Week 1: Intro to demographic concepts

SOC6708 ADA

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Read in the data

All these data come from the UN World Population Prospects 2024.

Packages:

```
library(tidyverse)
library(here)
library(readxl)
library(janitor)
```

Population data:

```
d_male <- read_xlsx(here("data/WPP2024_POP_F01_2_POPULATION_SINGLE_AGE_MALE.xlsx"), skip = 16
d_male$sex <- "Male"
d_male <- d_male |> drop_na(Year)
d_female <- read_xlsx(here("data/WPP2024_POP_F01_3_POPULATION_SINGLE_AGE_FEMALE.xlsx"), skip
d_female$sex <- "Female"
d_female <- d_female |> drop_na(Year)

d <- rbind(d_male, d_female)
rm(d_male, d_female)

d <- d  |>
  clean_names() |>
  select(region_subregion_country_or_area, iso3_alpha_code, year, x0:sex) |>
  rename(region = region_subregion_country_or_area) |>
  mutate(across(x0:x100, as.numeric))

head(d)
```

```
# A tibble: 6 x 105
  region iso3_alpha_code  year     x0     x1     x2     x3     x4     x5     x6
  <chr>  <lgl>           <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>  <dbl>
1 World  NA               1950 41603. 36997. 34245. 32359. 30007. 28065. 27335.
2 World  NA               1951 42615. 38588. 35577. 33456. 31876. 29664. 27829.
3 World  NA               1952 43984. 39615. 37182. 34798. 32980. 31545. 29427.
4 World  NA               1953 45183. 41001. 38243. 36421. 34326. 32646. 31320.
5 World  NA               1954 45934. 42199. 39641. 37489. 35955. 33999. 32422.
6 World  NA               1955 47059. 42972. 40848. 38889. 37023. 35636. 33784.
# i 95 more variables: x7 <dbl>, x8 <dbl>, x9 <dbl>, x10 <dbl>, x11 <dbl>,
#   x12 <dbl>, x13 <dbl>, x14 <dbl>, x15 <dbl>, x16 <dbl>, x17 <dbl>,
#   x18 <dbl>, x19 <dbl>, x20 <dbl>, x21 <dbl>, x22 <dbl>, x23 <dbl>,
#   x24 <dbl>, x25 <dbl>, x26 <dbl>, x27 <dbl>, x28 <dbl>, x29 <dbl>,
#   x30 <dbl>, x31 <dbl>, x32 <dbl>, x33 <dbl>, x34 <dbl>, x35 <dbl>,
#   x36 <dbl>, x37 <dbl>, x38 <dbl>, x39 <dbl>, x40 <dbl>, x41 <dbl>,
#   x42 <dbl>, x43 <dbl>, x44 <dbl>, x45 <dbl>, x46 <dbl>, x47 <dbl>, ...
```

Mortality data:

```
d_male <- read_xlsx(here("data/WPP2024_MORT_F01_2_DEATHS_SINGLE_AGE_MALE.xlsx"), skip = 16)
d_male$sex <- "Male"
d_male <- d_male |> drop_na(Year)
d_female <- read_xlsx(here("data/WPP2024_MORT_F01_3_DEATHS_SINGLE_AGE_FEMALE.xlsx"), skip = 
d_female$sex <- "Female"
d_female <- d_female |> drop_na(Year)

dm <- rbind(d_male, d_female)
rm(d_male, d_female)

dm <- dm  |>
  clean_names() |>
  select(region_subregion_country_or_area, iso3_alpha_code, year, x0:sex) |>
  rename(region = region_subregion_country_or_area) |>
  mutate(across(x0:x100, as.numeric))

head(dm)
```

```
# A tibble: 6 x 105
  region iso3_alpha_code  year    x0    x1    x2    x3    x4    x5    x6    x7
  <chr>  <lgl>           <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl> <dbl>
1 World  NA               1950 6779. 1815.  967.  588.  380.  255.  183.  142.
2 World  NA               1951 6780. 1796.  968.  582.  382.  257.  181.  138.
```

```
3 World  NA                1952 6867. 1743.  943.  578.  375.  252.  176.  132.
4 World  NA                1953 6831. 1726.  933.  572.  379.  264.  191.  142.
5 World  NA                1954 6841. 1706.  928.  568.  375.  252.  180.  136.
6 World  NA                1955 6815. 1663.  917.  566.  373.  256.  181.  137.
# i 94 more variables: x8 <dbl>, x9 <dbl>, x10 <dbl>, x11 <dbl>, x12 <dbl>,
#   x13 <dbl>, x14 <dbl>, x15 <dbl>, x16 <dbl>, x17 <dbl>, x18 <dbl>,
#   x19 <dbl>, x20 <dbl>, x21 <dbl>, x22 <dbl>, x23 <dbl>, x24 <dbl>,
#   x25 <dbl>, x26 <dbl>, x27 <dbl>, x28 <dbl>, x29 <dbl>, x30 <dbl>,
#   x31 <dbl>, x32 <dbl>, x33 <dbl>, x34 <dbl>, x35 <dbl>, x36 <dbl>,
#   x37 <dbl>, x38 <dbl>, x39 <dbl>, x40 <dbl>, x41 <dbl>, x42 <dbl>,
#   x43 <dbl>, x44 <dbl>, x45 <dbl>, x46 <dbl>, x47 <dbl>, x48 <dbl>, ...
```

Crude Rates

Calculate the crude death rates for Kenya and Canada in 2023

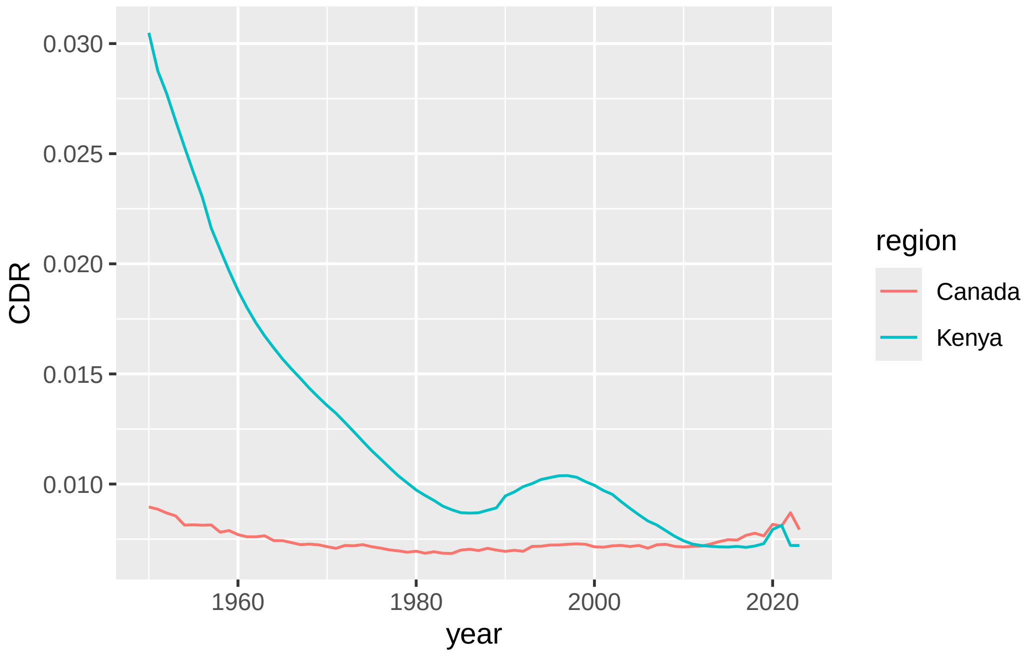
```r
# get total populations across all age and sex
total_pops <- d  |>
  filter(region=="Kenya"|region=="Canada") |>
  pivot_longer(x0:x100, names_to = "age", values_to = "pop") |>
  mutate(age = as.numeric(str_remove(age, "x"))) |>
  group_by(region, year) |>
  summarize(total_pop = sum(pop))

# get total deaths

total_deaths <- dm  |>
  filter(region=="Kenya"|region=="Canada") |>
  pivot_longer(x0:x100, names_to = "age", values_to = "deaths") |>
  mutate(age = as.numeric(str_remove(age, "x"))) |>
  group_by(region, year) |>
  summarize(total_deaths = sum(deaths))

# join these

total_pops |>
  left_join(total_deaths) |>
  mutate(CDR = total_deaths/total_pop) |>
  ggplot(aes(year, CDR, color = region)) +
  geom_line()
```




```
total_pops |>
  left_join(total_deaths) |>
  mutate(CDR = total_deaths/total_pop) |>
  filter(year==2023)
```

```
# A tibble: 2 x 5
# Groups:   region [2]
  region   year total_pop total_deaths     CDR
  <chr>   <dbl>     <dbl>        <dbl>   <dbl>
1 Canada   2023    39299.         312. 0.00793
2 Kenya    2023    55339.         399. 0.00721
```

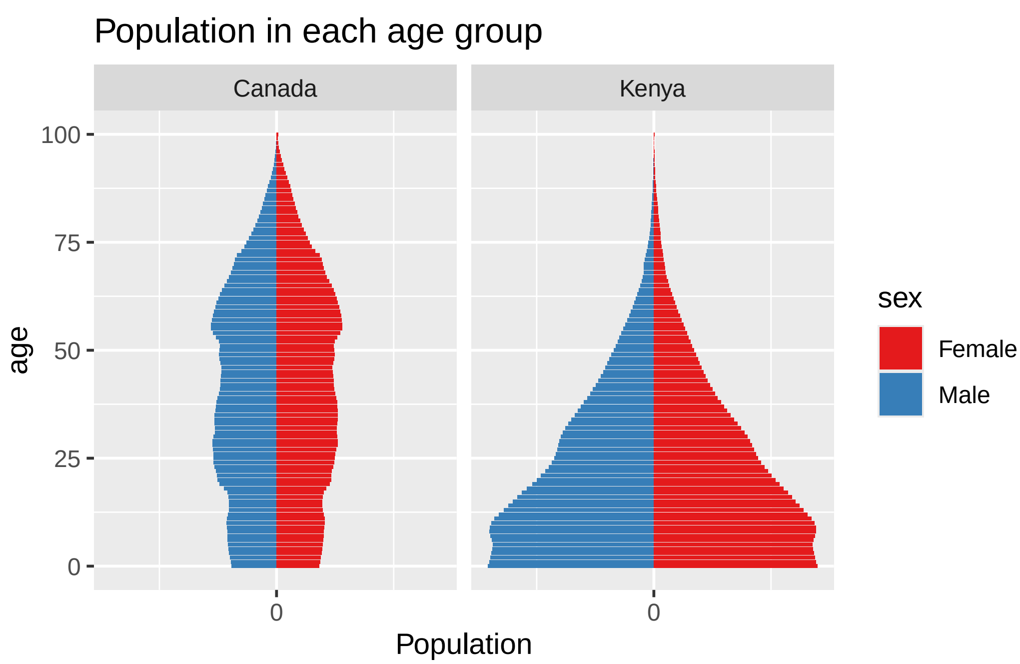
Population Pyramids

Population age structures of Kenya and Canada in 2019:

```
d_long <- d  |>
  pivot_longer(x0:x100, names_to = "age", values_to = "pop") |>
  mutate(age = as.numeric(str_remove(age, "x")))

d_long|>
```

```r
  filter(region=="Kenya"|region=="Canada", year == 2019)  |>
  mutate(population=ifelse(sex=="Male", -pop, pop)) |>
ggplot(aes(x = age, y = population, fill = sex)) +
  facet_wrap(~region)+
  geom_bar(stat="identity")+
  ggtitle("Population in each age group")+
  ylab("Population")+
  coord_flip() +
  scale_y_continuous(breaks = seq(-4000, 4000, 1000),
                     labels = c(seq(4000, 0, -1000), seq(1000, 4000, 1000))) +
  scale_fill_brewer(palette = "Set1")
```

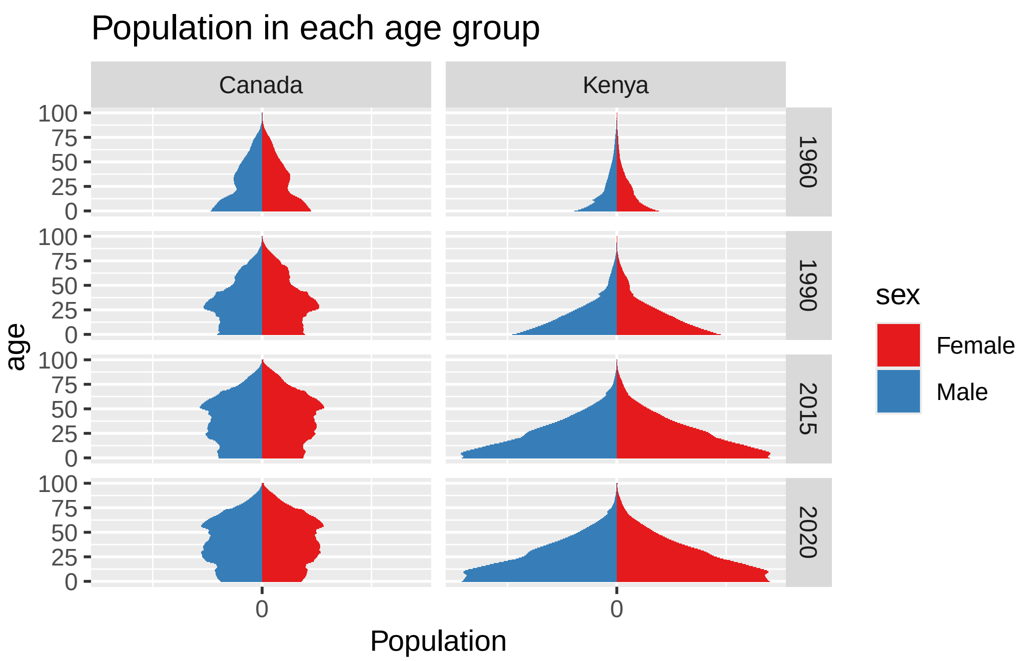



```r
ggsave(here("plots", "CAN_KEN_pyramid.pdf"))
```

Change in age structures over time:

```r
d_long |>
  filter(region=="Kenya"|region=="Canada", year%in% c(1960, 1990, 2015, 2020))  |>
  mutate(population=ifelse(sex=="Male", -pop, pop)) %>%
ggplot(aes(x = age, y = population, fill = sex)) +
  facet_grid(year~region)+
  geom_bar(stat="identity")+
```

```
  ggtitle("Population in each age group")+
  ylab("Population")+
  coord_flip() +
  scale_y_continuous(breaks = seq(-4000, 4000, 1000),
                     labels = c(seq(4000, 0, -1000), seq(1000, 4000, 1000))) +
  scale_fill_brewer(palette = "Set1")
```




```
ggsave(here("plots", "CAN_KEN_pyramid_time.pdf"))
```

Age-specific rates

Create and plot age-specific mortality rates (across both sexes)

```
pops <- d_long

dm_long <- dm  |>
  pivot_longer(x0:x100, names_to = "age", values_to = "deaths") |>
  mutate(age = as.numeric(str_remove(age, "x")))

# join these two tibbles and calculate rates
```

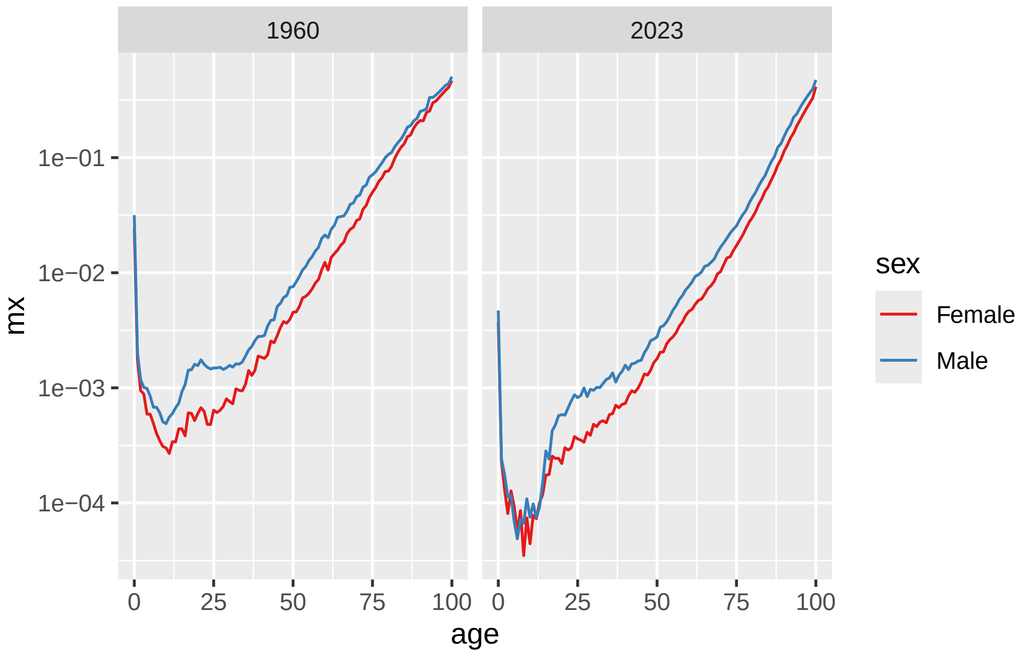
```
asmr <- d_long |>
  left_join(dm_long) |>
  mutate(mx = deaths/pop)

head(asmr)
```

```
# A tibble: 6 x 8
  region iso3_alpha_code  year sex     age    pop deaths      mx
  <chr>  <lgl>           <dbl> <chr> <dbl>  <dbl>  <dbl>   <dbl>
1 World  NA               1950 Male      0 41603.  6779. 0.163
2 World  NA               1950 Male      1 36997.  1815. 0.0491
3 World  NA               1950 Male      2 34245.   967. 0.0282
4 World  NA               1950 Male      3 32359.   588. 0.0182
5 World  NA               1950 Male      4 30007.   380. 0.0127
6 World  NA               1950 Male      5 28065.   255. 0.00909
```

Mortality rates for Canada

```
asmr |>
  filter(region == "Canada", year %in% c(1960, 2023)) |>
  ggplot(aes(age, mx, color = sex)) +
  geom_line()+
  scale_y_log10()+
  facet_wrap(~year)+
  labs("Age- and sex-specific mortality rates for Canada")+
  scale_color_brewer(palette = "Set1")
```




```
ggsave(here("plots", "CAN_mortality.pdf"), width = 6, height = 4)
```

Age-standardized rates

What would Kenya mortality look like in 2023 with Canada's age structure?

```
kenya_2023 <- asmr |>
  filter(year==2023, region=="Kenya")  |>
  rename(kpop = pop, kdeath = deaths, kmx = mx) |>
  select(-region)

canada_2023 <- asmr |>
  ungroup() |>
  filter(year==2023, region=="Canada")  |>
  rename(cpop = pop, cdeath = deaths, cmx = mx) |>
  select(-region, -age, -year, -sex, -iso3_alpha_code)

kc_2023 <- bind_cols(kenya_2023, canada_2023)

# now calculate age-standardized rates using canada's population

kc_2023  |>
```

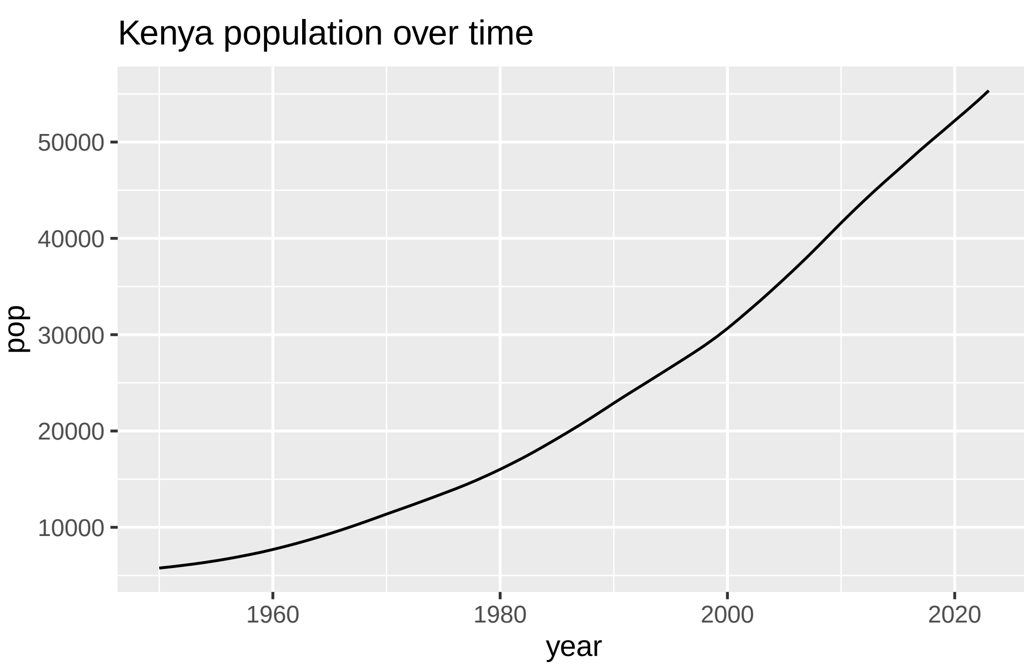
```
  mutate(std_deaths_kenya = cpop*kmx,
         std_deaths_canada = cpop*cmx) |>
  summarise(std_rate_kenya = sum(std_deaths_kenya)/sum(cpop),
            std_rate_canada = sum(std_deaths_canada)/sum(cpop))
```

```
# A tibble: 1 x 2
  std_rate_kenya std_rate_canada
           <dbl>           <dbl>
1         0.0223         0.00793
```

Population Growth

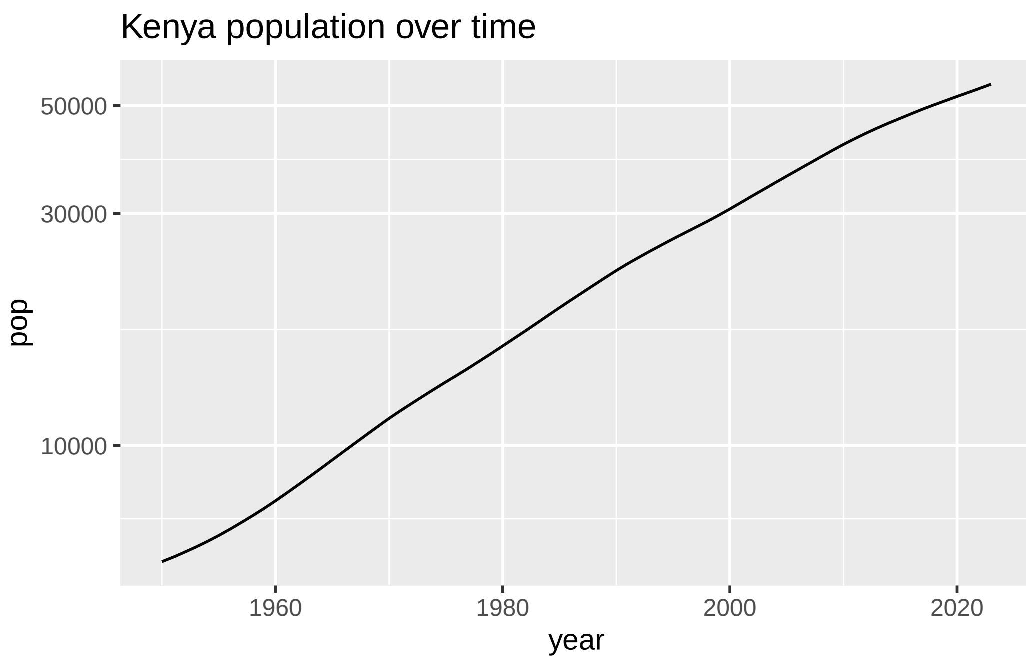
Plot Kenya total population over time

```
d_long |>
  filter(region=="Kenya") |>
  group_by(year) |>
  summarize(pop = sum(pop)) |>
  ggplot(aes(year, pop)) +
  geom_line() +
  ggtitle("Kenya population over time")
```



What does the log look like?

```
d_long |>
  filter(region=="Kenya") |>
  group_by(year) |>
  summarize(pop = sum(pop)) |>
  ggplot(aes(year, pop)) +
  geom_line() +
  ggtitle("Kenya population over time")+
  scale_y_log10()
```




```
ggsave(here("plots", "KEN_pop.pdf"))
```

Pretty straight! Let's calculate the growth rate from 1950 to 2015. This is just the slope of the logged graph. It's about 3% per year.

```
d_long |>
  filter(region=="Kenya") |>
  group_by(year) |>
  summarize(pop = sum(pop)) |>
  mutate(log_pop = log(pop))|>
  summarise(growth_rate = (log_pop[year==2023] - log_pop[year==1950])/(2023-1950))
```

```
# A tibble: 1 x 1
  growth_rate
        <dbl>
1      0.0310
```

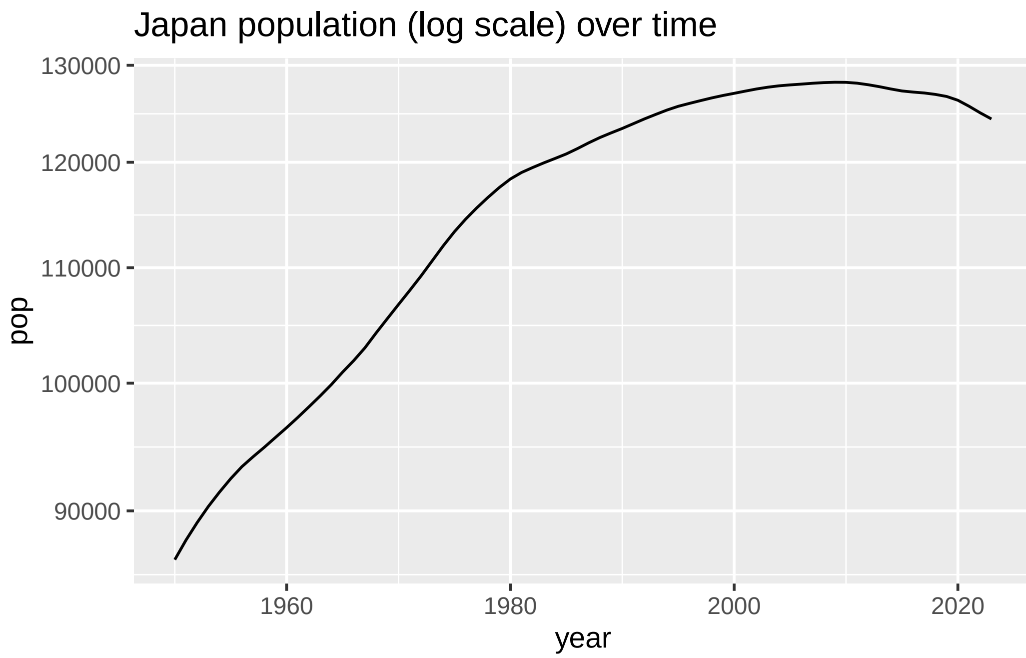
What about Canada? About half that.

```
d_long |>
  filter(region=="Canada") |>
  group_by(year) |>
  summarize(pop = sum(pop)) |>
  mutate(log_pop = log(pop))|>
  summarise(growth_rate = (log_pop[year==2023] - log_pop[year==1950])/(2023-1950))
```

```
# A tibble: 1 x 1
  growth_rate
        <dbl>
1      0.0144
```

Some countries have stagnated:

```
d_long |>
  filter(region=="Japan") |>
  group_by(year) |>
  summarize(pop = sum(pop)) |>
  ggplot(aes(year, pop)) + geom_line()+
  scale_y_log10()+
  ggtitle("Japan population (log scale) over time")
```



Questions

1. Pick two countries. Plot their population pyramids in 1960, 1990, and 2020.
2. Based on the shape and change in population pyramids in 1, do you think the population growth rate in each of your chosen countries is positive or negative in recent years?
3. Confirm your guesses in 2 by plotting population over time in both countries.
4. Taking the US population in 2000 as the standard population, calculate the standardized mortality rates for US in 2023 and Australia in 2023. How much higher was the death rate in US compared to Australia?