
  xlim(c(2000,2019)) +
  labs(y = "Infant mortality", x = "Year") +
  theme_bw()
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```




```
#Neonatal Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Neonatal_Mortality, group = ISO)) +
  geom_line(color = "skyblue") +
  xlim(c(2000,2019)) +
  labs(y = "Neonatal mortality", x = "Year") +
  theme_bw()
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```



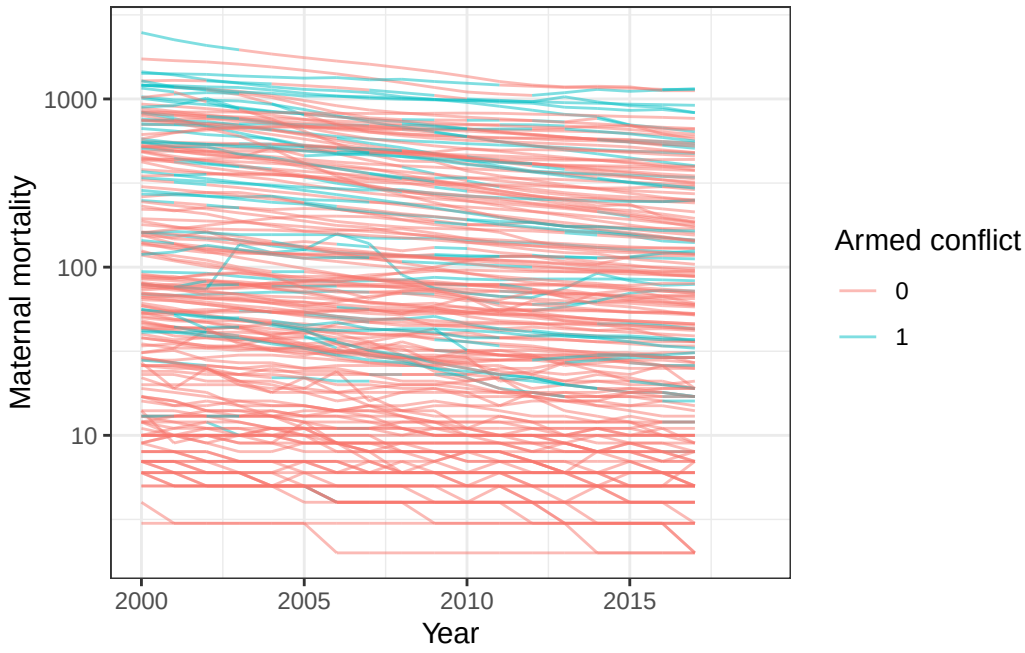

```
#Under 5 Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Under5_Mortality, group = ISO)) +
  geom_line(color = "skyblue") +
  xlim(c(2000,2019)) +
  labs(y = "Under 5 mortality", x = "Year") +
  theme_bw()
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```

The infant mortality trend graph shows a steep peak in mortality from 2009 to 2010 followed by a steep decline from 2010 to 2011. No discernible pattern for neonatal mortality. Similar peak and decline noticed for under 5 mortality as the infant mortality graph.

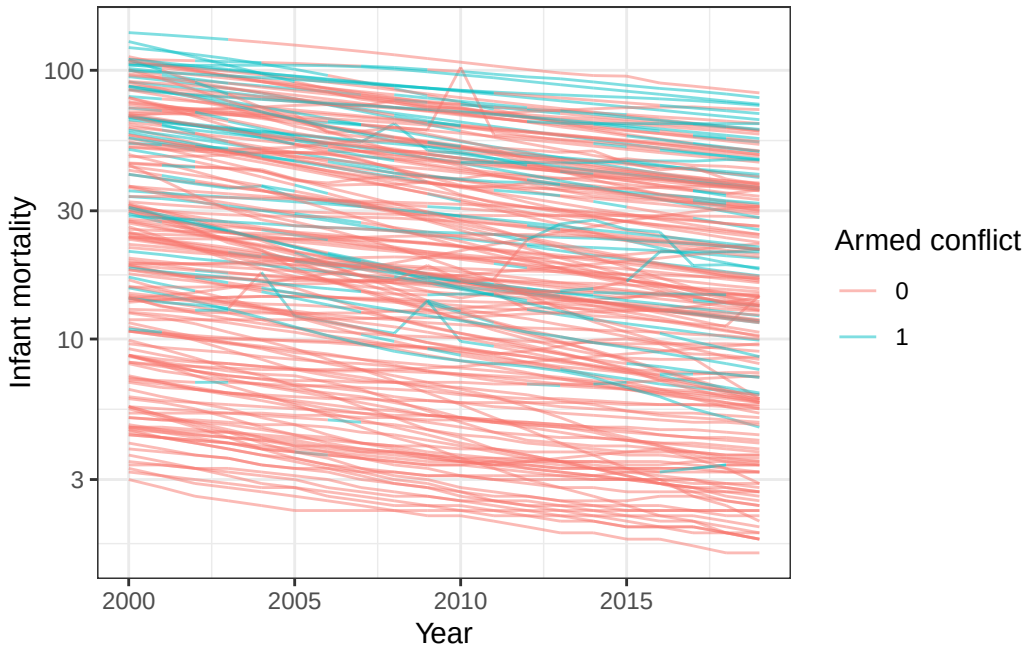
```
#Visualize mortality trends by armed conflict status

#Maternal Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Maternal_Mortality, group = ISO)) +
  geom_line(aes(color = as.factor(armconf1)), alpha = 0.5) +
  xlim(c(2000,2019)) +
  scale_y_continuous(trans='log10') +
  labs(y = "Maternal mortality", x = "Year", color = "Armed conflict") +
  theme_bw()
```

```
Warning: Removed 426 rows containing missing values or values outside the scale range
(`geom_line()`).
```



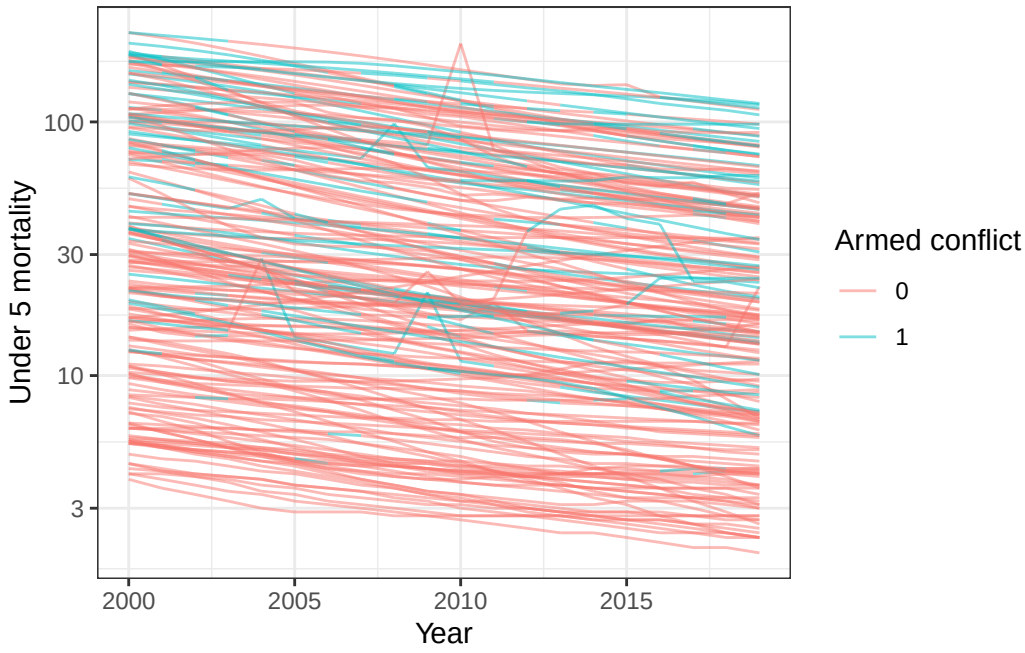

```
#Infant Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Infant_Mortality, group = ISO)) +
  geom_line(aes(color = as.factor(armconf1)), alpha = 0.5) +
  xlim(c(2000,2019)) +
  scale_y_continuous(trans='log10') +
  labs(y = "Infant mortality", x = "Year", color = "Armed conflict") +
  theme_bw()
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```



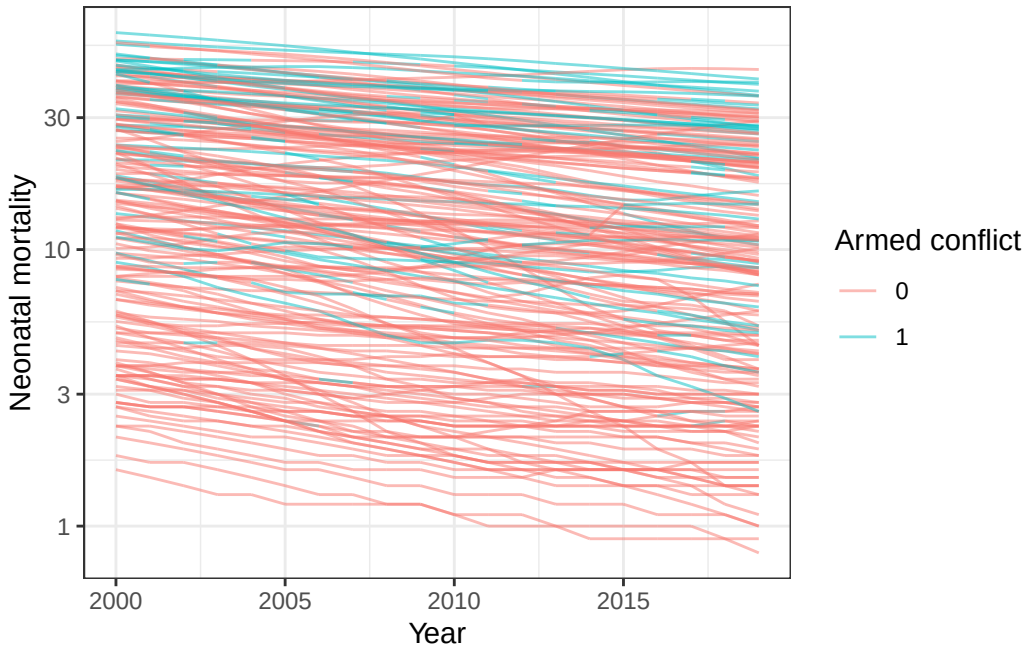

```
#Under 5 Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Under5_Mortality, group = ISO)) +
  geom_line(aes(color = as.factor(armconf1)), alpha = 0.5) +
  xlim(c(2000,2019)) +
  scale_y_continuous(trans='log10') +
  labs(y = "Under 5 mortality", x = "Year", color = "Armed conflict") +
  theme_bw()
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```




```
#Neonatal Mortality

finaldata %>%
  ggplot(aes(x = Year, y = Neonatal_Mortality, group = ISO)) +
  geom_line(aes(color = as.factor(armconf1)), alpha = 0.5) +
  xlim(c(2000,2019)) +
  scale_y_continuous(trans='log10') +
  labs(y = "Neonatal mortality", x = "Year", color = "Armed conflict") +
  theme_bw()
```

```
Warning: Removed 20 rows containing missing values or values outside the scale range
(`geom_line()`).
```



Similar trends observed for all 4 mortality outcomes, the highest mortality rates are observed where armed conflict is present.