Covid-19 Excess Death Report

Introduction

The Covid-19 virus started it's spread in Canada in March 2020. Causing thousands of deaths in different provinces across the country. However, Covid-19 might not be the only cause of some of these deaths. We are interested to explore the excess deaths caused by Covid-19 in British Columbia since the beginning of the pandemic. We will be using the weekly mortality dataset from 'https://open.canada.ca/data/en/dataset/2eac6167-e40c-47b1-ab7e-36bbc4c0cdbf'. This dataset includes weekly death count of different age groups in each province from 2010 to 2022. For our purpose, we will only use the part of data from British Columbia. With this data set, we will look at excess deaths caused by Covid-19 in different age group and whether vaccination helps reduce excess deaths due to Covid-19 in older age group in British Columbia.

Methods

To prepare the data set for model fitting, we first cleaned the data by filtering out only the mortality cases occurred in British Columbia and then changed date to week number with 1 representing the first week in a particular year. Next, we explored the weekly mortality by making line plots. We visualized mortality with respect to time and different age groups and looked for trends in the mortality count.

To model the excess death, we divided the data into two parts, pre-covid and post-covid. The cutoff date we used was March 1st, 2020, which was roughly the time when large number of cases began to emerge in British Columbia. An INLA model was then fitted to the pre-covid mortality count in British Columbia. Next, predictions for mortality count were made for the post covid time period and a 95% confidence interval was calculated. To get the posterior distribution

for total mortality count, we sampled from the posterior from the INLA model with a sample size of 30. With the posterior mortality count, we then calculated the excess mortality due to Covid-19 by subtracting the posterior from real mortality count form the data set. The above procedure was repeated for each of the age groups 0-44 years, 45-64 years, 65-84 years, 85 years old and over as well as the total of all the groups.

Results

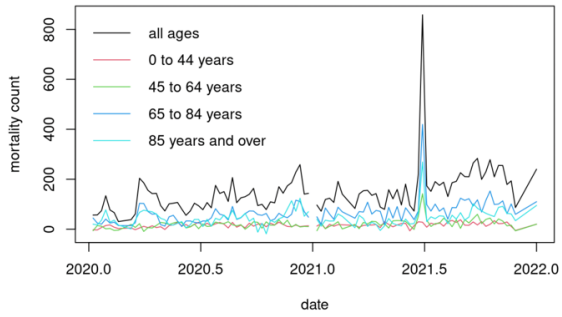


Figure 1 Mortality Counts for Different Age Groups during Covid in BC

From figure 1, we can easily spot that the mortality count is quite different each of the age groups and for the older age groups, the counts tend to be higher. We will take a closer look at the excess mortality for each group accounting for the aging of the population using the results from the 5 INLA models we fitted.

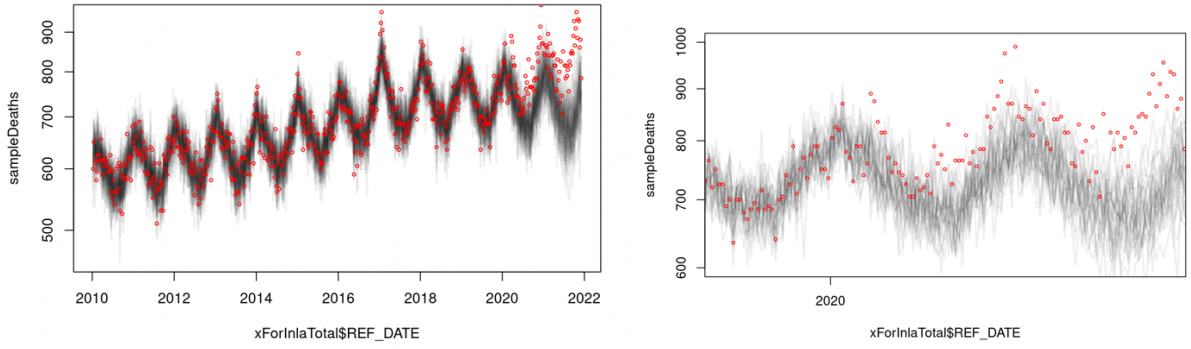


Figure 2 Posterior Sample vs Real Count for All Age Group

Figure 2 illustrates the posterior samples we took from results of our model and the red dots are our real data. There is an increasing trend in mortality in British Columbia from 2010 to 2022 with a seasonality of one year, where there is a decrease in the first half of the year and an increase in the second half. Taking a closer look at the post-covid period (Mar 1st and after), the real mortality count deviates from the samples in the post-covid period suggest a large number of excess deaths caused by Covid-19.

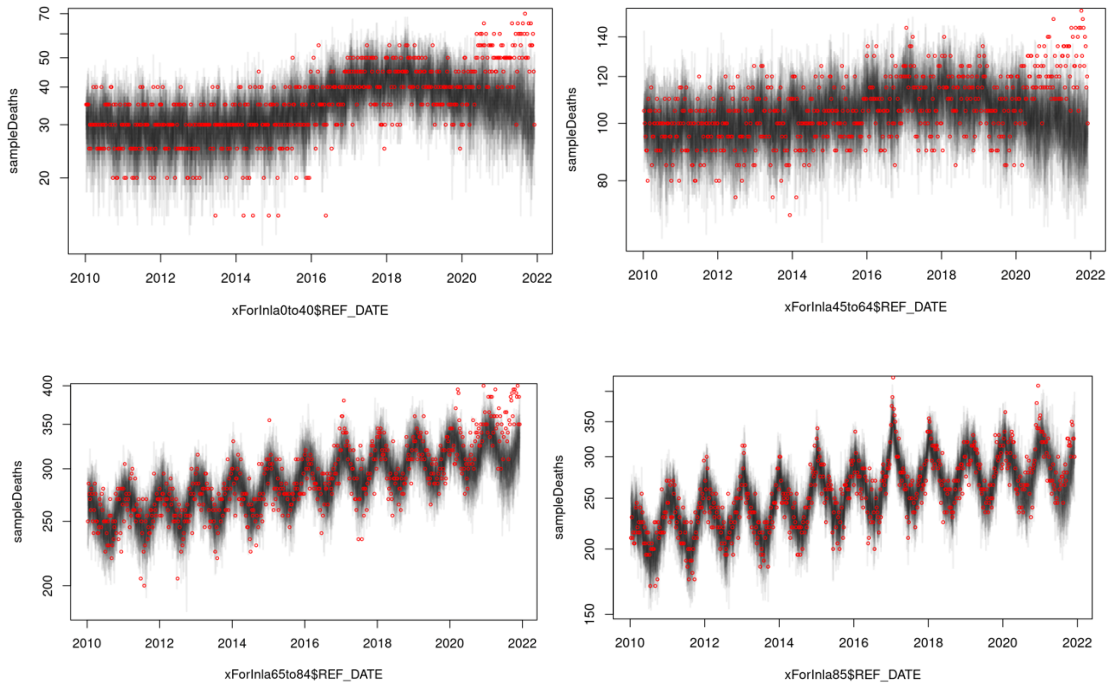


Figure 3 Sample and Real Data for Different Age Group

Figure 3 displays the posterior samples from our models, our data point from the pre-covid period fitted relatively well to the samples, which suggest our model should make a relatively accurate forecast about the mortality count without covid.

Table 1 Excess Mortality due to Covid-19 for Different Age Groups before Start of Vaccination

age	0-44	45-64	65-84	85 and over	total
Excess Mortality	1821	2770	4778	7705	17074
percentage	0.107	0.162	0.279	0.451	1

Table 1 shows the excess mortality calculated from the forecast from our model for the time period before vaccination started in British Columbia. Looking at the percentage, the 0-44 age group has the lowest excess mortality which is 10.7% of the total, the second lowest is the 45-64 age group with 16.2%. The older age groups have a higher mortality count as expected, the 65-84 age group has a percentage of 27.9% and the 85 and over age group accounts for 45.1% of total excess mortality. Overall, the excess mortality counts for people with age greater than 65 years old account for almost 3 quarters of the total excess mortality caused by covid-19 before vaccination started. Now let's take a look at the situation after the vaccination starts in December of 2020.

Table 2 Excess Mortality due to Covid-19 for Different Age Groups after Start of Vaccination

age	0-44	45-64	65-84	85 and over	total
Excess Mortality	1917	3154	3930	7358	16359
percentage	0.117	0.193	0.240	0.449	1

Table 2 shows the excess mortality and percentage for each age group after vaccination started in British Columbia. The 0-44 still have the lowest percentage of 11.7% of total excess mortality, followed by 45-64 age group with 19.3% and 65-84 age group with 24%. Same as before, the 85 and over age group has the highest percentage with 49.9% of the total excess mortality in British Columbia after the vaccination starts.

Comparing these two time periods, we see a slight decrease in the percentage of excess mortality in the people with age above 65. Corresponding with the decrease, the percentage of excess mortality in the 64 and below age groups increased.

Conclusion

As shown by the results from our calculation, there is a decrease in the percentage of excess mortality count of the people with age above 65. This indicate that the vaccination program, which started in December 2020, helped reduce the excess mortality for elderly in British Columbia.

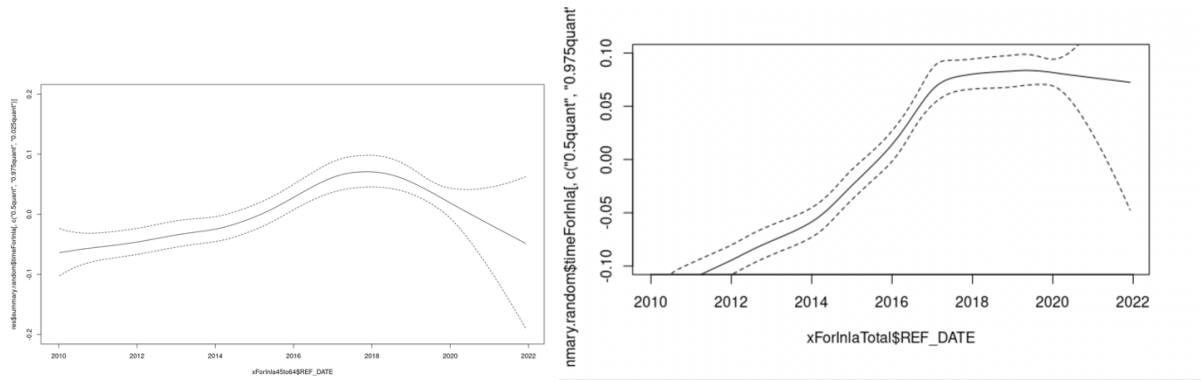
Appendix

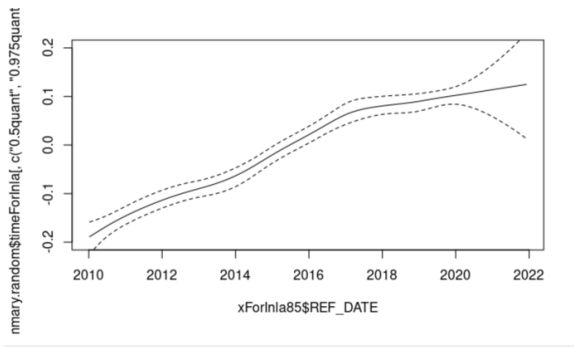
Data cleaning code

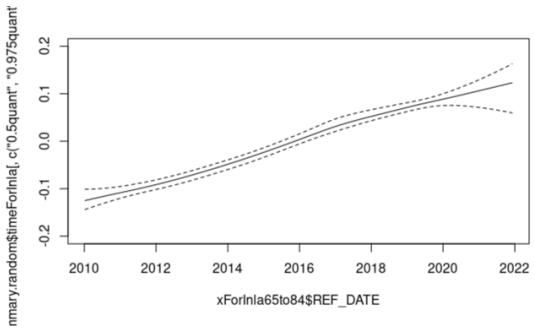
```r
#filter for BC
data_BC = data %>% filter(GEO == 'British Columbia, place of occurrence') %>% filter(Sex == 'Both sexes')
data_BC_clean = data_BC[,c('REF_DATE', 'Age at time of death', 'VALUE') ]
```

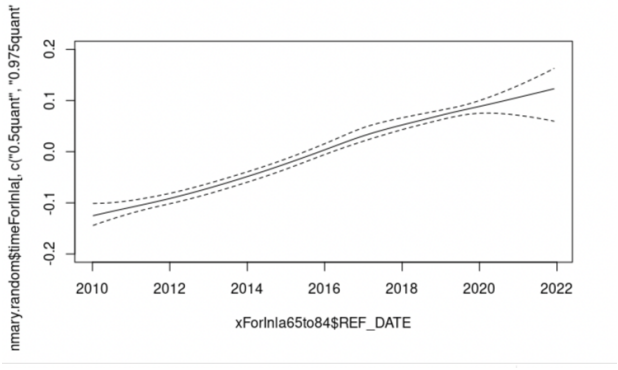
```r
data_BC_clean = data_BC_clean %>%
  mutate(week = strftime(c(REF_DATE), format = "%V")) %>%
  mutate(year = as.numeric(format(REF_DATE,'%Y')))
data_BC_clean = data_BC_clean %>%
  mutate(week = strtoi(week))
library(stringr)
data_BC_clean = data_BC_clean %>%
  mutate(age = str_sub(`Age at time of death`, 23))
```

Models for different age groups and the code










```r
xForInla0to40= xForInla[xForInla$age == '0 to 44 years', ]
library(INLA, verbose=FALSE)
res = inla(VALUE ~ sin12 + sin6 + cos12 + cos6 +
    f(timeIid, prior='pc.prec', param= c(log(1.2), 0.5)) +
    f(timeForInla, model = 'rw2', scale.model=TRUE,
      prior='pc.prec', param= c(0.01, 0.5)),
  data=xForInla0to40,
  control.predictor = list(compute=TRUE, link=1),
  control.compute = list(config=TRUE),
#  control.inla = list(fast=FALSE, strategy='laplace'),
  family='poisson')

qCols = paste0(c(0.5, 0.025, 0.975), 'quant')
rbind(
  res$summary.fixed[,qCols],
  Pmisc::priorPostSd(res)$summary[,qCols])

matplot(
  xForInla0to40$REF_DATE,
  res$summary.fitted.values[,qCols],
  type='l', ylim = c(20, 70), lty=c(1,2,2), col='black',
  log='y', xlab = 'date', ylab = 'mortality count')
points(data_BC_clean[data_BC_clean$age == '0 to 44 years', c('REF_DATE','VALUE')], cex=0.4,
col='red')
matplot(
  xForInla0to40$REF_DATE,
  res$summary.random$timeForInla[,c('0.5quant','0.975quant', '0.025quant')],
  type='l', lty=c(1,2,2), col='black',ylim = c(-2,2)*0.1)
```