A general view of the ***SARS-CoV-2*** impact in ***Mexico***

0.77 correlation between the number of citizens per state and the number of positive cases that ended in death per state and the economic climate that may soon follow the pandemic.

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Since the appearance of the SARS-CoV-2 in Wuhan, China in December 2019, our way of life changed dramatically in just a few months. Although most believed the situation eventually would be under control, more than a year later the pandemic continues to claim significant number of lives throughout the world. The virus initially spread through Asia, Europa, Africa and finally arrived to the Americas. It started to significantly impact our side of the hemisphere in the middle of March 2020, when many shopping centers, restaurants, big and small businesses were forced to close their doors partially or permanently. At the beginning, it seems most people followed the guidelines given by their national governments and took many precautions which created what seemed like a relatively safe environment, albeit with several positive cases, the number of deaths seemed relatively controlled. However, desperation, anxiety and other social and economic factors started to negatively impact COVID statistics. Today not much is certain about the future of this disease and its impact on our lives and on the world economy. While there are some positive signs, such as a high vaccine rate in many nations, which mitigate the negative impact on our society, we are far from being able to return to pre-COVID normalcy.

Keywords: SARS-CoV-2, COVID-19, health, virus, disease, Mexico.

A general view *of the SARS-CoV-2 impact in Mexico and its principal causes.*

There are more women than men infected by the COVID 19, 51% and 49% respectively

We have used the latest data (April 15, 2021), which was obtained from CONACyT and published in Mexico's SEGOB website (Salud, 2021).

As of April 20th, 2021, the government has officially reported 2.3 million cases and 212,416 deaths. However, many outlets have claimed that the initial number of deaths to be possibly as high as three times the official number (Ahmed, 2020). At this time the government has reported over 261,000 active cases of SARS-CoV-2.

Our dataset is divided into two groups of infection cases: [1] people who died and [2] people who did not. To follow the main interests of this investigation, we will focus on data where people have died. Nonetheless, we will also give some statistics about the second group.

It is imperative that all data be analyzed in the same terms, which is why we only considered positive cases as described by the Diccionario de Datos de la Secretaria de Salud (Salud, 2021) which classifies positive cases as determined by the Clinical Epidemiological Association, either by hospital opinion committees, laboratories or antigen tests.

Once we establish the above criteria, we begin with the analysis. We begin with people who survived and were confirmed as positive cases. As **Figure 1** shows, in the first instance, there are more women than men infected by the COVID 19, 51% and 49% respectively, however, this can most likely be explained given that women are more than 50% of the population. If we assume the distribution of the age to be normal among the population, we can calculate the mean age to be around 42 years old with a standard deviation of about 16 years. However, to do inference statistics we need to take a sample. This sample was composed of 100 randomly selected people without replacements. We then calculate a confidence interval where the mean of the sample is 42 and the standard deviation is 14 years. With 95% confidence, we can estimate that people who test positive and did not die are predominantly between 38 and 45 years old. Furthermore, with a quantile analysis, we can estimate that 50% of people who did not die and tested positive oscillate between 31 and 50 years of age, regardless of gender, which is a positive statistic for people in this interval given their low probability of succumbing to the disease.

Age dispersion of people who ***didn't died*** and tested positive

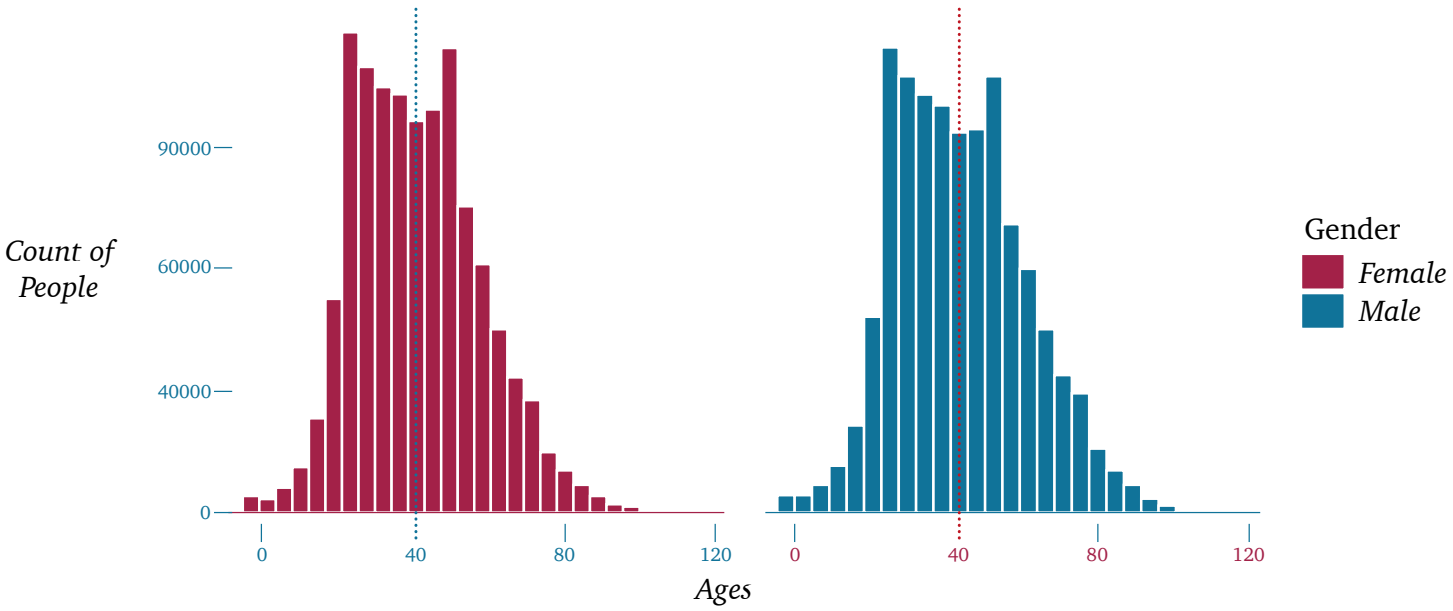


Figure 1 Age dispersion of people who didn't die and tested positive as assumptions implied per gender

[1]*In the case of people dying from an atypical pneumonia before being tested for COVID-19, many hospitals had Opinion Committees to determine the likelihood of COVID-19 being the cause of death.*

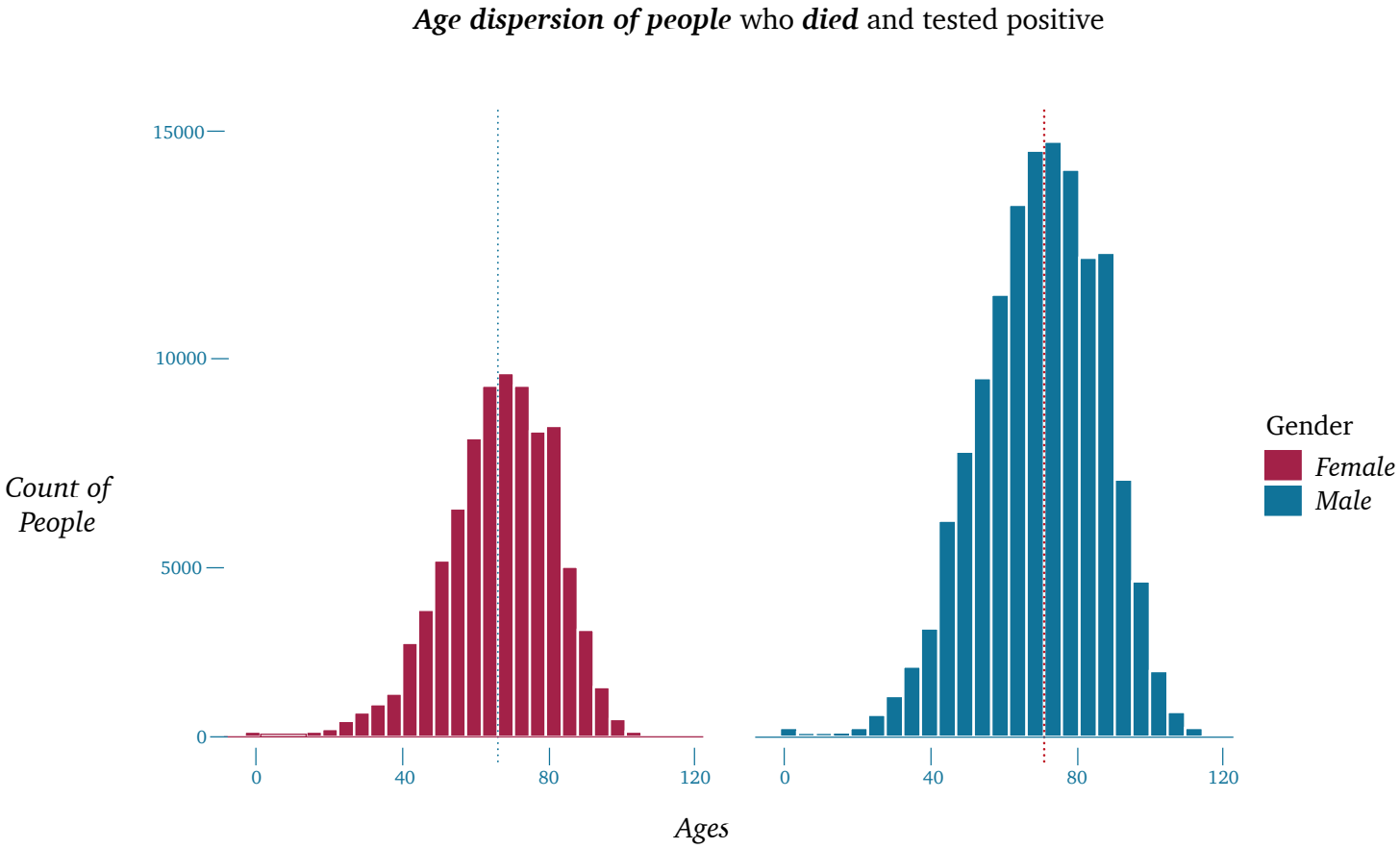


Figure 2 Age dispersion of people who died and tested positive as assumptions implied per gender

In the main dataset we are going to focus on people who tested positive and died of COVID 19. Similar to the last analysis, the population's age distribution behaves as a normal curve with a mean of 63 years of age and a standard deviation of 14 years. We observe a 21-year difference dispersion when comparing the mean of people who were infected but did not die to the mean of those who were infected but did die. In this dataset the difference in proportion of women and men is statistically significant; 37% of this dataset are women and 63% are men, as **Figure 2** shows. Taking the same number of samples as the last dataset (with n = 100) and splitting by gender, we can estimate that people who tested positive, died and are women, have a mean of 61 years of age and a standard deviation of 15 years, which means that with a 95% confidence level we can state that the age of people with these characteristics oscillate between 58 and 64 years old. On the other hand, we can also estimate that people who tested positive, died and are men have a mean of 59 years of age and a standard deviation of 15 years, which means that with a 95% confidence level we can state that the age of people with these characteristics are between ages 56 and 62.

Given the last data analysis, we want to know if the mean of men and the mean of women are significantly different. To calculate this difference, we are going to build a hypothetical proof of the mean differences with the same number of samples and the same variances as Equation 1 shows:

With a significance level of 5%, the *p-value*= 0.2106, where this metric establishes the probability of success against the null hypothesis. In conclusion where the *p-value* is greater than α, the mean age of men and the mean age of women from these samples are not significantly different at the 5% level of error.

Once we established the age parameters, it was imperative that we analyze the origins of people in terms of nationality and then states in Mexico. To begin with, Mexico confirmed 241 cases of foreigners who died from COVID-19; most of these cases came from the United States of America (87 cases), followed by Venezuela and Colombia (33 and 23 cases, respectively), as **Figure 3** shows below.

Given: $\mu 1$ *=mean of sample men's age*

$\mu 2$ *=mean of sample women's age*

We determine the following hypothesis

$$H0: \mu 1 = \mu 2 \quad \text{and} \quad H1: \mu 1 \neq \mu 2$$

and establish the error type I with $a = 0.05$

Equation 1 Hypothesis proof for men's and women's mean differences

Age dispersion of foreign people who tested positive and died in Mexico per Nationality

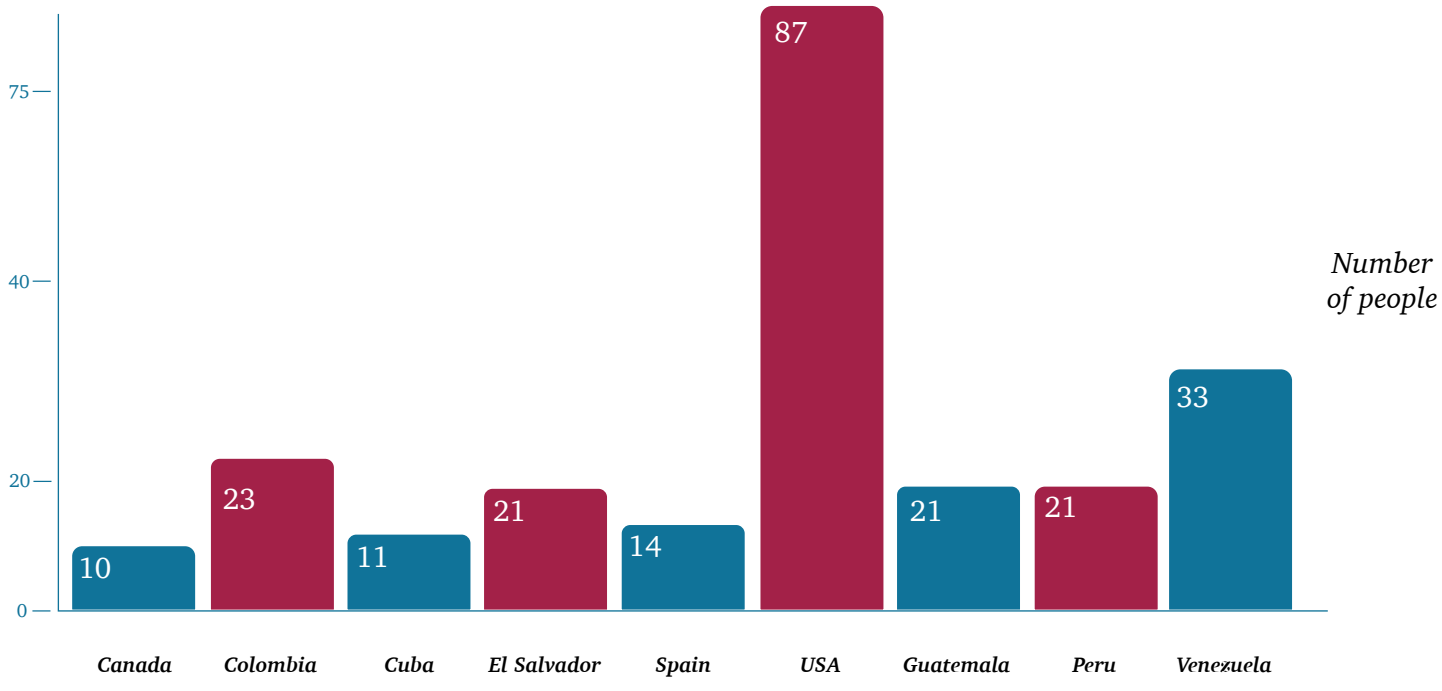


Figure 3 Age dispersion of foreign people who died and tested positive in Mexico per Nationality

Whether we compare these foreign cases with national cases, they are very insignificant since 99.87% of the data are Mexicans. Given the last statistics we are going to go deeper in the analysis by looking at Mexican states.

As **Figure 4** shows, Mexico City and the State of Mexico are the areas with most deaths. Both federal entities represent **31% of deaths**. They are followed by Jalisco, Veracruz and Puebla. The top 10 states constitute 65% of deaths caused by COVID-19 as Table 1 shows (INEGI, 2021), **but those 10 states constitute roughly only 43%** of the country's population (INEGI 2020).

This can be due to the much higher concentration of people in urban areas in these states, as well as better access to public and private medical infrastructure and services which help people who have contracted the disease to be adequately diagnosed.

Mexico City & State of Mexico are the top areas in terms of deaths.

Percentage of participation and ***cumulative deaths*** per state

Age dispersion of Mexicans who ***died*** and tested positive per state because of ***Covid-19***

Figure 4 Age dispersion of Mexicans who tested positive and died per State because of COVID-19

These results are also explained by the number of people who live there. For example, the State of Mexico has 16,992,418 people and Mexico City has 9,209,944 people (Cañas, 2021). Given the last results and a Pearson correlation proof between the population and positive cases ending in death per state, we can conclude that there exists a strong positive correlation (0.77) between the number of citizens per state and the number of positive cases that ended in death, as **Figure 5** shows, which indicates that if there's a larger population, the number of deaths of those who tested positive also increases; there is a linear correlation between population size and the number of positive cases who also died.

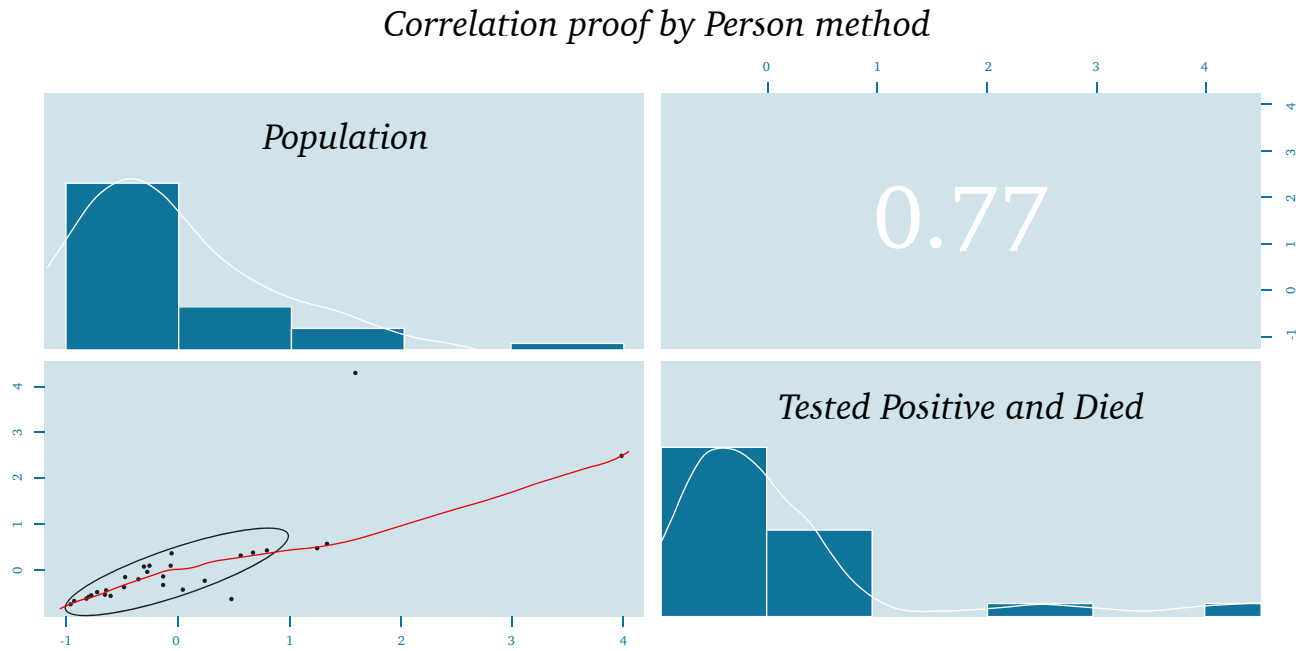


Figure 5 Correlation proof by Pearson method

Another important statistic is the relation among positive cases that ended in death. Currently, hospital capacity is almost full in Mexico, but what type of hospitals are we talking about?

As **Figure 6** shows, of the total of COVID-19 patients the IMSS (Mexican Institute of Social Security by its acronym in Spanish) has 57.7%, the SSA (Secretary of Health and Assistance by its acronym in Spanish) has 27.7% and the ISSSTE (Institute for Social Security and Services for State Workers by its acronym in Spanish) has 7%. These are the top three medical institutions which have the most deaths and, positively correlated, are the sectors which have been attended the most by COVID-19 patients. Institutions like PEMEX, SEDENA or even private hospitals have few deaths reported because, to begin with, they are not easily accepting people with COVID-19 at their facilities.

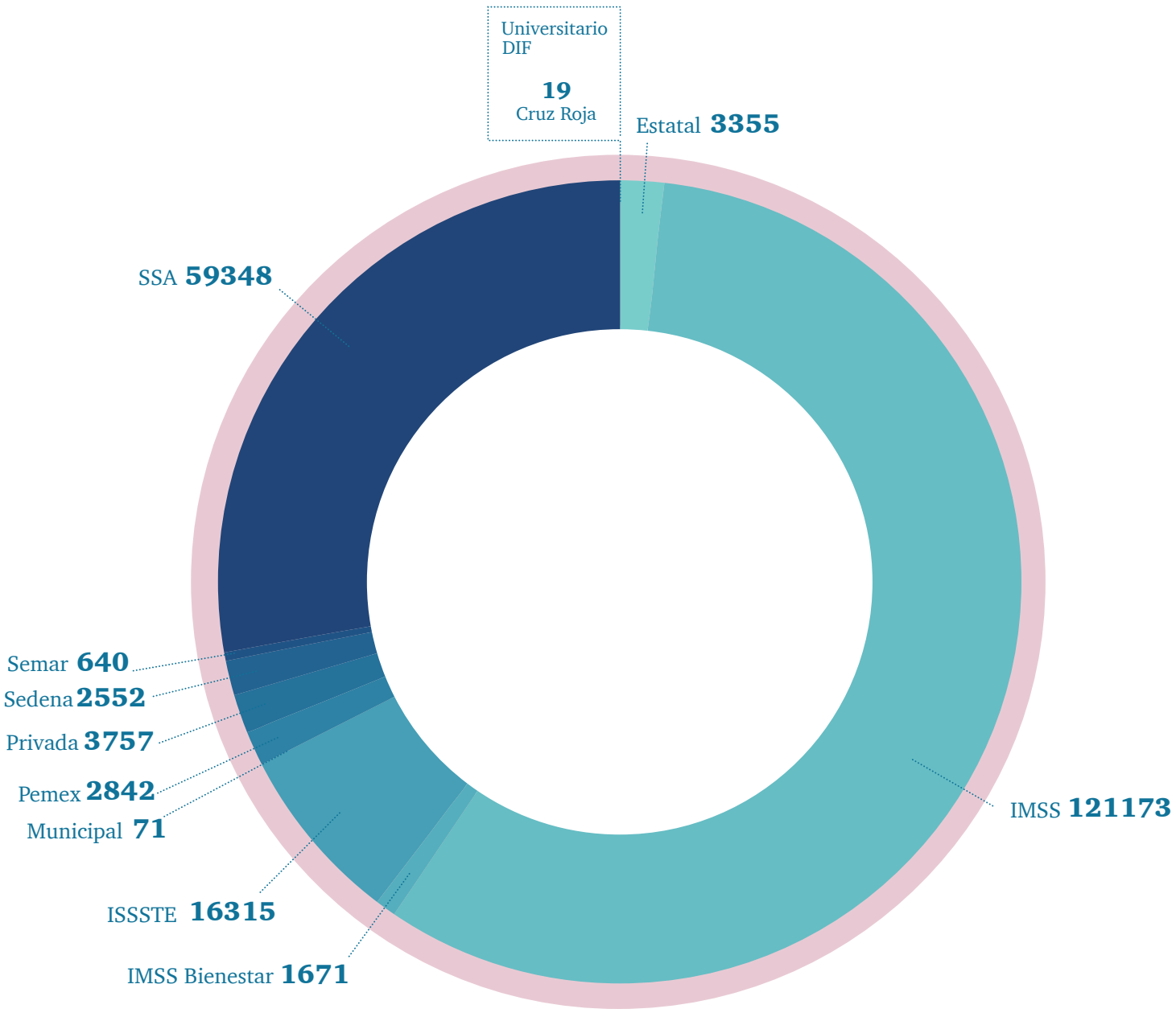
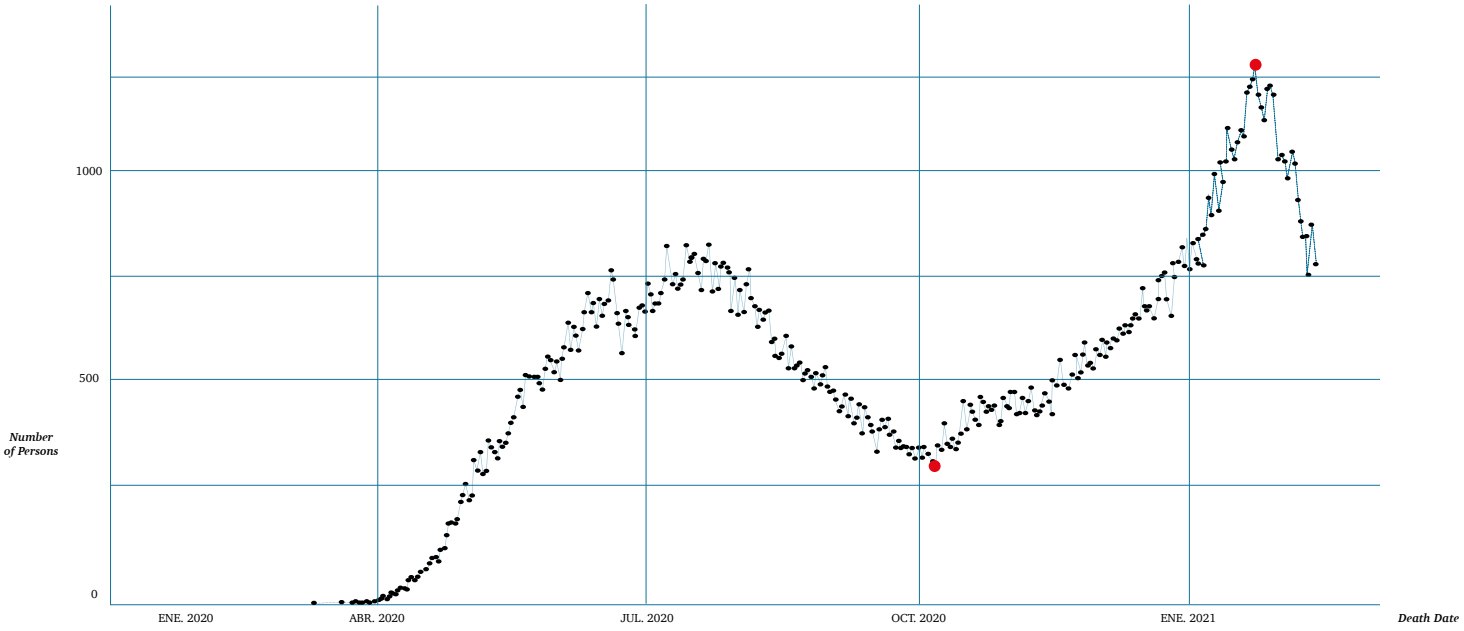


Figure 6 Number of people who died and tested positive per sector

Figure 7 shows the peak number of deaths per day throughout 2020 and 2021 in Mexico. As we have explained, reported COVID-19 deaths started in the middle of March 2020, with an increasing number of deaths until August 2020, while firms and businesses and ordinary citizens were still adapting to the new reality brought on by the pandemic. At that time, we notice the number of deaths per day decreased significatively; however, and despite the Mexican Government's actions, in October and as consequence of holidays like Mexican Independence Day, Day of the Dead and highly probable people's false sense of safety, the number of deaths per day started to increase again. The worst numbers started in late December and early January, because of various Christmas and New Year holidays when numerous people gathered to celebrate. Currently, we do not see a significant decrease in the number of people who die per day and that is why the Government implemented the red and orange-light alert in many states, aiming to decrease the number of infections and deaths. We notice a slow decline in the number of daily COVID deaths in February and the slow decline has been relatively consistent until the present (April 20th).

Number of ***Mexicans who have died per day***



A general view of pandemics and the ***economic climate in the aftermath***

The Spanish Flu of 1917-1918 was the deadliest pandemic since the Black Plague in the mid-14th century. Economists debate the economic impact that pandemics have on later economic growth. However, there is a strong correlation between the Black Plague and the economic growth in GDP per capita (Melanima, 2012) that followed and the economic boom of the 16th century that played its own role to contributing to the Renaissance. The Spanish Flu pandemic was very likely a factor for the strong economic growth of the 'roaring' twenties.

After the World Wars there were strong economic shifts that necessarily occurred; both World Wars were followed by strong economic growth and permanent social changes, such as a sudden increase in the percentage of people living in urban settings versus rural ones. In order to more accurately predict the post-COVID 19 economic climate requires determining exactly what role the Spanish Flu played in the economic boom of the 1920's, which economists agree was mostly a consequence of the end of World War I (Terzi, 2021). However, there is strong evidence to indicate that a pandemic of the magnitude of COVID 19 will inevitably lead to economic development in its aftermath, especially when considering the opportunities that 21st century technology offers a world economy recovering from such a severe blow.

While Mexico did not play a significant part in World War I, the country had its own civil war which has been named the Mexican Revolution. This war lasted between 1910-1917. During the war, Mexico lost about 1.4 million people due to battles and diseases, a result of damaged infrastructure and malnutrition. However, in about a year, the Spanish Flu alone claimed 460-500 thousand Mexican lives. Despite high birth rates, Mexico saw a strong decline in population from 1910-1921, roughly 5.4%. By the time the Spanish Flu hit Mexico, only about 28.7% of people lived in urban areas (2,500 people or more), and 71.3% of people lived in rural areas; in contrast today, 79% of Mexicans live in urban areas (2,500 people or more), significantly facilitating the spread of a contagious disease much more than a century ago.

	1910		1921	
	Número	%	Número	%
Total	15.160	100.0	14,335	100.0
Urbana 1/	1,783	11.8	2,100	14.6
No Urbana	13,377	88.2	12,235	85.4
Mixta 2/	2,565	16.9	2,355	16.4
Rural 3/	10,812	71.3	9,880	68.9
Ciudad de México	471.1		661.7	
Guadalajara	119.5		143.4	
Monterrey	78.5		88.5	
Puebla	96.1		95.5	
Tampico	16.5		44.8	
Torreón	34.3		50.9	
Las 6 ciudades	816.0	5.4	1084.8	7.6

The Spanish Flu claimed the lives of 1 in 30 Mexican, so far, COVID 19 has claimed the lives of approximately 1 in 600 people (according to the official numbers). *Areas with higher mortality rates tend to have stronger economic recoveries (Garrett)*. While COVID 19 is not as deadly as previous pandemics, technology and better understating of good public policy can very well give us strong positive economic outcomes (Kolodko, 2020) in the years to come.

Areas with higher mortality rates tend to have stronger economic recoveries (Garrett).

Conclusion

According to many experts, Mexico initially had some of the laxest policies against the spread of COVID 19 (Pinzón, 2021) in Latin America, which could have contributed to Mexico's having a much higher death rate than the Latin American average of 1 death per 1,000 people (Pinzón, 2021). This shows that Mexico needs to aim at better public policies in terms of public health. Reports of the high death count in places like New York City were known by the world in mid-March of 2020 but adequate safety measures were almost discouraged in Mexico.

As a conclusion of government data, we can establish that there is a linear correlation between population size and the number of positive cases who also died and that the rate of death is very similar in almost every state, but with certain exceptions in urban areas with high density of inhabitants.

From a public policy perspective, a decentralization model should be reexamined to avoid massive concentrations of people in just a handful of cities in the country. New and diverse economic resources and political decisions are awaiting. In an age of great advances in communications, the great cities become less indispensable. "Estudios sobre el proceso de descentralización en México 1997-2017" conducted by Consejo Nacional de Evaluación de la Política de Desarrollo Social (CONEVAL), may provide helpful statistics and policy recommendations for interventions that help alleviate massive concentration of people for economic reasons and, currently, for public health and safety.

Finally, despite the obvious differences a little over a century has done, there are many parallels between the world hit by the Spanish Flu and the world as it is now in the era of COVID 19, such as the proliferation of new technologies (cellular phones and apps) and a transport revolution (cheaper and faster travel and electric vehicles) which according to many may lead the 21st century to have its own roaring twenties (Terzi, 2021).

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