

Research on the Phenomenon of COVID-19 Mortality Rate Changes

Xingyue Yan *

Department of Statistics, University of Minnesota Twin Cities, Minneapolis, MN, 55414, USA

* Corresponding author: yan00178@umn.edu

Abstract. In the last three years, the most commonly occurring topic in people's day-to-day dialogue has inevitably been the corona-virus disease 2019 (COVID-19). At the same time, it is embodied in various aspects of our lives. For example, keeping social distance, wearing masks, getting vaccinated, staying at home order, working at home have had an impact on people's lives. With the tendency of COVID-19 mutations, more people are being diagnosed or even dying. In addition to this, there is a significant risk of sequelae in those who are recovered. However, there are still no other options such as medical treatment to stop the occurrence of COVID-19 completely. Therefore, this research examines the changes affecting the causes of COVID-19 deaths for these conditions. While many researchers have explored relevant topics during the period affected by the epidemic, this research provides a fairly comprehensive overview of age (11 age groups), sex (male and female), vaccination status, and alterations in the overall number of diagnoses and fatality cases since COVID-19's inception up until the present. It is possible to obtain from the detailed investigation whether there is a significant relationship between COVID-19 and age, sex, and vaccination status. This research includes Box plots and Anova test for different age groups and sexes, and line graphs of the number of vaccinations, the amount of COVID-19 mortality in the United States, and the amount of COVID-19 confirmed cases and mortality worldwide to compare, interpret, and analyze the data to obtain conclusions.

Keywords: Anova test, COVID-19 deaths, COVID-19 cases, sex, age.

1. Introduction

On January 9th 2020 the Chinese government discovered a highly virulent coronavirus and the same day that the WHO discovered this new SARS-CoV-2 [1]. This coronavirus was initially identified in December 2019 in Wuhan that is a metropolis in the middle of China, and soon after, the virus consequently spread worldwide [2]. This virus was later even called the Wuhan virus and the suggestion that Its possible origin in bats puts them at higher danger. [1,3]. Single standard RNA viruses with large envelopes belong to the coronavirus family [4]. The Coronavirus disease 2019 (COVID-19) is a respiratory infection that can be spread by airborne droplets, and its symptoms are mainly in the lungs [1]. Coronavirus has also taken a lot of people around everyone in their daily life. Not only does coronavirus disease cause great distress in human life, but it also brings several indelible sequels to patients diagnosed with the disease. Sequelae include persistent fatigue (39-73% of those examined), shortness of breath (39-74%), poor quality of living environment (44-69%), diminished pulmonary function system, and anomalous pulmonary fibrosis, CT findings (39-83%), proof of peripheral, peripheral, pericardio-myocarditis (3-26%), psychiatric improved morbidity of diagnosis (5.8% vs 2.5-3,4%) [5].

What is most frightening is not only the effect of the COVID-19 virus but also Omicron, Delta, Alpha and more mutated viruses that have not yet appeared are attacking humans. These mutated viruses that have developed have also greatly increased the number of diagnoses and deaths [6]. In addition, the impact of coronaviruses has caused economic distress in countries around the world. As a result of the epidemic, more and more companies, businesses, and small stores had to declare bankruptcy and close down for more than two years. In every particular, the most impacted fact includes tourism organization, hotel, restaurants, transportation, business, and factory. Nevertheless. high housing rentals, staff salaries, employee insurance, loans, and different taxes put strain on these firms as well. Banks encouraged refinancing to enterprises restart labor and manufacturing during the

epidemic, it was relatively burdensome for small and micro enterprises to obtain loans. In addition, company closures and layoffs put employees at risk of losing their jobs. The unemployment rate (5.9%) remained higher than the level in February 2020 (3.5%) in June 2021 [7]. A great many of students have to attend classes at home through some online video conferencing software such as Zoom or Tencent meeting in addition to commuters, therefore, students lose all group activities. This online mode of learning not only increases students' academic stress but also poses a danger to their mental health [8]. Being close at home for long periods has changed the way many people used to live, there is a certain degree of restriction and academic progress is affected to some extent. The epidemic is known to have lasted from the early 2020s until now or longer, and no one knows when it will end. Although the epidemic is much more under control now, people's performance has become mask-to-mask communication from face-to-face communication. People need to wear masks every day when they go out in addition to the essentials. Mask-to-mask communication has also become a habit for most people. In addition, vaccination allows most people to gain immunity, which effectively reduces the total number of mortalities, serious disease, and amount of diagnosis [9].

Furthermore, the epidemic of COVID-19 can be blocked by the progressive establishment of an immune barrier in the population through an orderly vaccination [10]. Therefore, it is crucial to analyze the causes affecting coronavirus mortality. This study investigates and analyzes the main causes of coronavirus deaths in the United States, including different age groups, gender, and the number of vaccinations. The subject of this study was to analyze the phenomenon of variation in COVID-19 mortality through statistically significant charts and Anova Test forms. The study included six charts and two Anova Test tables to analyze whether 11 different age groups, sexes, and vaccines were strongly associated with COVID-19 mortality.

2. Method

The research mainly looked for the relationship with the factors affecting the changes in the mortality rate of the pandemic through the detailed data of the mortality rate and the number of vaccinations by different ages, genders, and regions. The data selection date for this research was January 22, 2020, the time when the world's first COVID-19 was reported, but it is well known that the epidemic is not over, and the data cut-off time is August 2022.

The data selecting requirements of the research must be officially recognized, must include the initial period of the COVID-19, must have a unified time period for each variable, and must have detailed explanation for each variable. Inconsistent time data can lead to inaccurate research results. Unrecognized data can lead to misleading results. Having data from the initial period of the epidemic can facilitate better time-to-time comparisons.

A total of four data were used in this research. The first data is on the COVID-19 number of death cases by different age groups and gender (male and female) in America from the Centers for Disease Control and Prevention (CDC). The age and gender data will help research analyze whether the COVID-19 death cases vary by age and gender relation. The second is the data on the number of research the COVID-19 vaccinations in various countries from Our World in Data, including those who received the full vaccine and those who received the booster shot. The relationship with the COVID-19 mortality was studied by comparing mortality rates before and after vaccination. The third and fourth data are statistics about the detailed number of daily confirmed and deaths cases of the global COVID-19, which provides by the COVID-19 Datasets of the Center for Systems Science and Engineering at Johns Hopkins University (JHU). Those two are main comparative data in this research.

The research is mainly worked through R Studio, SPSS Data Analysis and CDC official web page configure visualization. There are four plots in the research, the week mortality toll from COVID-19 by different age group in America, and the trend of people who received fully vaccine numbers from January 2020 to August 2022, and 217 countries COVID-19 deaths and confirmed cases from January 2020 to August 2022. The predictors of this research are age, sex, and data of vaccinations, also the

outcome is the total of fatalities during the epidemic period. In addition, this research will use the Anova Test to study the relationship between variables. In this research, it is hypothesized that age, gender and number of vaccinations are each associated with COVID-19 mortality rate.

3. Results and Discussion

3.1. Gender

From top to bottom, the Box plot in Figure 1 comprises five lines. The death toll of maximum, upper quartile, median, lower quartile, and minimum are represented by them. By comparing the median for men and women, it can be concluded that there are more COVID-19 mortality instances in men than in women. The hypothesis of COVID-19 Deaths by gender is that different sex does not have a significant relationship with COVID-19 deaths. However, the conclusion is contrary to the null hypothesis. The conclusion for the COVID-19 Deaths by gender is that different sex has a significant relationship with the COVID-19 Deaths since the p-value is small and close to 0 in Table 1. Compared with the alpha value (0.05), the p-value is extremely small, especially male have high death number than female.

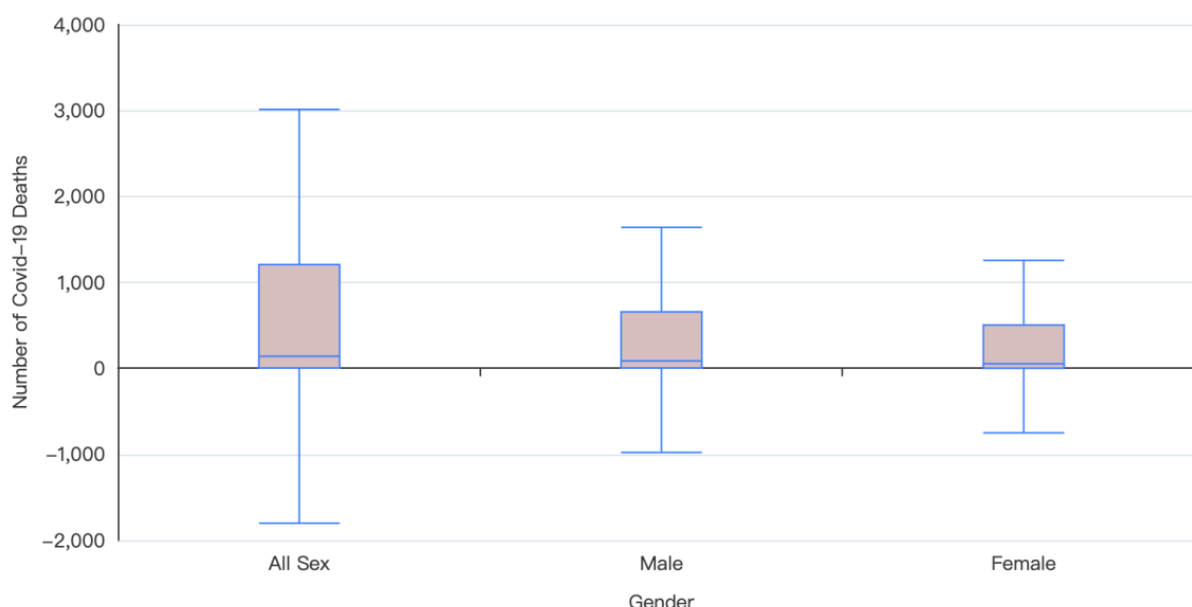


Figure 1. Box plot of COVID-19 Deaths by gender

Table 1. COVID-19 deaths by gender Anova result table

Variable	Sample Size	Average Value	Standard Deviation	F value	P-value
All Sex	1644	444.491	502.692	8.149	0.000***
Male	1644	391.477	480.393		
Female	1644	380.439	475.543		
total	4932	405.469	487.058		

Note: *** represent the significance levels of 1%.

3.2. Age

From top to bottom, the Box plot in Figure 2 comprises five lines. The death toll of maximum, upper quartile, median, lower quartile, and minimum are represented by them. It can be concluded that the population of deaths of COVID-19 is obvious higher in those 3 groups (age between 65 and 85 years old over) than in other 8 age groups (age between under 1 year to 64 years old) from comparing the median for those 11 age groups. The hypothesis about the COVID-19 deaths by age

bracket is that there is no discernible connection between various age groups and COVID-19 deaths. However, the conclusion is contrary to the hypothesis. The conclusion for the COVID-19 mortality by 11 age groups is that each age group has a significant relationship with COVID-19 deaths since the p-value (0.000) is extremely small and close to 0 in Table 2. Compared with the alpha value (0.05), the p-value is smaller than alpha value, especially old people (Age range: 55 to 85 years old over) always have high death number than young people (Age range: 0–1 year, 1–4, 5–14, 15–24, 25–34, 35–44, and 45–54 years). Therefore, the hypothesis can be rejected.

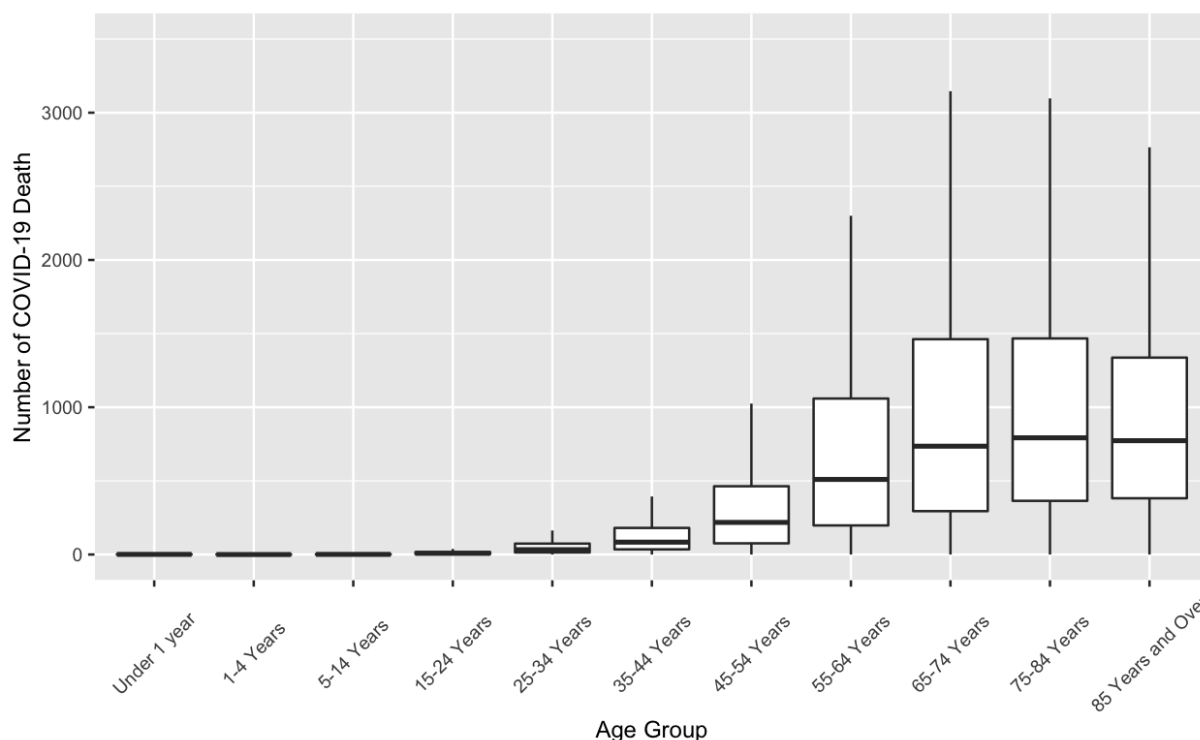


Figure 2. The box plot of the COVID-19 Death's mortality by 11 age groups

Table 2. COVID-19 deaths by age group Anova result table

Variable	Sample Size	Average Value	Standard Deviation	F value	p-value
Under 1 year	411	1.635	2.380	237.007	0.000***
1-4 Years	411	0.852	1.390		
5-14 Years	411	1.869	2.222		
15-24 Years	411	13.465	15.470		
25-34 Years	411	56.136	65.732		
35-44 Years	411	138.423	160.976		
45-54 Years	411	330.891	354.421		
55-64 Years	411	732.350	721.028		
65-74 Years	411	1149.878	1135.601		
75-84 Years	411	1301.401	1352.139		
85 Years and Over	411	1308.915	1450.635		
Total	4521	457.801	903.422		

Note: *** represent the significance levels of 1%.

3.3. Vaccinated

The Figure 3 is the daily COVID-19 fully vaccinate area graph in U.S. from time period 2020.12.13 to 2022.08.09. People who received fully vaccinate increase at time period 2020.01 to 2021.06.

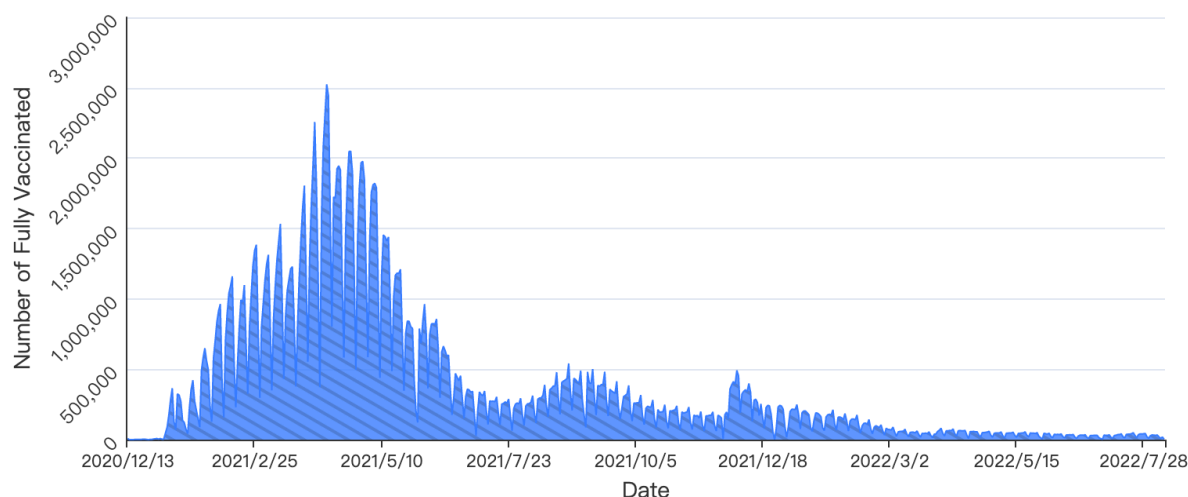


Figure 3. Area graph of COVID-19 fully vaccinate in U.S.

3.4. New Deaths in U.S.

The Figure. 4 is the daily COVID-19 deaths line graph in U.S. from time period 2020.12.13 to 2022.08.09. People who received fully vaccinate increase at time period 2020.01 to 2021.06. The Figure. 5 is the global number of daily COVID-19 deaths line graph from time period 2020.01.22 to 2022.08.18. During 2020.10 to 2022.02, number of new deaths was increase.

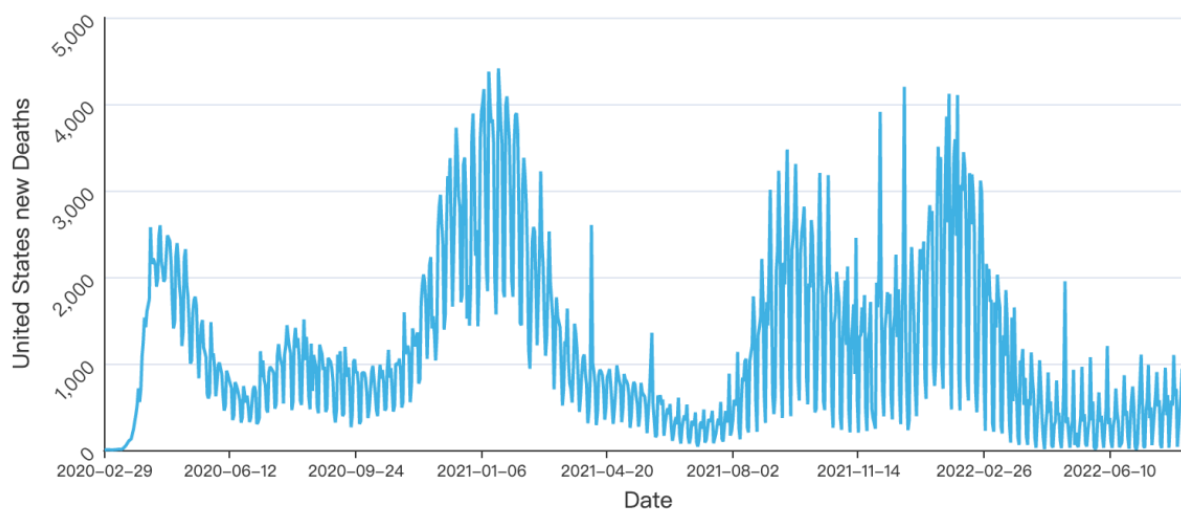


Figure 4. Line graph of COVID-19 deaths

3.5. Global COVID-19 New Deaths and Cases

Figure 5 is the daily average number of COVID-19 fatalities worldwide line graph from time period 2020.01.22 to 2022.08.18. During 2020.10 to 2022.02, number of new deaths was increase.

Figure 6 is the global number of daily COVID-19 new cases line graph from time period 2020.01.22 to 2022.08.18. Number of new deaths was increase during 2021.12 to 2022.05. In this research, it is assumed that the global mortality rate of COVID-19 varies according to changes in the diagnosis rate, for example, when the COVID-19 diagnosis rate increases, the mortality rate also increases, and vice-verse. The conclusion is the same as the research hypothesis, except that there is a sharp upward trend in the death rate of the COVID-19 from December 2021 to March 2022.

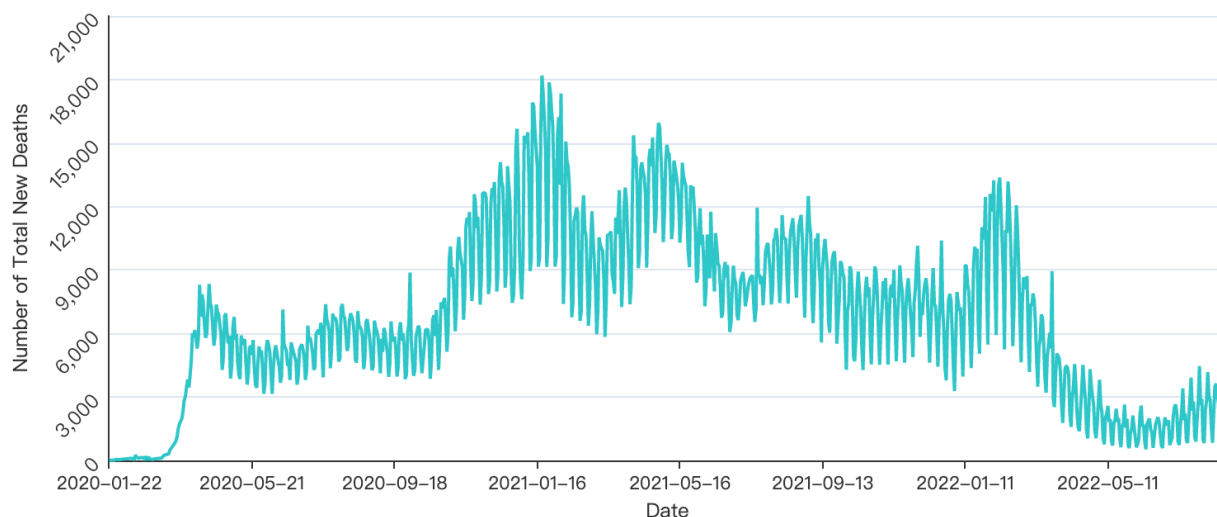


Figure. 5 Line graph of global COVID-19 new deaths

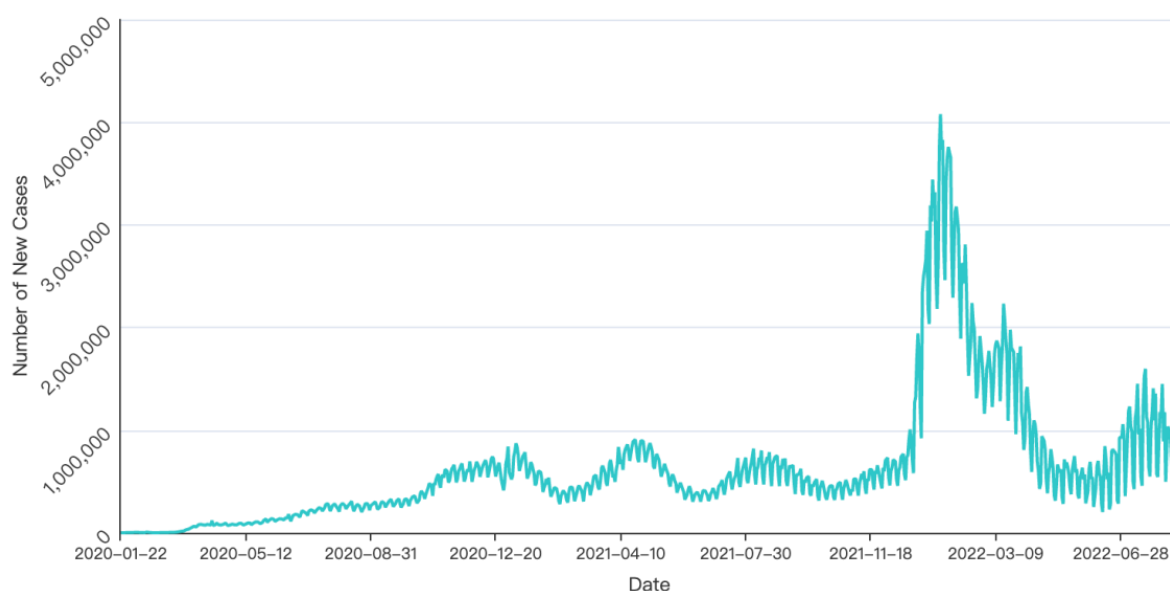


Figure. 6 Line graph of global COVID-19 new cases

The research evaluated the amount of the epidemic fatalities through age bracket in America from January 4th, 2020 until August 13th, 2022. As shown in Figure. 2, the population of deaths among those aged 45 years and older is much greater than that among those younger than 45 years old. Different age groups and COVID-19 deaths are related. The hospitalization rate for those aged 10 to 40 was 4.44%, while the hospitalization rate for those aged 40 to 59 and the hospitalization rate for those aged 60 and older were 12.5% and 46.8%, respectively. This growing trend is obvious. As De mentioned in his survey, older adults have psychological, social and environmental vulnerabilities that increase the risk of infection and reduce their immune systems. Consequently, elderly individuals are more vulnerable to the COVID-19, which is why the older people in Figure. 2 show higher mortality rates. On December 11 and 14, 2020, the Pfizer and Moderna COVID-19 vaccines were given two emergency use authorizations (EUA) for injection in people older than 16 and 18, respectively, by the Food and Drug Administration (FDA); Meanwhile, the COVID-19 vaccine also started on December 14, 2020. In Figure. 3, the number of vaccinations also rose sharply at the same time. Looking at data on COVID-19 vaccinations, vaccinations peaked between March and April 2021. Comparing Figure. 3 and Figure. 4, the number of COVID-19 fatalities similarly shown a decreasing tendency over the same time period as the number of vaccinations rose. It is worth mentioning that a George Floyd protests against police brutality and racial protests started in Minneapolis at the end of May 2020. This protest followed up with thousands of protesters taking to

the streets in several metropolises, a widespread protest that severely affected social distance and resulted in a growing epidemic in the United States. As a result, beginning in June 2020, Figure 4 demonstrates a rise in COVID-19 mortality. Furthermore, population of the COVID-19 deaths in America from October 2020 to April 2021 shows a dramatic increase in Figure. 4. However, it was during this period of time that the variant of corona virus Delta appeared. In addition, the United States came out another new variant of corona virus Omicron before December 2021. The dual power of Delta and Omicron has forced the COVID-19 fatality rate to increase in America, which also rend is also presented in Figure. 4, Figure. 5 and Figure. 6 are line graphs of COVID-19 confirmed and deaths cases worldwide. The population of deaths and the confirmed cases are related. The increase in confirmed cases in December 2021 is also due to the presence of corona virus Omicron and Delta.

4. Conclusion

The causes of mortality changes in COVID-19 are inextricably linked to sex, age, and vaccination status according to the above research. In the experimental comparison, men had a higher mortality rate after infection with COVID-19 compared to women. People aged over 65 years were more likely to die from COVID-19 than other age groups. Vaccination is relatively effective in controlling the epidemic. Therefore, men should be more aware and maintain their health than women. Older individuals should take nutritional supplements and exercise to reduce the risk of infection. Advocating vaccination for everyone who is eligible to receive the vaccine can reduce the risk of infection. The data and analysis in this research are useful for all who want to understand the causes of the changes in COVID-19 deaths. This unprecedented pandemic is unpredictable. Since the epidemic is not finished, every detail should be carefully evaluated and closely monitored for updates on the epidemiological characteristics of COVID-19. Everyone should practice self-protection by staying indoors more often, avoiding crowds and close contact, keeping hand and respiratory cleanliness, and using effective masks while it's outside.

References

- [1] Tsai, Ping-Hsing, et al. Clinical manifestation and disease progression in COVID-19 infection. *Journal of the Chinese Medical Association*, 2021, 84 (1): 3 - 8.
- [2] Kumar, Ashok, et al. Wuhan to world: the COVID-19 pandemic. *Frontiers in cellular and infection microbiology*, 2021, 242.
- [3] Zhao Huabin. COVID-19 drives new threat to bats in China. *Science*, 2020, 367: 1436 - 1436.
- [4] Willi, Sandra, et al. COVID-19 sequelae in adults aged less than 50 years: a systematic review." *Travel medicine and infectious disease*, 2021, 40: 1019.
- [5] Abhilash, Kundavaram Paul Prabhakar. Alpha, delta and now Omicron: When will the COVID-19 pandemic end? *Current Medical Issues*, 2021, 19 (4): 221.
- [6] Falk, G., et al. Unemployment Rates During the COVID-19 Pandemic. *Congressional Research Service* R46554, 2021.
- [7] Grubic, Nicholas, Shaylea Badovinac, and Amer M. Johri. Student mental health in the midst of the COVID-19 pandemic: A call for further research and immediate solutions. *International Journal of Social Psychiatry*, 2020, 66(5): 517 - 5.
- [8] Haque, Azizul, and Anudeep B. Pant. Efforts at COVID-19 vaccine development: challenges and successes. *Vaccines*, 2020, 8(4): 739.
- [9] Mahase, Elisabeth. Covid-19: death rate is 0.66% and increases with age, study estimates. *BMJ: British Medical Journal (Online)*, 2020.
- [10] Banerjee, Debanjan. The impact of Covid-19 pandemic on elderly mental health. *International journal of geriatric psychiatry*, 2020, 35 (12): 1466.