1918 Spanish Flu:A data driven study

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Abstract

In 1918, a new influenza virus emerged. During this same time period World War I was taking place. The conditions of World War I (overcrowding and global troop movement) helped the 1918 flu spread [1]. The vulnerability of healthy young adults and the lack of vaccines and treatments created a major public health crisis, causing at least 50 million deaths worldwide. This is a data-oriented project to try to understand the Spanish Flu outbreak of 1918 and how it can teach us valuable lessons. We studied the death and mortality related aspects, economic impacts and how social distancing helped mitigate the spread.

Keywords: Spanish Flu, Pandemic, Pathogen, Social Distancing, Disease

Introduction

The Spanish flu pandemic, often regarded as one of the deadliest in history, killed an almost 50million people of the 500 million it infected as it tore through Europe in 1918 and travelled to the US, killing 675,000 Americans. By comparison, the First World War, which ended in 1918, had around 20million deaths.The outbreak was in two waves. The first wave of the 1918 pandemic occurred in the spring and was generally mild with the sick experiencing typical flu symptoms such as chills, fever and fatigue then recovering after several days [2].However, a second, highly contagious wave appeared with a vengeance in autumn of that same year and victims died within hours or days of developing symptoms, their skin turning blue and their lungs filling with fluid that caused them to suffocate.In those times, there were no effective drugs or vaccines to treat it. Citizens were ordered to wear masks, schools, theatres and businesses were shuttered and bodies piled up in makeshift morgues with many having to dig graves for their own family members.It had one difference from other similar diseases. Instead of just young and old people being severely affected, adults in their prime age of 18-40 were also highly affected. By the summer of 1919, the flu pandemic came to an end, as those that were infected either died or developed immunity.

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1. Methodology

We proceed on a model of data-driven analysis. The relevant data have been collected to understand and find patterns in data. We used Python as a Data Analysis tool and several Python libraries like Seaborn, Matplotlib and Plotly have been used to create many of the visualizations. Seaborn was used to create scatterplots, the country wise data was analyzed using Pandas in Python. The line plot was created using Plotly. The context of this report is to understand the Spanish flu as a whole, but adequate numeric data or reports could not be found for regions all across the globe. We researched through many papers and web content to find out accurately what happened in those times. We have tried to understand the pandemic in three ways, how it affected deaths and mortality rates, its economic impact on the world and how effective was social distancing in fighting this invisible enemy. The reason of working on social distancing is that, it occurred in a time before antibiotics. Mankind did not have proper medication to fight against the pathogen. The best weapon in such conditions is social distancing. Hence, we tried to have a look at it.

2. Mortality due to Spanish Flu

"I had a little bird, its name was Enza
I opened the window and In-Flew-Enza.
Obey the laws and wear the gauze,
Protect your jaws from septic paws."
(Popular poem regarding the flu in those days)

Country	Estimated Deaths(UpperLimit)	Country	Estimated Deaths(UpperLimit)
Australia	15000.0	Japan	390000.0
Brazil	300000.0	Korea	200000.0
Canada	50000.0	Mexico	230500.0
China	1280000.0	New Zeland	8900.0
Denmark	5000.0	Norway	15000.0
France	400000.0	Portugal	118065.0
Germany	426600.0	Spain	260000.0
Ghana	100000.0	Sweeden	34500.0
India(British Republic)	13880000.0	Switzerland	25000.0
Indonesia	1500000.0	UK	250000.0
Iran	2431000.0	US	675000.0
Iraq	700000.0	USSR	450000.0
Italy	410000.0	Vietnam	33000.0

Table1:Estimated deaths in countries due to Spanish Flu

The Spanish flu of 1918, which lasted from January 1918 to December 1920 infected about 500 million people and caused a total death toll of about 50-70 million across the world, making it one of the deadliest pandemics in the history of mankind [3]. The time also coincided with the last phase of World War I and thus to maintain morale many of the participating nations didn't report their deaths. Hence, it's safe to assume that the deadly Flu has affected and resulted in lot more deaths than accounted for. The origin of the virus is believed to be in France, but several other theories exist. Since it was an avian virus and had the ability to spread via air, it spread throughout the world very rapidly infecting and killing people on its way. The above tables show the estimated deaths in major countries around the world. India has the highest number of reported deaths estimated to be about 14 million people. The total deaths including both US and USSR sum up to about 1.2 million.In the 1918 pandemic most deaths occurred among young adults, a group that usually has a very low death rate from influenza [4].One of the hardest hit countries due to the flu was in New Zealand which killed approximately 6500 Pakehas and 2500 Maoris. Japan and Korea also had their fair share of affected cases and mortality. China was hit in two waves. The first wave hit the country around June 1918 and had very less effect whereas the second wave was more devastating and hit the country hard. The flu also caused lots of deaths around the world. The Spanish Flu of 1918 had a huge impact of several Asian countries. Countries like Indonesia, China, Iran and Iraq suffered over half a million people each.The pandemic was probably responsible for >260,000 deaths (1% of the Spanish population), with an excess mortality of close to 1.5% [5].
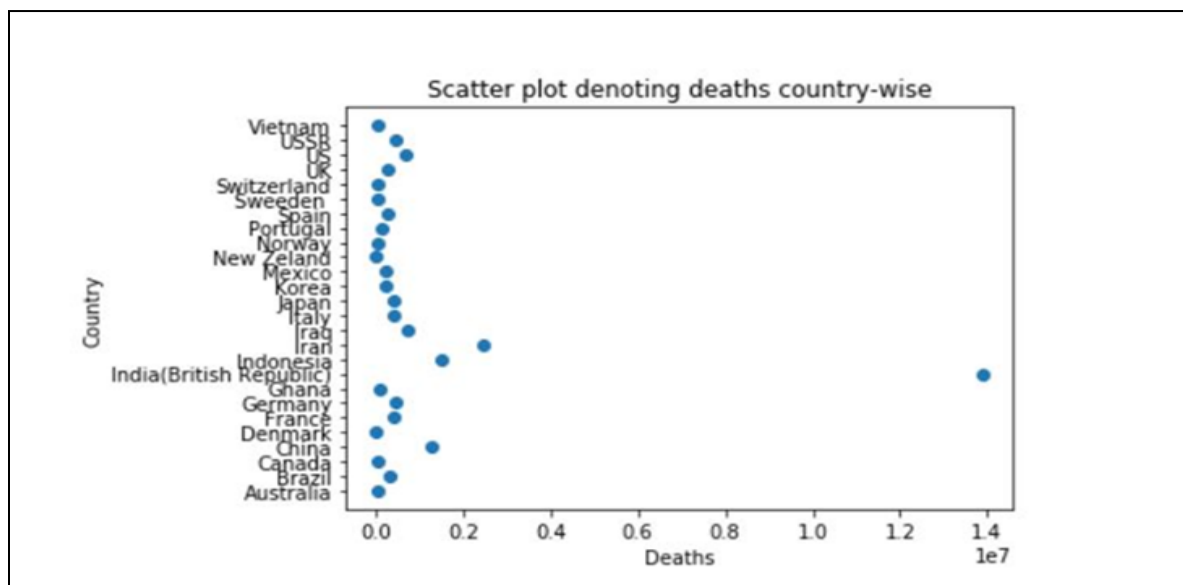

Fig 1. The number of deaths as a scatterplot

The above horizontal scatter plot shows the country wise death rates. The countries all around the globe suffered heavy losses both in terms of human lives and money. The Spanish flu taught the world that humanity still had a long way to go. Development in medicines, improve in healthcare and hygiene and proper facilities to treat ill people are the need of the hour.

4. Life Expectancy during the "Spanish Flu" pandemic

What is Life expectancy?

Life expectancy is basically a calculated figure that tells how long an organism is supposed to live. It is measured using historical data and statistical methods. During measuring the life expectancy of a person, analysts must take several factors into consideration such as demographics, the economic stability of the region, etc.
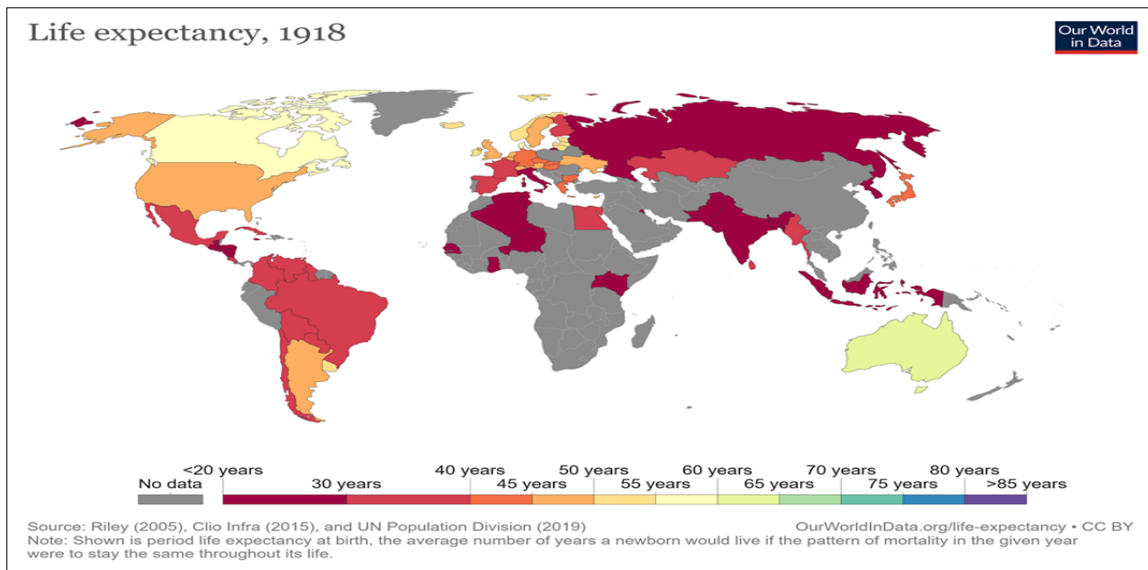

Fig 2. Life expectancy during 1918 Spanish Flu.

The flu took place in three waves. The first wave (took place during the spring of 1918) being mild and the patients took a few days to a few weeks to recover [6]. It was during the second wave(broke out during Sep-Nov 1918) that the flu claimed the greatest number of victims. The virus by now had mutated and had enhanced virulence. It affected healthy people who were also immune to the first wave thereby marking the deadliest phase of the flu. At the beginning of 1919, some places reported a "third" wave.
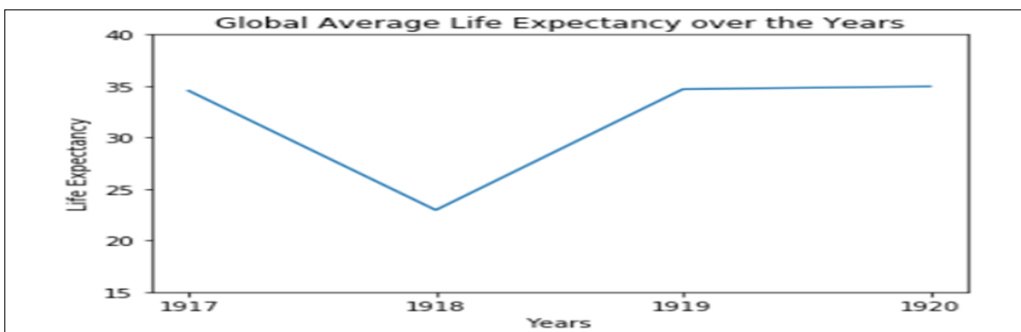
Global Average:-

Fig 3. Global Average Life Expectancy

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- From the plot above we see that there's a dip in the life expectancy with an all-time low of 22.5 years globally with the onset of the pandemic,
- Within a year, after the pandemic had passed, the life expectancy was back on track with an average of 35 years
- During 1918, people most vulnerable to the flu was between the ages of 17- 40. [7]
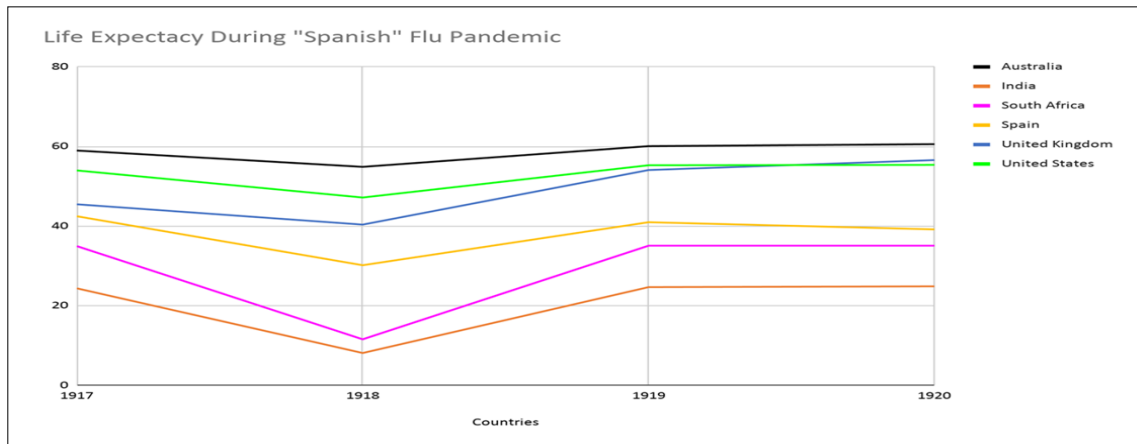

Fig 4. Life Expectancy plot across the countries

From the above plot we can conclude that the Australia had the highest life expectancy amongst all the countries both before and after the pandemic. During the pandemic, India had the lowest life expectancy of around 8 years. South Africa saw a staggering drop from 35 years to 11 years. Unlike other countries, Spain's life expectancy did recover after the pandemic but slowly started going downhill thereafter. After the pandemic passed, the life expectancy in United States rose to 55 years.United Kingdom on the other hand had the least drop in life expectancy, but it was observed that young adults were most vulnerable to the flu in 1918 and the elderly people aged more than 75 had the least death rate of all.

How life expectancy drop and rose again?

- **Aftermath of WW1:** The pandemic hit immediately after the end of the World War 1. Industries, public health centers were disrupted. Millions were getting infected and the medical professionals had no idea on how to treat the patients. On top of that the homebound soldiers took the virus to different parts of the world.
- **Public health measures:** Governments of most countries shut down public community places, schools, offices, etc. Disinfecting the streets were now a common sight. For the financially backward, officials arranged for soap and water and banned anybody to spit on the streets. They also set up centers for checking milk and other food products. These measures helped in curbing the spread of the virus to some extent.

- **Back to Normalcy:** Reports suggest after the virus died out in early 1919, there was an increase in 50% of market value which lasted until the end of 1919. From this we can infer that industries were

getting back on track and thus people could now find jobs. This in turn let them provide for their families which drastically brought up the life expectancies in countries around the world.

Takeaway

The Spanish Flu was one of the deadliest pandemics in modern history. With no vaccines or medicines, the only viable way people could protect themselves was by avoiding transmission. We can't control the outbreak of pandemics in the future but with the lessons learnt from the "Spanish" flu we can model a better pandemic preparedness plan - which we are doing currently in the case of CoVID-19.

Economic Impact

The Spanish flu outbreak of 1918 had far reaching economic effects. Offices, theatres, businesses were shut down, to contain the outbreak. Important fact worth noting is that males aged 18 to 40 were highly affected, and had serious economic impact, both in the businesses and factories they worked for, and also for their own families [8]. Important thing to understand, in case of trying to assess the economic situation in those days is that, there is not adequate data for those times. In a 2007 research paper by Thomas A. Garrett, Federal Reserve Bank of St. Louis; "Economic Effects of the 1918 Influenza Pandemic", has tried to portray the effects from newspaper articles of that time. Industrial plants are running at limited capacity. Out of a total of about 400 men in the transportation department of the Memphis Street Railway, 124 men were incapacitated the day before due to the pandemic. This led to limitations on the Street Railway service. Influenza mortalities had a direct impact on the worker wages in the US industries. It is based on a simple economic model; large number of deaths in the age group of 18-40 in males led to decrease in number of workers for the industrial sector. This reduced the labor supply, thus increasing the marginal product of labor and capital per worker and led to increased wages. There was already a demand for labor in US, as due to the war many men were drafted into the armed forces. And after the pandemic outbreak of 1918, the demand and pay rate also increased. Let us try to understand this labor hourly pay data.

Book and job printing

Job Printing is printing that uses display type and no more than a sheet or two of paper. Short as that definition is, it encompasses a world of paper items—tickets, letterheads, notices, invoices, vouchers, coupons, cards, labels, posters, receipts, and timetables, to name only a very few. Book Printing refers to the mainstream printing industry.

Payroll manufacturing industries

Manufacturing is one industry that holds a high proportion of unionized labor. Manufacturing pay scales usually come with different pay cycles as well for workers, and this can make payroll administration for manufacturing quite challenging. Here it relates to the manufacturing sector working as workers working in assembly work, machine operation, packaging, shipping, or supervising. This indicates that this sector had high need of labor and hence an increase in hourly wages.
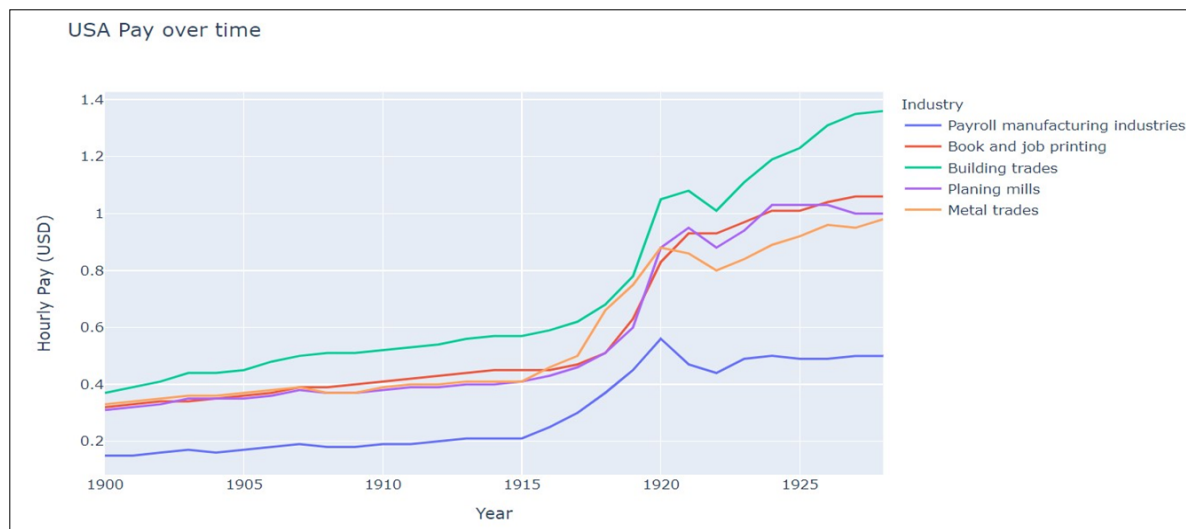
Fig 5. USA Pay over time plot

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Building trades

Related to the building and construction industry, trades (as carpentry, bricklaying, plumbing) that are essential to and chiefly practiced in connection with building construction. This sector saw a high increase in the hourly wages, indicating a large increase in demand in this sector.

Planning mills

Related to the timber and woodwork industry, a planning mill is a facility that takes cut and seasoned boards from a sawmill and turns them into finished dimensional lumber.

Metal trades

Related to the metal industry. Jobs like blacksmith, foundry workers, metal mine workers, Steel erector, Welder, Boilermaker and so on.The influenza pandemic caused a lot of economic and financial problems for the United States. Coupled with wartime expenditure, this led to various issues in those times. Businesses in entertainment and service sectors faced huge losses. Businesses in the healthcare industry experienced an increase in revenue.

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Urban areas and cities, with most of the business and offices were highly affected by the flu, with death rates increase to many times of death rates. These lead to breakdown in the civil infrastructure of the cities and caused economic and financial problems.

Overall, it hampered the economic growth and led to closure of many businesses and firms. Labor hourly pay rates increased due to increase in demand.

Effects of Social Distancing

The pandemic is thought to have begun in crowded army training camps on the Western Front. The unhygienic conditions especially in the trenches along the French border – helped it to spread and have a far-reaching impact. The war ended in November 1918, but as the soldiers returned home, bringing the virus with them, an even greater loss of life was just around the corner; between 50 million and 100 million people are thought to have died.Thevirus infected 500 million people worldwide and killed an estimated 20 million to 50 million victims— that's more than all the soldiers and civilians killed during World War I combined [9].

Implementation of Social Distancing and its Effects: -

Back in 1918, states and cities across the country told people to stay home. Schools and restaurants were shut down. Public events and community gatherings were canceled. People were told to isolate and quarantine. In some places which lasted for months. All of these led to a huge disruption in American life. Although it worked, things were not so smooth as people didn't always obey what experts and followed Social Distancing [10]. But studies show that the social distancing efforts helped slow the spread of the 1918 flu and reduce the mortality rate overall. Sustained, Layered and Early actions saved lives which was perhaps the most important takeaway from the 1918 flu. The people acted quickly particularly before the flu got to an inflection point in which the virus infected a certain amount of people and spread rapidly. They sustained interventions until the virus truly went away and quickly redeployed if the virus came back. The best thing was that the approaches were layered. Placing restriction on top helped a lot which meant advising against or prohibiting just about every aspect of public life, from schools to restaurants to entertainment venues (with some exceptions for grocery store and medical shops). Cities in which multiple interventions were implemented at an early phase of the epidemic also showed a trend toward lower cumulative excess mortality, but the difference was smaller approximately 20% which was less statistically significant than that for peak death rates.The following chart from the PNAS study, which shows that Philadelphia had a much bigger spike in deaths, while St. Louis kept its death toll down overall due to social distancing measures. Philadelphia waited eight days after their death rate began to take off before banning gatherings and closing schools. They endured the highest peak death rate of all studied. Philadelphia, as just one example, didn't cancel a World War I parade as the 1918 flu picked up, which likely led to thousands of infections
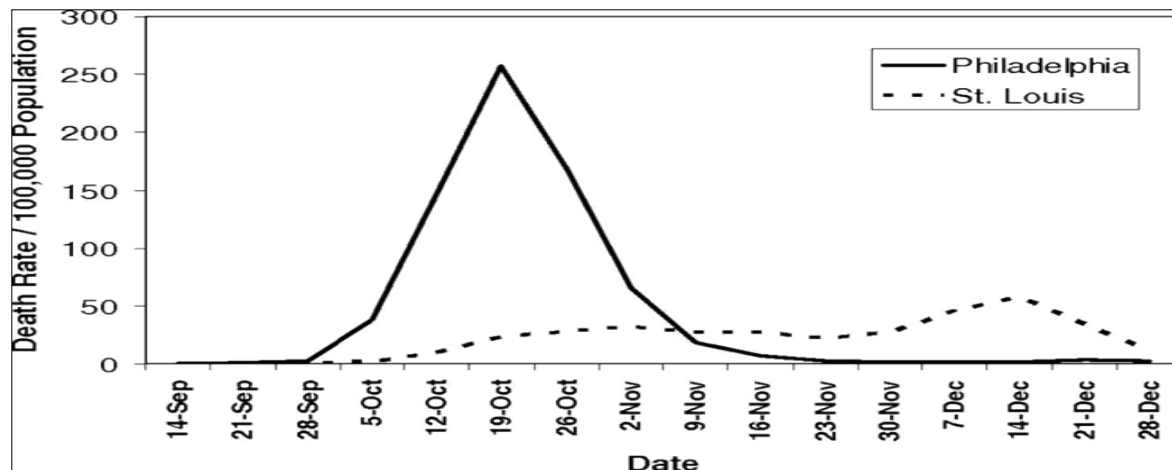
Fig 6: Comparative analysis of Weekly deaths per 1,00,000 in Philadelphia & St. Louis.

As the pandemic appeared to subside, St. Louis pulled back its social distancing measures. But it turned out that the pullback was premature — and flu deaths started to rise once again. This graph shows that, with the line chart tracking flu deaths over time and the black and gray bars below showing when key social distancing measures were in place. Thus, we can conclude that St. Louis had strong social distancing measures and a low total death rate. The city successfully delayed its peak in deaths, but faced a sharp increase when restrictions were temporarily relaxed.Notably, the second spike in deaths only appeared when cities removed social distancing measures. The PNAS study, which looked at 17 US cities, reported similar findings that no city experienced a second wave while its main battery of non-pharmaceutical interventions was in place. Second waves occurred only after the relaxation of interventions. Officials instituted social distancing measures, saw flucases fall, then pulled back the measures, saw flu cases rise again, and reactivated the measures.

Seeing the effects of outbreaks drove people to serious action. But people did do social distancing for weeks and months during the 1918 flu pandemic. The city had the lowest death rate on the Eastern Seaboard. After relaxing social distancing measures, San Francisco faced a long second wave of deaths.The following visual on the shows a comparison of death rate per 100,000 population in 1918, based on their strict or lenient lockdown policy.

The rise of globalization, urbanization, and larger, more densely populated cities facilitated the virus' spread across a continent in a few hours—while the tools available to respond have remained nearly the same. Public health interventions were the first line of defense against an epidemic in the absence of a These measures include closing schools, shops, and restaurants; placing restrictions on transportation; mandating social distancing and banning public gatherings. Thus, we can conclude that the cities that ordered Social Distancing measures for shorter periods tended to have spikes in death and higher death rates as compared to the cities that had longer social distancing measures.
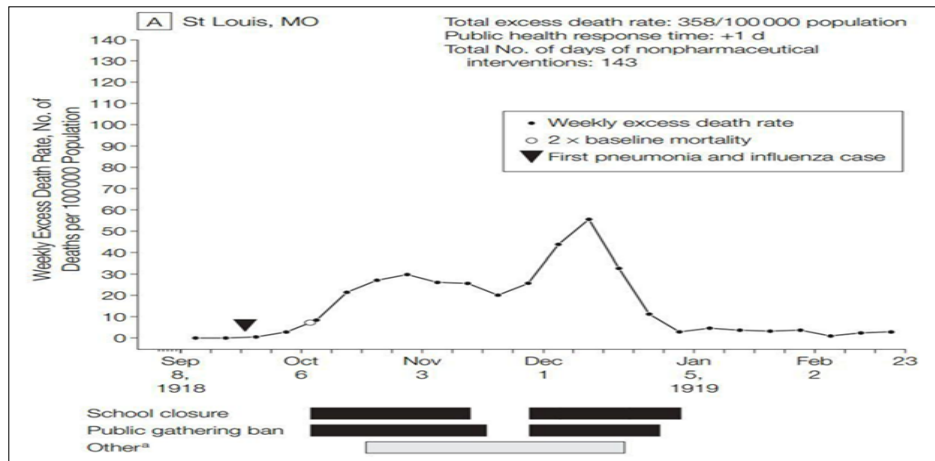
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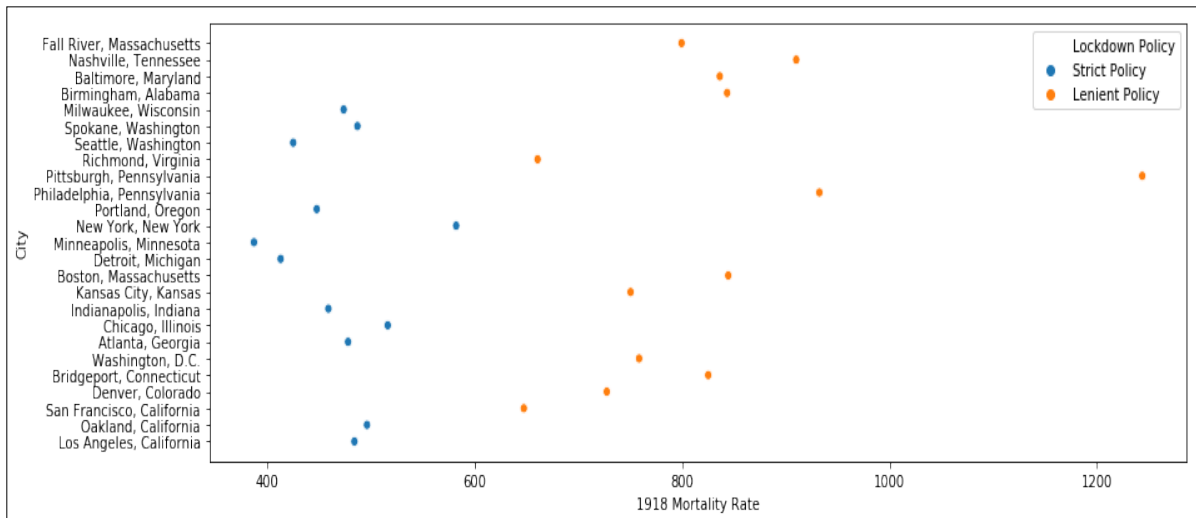Fig7: Weekly Excess Death Rate & Death Rates per 1,00,000 population   .

Fig 8: - US Cities based on strict versus lenient lockdown policies (per 100,00 people)

Relation to the COVID-19 Outbreak

In comparing the two outbreaks, there a number of things to be considered. The COVID-19 is caused by a corona virus, whereas the Spanish Flu was caused by a influenza virus. There also seems to be a difference in age specific mortality. Spanish flu was seen to be dangerous to young and old alike, but the COVID-19 seems to be more lethal towards the elderly. In case of the Spanish flu, railroads and ships were the only means to carry people over long distances. Hence spread of the virus was gradual. In today's modern world, with planes and shorter ship travel times, the virus was carried to many corners of the world in a short time. Spanish flu hit the world in a time before Sir Alexander Fleming had discovered Penicillin. Without antibiotics, many deaths were perhaps, not caused by virus itself, but by secondary bacterial infections. Spanish Flu reminds us how large can be, the impact of a pandemic. A new unknown

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pathogen can cause terrible devastation and numerous deaths. It served as a motivation, to prepare for such large pandemic outbreaks. The Spanish Flu pandemic did teach us important things. It showed us that, in battles such outbreaks, the most important tool we have is social distancing and lockdowns. Back in 1918, US cities with strict lockdown policies recorded lower deaths. A similar attitude is to be followed in case of the COVID-19 outbreak.

7. Conclusion

In relation to the Covid-19 pandemic governments must decide how much economic disruption to tolerate in order to suppress the disease, or at least to slow its spread [11]. Seeing the overall report, we can say that the economy will be in a bad state after any large disease outbreak, but given time, recovery will happen, and everything will slowly return to normal. There will be large number of deaths, but proper precaution can help in limiting the number of deaths. Proper social distancing can help a lot in spread of disease.

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