CASE STUDY FOR COVID-19 PANDEMIC

Q1 (a)

Selected four other countries:

1. England and Wales (U.K)
2. Japan
3. New Zealand
4. Sweden
5. United State of America (U.S.A)

These selected countries have data observed up to 2020/2021. This means covid-19 started to spread at the beginning of 2020 and it was a normal end of 2021 last. Also, when we analyze this country, we can give a worldwide approximation about the covid-19 pandemic the reason is these countries show the world.

1. England and Wales (U.K)

In this dataset, there was data that we need there except. Known also as the U.K., the United Kingdom consists of a group of islands off the northwest coast of Europe. Four nations make up this unique country: England, Wales, Scotland, and Northern Ireland. Great Britain also includes England, Wales, and Scotland.

Considering a growing number of restrictions, including another national lockdown in England from November to December, a few economic support measures that had been due to end have been extended into the new year. Alongside managing the health and economic fallout from the COVID-19 pandemic, the UK government is also involved in negotiations with the EU regarding the end of the Brexit transition period, on 31 December.

Serio’s sickness is more likely to strike older persons and those with underlying medical conditions including cancer, diabetes, cardiovascular disease, or chronic respiratory diseases. sickness is more likely to strike older persons and those with underlying medical conditions including cancer, diabetes, cardiovascular disease, or chronic respiratory diseases.

2. Japan

Japan is a fascinating country of economic and business prowess, rich culture, technical wizardry, spatial conundrums, and contradictions. Japan held onto the title of the world's second-largest economy for more than 40 years. It is an archipelago of 6,852 islands, most of which are mountainous, and many volcanic.

Japan has struggled to stop the spread of COVID-19, like many other nations. The virus spread in waves, which led to emergency measures restricting public activities like eating in restaurants and boosting the capacity of Japan's healthcare facilities. The handling of COVID-19 by the government has drawn criticism from the Japanese public, with obvious political repercussions.

As the number of new cases of infection increases, the number of patients receiving medical treatment continues to increase, and the use rate of beds continues to rise almost nationwide and putting a heavy burden on the medical care provision system. In addition, the numbers of severe cases and deaths continue to increase, and attention should be paid to future trends. The value for new cases of infection is the number of persons per 100,000 among the total number for the latest week, based on reporting dates.

3. New Zealand

New Zealand is a wealthy Pacific nation dominated by two cultural groups - New Zealanders of European descent, and the Maori, who are descendants of Polynesian settlers. It is made up of two main islands and numerous smaller ones. New Zealand's economy is developed, but it is comparatively small in the global marketplace. It has a long history of government intervention in the economy, ranging from state institutions' competing in banking and insurance to an extensive social security system.

Throughout the pandemic, New Zealand has continued to build its capacity for testing and contact tracing. Coupled with tight quarantines for returning New Zealanders, this has helped the country control the virus and prevent further outbreaks. New Zealand confirmed its first imported COVID-19 case in February 2020.

4. Sweden

Sweden is a constitutional monarchy and a parliamentary democracy, with legislative power vested in the 349-member unicameral Riksdag. It is a unitary state, currently divided into 21 counties and 290 municipalities. It was centered at Fort Christina, now in Wilmington, Delaware, and included parts of the present-day states of Delaware, New Jersey, and Pennsylvania. The economy of Sweden is a highly developed export-oriented economy, aided by timber, hydropower, and iron ore. These constitute the resource base of an economy oriented toward foreign trade.

The COVID-19 pandemic in Sweden is part of the pandemic of coronavirus disease 2019 caused by severe acute respiratory syndrome coronavirus 2. As of August 2022, there have been 2,551,996 confirmed cumulative cases and 19,528 deaths with confirmed COVID-19[3] in Sweden. Sweden ranks 57th in per capita deaths worldwide, and out of 47 European countries, Sweden places 30th. A 2022 estimate of excess mortality during the pandemic using the IHME COVID model estimated 18300 excess deaths during 2020-2021. The Economist model value estimated 13,670 excess deaths between 2020-2022.

5. United State of America (U.S.A)

It consists of 50 states, a federal district, five major unincorporated territories, nine minor outlying islands, and 326 Indian reservations with limited sovereignty. It is the third-largest country in both land and total area. The United States shares land borders with Canada to the north and with Mexico to the south as well as maritime borders with the Bahamas, Cuba, and Russia, among others. It has a population of over 331 million and is the third most populous country in the world. The national capital is Washington, D.C., and the most populous city and financial center in New York City. The United States is a melting pot of cultures and ethnicities, and its population has been profoundly shaped by centuries of immigration. It has a highly diverse climate and geography and is officially recognized as one of the 17 ecologically megadiverse countries.

The story of COVID-19 in the United States is one of a daunting scale. The U.S. epidemic dwarfs that of any other country. At the time of writing, the U.S. reports almost 30 million cases and over 500,000 deaths, accounting for 25% of global cases and 20% of global deaths, despite comprising only 4% of the world's population. Life expectancy in the U.S. shrank by a full year in 2020. Had the U.S. responded with the swiftness and effectiveness of East Asia, over 428,000 American lives could have been saved.

Coordinated and well-funded vaccine distribution program. Investments in vaccine equity including health promotion campaigns led by community leaders to allay fears and overcome high levels of vaccine hesitancy among some communities. Targeted relief for small businesses and those experiencing financial hardship. Investments and active participation in global immunologic equity, including support of COVAX, and initiatives to develop and deploy new therapeutics and diagnostics for low and lower-middle income countries.

- Discuss What makes a good cross-country comparison.

Coronavirus has claimed the lives of over half a million people worldwide and this death toll continues to rise rapidly each day. In the absence of a vaccine, non-clinical preventative measures have been implemented as the principal means of limiting deaths. However, these measures have caused unprecedented disruption to daily lives and economic activity. Given this developing crisis, the potential for a second wave of infections and the near certainty of future pandemics. We address the challenges of cross-country comparisons by allowing for differences in reporting and variation in underlying socio-economic conditions between the above countries. This show that, to date, differences in policy interventions have outweighed socio-economic variation in explaining the range of death rates observed in the data. Our epidemiological models show that across 5 countries a further week-long delay in imposing lockdown would likely have cost more than half a million lives. Fur Linking decisions over the timing of lockdown and consequent deaths to economic data, we reveal the costs that national governments were implicitly prepared to pay to protect their citizens as reflected in the economic activity foregone to save lives. This ‘price of life’ estimates varies enormously between countries, ranging from as low as around $100,000 (e.g., the UK, USA) to more than $ 1 million (e.g., New Zealand). The lowest estimates are further reduced once we correct for under-reporting of Covid-19 deaths.

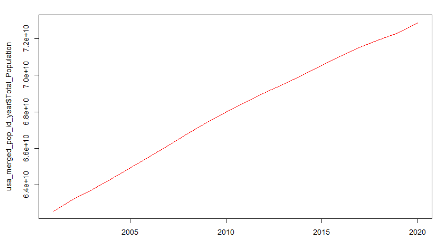
Q1 (b)

COVID-19 pandemic impacted mortality levels in the UK. It is too early to say with any certainty what impact coronavirus may have on long-term mortality trends, but in the last few years, it has undoubtedly influenced mortality. In 2020, the period of life expectancy at birth in England and Wales was 78.6 years for males and 82.6 years for females; this is 1.2 years lower for males and 0.9 years lower for females than in 2019. This data reflects very high mortality in 2020 during the coronavirus (COVID-19) pandemic. Now consider plotting what we get from a dataset.

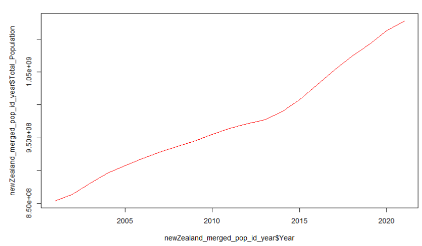
Now consider the following plots,

Year Vs Population.

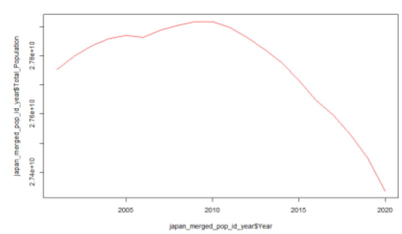
USA



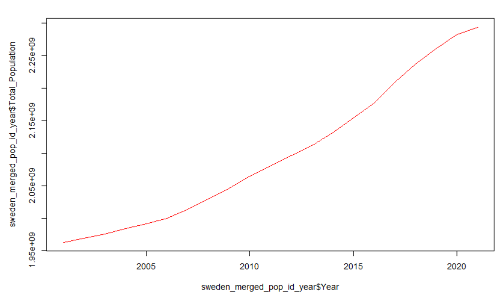
New Zealand



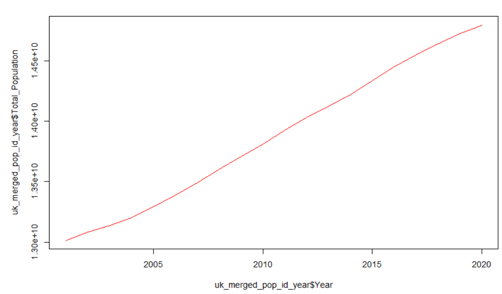
Japan



Sweden



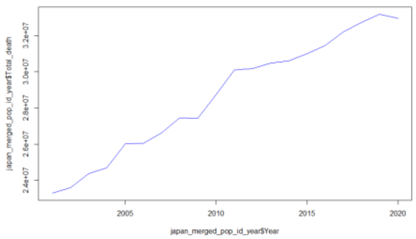
UK



USA, New Zealand, Sweden, and the UK have an increasing trend but before 2010 there was an increasing trend after 2010 Japan’s population decreasing trend.

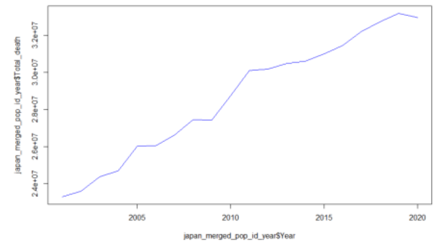
Year Vs Death

USA



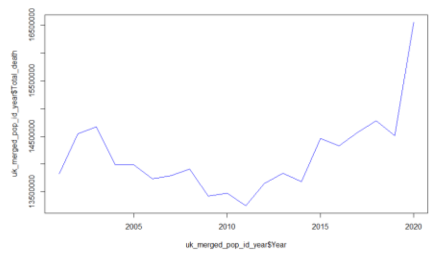
New Zealand

Japan



Sweden

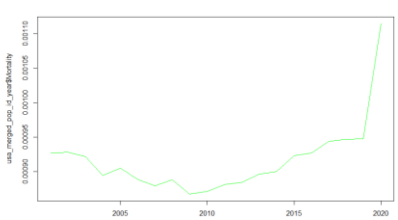
UK



New Zealand, the USA, Japan, and the UK usually increase deaths, but Sweden has irregular variation and can see the latest year’s deep decreasing trend.

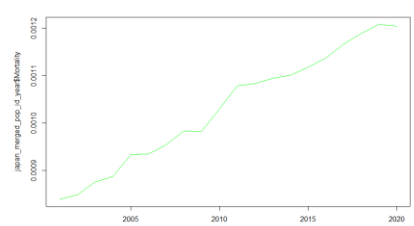
Year Vs Mortality

USA

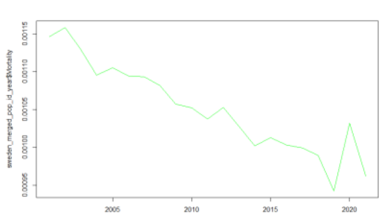


New Zealand

Japan



Sweden



UK

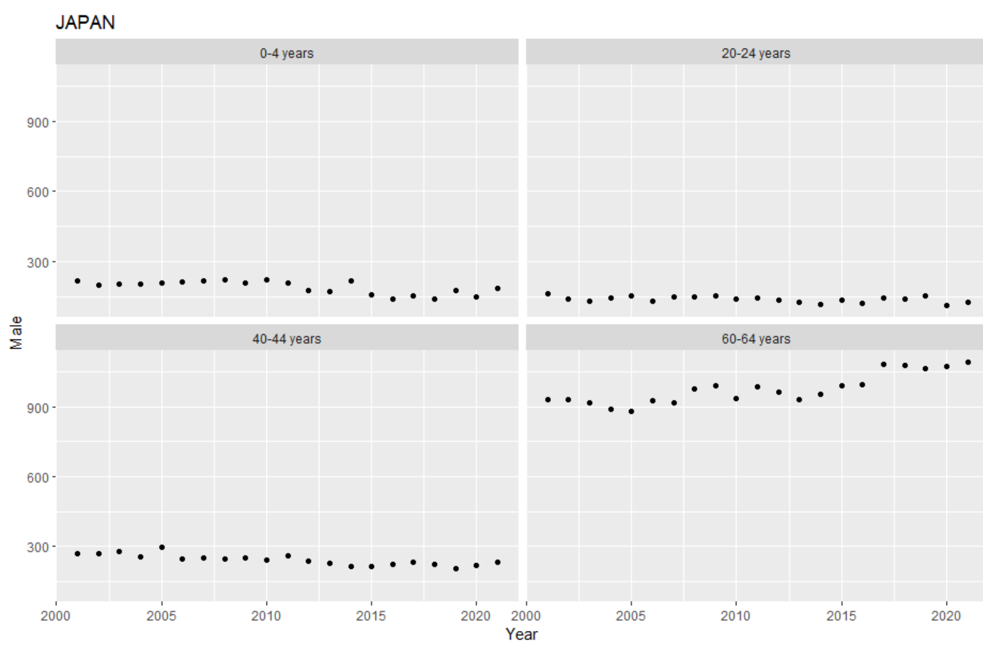
While considering mortality since 2001 all countries have irregular observations but after 2019 last year mortality rate increased rapidly.

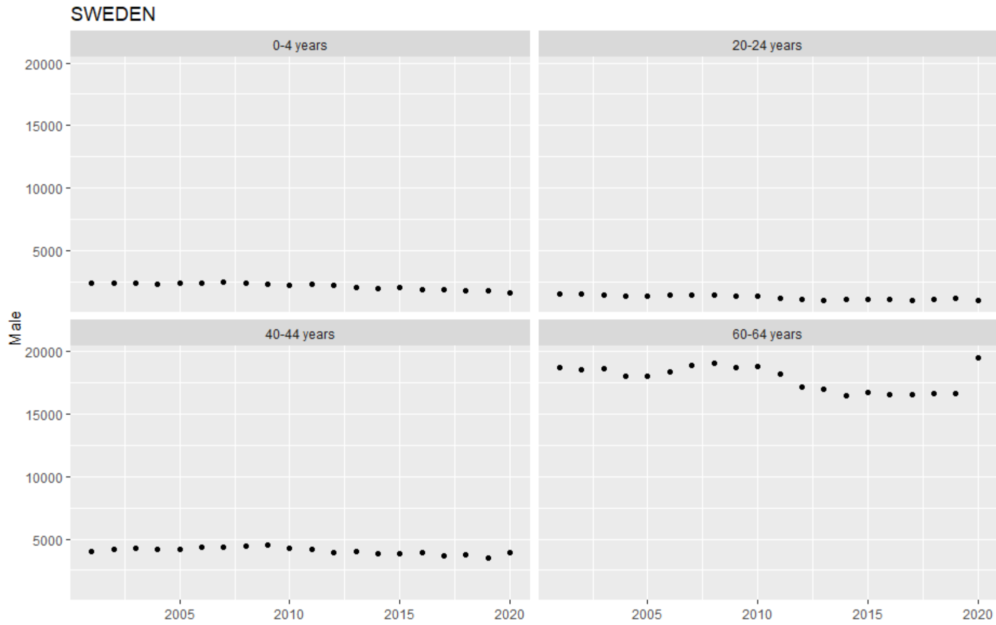
Now want to compare Changes over time and the Effects of COVID-19 Compare across countries. Long-term, overall mortality has been declining in these five countries, although we have been seeing an uptick in recent years. This could be exacerbated by COVID-19.

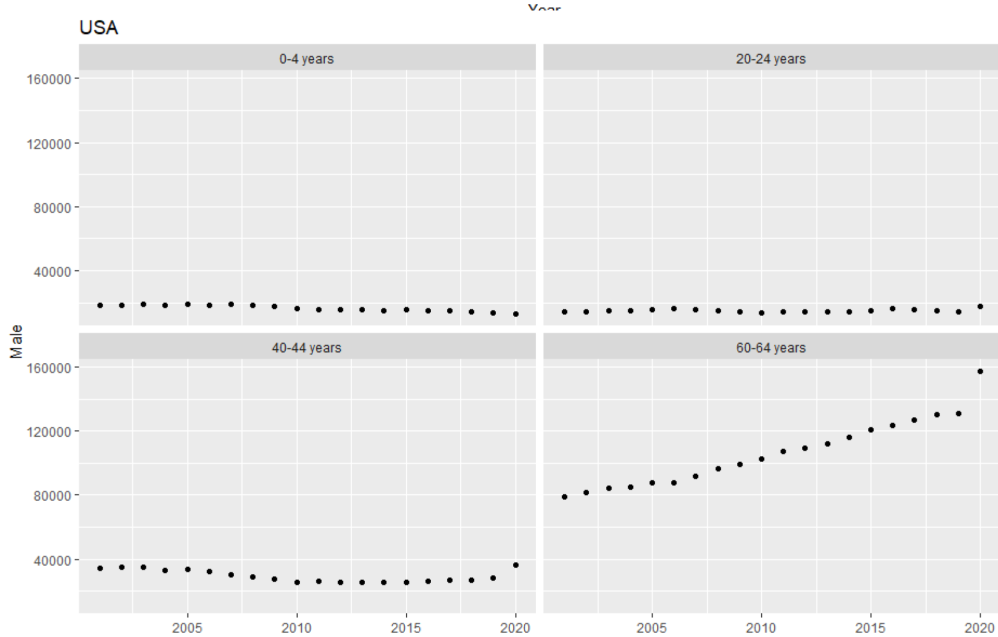
Most COVID-19 deaths have been among older adults, with people over ages 60 and 80 experiencing the bulk of COVID-19 mortality so far. In addition, workers coming from outside the community often work in multiple facilities, potentially introducing disease. Furthermore, the distribution of COVID-19 deaths has not been unfirming across race and ethnic groups. Recent data on provisional death rates compiled by the CDC from the National Center for Health Statistics show that a greater percentage of deaths among Hispanic, non-Hispanic Black, and non-Hispanic American Indian or Alaska Native people relative to the percent of these racial and ethnic groups in the population. These disproportionate death rates have the potential to change the very face of the population, placing a greater burden on specific communities and groups. According to the above graph can conclude that very high impact on the mortality rate in the USA. Japan had less impact compared to other countries. Also, can see during the COVID-19 period there was an impact before 2020 and after that rapidly decreasing mortality rate in Sweden. Conclude that Sweden controls death perfectly quickly.

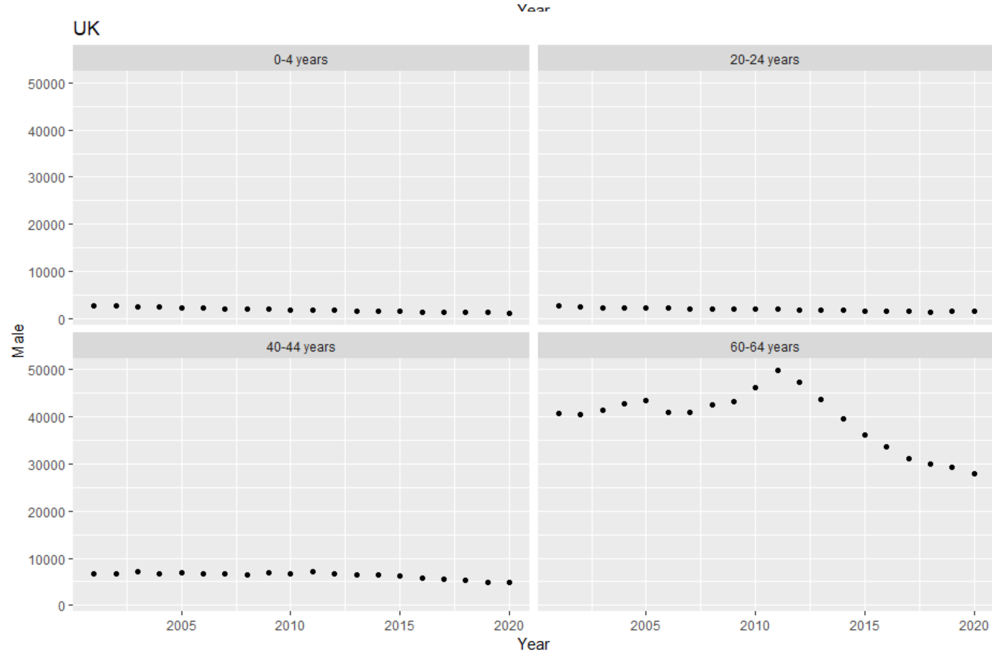
Q1 (c)

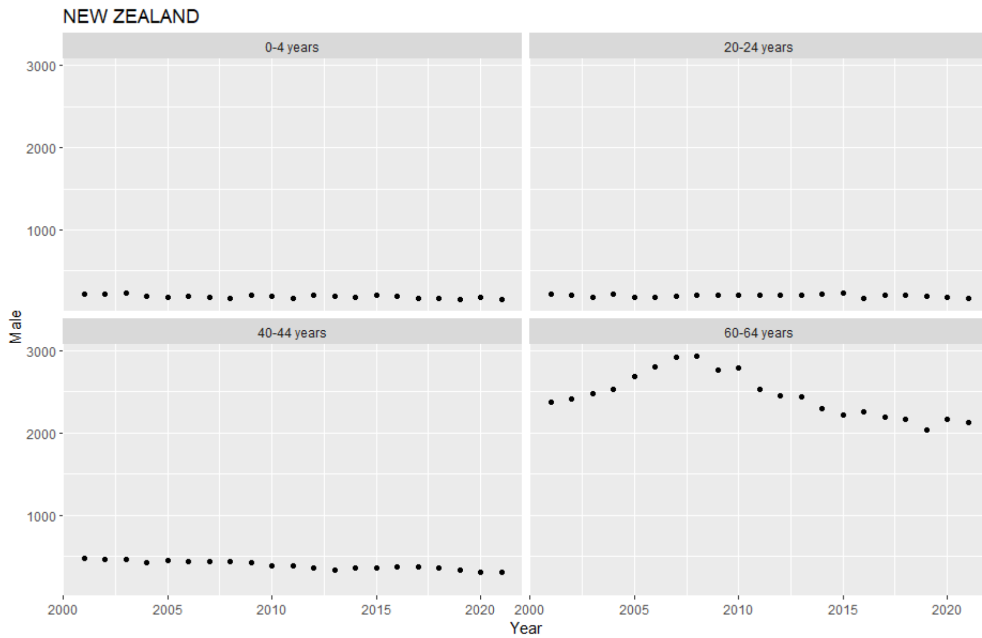
Need to compare four age groups so, that age group must vary from 0 to human survival age. Among the age chosen, 0-5, 20-25, 40-45, and 60-65 are four age groups to make a good comparison. There was a good age variation and a high age distance between 0 to 65 years. Also, can compare children, teenagers, adults, and old humans' death rates using this age group. Then these age groups are interesting. Now see the following plots that we get from Male log-mortality rates.




SWEDEN
0-4 years
20-24 years
40-44 years
60-64 years
Male
20000
15000
10000
5000
2005
2010
2015
2020
Year


USA
0-4 years
20-24 years
40-44 years
60-64 years
Male
160000
120000
80000
40000
2005
2010
2015
2020
Year


UK
0-4 years
20-24 years
40-44 years
60-64 years
Male
50000
40000
30000
20000
10000
0
2005
2010
2015
2020
Year

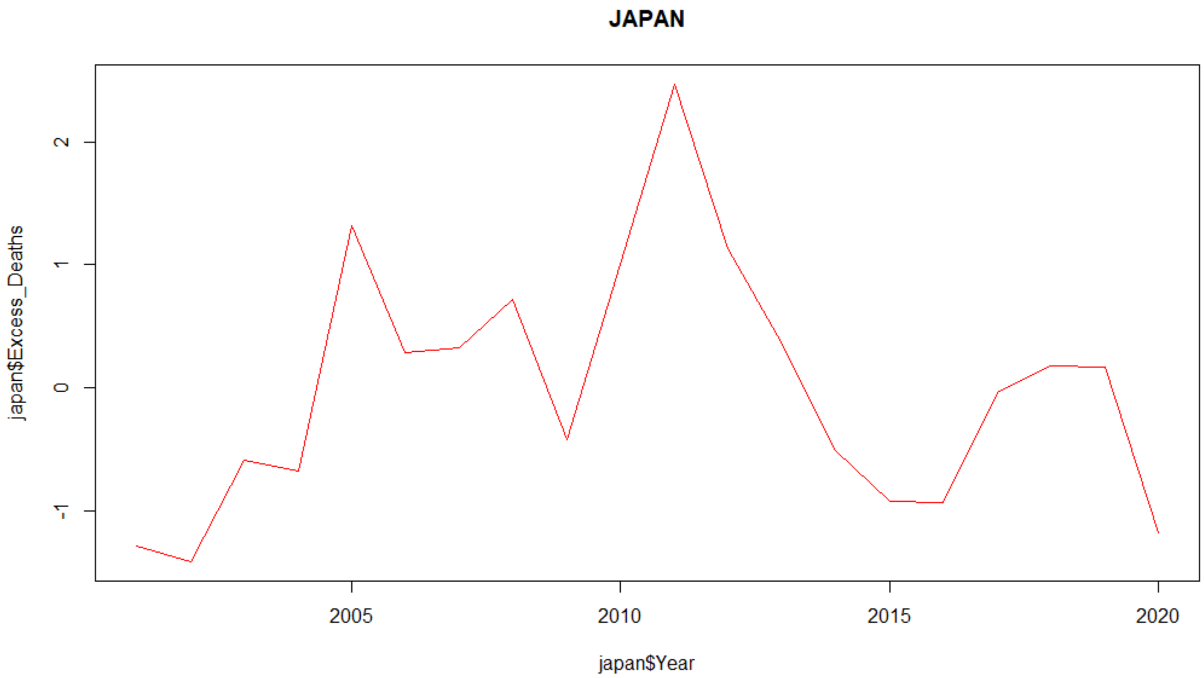


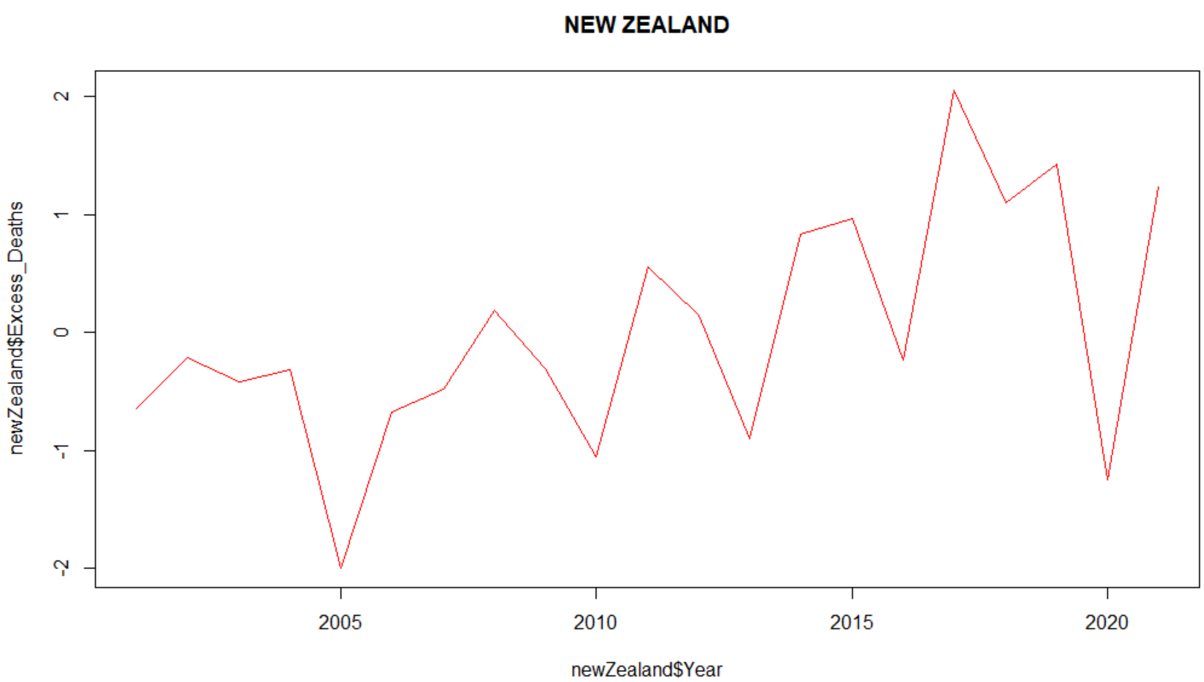
Simply looking at the cumulative yearly number of confirmed deaths does not allow us to understand or compare the speed at which these figures are rising. The plots here show how long it has taken for the number of confirmed deaths to double in each country for which we have data. The plots also show both the cumulative total and yearly new number of confirmed deaths, and how those numbers have changed over the last years. Usually, in all five countries 0-5, 20-25, 40-45 age groups death rate is very low compared to the 60–65-year range. In covid -19 period, Sweden, and the USA's 60–65-year range of male mortality rapidly increases but others can't see that increase. In other all countries, other age groups can't see a high mortality rate. Then conclude that covid-19 has more impact on the age group 60-65.

Q1 (d)

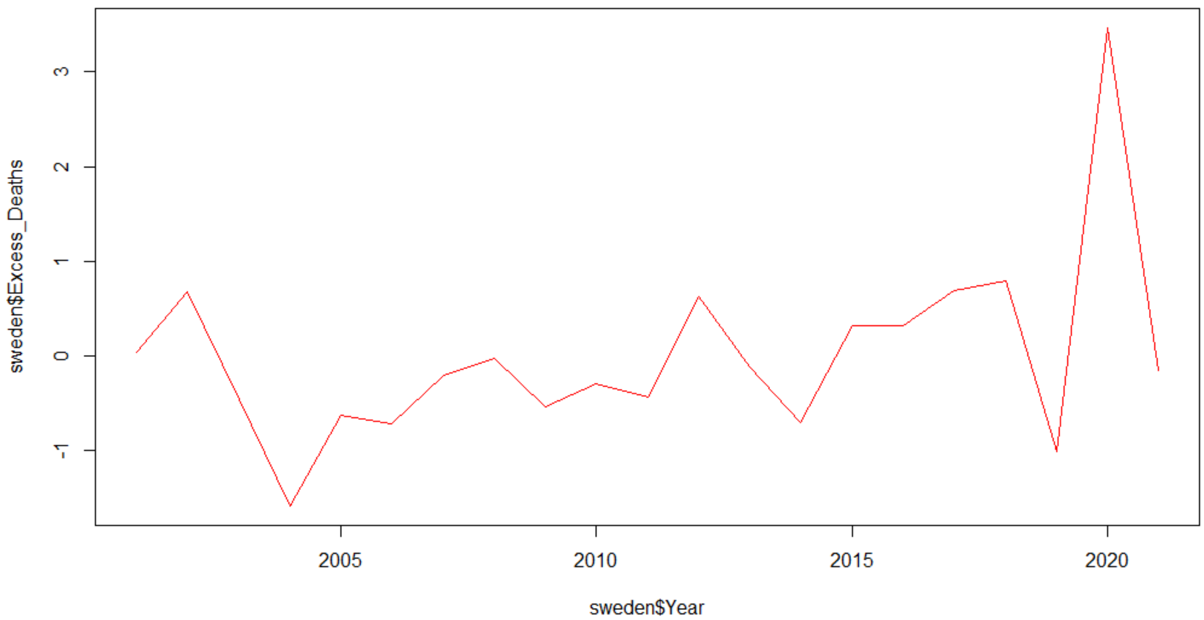
The pandemic may also result in fewer deaths from other causes. For example, mobility restrictions during the pandemic might lead to fewer deaths from road accidents. Or there might be fewer deaths from the flu because of interventions to stop the spread of COVID-19, or because COVID-19 now causes deaths that would have otherwise been caused by the flu. Also, some (but not all) countries only report COVID-19 deaths that occur in hospitals people that die from the disease at home may not be recorded. So can't conclude that the total excess death in each country is caused by COVID-19. But exactly in COVID-19 pandemic helps to increase the mortality rate in the world while. Now see the below graphs.

Excess mortality is a term used in epidemiology and public health that refers to the number of deaths from all causes during a crisis and beyond what we would have expected to see under 'normal' conditions. In this case, we're interested in how the number of deaths during the COVID-19 pandemic compares to the deaths we would have expected had the pandemic not occurred a crucial quantity that cannot be known but can be estimated in several ways. Excess mortality is a more comprehensive measure of the total impact of the pandemic on deaths than the confirmed COVID-19 death count alone. It captures not only the confirmed deaths but also COVID-19 deaths that were not correctly diagnosed and reported2 as well as deaths from other causes that are attributable to the overall crisis conditions.

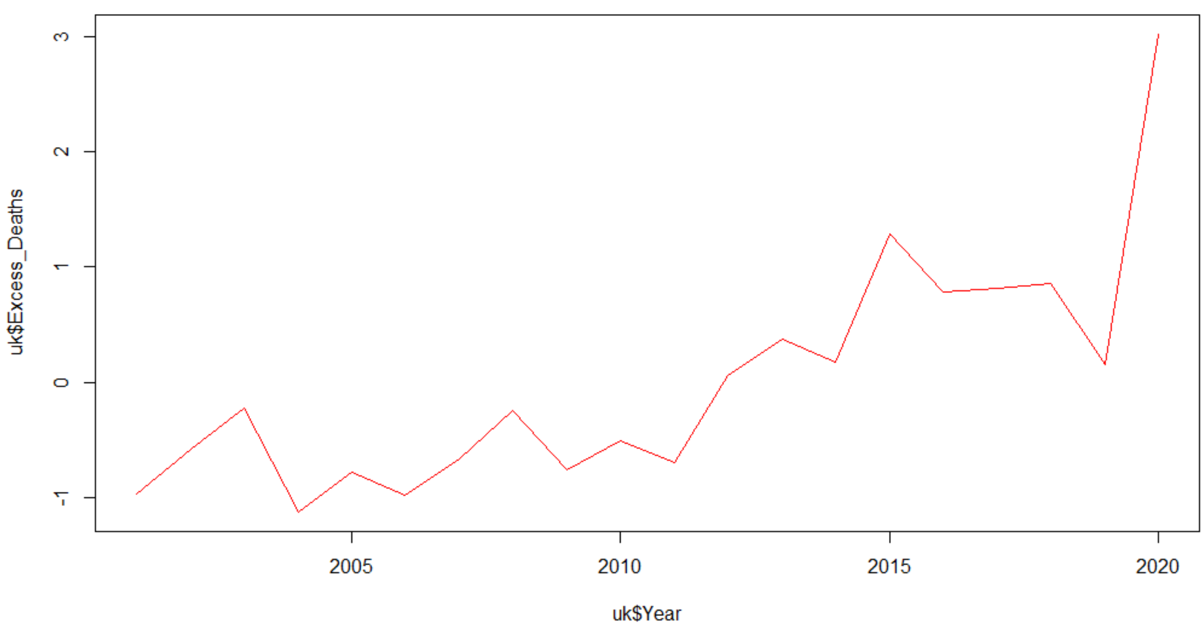


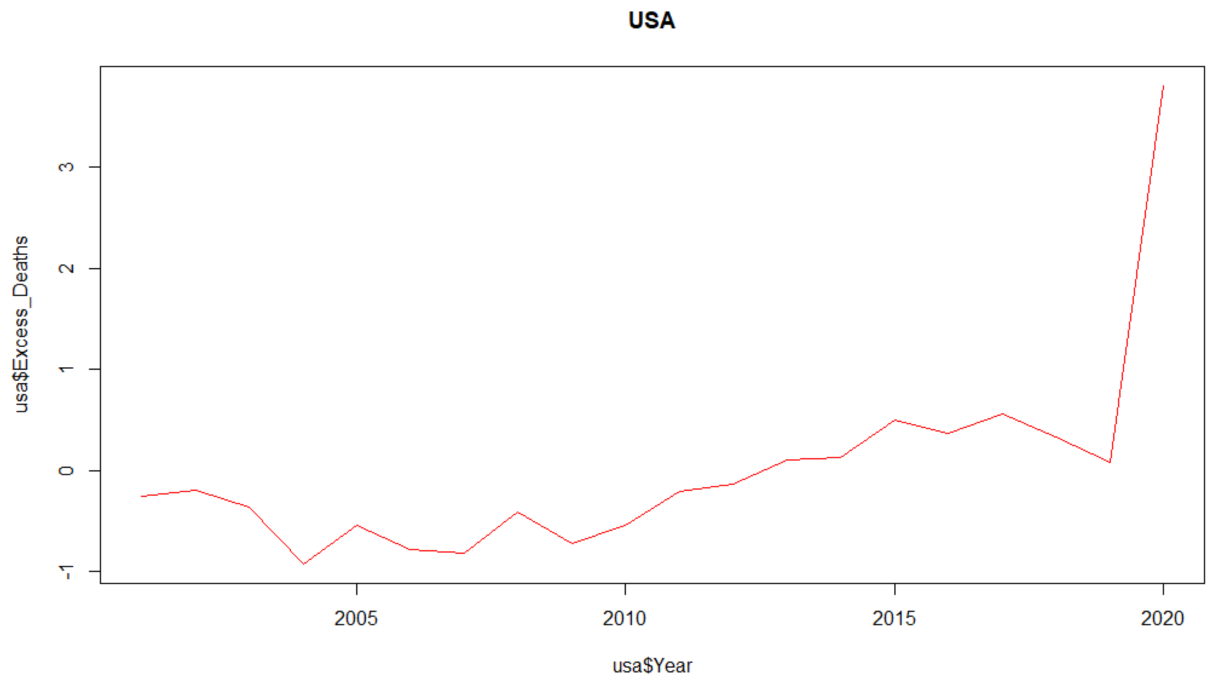


SWEDEN


sweden$Excess_Deaths
-1
0
1
2
3
2005
2010
2015
2020
sweden$Year

UK


uk$Excess_Deaths
-1
0
1
2
3
2005
2010
2015
2020
uk$Year



Calculate excess death in each country,

First, get data from the dataset and choose Year and death rate column that need to calculate excess death in each country. After getting a five-year average baseline (E.g., for 2020, use the 2015-2019 average) and calculate excess death in each country using the below function.

Excess death = Total death in a year - Five-year average baseline

Finally, the Plot totals excess deaths per million people (standardizing for ease of comparison).

After considering the above graphs related five countries can see New Zealand, UK, and USA excess deaths are increase. So can conclude that COVID-19 impacts those excess deaths. But in Sweden and Japan, excess deaths are decreasing over time.

Q1(e)

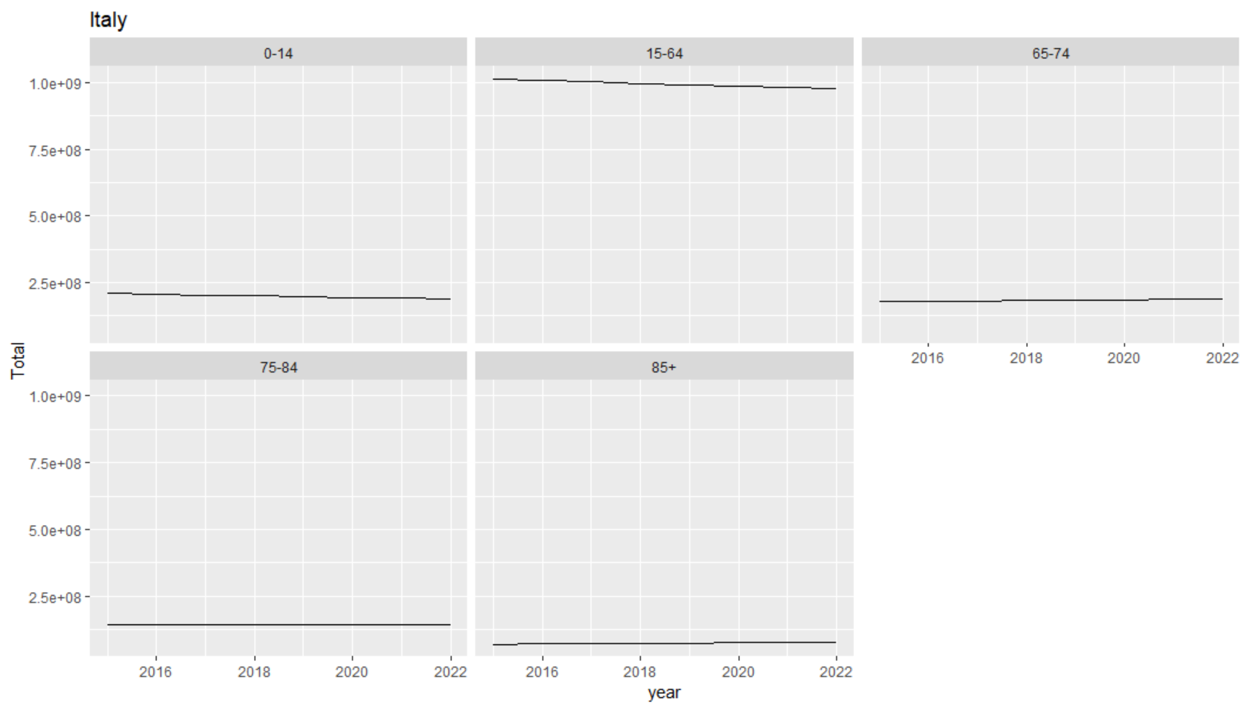
There's a reason so many companies conduct traditional reviews every year. Annual performance reviews are a reliable way to schedule and organize critical conversations that may otherwise be difficult to conduct. Demographics have highlighted racial and economic disparities in COVID-19 survival and outcomes, giving us yet another reason to be instruments for change towards equality. Sometimes health care policies felt like they did not adequately reflect physicians’ scientific views. The pandemic has reiterated the need for physicians to have a stronger voice in health care policies instead of being silent spectators. The philosophical side of life is the grounding patch. Humans are not indestructible, and life is unpredictable. The pandemic has made these distant statements crystal clear for us. We learned that nature should not be taken for granted.

Around the world turned to each other on how to best manage a novel virus. What is the clinical course? Spread? Most vulnerable population? Normally, questions like these were answered by random clinical trials or meta-analyses. CDC changed recommendations almost every other day. For most physicians came this challenge: "Are we trained enough to function in uncertainty?" Physicians were learning as they go, and not being able to offer definitive plans for patients is extremely distressing.

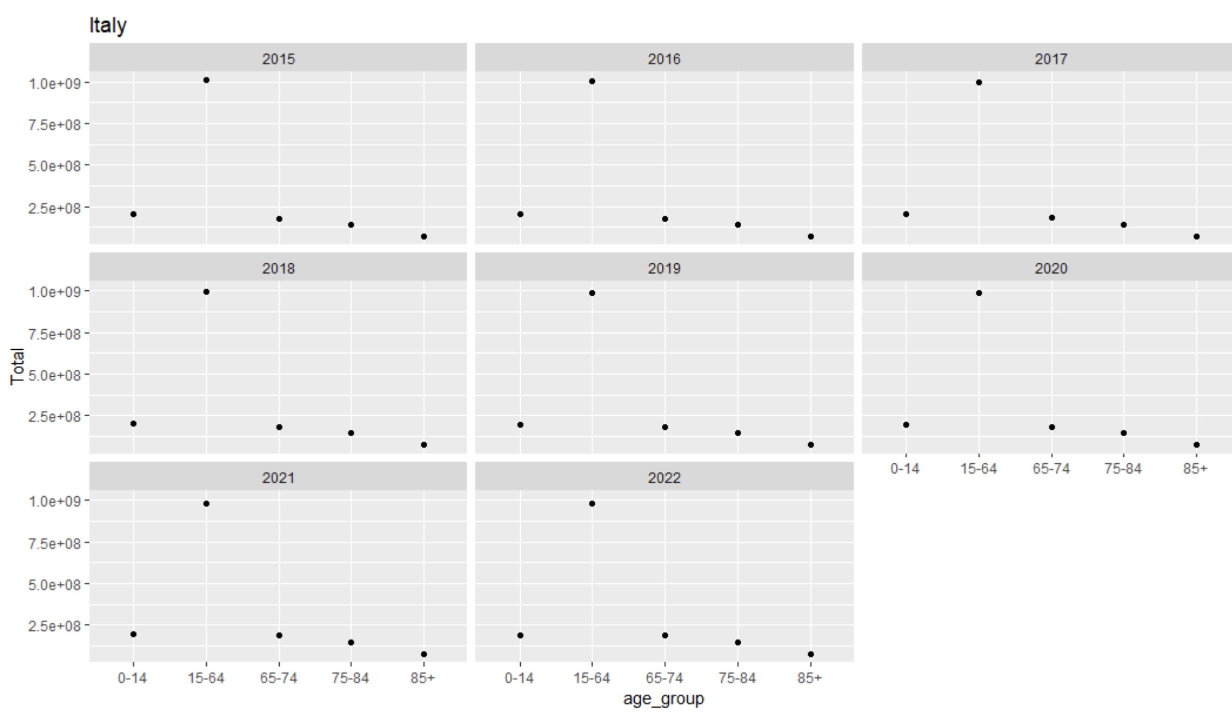
Out of 5 countries analyzed, the COVID-19 pandemic led to losses in life expectancy. Compared to recent trends, females from countries and males ended up with lower life expectancy at birth in 2020 than in 2015 a year when life expectancy was adversely impacted already due to an especially bad flu season. Losses in life expectancy were largely attributable to increased mortality above age 60 years and linked to official COVID-19 deaths. The study findings show how covid-19 can have a considerable impact on the health of a small community. Furthermore, the results suggest that the full implications of the covid-19 pandemic can only be completely understood if, in addition to confirmed deaths related to covid-19, consideration is also given to all-cause mortality in each region and time frame. Finally, The COVID-19 pandemic triggered significant mortality increases in 2020 of a magnitude.

Q2(a)

Group by age group.



Group by year.



Italy was a country severely hit by the first coronavirus disease 2019 (COVID-19) pandemic wave in early 2020. Mortality studies have focused on the overall excess mortality observed during the pandemic. This investigates the cause-specific mortality in Italy from 2020 and the variation in mortality rates compared with those in 2015–2019 regarding sex, age, and epidemic area. In the choice of age groups, we took as reference the age group 15–64 years, instead of the youngest class (0–14 years). The reasons for this decision were that the age group 15–64 years has undergone only marginal alterations in overall mortality during the pandemic in Italy, and it is larger than the younger age class (0–14 years). Therefore, its use as a reference provides good stability for risk estimates. Showed that age groups older than 65 had mortality risks that were greater than that of the 15- to 64-year-old reference class. The 0–14 years age group had a mortality risk that was less than that of the reference class. Age group 65-74 and 85^+ death is increased after 2020 last can assume caused by covid-19. Also want to mention that in above graphs have approximately decreasing pattern in age group 0-14 and 15-64 after that in the age group 65^+ can see an approximately increasing pattern.

In non-hospitalized patients, the mortality risk associated with age was greater than that for the whole series. This difference might be explained by the observation that most deceased non-hospitalized patients were very old, with a median age of 86 years. As a possible interpretation, we suppose that some elderly persons deteriorated rapidly and died before they could be hospitalized. In conclusion, the analysis of death data allowed us to deeply investigate the mortality in the pandemic and to evaluate both the direct and indirect effects that have affected the Italian territories.

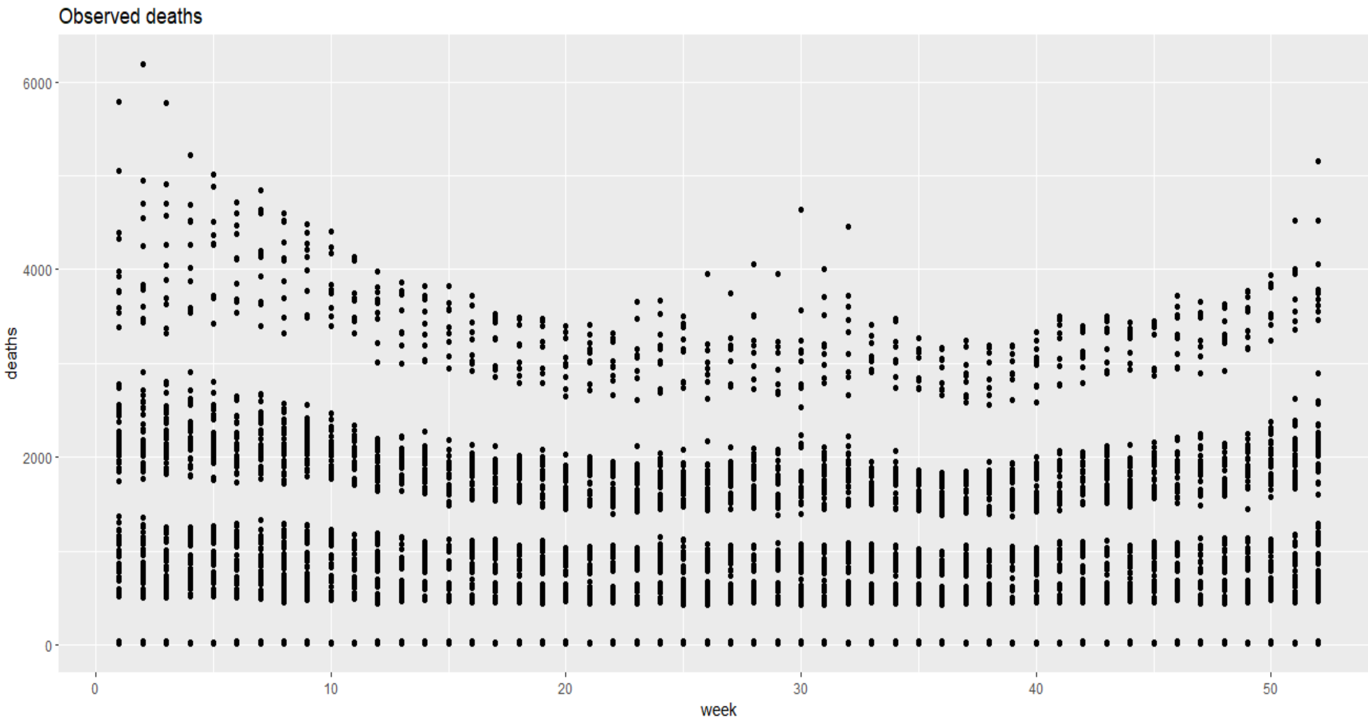
Q1(b)

Familiarize me with Aburto et al. (2021) and supplementary material. They estimate excess deaths for England and Wales Four models are considered for the baseline

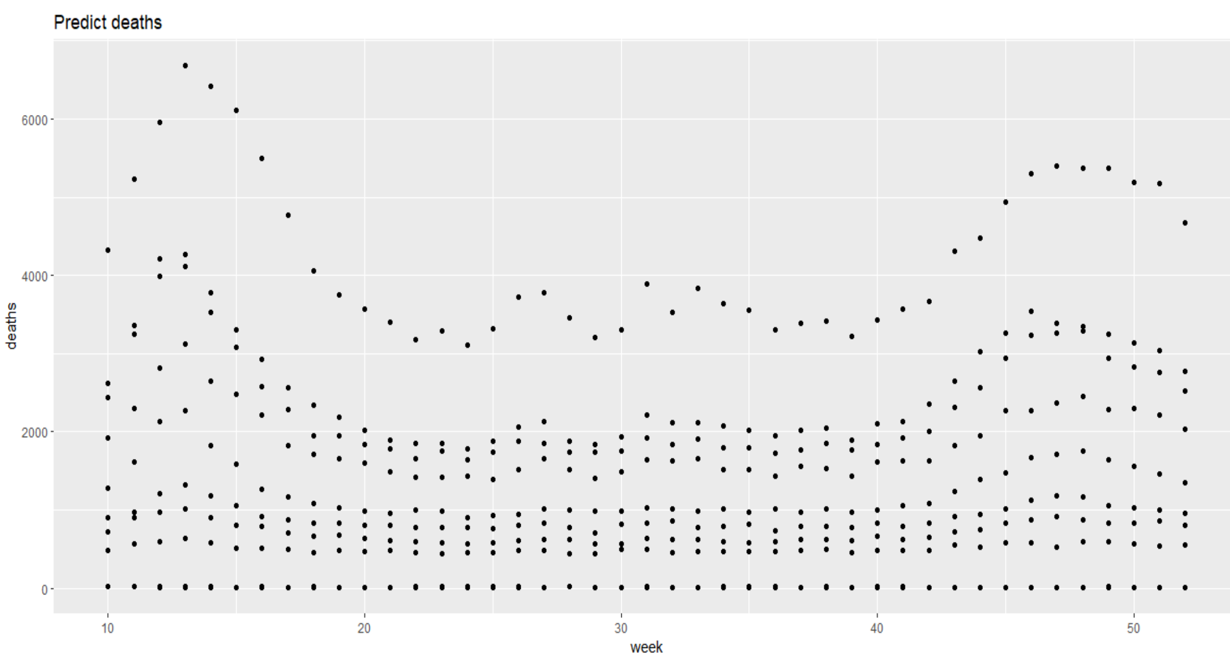
- Negative binomial GAM
- Poisson GAM
- Poisson Serling GLM
- Averaging the weekly death rates from 2015-19 We will

But, here fit the Negative binomial GAM to the Italian data.

First, fit the model to the data from week 1 of 2011 to week 9 of 2020. The below graph visualizes Observed deaths from week 1 of 2011 to week 9 of 2020.



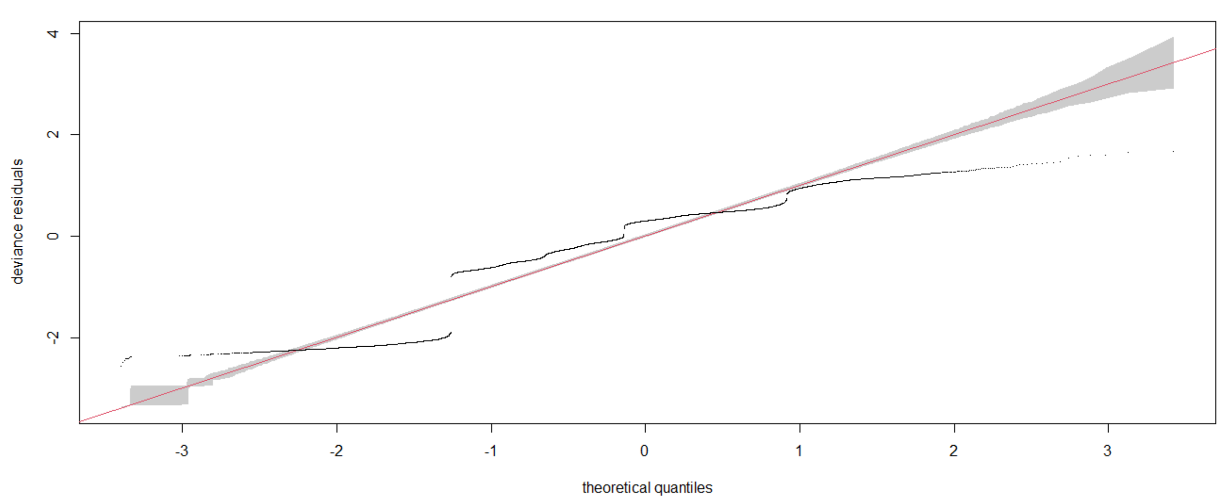
Additionally, below can see deaths up to week 51 of 2021.

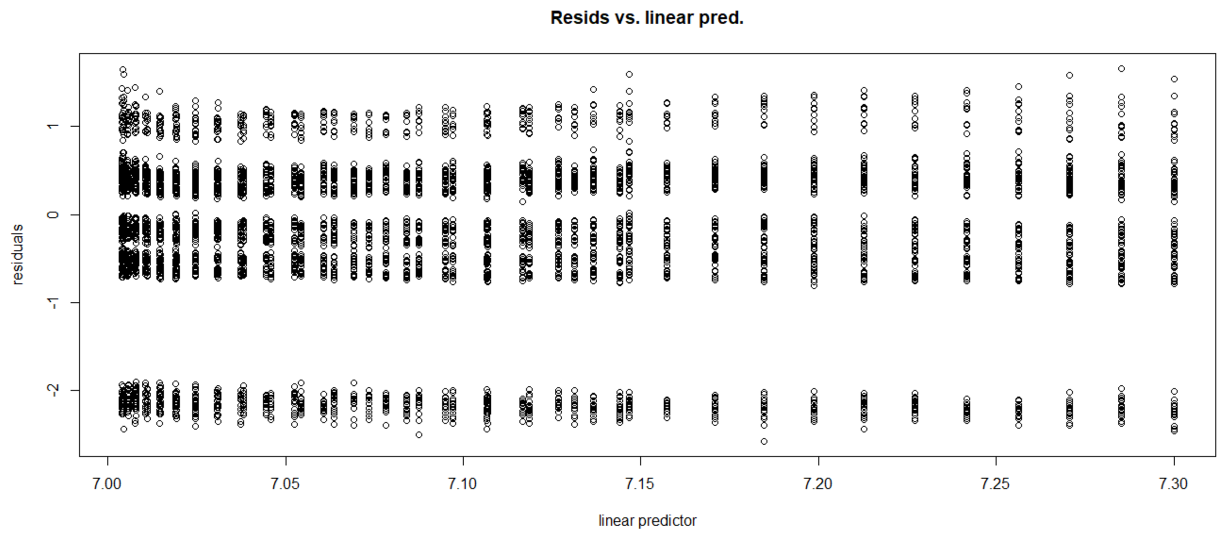


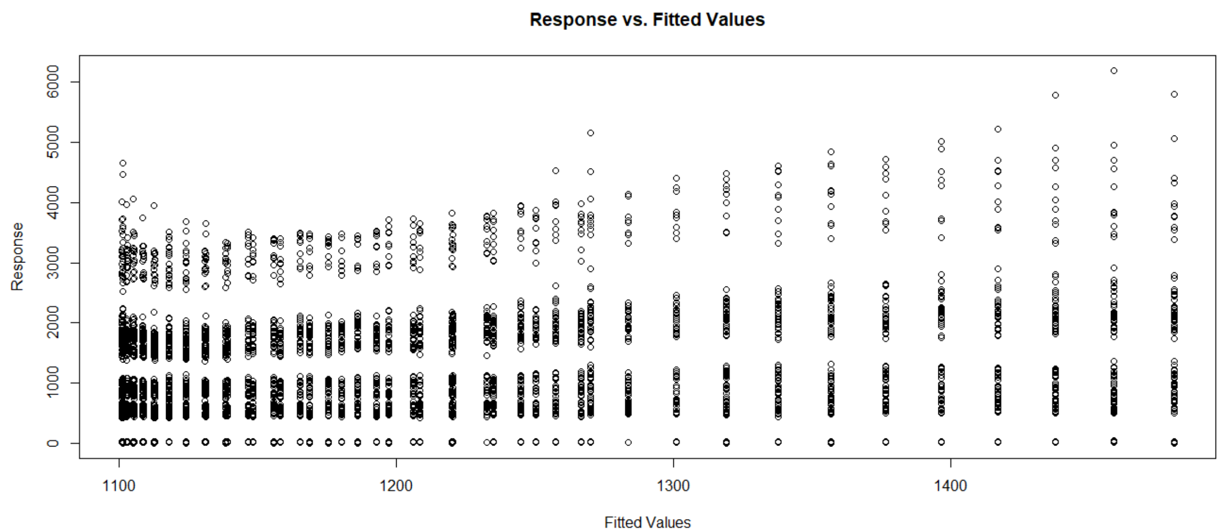
Now see a summary about negative binomial GAM and gam.check,

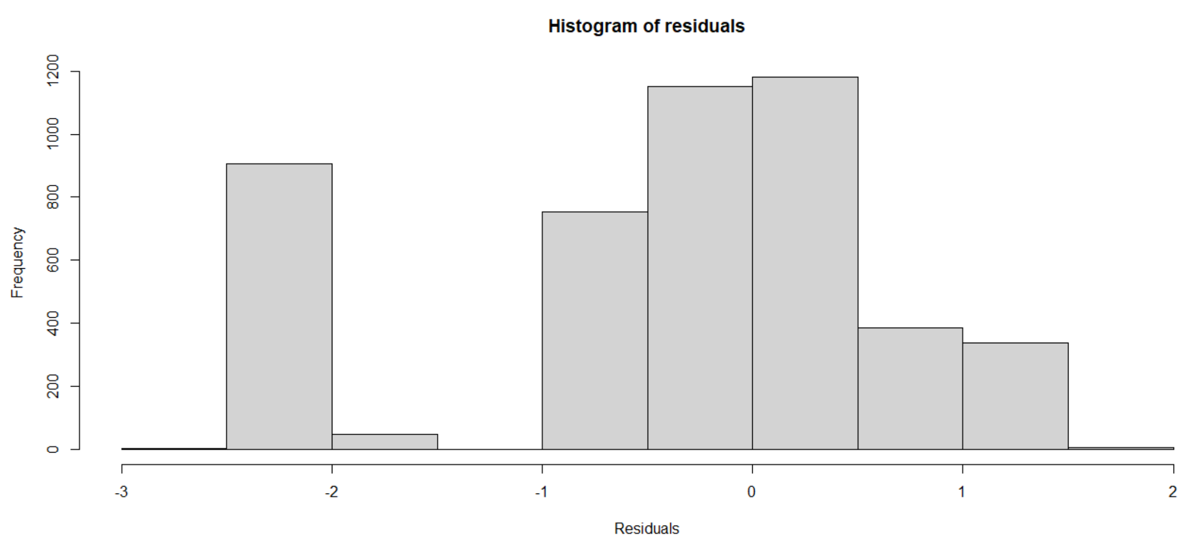
```
> summary(gam_mod)

Family: Negative Binomial(0.763)
Link function: log

Formula:
deaths ~ s(week, k = 4)

Parametric coefficients:
            Estimate Std. Error z value Pr(>|z|)
(Intercept)  7.09631    0.01659   427.8   <2e-16 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Approximate significance of smooth terms:
          edf Ref.df Chi.sq p-value
s(week) 2.512  2.829   28.2   7e-06 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

R-sq.(adj) =  0.0115   Deviance explained = 0.523%
-REML =  38504  Scale est. = 1         n = 4770
> gam.check(gam_mod, rep = 500)

Method: REML   Optimizer: outer newton
full convergence after 5 iterations.
Gradient range [0.0001184448,0.0003157716]
(score 38503.84 & scale 1).
Hessian positive definite, eigenvalue range [0.783516,3203.374].
Model rank =  4 / 4

Basis dimension (k) checking results. Low p-value (k-index<1) may
indicate that k is too low, especially if edf is close to k'.

          k'  edf k-index p-value
s(week) 3.00 2.51    1.04       1
>
```

Below can see graphs related to the gam.check and can get an idea about Resids vs lineae pred, Histogram of residuals, and Response vs Fitted Values.

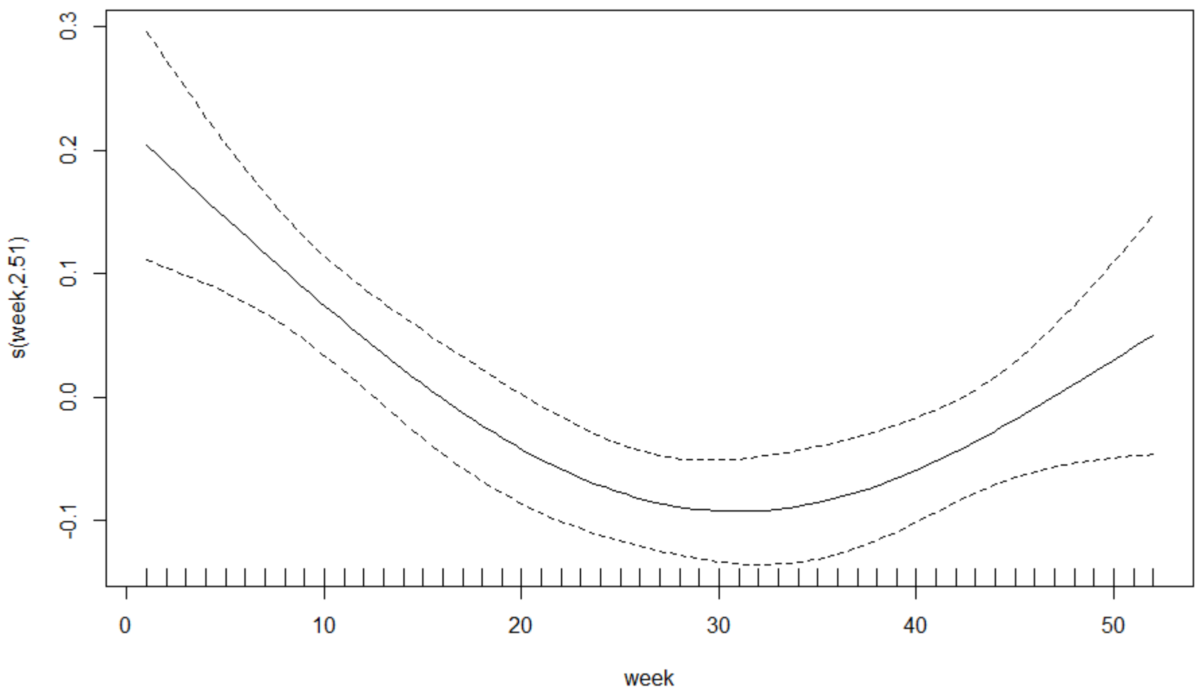



Resids vs. linear pred.
residuals
linear predictor
7.00
7.05
7.10
7.15
7.20
7.25
7.30
-2
-1
0
1


Response vs. Fitted Values
Response
Fitted Values
1100
1200
1300
1400
0
1000
2000
3000
4000
5000
6000


Histogram of residuals
Frequency
Residuals
-3
-2
-1
0
1
2
0
200
400
600
800
1000
1200

Below show that fits the model for the data from week 1 of 2011 to week 9 of 2020.



Now consider the prediction interval.

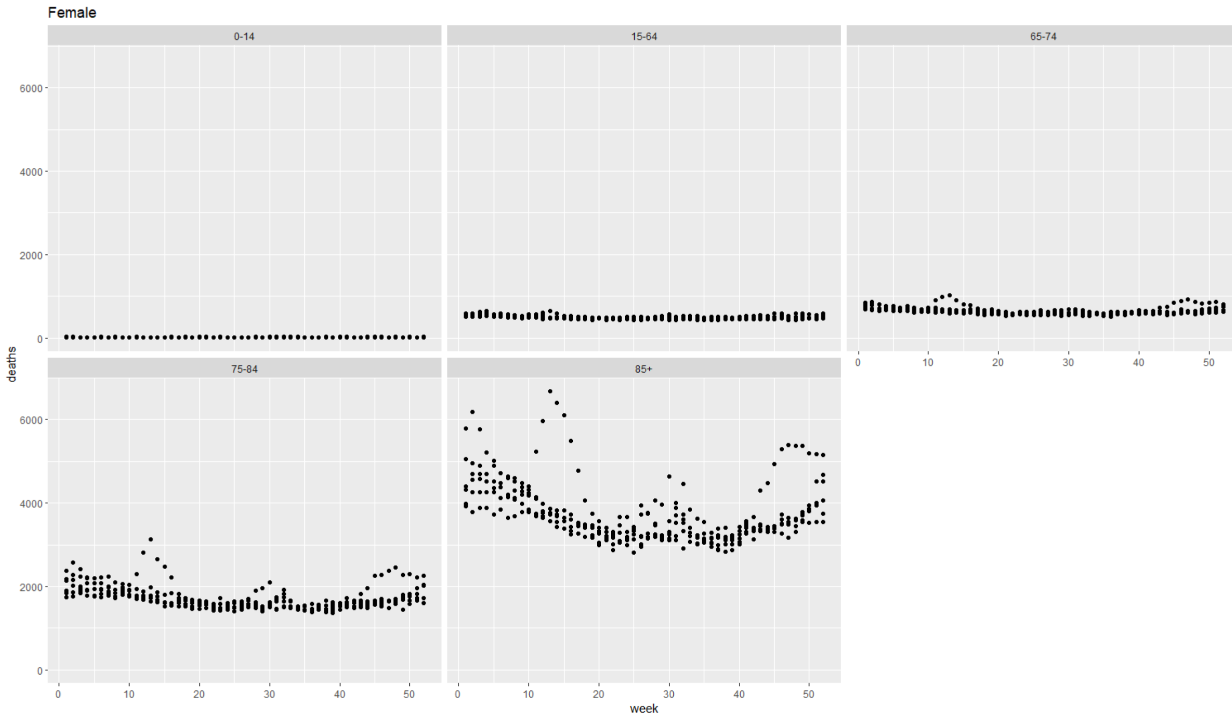
A prediction interval is an estimate, based on earlier observations, of the interval in which future data points will fall, for an input probability. Prediction intervals are similar to confidence intervals, but rather than estimating the distribution of a parameter, prediction intervals are used to predict the distribution of future points by looking at the distribution of prior points.

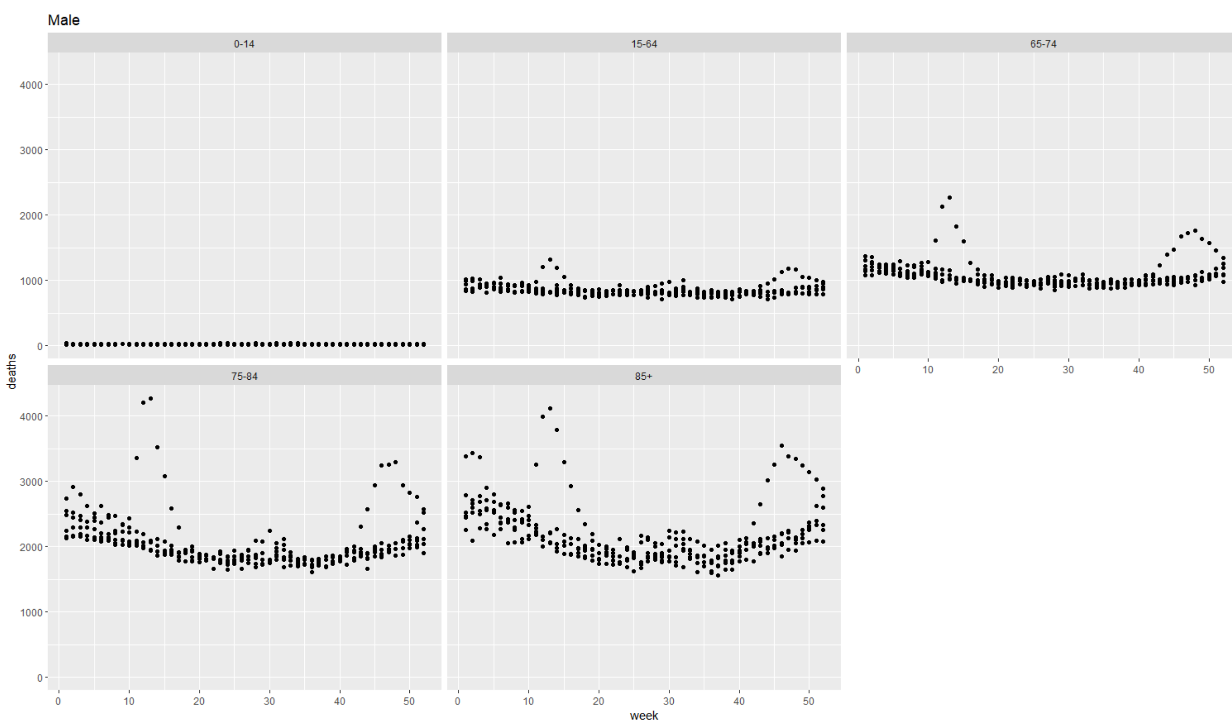
This aggregation is done by quadrature, the square root of the sum of the squares:

Prediction interval = $\sqrt{}((\text{t} \times \text{Std Error} \times 2)2 + (\text{Confidence itintervalerval})2)$

- 95% Prediction interval = [-0.001587514, 0.012047514]

Plot results for each age group and sex from week 1 of 2015 onwards can see below.





When considering the above graphs both female and male observations are approximately the same. But when increase age deaths are increasing. The largest death can be seen in the 85^+ age group. The minimum number of deaths can be seen in the 0-14 age group. Also, there is no huge variance in the 0-14 age group but, there was a huge variance can see in the 75-84 and 85^+ age groups. Especially can see deaths increase over time in both females and males.

The Evaluation of Measurement Data - Guide to the Expression of Uncertainty in Measurement (usually referred to as the GUM) provides general rules for evaluating and expressing uncertainty in measurement. When a measurand, y, is calculated from other measurements through a functional relationship, uncertainties in the input variables will propagate through the calculation to uncertainty in the output y. The way such uncertainties are propagated through a functional relationship provides much of the mathematical challenge to fully understanding the GUM.

The aim of this review is to provide a general overview of the GUM and to show how the calculation of uncertainty in the measurand may be achieved through a functional relationship. That is, starting with the general equation for combining uncertainty components as outlined in the GUM, we show how this general equation can be applied to various functional relationships to derive a combined standard uncertainty for the output value of the function (the measurand). The GUM equation may be applied to any mathematical form or functional relationship (the starting point for laboratory calculations) and describes the propagation of uncertainty from the input variable(s) to the output value of the function.

Errors may be divided into two classes: systematic errors and random errors. Three terms that are often used in association with laboratory errors are accuracy (inaccuracy), bias, and precision (imprecision). Both VIM and GUM define accuracy as a qualitative concept that describes the closeness of agreement between a measured quantity value and a true quantity value of a measurand. As such, accuracy includes the effects of systematic error even though it does not have a numerical value. Bias is the term used to describe the magnitude of any systematic error, with VIM defining bias as ‘an estimate of a systematic measurement error’. Precision describes the unpredictable (random) variability of replicate measurements of a measurand.

All the models' fit statistics are computed and presented in the Model Fit table. It gives a succinct overview of how well the re-estimated parameterized models fit the data. The table lists the mean, standard error (SE), and lowest and maximum values for each statistic across all models. Examining residuals, or the discrepancies between actual values and anticipated values is a helpful technique to gauge how well the model fits the data. The expected values are shown as a curved line in the figure above. The residual is shown by the dotted line that extends from the curved line to the observed data value.

Q2(C)

Compute weekly cumulative excess deaths from week 10 of 2020 onwards. Using the below equation can find excess deaths,

Excess deaths = Observed deaths - Expected deaths

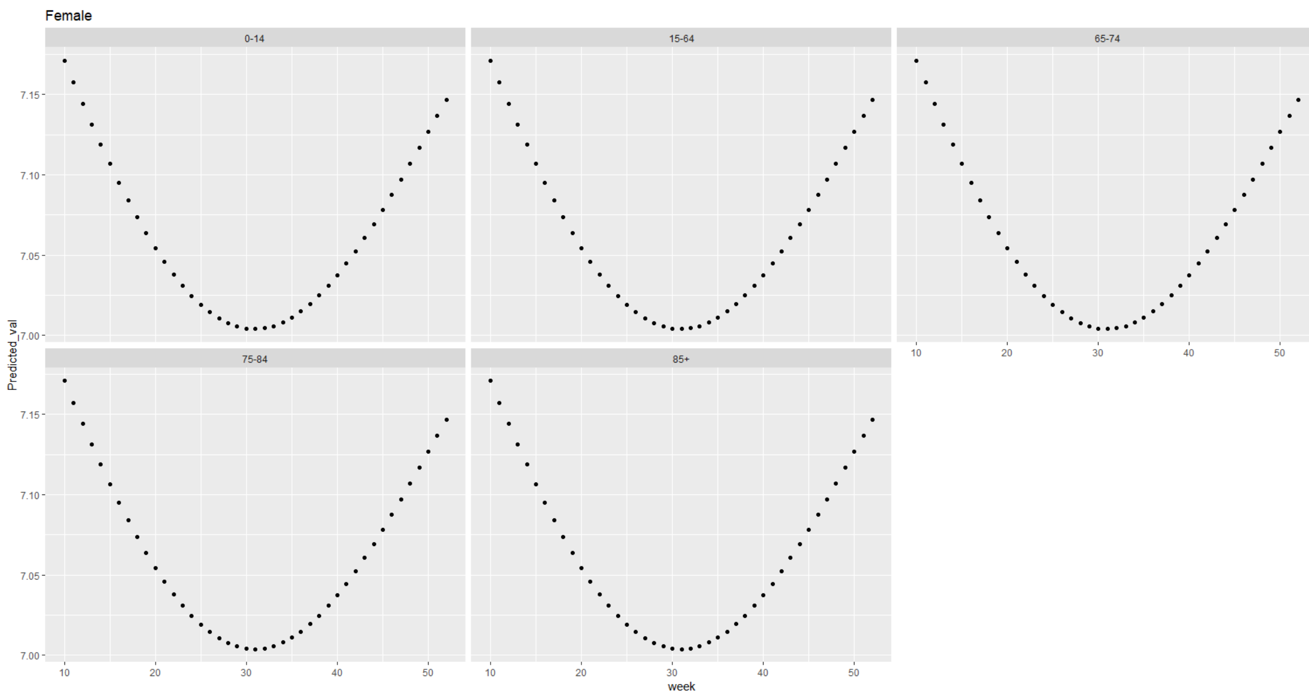
Cumulative excess deaths = 613961.1508

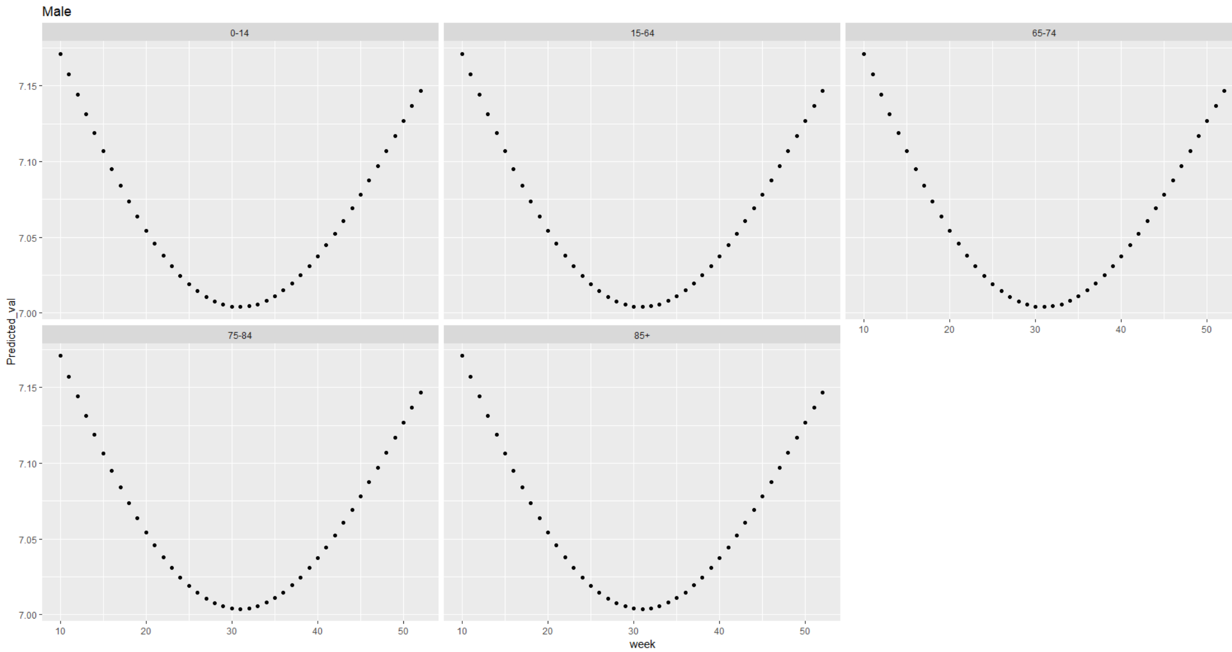
Obtain 95% prediction intervals:

Sample death counts from appropriate negative binomial distributions

95% prediction interval = [-0.0009459056, 0.0146459056]

Now plot for each age group and sex, as well as combined across age groups.





Data is used in predictive analytics to foretell future trends and occurrences. It forecasts prospective outcomes using past data to inform strategic decisions. After calculating predicted values plot for each age group and sex, as well as combined across age groups. After predicting can see females and males have approximately the same curved distribution. In starting, weeks and last weeks have more deaths and the middle week have a smaller number of deaths. All age groups have a Parabolic shape.

Using the below R-programming output can see a summary of prediction data gender vise.

```
> summary(male_Predicted_val)
    Obs_num           year           week          sex                Age_group    personweeks           deaths       Predicted_val  
 Min.   :  6.0   Min.   :2020   Min.   :10   Length:215         0-14 :43   Min.   :  705666   Min.   :   8   Min.   :7.004  
 1st Qu.:109.5   1st Qu.:2020   1st Qu.:20   Class :character   15-64:43   1st Qu.: 2122468   1st Qu.: 791   1st Qu.:7.015  
 Median :218.0   Median :2020   Median :31   Mode  :character   65-74:43   Median : 3190980   Median :1169   Median :7.052  
 Mean   :218.0   Mean   :2020   Mean   :31                      75-84:43   Mean   : 5817988   Mean   :1402   Mean   :7.062  
 3rd Qu.:326.5   3rd Qu.:2020   3rd Qu.:42                      85+  :43   3rd Qu.: 3977211   3rd Qu.:1980   3rd Qu.:7.107  
 Max.   :430.0   Max.   :2020   Max.   :52                                 Max.   :19105764   Max.   :4265   Max.   :7.171  
 Excess_deaths    
 Min.   :   0.853  
 1st Qu.: 783.965  
 Median :1161.893  
 Mean   :1394.919  
 3rd Qu.:1973.466  
 Max.   :4257.869  
> summary(female_Predicted_val)
    Obs_num           year           week          sex                Age_group    personweeks           deaths          Predicted_val  
 Min.   :  1.0   Min.   :2020   Min.   :10   Length:215         0-14 :43   Min.   : 1438702   Min.   :   4.0   Min.   :7.004  
 1st Qu.:104.5   1st Qu.:2020   1st Qu.:20   Class :character   15-64:43   1st Qu.: 2765903   1st Qu.: 465.5   1st Qu.:7.015  
 Median :213.0   Median :2020   Median :31   Mode  :character   65-74:43   Median : 3563433   Median : 655.0   Median :7.052  
 Mean   :213.0   Mean   :2020   Mean   :31                      75-84:43   Mean   : 6096625   Mean   :1467.8   Mean   :7.062  
 3rd Qu.:321.5   3rd Qu.:2020   3rd Qu.:42                      85+  :43   3rd Qu.: 3753137   3rd Qu.:2242.5   3rd Qu.:7.107  
 Max.   :425.0   Max.   :2020   Max.   :52                                 Max.   :19005490   Max.   :6677.0   Max.   :7.171  
 Excess_deaths    
 Min.   :  -3.131  
 1st Qu.: 458.492  
 Median : 647.948  
 Mean   :1460.714  
 3rd Qu.:2235.392  
 Max.   :6669.869  
> 
```

Final data frame summary.

```
> summary(Final_dt)
    Obs_num           year           week          sex                age_start    personweeks           deaths          Predicted_val  
 Min.   :  1.0   Min.   :2020   Min.   :10   Length:430         0-14 :86   Min.   :  705666   Min.   :   4.0   Min.   :7.004  
 1st Qu.:108.2   1st Qu.:2020   1st Qu.:20   Class :character   15-64:86   1st Qu.: 2125327   1st Qu.: 492.0   1st Qu.:7.015  
 Median :215.5   Median :2020   Median :31   Mode  :character   65-74:86   Median : 3377373   Median : 995.5   Median :7.052  
 Mean   :215.5   Mean   :2020   Mean   :31                      75-84:86   Mean   : 5957306   Mean   :1434.9   Mean   :7.062  
 3rd Qu.:322.8   3rd Qu.:2020   3rd Qu.:42                      85+  :86   3rd Qu.: 3965073   3rd Qu.:2025.5   3rd Qu.:7.107  
 Max.   :430.0   Max.   :2020   Max.   :52                                 Max.   :19105764   Max.   :6677.0   Max.   :7.171  
 Excess_deaths    
 Min.   :  -3.131  
 1st Qu.: 484.957  
 Median : 988.416  
 Mean   :1427.817  
 3rd Qu.:2018.456  
 Max.   :6669.869  
> 
```

Excess deaths,

- Mean = 1427.817
- Median = 988.416
- 1st quantile = 484.957
- 3rd quantile = 2018.456

Q2(d)

Variations in the age patterns and magnitudes of excess deaths, as well as differences in population sizes and age structures, make cross-national comparisons of the cumulative mortality impacts of the COVID-19 pandemic challenging. Life expectancy is a widely used indicator that provides a clear and cross-nationally comparable picture of the population-level impacts of the pandemic on mortality. Life expectancy at birth and at age 60 years for 2020 was contextualized against recent trends between 2015 and 2019. Using decomposition techniques, we examined which specific age groups contributed to reductions in life expectancy in 2020 and to what extent reductions were attributable to official COVID-19 deaths. Life expectancy at birth declined from 2019 to 2020. Males experienced the largest losses in life expectancy at birth in 2020. Reductions were mostly attributable to increased mortality above age 60 years and to official COVID-19 deaths. The COVID-19 pandemic triggered significant mortality increases in 2020.

The study findings show how covid-19 can have a considerable impact on the health of a small community. Furthermore, the results suggest that the full implications of the covid-19 pandemic can only be completely understood if, in addition to confirmed deaths related to covid-19, consideration is also given to all-cause mortality in region and time frame.