STAT 251 - Project

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Introduction

Between the years of 2000 and 2019, the World Health Organization (WHO) has collected data on causes of death in 183 countries. We are interested particularly in Cardiovascular Disease. The purpose of this analysis will be to determine if cardiovascular disease is a more prevalent cause of death in the United States than elsewhere, that is if the proportion of deaths due to cardiovascular disease is greater in the US than in other countries.

To do this, we will model the proportion of deaths due to cardiovascular disease in the United States as the probability of success of a binomial random variable, where the population consists of all deaths in the United States and a trial consists of sampling one death and determining whether or not the cause was cardiovascular disease. We will consider a success to be that the death was caused by cardiovascular disease and a failure that it was not. We will similarly model the proportion of deaths outside the United States caused by cardiovascular disease as the probability of success of a binomial random variable where the population is all deaths that occurred outside of the United States.

We will then determine an appropriate gamma prior distribution, which we will use for both data distributions; we will run a Bayesian update based on data from WHO; and we will compare the posterior distributions using Monte-Carlo methods. Based on the Monte-Carlo estimated posterior distribution for the difference in proportions, we will determine a 95% confidence interval and conclude whether the proportions are significantly different.

Data

Below is a summary of the data to be used. The variable `Total_Deaths` is the total number of deaths, measured in thousands of deaths, in that country during the time period of data collection. The variable `Cardio_Disease` is the number of those deaths that were caused by cardiovascular disease, also measured in thousands of deaths.

ID	Country	Cardio_Disease	Total_Deaths
1	AFG	71.26378	254.8099
2	ALB	19.4825	31.1542
3	DZA	91.51461	203.3004
…	…	…	…
175	USA	873.20014	2949.2139
…	…	…	…
182	ZMB	16.6686	121.1049
183	ZWE	17.3354	117.7098

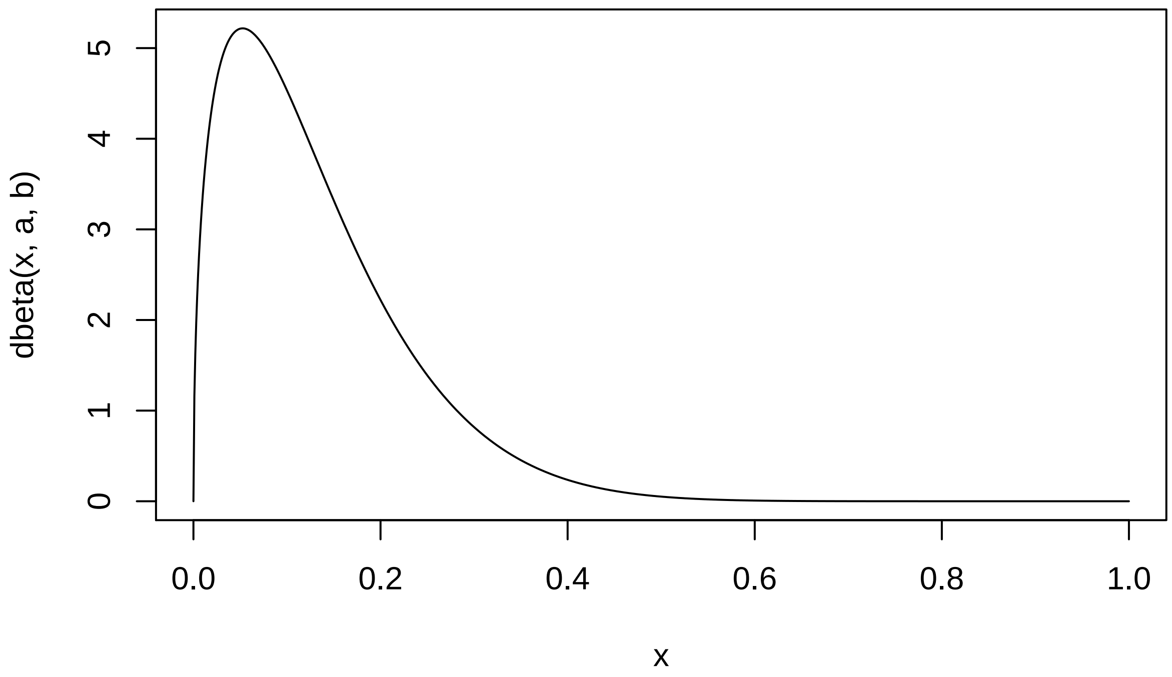
```
# A tibble: 8 x 4
  ID    Country Cardio_Disease Total_Deaths
  <chr> <chr>   <chr>          <chr>
1 1     AFG     71.26378       254.8099
2 2     ALB     19.4825        31.1542
3 3     DZA     91.51461       203.3004
4 ...   ...     ...            ...
5 175   USA     873.20014      2949.2139
6 ...   ...     ...            ...
7 182   ZMB     16.6686        121.1049
8 183   ZWE     17.3354        117.7098
```

	Min.	1st Qu.	Median	Mean	3rd Qu.	Max.
Cardio_Disease	0.1548	5.9390	17.5439	97.6165	59.7985	4306.536
Total_Deaths	0.6186	20.5604	72.8564	302.8184	187.4312	10105.596

We will make a comparison between the United States and all other countries, so we will summarize the data in just two rows.

Category	Cardio_Disease	Total_Deaths
USA	873200	2949214
OTH	16990627	52466558

Prior Distribution



Apendix A: Data Source

Global health estimates: Leading causes of death

Cause-specific mortality, 2000–2019

See Global summary estimates

https://www.who.int/data/gho/data/themes/mortality-and-global-health-estimates/ghe-leading-causes-of-death

Apendix B: Code

```r
library(knitr)
opts_chunk$set(echo = FALSE, comment=NA)

library(readxl)
library(tidyverse)
set.seed(3812)
# Read in the data
country_codes <- read_xlsx("deaths2019.xlsx",
          range = "’Deaths All ages’!H8:GH8",
          col_names = FALSE) %>%
  pivot_longer(everything(), names_to = "Names", values_to = "Country") %>%
  select(-Names)
cardio_disease_vals <- read_xlsx("deaths2019.xlsx",
          range = "’Deaths All ages!H148:GH148",
          col_names = FALSE) %>%
  pivot_longer(everything(), names_to = "Names", values_to = "Cardio_Disease") %>%
  select(-Names)
total_deaths_vals <- read_xlsx("deaths2019.xlsx",
          range = "’Deaths All ages!H11:GH11",
          col_names = FALSE) %>%
  pivot_longer(everything(), names_to = "Names", values_to = "Total_Deaths") %>%
  select(-Names)
cardio <- bind_cols(country_codes, cardio_disease_vals, total_deaths_vals)
##
?read_xlsx

cardio_tail <- cardio %>%
  rownames_to_column("ID") %>%
  tail(2) %>%
  mutate(Cardio_Disease = as.character(round(Cardio_Disease, 4)),
         Total_Deaths = as.character(round(Total_Deaths, 4)))
row_USA <- cardio %>%
  rownames_to_column("ID") %>%
  filter(Country == "USA") %>%
  mutate(Cardio_Disease = as.character(round(Cardio_Disease, 5)),
         Total_Deaths = as.character(round(Total_Deaths, 4)))
cardio_head <- cardio %>%
  rownames_to_column("ID") %>%
  head(3) %>%
  mutate(Cardio_Disease = as.character(round(Cardio_Disease, 5)),
         Total_Deaths = as.character(round(Total_Deaths, 4))) %>%
  add_row(ID = "...", Country = "...",
          Cardio_Disease = "...", Total_Deaths = "...") %>%
  add_row(row_USA) %>%
  add_row(ID = "...", Country = "...",
          Cardio_Disease = "...", Total_Deaths = "...") %>%
  bind_rows(cardio_tail)
kable(cardio_head, align = "c")
cardio_head
cardio_summ <- cardio$Cardio_Disease %>%
  summary() %>%
  as.matrix() %>%
  t()
death_summ <- cardio$Total_Deaths %>%
  summary() %>%
  as.matrix() %>%
  t()
overall_summ <- rbind(cardio_summ, death_summ) %>%
  round(4)
row.names(overall_summ) <- c("Cardio_Disease", "Total_Deaths")
kable(overall_summ, align = "c")
cardio_comp <- cardio %>%
  mutate(Category = fct_collapse(cardio$Country,
                                 USA = "USA",
                                 other_level = "OTH")) %>%
  group_by(Category) %>%
  summarise(Cardio_Disease = round(sum(Cardio_Disease) * 1000),
            Total_Deaths = sum(Total_Deaths) * 1000)
kable(cardio_comp, align = "c")

data <- cardio_comp %>%
  select(-Category) %>%
  as.matrix()
row.names(data) <- cardio_comp$Category
x <- seq(0, 1, length = 1001)
a <- 1.5
b <- 10
plot(x, dbeta(x, a, b), type = "l")
```