Title: **Assessment of epidemiological determinants of COVID-19 pandemic related to social and economic factors globally**

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Abstract

The COVID-19 outbreak has severely affected the social and economic conditions across this globe. Little is known about the relationship of COVID-19 with countries' economic and socio-demographic status. Publicly available data on COVID-19 test rate, attack rate, case fatality rate, and recovery rate were analyzed in relation to country's economic status, population density, median age, and urban population ratio. We also conducted multinomial logistic regression analysis to predict the influence of countries' social and economic factors on COVID-19. The results revealed that the median age had significant positive correlation with attack rate (r=0.2389, p=0.003), case fatality rate (r=0.3207, p=0.000) and recovery rate (r=0.4847, p=0.000). The urbanization has positive significant correlation with recovery rate (r=0.1957, p= 0.016). The multinomial logistic regression analysis revealed low-income countries are less likely to have an increased recovery rate (p=0.000) and attack rate (p=0.016) compare to high-income countries. The lower-middle-income and upper-middle-income countries are less likely to have an increased recovery rate (p=0.000 and p=0.001, respectively) compared to high-income countries. Based on the result of this study, these economic and socio-demographic factors should consider in designing appropriate preventive measures as a next step. The low and lower-middle-income countries should invest more in health care services to lower the case fatality rate and increase test and recovery rates as part of pandemic preparation like COVID-19. As the number of COVID-19 attacks, death and recovery rates are constantly changing; however, the intensive study is required to obtain a clear picture.

Keyword: *COVID-19, assessment, global, social and economic factors, correlation and regression analysis*

1. Introduction

Severe acute respiratory syndrome corona virus-2 (SARS-CoV-2) affected the advancement of the normal lifestyle of humans, and now the whole world is fighting against the invisible enemy that most of the story is unseen in most instances. In December 2019, a virus emerged in Wuhan, Hubei province, China, diffusing to 215 countries with the immense power of human to human transmission [1]. Initially, the Chinese CDC (Center for Disease Control) isolated this novel virus belongs to coronavirus family from a patient's lower respiratory tract, and then WHO declared this virus as SARS-CoV-2 on 11 February 2020 [2]. Still, the virus spillover point being a mystery as some studies have shown that it may originate from a seafood wholesale market (local seafood and live animal market with different species including wildlife being sold) of Wuhan, China, and the reservoir sources might be bats [3] through utilizing an intermediate host, preferably pangolins. Atypical pneumonia, fever, coughing, muscle soreness, fatigue, were seen in critical cases and sought intensive care as breathing difficulty was an expected outcome [4]. Due to the lunar year celebration in China the massive movement of people from and between the Asian region and other parts of the world, increased the geographical spreading of contagion during the outbreak [5]. Higher mortality was seen in the patients with comorbidities like cancer, diabetes, and high blood pressure, which make the condition more critical. Rapidly the disease has spread throughout the world, and now it is a global pandemic. The traveling from the affected area is one of the main causes of spreading this disease between the countries throughout the world, but there are limited research results on global risk factors of COVID-19 transmission and pattern of spread [6-9]. Many countries of the globe badly affected by COVID-19 with a higher number of cases and mortality, including the USA, Brazil, Russia, European countries (Spain, Italy, France, Germany, UK, etc.), Iran, and India. The overcrowded areas like schools, markets, public transports, workplaces are the high-risk zone for transmission as it highly contagious infection [10]. Countries with high economic status or modern cities are the choice of a better workplace for the people aiming for more income, better livelihood, and better facilities. An urban area with high population density, which responsible for any epidemic situation. The pandemic situation of COVID-19 aggravated by urbanization as people fail to maintain social distance and contamination. An urban area with high population density might be a risky place as more people come to contact infected persons that increase the chance of contamination [11]. Moreover, critical care capacity is a problem in comparatively low and lower-middle-income countries [12], and only a few hospitals have isolation capacity, which can provide intensive care with respiratory support. South Asia has an estimated 0.7-2.8 critical care beds per 100000 population [13] and the number of beds scarce in the lower and middle-income countries compared to developed countries in the world. Furthermore, asymptomatic and in early-stage infected persons can spread to the densely populated community. Older people more prone and have shown more fatal than the younger due to the clinical and immune response [14]. The government of different countries has implemented several steps to reduce the possibility of spreading the ongoing pandemic coronavirus. Social distancing, the lockdown of affected areas, restriction of public transport, work from home, and restriction of international flights were the main steps to prevent coronavirus spread.

Indeed, the extensive spreads of SARS-CoV-2 virus around the globe have several million confirmed cases till to-date; the gradual concerns will be not only our health but also our livelihoods. The demographic determinants in the population are the key to determine the contact patterns. Eventually, the nature of pandemic spreads around the world with the implications of effective control measures in the near future from a government perspective [15]. Population density, the age median age of the population of the individual countries are the most critical issue to be assessed to measure the impact of pandemics and its spread. The increased number of the median age of the population in a community becomes more pronounced in decreasing disease incidence, even when pre-existing immunity levels in young individuals are low [16]. Overall, the evolving nature of the pathogen, disease biology, and the demographic characteristics of the population, which are the significant in identifying the type and intensity of public health intervention measures required for disease control [17]. Furthermore, the differential prevalence of predisposing health conditions and other types of health disparities increases uncertainty about how a novel virus would impact different countries with distinctly different mobility patterns, economic status, social interactions and health characteristics. Based on available data from online sources, we test the hypothesis of countries social and economic status influences on the test rate, attack rate, case fatality rate, and recovery rates of COVID-19.

2. Materials and Methods

2.1. Data

We extracted the total population of 2020 of the affected countries from the world population review (WPR) and the worldometer database [18]. We extracted data about the total number of tests for COVID-19, new cases, total cases, total deaths, and total recovery from the World Health Organization (WHO) database [19]. We analyzed data from the WHO coronavirus database from the beginning (January 2020) of the COVDI-19 outbreak in China until 31 May 2020. Furthermore, we extracted the social and economic status of the individual country (based on GDP), population density per square kilometer, the median age of the population, and percentages of the people living in the urban area from the World Bank database [20]. Primarily, we collected the data mentioned above from 216 Countries and Regions. Among them, we excluded some countries, as they did not disclose their data officially. We also excluded countries having populations are less than 50,000. Finally, we included 151 countries data in our analysis. However, there are variations in data recording and disease-tracking systems in different countries, which we considered as a shortcoming of the present study.

2.2. Assessment of test rate, attack rate, case fatality rate, and recovery rate:

We calculated the test rate (in 100000 population), attack rate (in 100000 population), case fatality rate (in 100 cases), and recovery rate (in 100 cases) using the formula described [21].

2.3. Statistical analysis:

The extracted data analyzed using statistical data analysis software STATA-13. To test the hypothesis, correlation, and multinomial logistic regression analysis performed in the study. For the correlation analysis, we considered the country's economic status, population density rate, urbanization rate, and median age during test rate, attack rate, case fatality rate, and recovery rate. Further, we performed multinomial logistic regression analysis to understand the relationships between explanatory variables and the outcome of the COVID-19 test rate, attack rate, case fatality rate, and recovery rate.

3. Result

3.1.Correlation analysis of social and economic factors

3.1.1 Population density and COVID-19 test rate, attack rate, case fatality rate, and recovery rate

The correlation of population density of different countries varied with COVID-19 outcomes (Table 1). The analysis revealed that, population density has positive relations with COVID-19 test rate (r= 0.0301), case fatality rate (r= 0.0049) and recovery rate (r= 0.0056) but none of these were statistically significant (p=0.7138; p=0.9525 and p=0.9459, respectively). On the other hand, the attack rate found a negatively insignificant association with the population density of the study countries.

3.1.2 Median age and COVID-19 test rate, attack rate, case fatality rate, and recovery rate

Overall, COVID-19 outcomes had a significant positive relationship with the median age of the countries (Table 2). Specifically, the analysis revealed that the median age of the population of different countries has a significant positive correlation with attack rate (r=0.2389, p=0.003), case fatality rate (r=0.3207, p=0.000) and recovery rate (r=0.4847, p=0.000). The test rate, however, had a positive correlation (r=0.0732), but the association is not significant (p=-0.3719).

3.1.3 Urban population rate and COVID-19 test rate, attack rate, case fatality rate, and recovery rate

In general, the analysis revealed that the urban population rate with COVID-19 outcomes has a different correlation with a different significance level (Table 3). Precisely, urbanization had positive significant correlation recovery rate (r=0.1957, p= 0.016). On the other hand, the correlation of urbanization with test rate, attack rate and case fatality rate found positive (r= 0.0489; r= 0.0646 and r= 0.1138, respectively) but the correlation is not significant (p= 0.551; p= 0.431 and p= 0.164, respectively).

3.2.The outcome of multinomial logistic regression analysis

We performed multinomial logistic regression analysis to predict if the economic status of different countries influences on COVID-19 test rate, attack rate, case fatality rate, and recovery rate. Based on the World Bank's classification, the economic status of different countries categorized as "High Income", "Low Income", "Lower Middle Income" and "Upper Middle Income". In the analysis, we compared the results of Low Income, Lower Middle Income, and Upper Middle Income with High-Income countries. Therefore, we considered Higher Income countries as our baseline. The results of the multinomial regression analysis given in table 4.

The multinomial logistic regression analysis revealed that the relative risk ratio (RRR) for 'attack rate' indicates the 'high income' countries are less likely to have a relative risk of attack to 'low income' countries and this prediction changes by a factor of 0.983 which is significant (se= 0.0070, p=0.016). That means that the countries with greater risk of attack rate are falling into the 'high income' countries and at lower risk of being in the 'low income' countries. The RRR for 'recovery rate' indicates that the relative risk for 'low income' countries, which is 0.970 times higher than high-income countries. This predictor found statistically significant (se= 0.0079, p=0.000). This means that low-income countries are at a greater risk of falling into the 'recovery rate' and at a lower risk of belonging to the 'high income' category.

In the case of 'test rate' and 'case fatality rate,' there is an increased relation with statistical insignificance. The RRR for 'test rate' indicates an increase in this variable, the risk of falling into the 'high income' countries the relative risk of fitting to the 'low income'

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countries are predicted to change by a factor of 1.000 but not a significant predictor (p=0.965). The RRR for 'case fatality rate' indicates that the relative risk for 'low income', which is 0.987 times higher that of high-income countries, but this predictor is not statistically significant (p=0.088).

In the case of lower-income countries, the RRR for 'recovery rate' indicates that the relative risk for 'lower middle income' which is 0.970 times that of higher-income countries, which is a significant predictor (se= 0.0066, p=0.000). The 'test rate' and 'case fatality rate' have an increased risk for the 'lower middle income' countries compared to 'high income', but these are not significantly associated (p=0.120 and p=0.409 respectively). Similarly, the RRR for 'attack rate' indicates increase on this variable, the risk of falling into the 'lower middle income' countries relative to the risk of belonging to the 'high income' countries by a factor of 0.992 which is not a significant predictor (se= 0.0059, p=0.0.204). Likewise, while analyzing upper-middle-income countries, the RRR for 'recovery rate' in 'upper middle income' countries indicate increased risk compare to 'higher income' countries by a factor of 0.983, which is significant (se= 0.0053 p=0.001). Upper middle-income countries are at higher risk in case of 'attack rate,' 'case fatality rate', and 'recovery rate' compared to higher-income countries. On the other hand, the 'test rate' indicates that one-unit increase on this value, the relative risk of being in the 'upper middle income' changes by a factor of 1.0000, which is not a significant predictor (p=0.989).

4. Discussion

4.1. Possible effects of social and economic factors on COVID-19 test rate, attack rate, case fatality rate and recovery rate

We have analysed the impact of population density of the countries being affected by COVID-19 by examining the correlations with defined selected outcomes like social and economic factors in this study. However, population density produces a positive impact through it was an insignificant relationship with the COVID-19 test rate and case fatality rate while negative but insignificant relations found with attack rate and recovery rate. The outcomes of this statistical model demonstrated that the population density of the particular countries does not have any significant relations with COVID-19 outcomes. In infectious disease epidemiology, the population density is the communication mode is likely to follow an initial sub-linear density-dependent form until the saturation of transmission rate evolutions [22]. The proven principles indicate that an epidemic of transmissible disease spread more rapidly and intensely in densely populated areas [23] than in lightly populated because of the lower chances of interpersonal contacts or mixing in less human population density countries or areas. These opposing findings might be because COVID-19 is currently anticipated to transmit only through person-to-person contact, and contact with contaminated surfaces might not be correct. Other means of virus spread need to be explored. Travelers, social events like marriage ceremony, birthday, etc. and different religious congregation might be some other factors increasing disease burden even in places where population density is not too high. The rapidly growing population force the creation of megacities of China and India and produce fast track international connectivity seeking the importance of more research on this aspect of COVID-19 impact in the densely populated country. The mega country like China, India, Brazil, could be the place where the pandemic is posing significant public health threats. A positive relationship between mortality rates and population densities in the USA perspective for influenza pandemics were recognized [24]. Once cities introduced into the equation, normalizing the mortality rate of the cities with those of the states also showed a positive relationship with population density. The opposite scenario also identified a link between population density and mortality for the 1918 pandemic; in rural areas of Wales and England [25], the low population density was positively associated with mortality. On a larger county scale, however, they found no connection between population density or residential crowding and mortality or transmissibility.

The median age has significant positive relations with attack rate, case fatality rate, and recovery rate while insignificant positive association observed in the case of test rate. The median age positively influences on COVID-19 attack rate, recovery rate, and case fatality rate. Previous research indicated that the increasing median age had increased the chance of infection [26] and death as recent findings suggested patients with age ≥60 years are at higher risk [27] than children who might be less likely to become infected or if so, may show milder symptoms or even asymptomatic infection [28]. In this globalization of one village concept, the population demographic feature being changed through an increase in life expectancy and decrease fertility led to the establishment of the older people living in smaller households. The drivers of these demographics include public health improvement and social and economic transformation associated with the growth of urbanization [29]. Similar trends are occurring, at differing rates and dimensions, among less developed countries of the world. Understanding how changes in the demographic structure of a population affect disease transmission is a necessity step towards the design of more effective strategies for disease control. Though, the case fatality rate of COVID-19 infections has been lower (12th March, 6.22% versus 23rd March, 9.26%) [30], than recently occurred other outbreaks; as it was 9.6% in the SARS-CoV outbreak [31] and 34.4% in the MERS-CoV outbreak [32].

The ratio of the urban population has a positive significant relation recovery rate. On the other hand, relation with test rate found negative but insignificant while association with case fatality rate and attack rate found positive but insignificant. That means urban people are more likely to recover from COVID-19. Urban areas considered as the center of any country. Like many other public services, most of the improved health care facilities established in urban areas. Both government and private sectors invest more in health care facilities. As a result, health and health service provisions are improved and intensive in urban areas than in rural areas. Urbanization plays the emergence of zoonotic diseases as the rapid intensification of agriculture, socioeconomic change, and ecological fragmentation, which can have profound impacts on the epidemiology of infectious disease [33]. Urban planning and appropriate surveillance system can be powerful tools to improve global health and decrease the burden, especially highly transmissible diseases [34]. However, the shift of populations from rural areas to the urban landscape, pose the risk of the concentration of a succession of epidemics and pandemics in cities has become stronger [35]. Urban activities provide the space of people to come together. This goes against the rules of social distancing. The other factor within a city in which the urban poor people live and where many public amenities such as toilets and collection of water shared among themselves. Avoiding crowding in this situation becomes almost impossible. The consequence of this city deficit is borne out by a vast number of cases among slums and the urban poor. They also attract travelers and tourists from across the world. Throughout while, they have especially crafted their policies and city services to assist and facilitate these visitors. One of the reasons why European countries suffered so badly was due to the ingress of Chinese and other tourists that helped, more substantial, and quicker spread of the virus.

Gross Domestic Product (GDP) is the indicator for the status of the individual country, and World Bank categorized the countries as high-income, upper middle income, lower middle-income, and low-income [20]. Low-income countries are less likely to have an increased recovery rate, and attack rate compares to high-income countries. This might be due to the lack of proper healthcare facilities in low-income countries. Usually, the health care sector received little attention from the international public health community; these problems are not restricted to high-income countries but are becoming increasingly crucial in middle-income and, to a lesser extent, some low-income countries [36]. Lower middle-income and upper-middle-income countries are less likely to have an increased recovery rate compare to high-income countries. Individuals in low and middle-income countries have to fight mainly against infectious and contagious diseases, while in the high-income countries' battles are mostly against lifestyle diseases [37] as the healthcare system provided significant facilities.

Person to person contact, using public transports during travel, and exposure to public gathering, social and religious events are the primary sources of spreading this virus massively. Therefore, in following with the World Health Organization's guidelines, countries are taking different initiatives to stop the spreading. Maintaining social distancing, isolation, quarantine, and lockdown are the key measures. Countries have failed to control the extent of COVID-19 due to people's denying attitudes and misunderstanding of following social distancing for control of an epidemic [38, 39]. However, if we consider the recent trend of COVID-19 attack, recovery, and death rates, then it can be said that these measures fail to stop the spreading virus due to not considering the economic and demographic factors. In this context, our study offers some key social and economic factors, which have a positive correlation with COVID-19. These factors should consider designing an effective spreading control mechanism. We can understand that it may be challenging to maintain a universal system in data reporting and sharing. Considering this, we excluded several countries from our study. Finally, we analysed a data set, as the number of COVID-19 cases, death rate and recovery rate, and countries' capacity are increasing in testing day by day, we considered data as of 31st May 2020. The trend on the test, attack, case fatality, and recovery rate may change after this time. In this regard, this study may not represent the whole COVID-19 scenario.

4.2. Limitation of the study

Nevertheless, we must acknowledge the limitations of our present rear arch work. First, we used data until 31 May 2020 and the status might be changed over the time. Besides, asymptomatic cases of COVID-19 were not considered in the study since the WHO or other authentic organization or authority did not report the number of asymptomatic COVID-19. Up to now, globally, nobody has known the accurate data of asymptomatic COVID-19 cases. Second, data of social and economic factors were extracted from open sources like WHO, World Bank, Worldometer etc. We did not consider the country those has not reported their COVID-19 information publicly and country has the population less than 50000. Third, heterogeneity of the diagnosis, and data reporting among the different countries were not considered in this study. It might effect in the deviation of the associations between social and economic factors and COVID-19 spread. Furthermore, we need to review the up-to-date COVID-19 test rate, attack rate, case fatality rate, and recovery rate and include missing data on social and economic factors during the ongoing COVID-19 outbreak.

5. Conclusion:

By analysing COVID-19 data, economic status, and population data of 151 countries, we found that economic status, the median age of the population, and urban population ratio significantly influence on COVID-19 attack rate, case fatality rate, and recovery rate. Based on the result of this study, these detail economic and socio-demographic factors should consider designing appropriate control mechanisms as a next step. The low and lower-middle-income countries should invest more in health care services to lower the case fatality rate and increase test and recovery rates as part of pandemic preparation like COVID-19.

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Ethical approval:

Not required

Authors contribution:

Conceived and designed the research: MMH, AI and SAK. Data collection: MMH, MKR and MRKN. Data analysis: AK, MMH and AI. Wrote the paper and made comments: MMH, AK, SS, MRKN, MKR, SAK and AI.

Conflict of interest:

Not exist

Reference

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Figures

Figure 1: Correlation between Median age and attack rate (in one hundred thousand

Figure 2: Correlation between median age and case fatality

Figure 3: Correlation between median age and recovery rate

Figure 4: Correlation between urban population rate and recovery rate

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Table 1: Correlation analysis between population density rate and COVID-19 test rate, attack rate, case fatality rate, and recovery rate

Variables	Population density (sq. km)	Test rate in one hundred thousand	Attack rate in one hundred thousand	Case fatality rate	Recovery rate
Population density (sq.km)	-				
Test rate in one hundred thousand	0.0301				
Attack rate in one hundred thousand	-0.0426	0.0451			
Case fatality rate	0.0049	-0.0818	0.0216		
Recovery rate	0.0056	0.0416	0.0938	0.2321*	-

*p value <0.05

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Table 2: Correlation analysis between median age and COVID-19 test rate, attack rate, case fatality rate, and recovery rate

Variables	Median age	Test rate in one hundred thousand	Attack rate in one hundred thousand	Case fatality rate	Recovery rate
Median age	-				
Test rate in one hundred thousand	0.0732	-			
Attack rate in one hundred thousand	0.2389*	0.0451	-		
Case fatality rate	0.3207*	-0.0818	0.0216	-	
Recovery rate	0.4847*	0.0416	0.0938	0.2321	-

*p value <0.05

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Table 3: Correlation analysis between urban population rate and COVID-19 test rate, attack rate, case fatality rate, and recovery rate

Variables	Urban population rate	Test rate in one hundred thousand	Attack rate in one hundred thousand	Case fatality rate	Recovery rate
Urban population rate	-				
Test rate in one hundred thousand	0.0489	-			
Attack rate in one hundred thousand	0.0646	0.0451	-		
Case fatality rate	0.1138	-0.0818	**0.0216**	-	
Recovery rate	0.1957*	0.0416	0.0938	0.2321*	-

*p value <0.05

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Table 4: Multinomial logistic regression analysis on factors predicting the likelihood with relevant risk ratio

Economic status	**RRR**	**S. E.**	**p-value**	**95% CI**
High Income	(base outcome)			
Low Income				
Test rate in one hundred thousand	1.000304	0.0070161	0.965	0.9866465 - 1.01415
Attack rate in one hundred thousand	0.9827875	0.0070803	0.016	0.969008 - 0.996763
Case fatality rate	0.9874364	0.0073279	0.088	0.9731779 - 1.001904
Recovery rate	0.9699087	0.0078576	0.000	0.9546298 - 0.9854322
_cons	16.42125	26.7279	0.003	2.876348 - 208.1591
Lower Middle income				
Test rate in one hundred thousand	0.9884432	0.0060143	0.056	0.9767254 - 1.000302
Attack rate in one hundred thousand	0.9924396	0.0059309	0.204	0.980883 - 1.004132
Case fatality rate	0.9977505	0.0059797	0.707	0.986099 - 1.00954
Recovery rate	0.9700615	0.0066459	0.000	0.9571229 - 0.983175
_cons	24.74972	23.56084	0.001	3.830514 - 159.9128
Upper Middle Income				

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Test rate in one hundred thousand	1.000068	0.0048382	0.989	0.9906303 - 1.009596
attack rate in one hundred thousand	0.9950287	0.004893	0.311	0.9854846 - 1.004665
Case fatality rate	0.9993682	0.0049592	0.899	0.9896954 - 1.009135
Recovery rate	0.9827827	0.0053308	0.001	0.9723899- 0.9932866
_cons	5.316753	4.296089	0.039	1.091066 - 25.90847

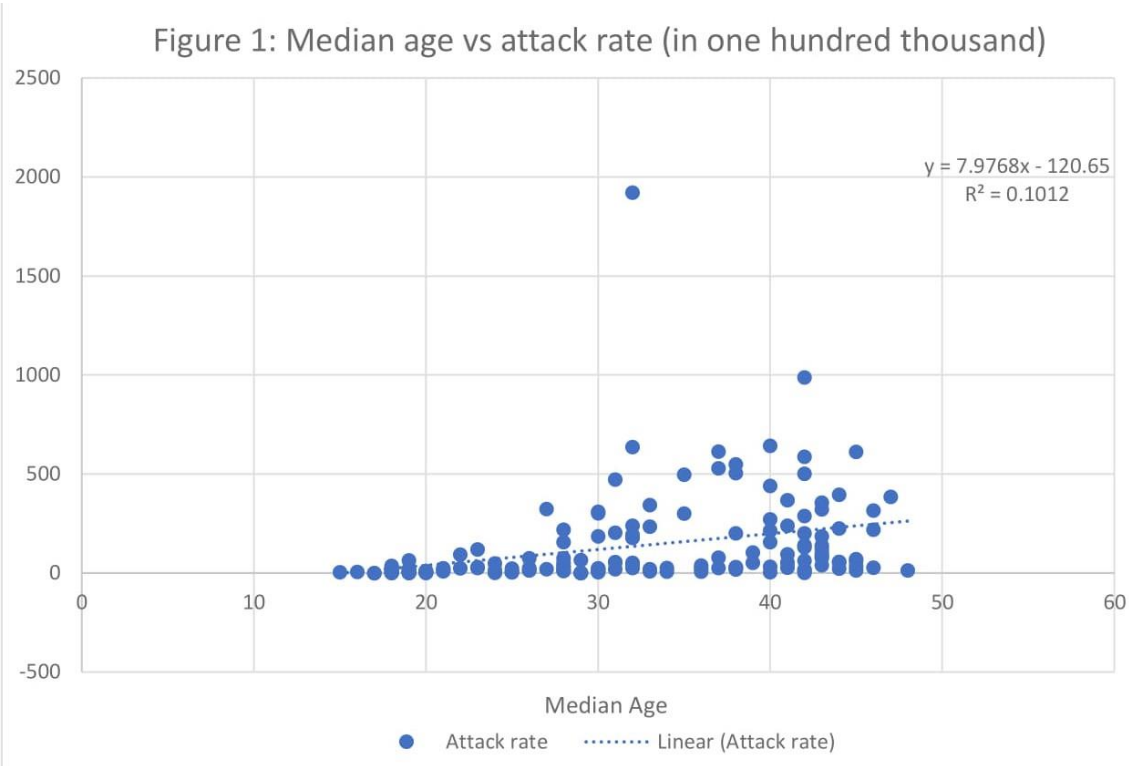
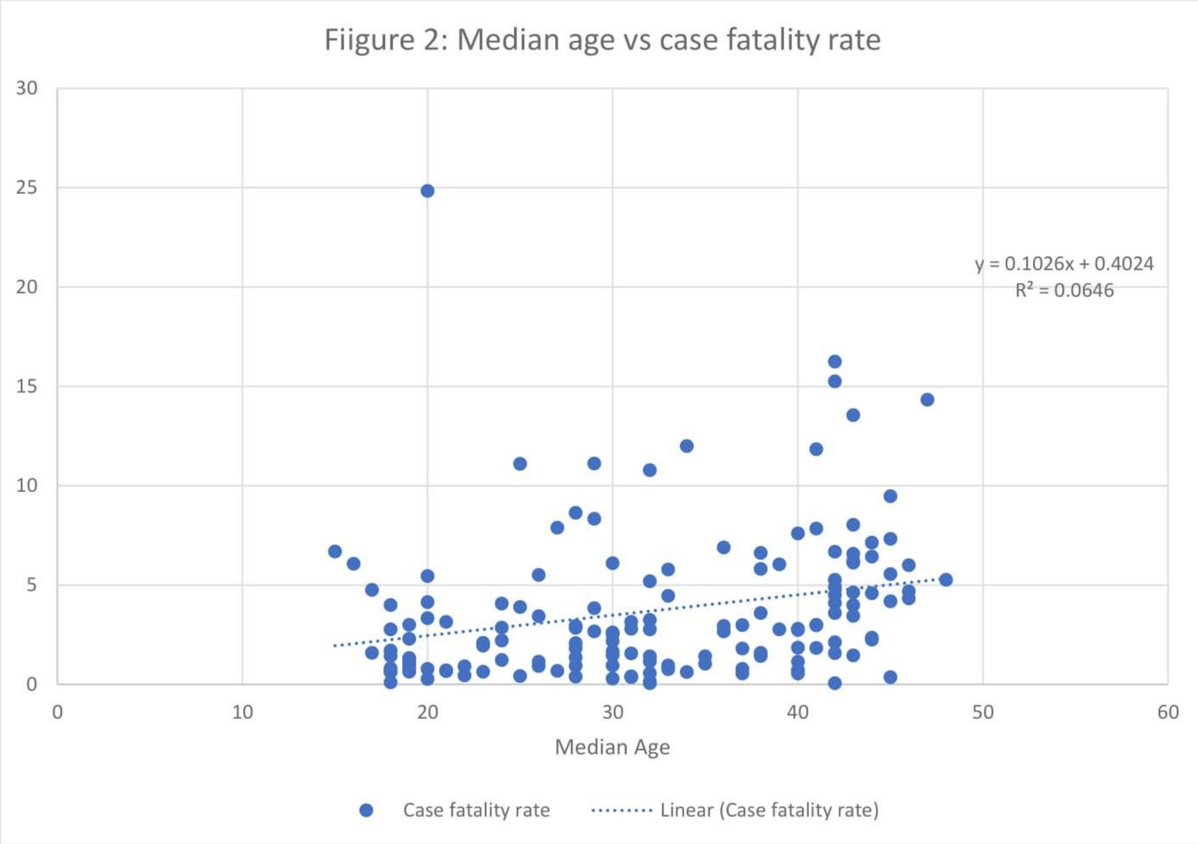


Figure 1: Median age vs attack rate (in one hundred thousand)


Fiigure 2: Median age vs case fatality rate
30
25
20
15
10
5
0
0
10
20
30
40
50
60
Median Age
y = 0.1026x + 0.4024
R² = 0.0646
Case fatality rate
Linear (Case fatality rate)

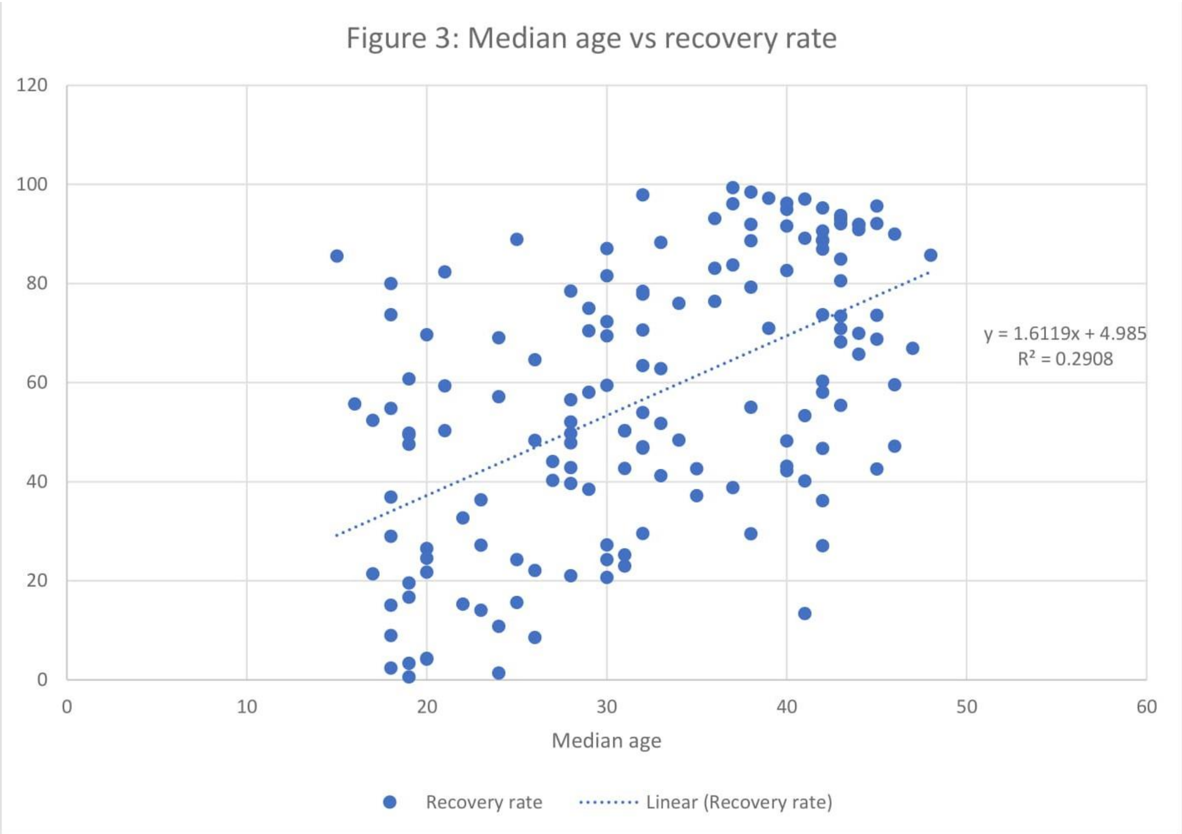


Figure 3: Median age vs recovery rate
120
100
80
60
40
20
0
0
10
20
30
40
50
60
Median age
y = 1.6119x + 4.985
R² = 0.2908
Recovery rate
Linear (Recovery rate)

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