What factors can help COVID-19 patients to recover quickly in Pakistan

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Abstract

The research paper uncovers the socioeconomic factors which are associated with the recovery of coronavirus in Pakistan. Using a self-designed questionnaire, we collected the data from 170 corona recovered patients and applied Multiple linear regression to predict the effect of socioeconomic factors. The paper finds that patients aged between 36 and 46 years take around 3 more days to recover, whereas, patients aged above than 46 years take around 7 more days to recover in comparison to the young adults (17-25 years). In addition, patients who live in urban areas recover almost 1.5 days earlier than those who live in rural areas. Patients who have other serious diseases take almost 1.7 more days to recover in comparison to those who do not have any disease. Patients who smoke take 2 more days to recover in comparison to those who do not smoke. Moreover, obese people take almost 2.6 more days to recover in comparison to those who have a normal body mass index. Surprisingly, income, gender, and education remain insignificant in relation to the recovery days. We suggest, people above 46 should be given extra care, policies regarding smoking cessation, and lowering obesity should be implemented to combat coronavirus.

Keywords: COVID-19; Recovery; Factors; Pakistan

1. Introduction

In December 2019, in Wuhan City, Hubei province China a total of 41 cases of pneumonia of unknown etiology were confirmed. Later on, a scientific team of the Chinese Academy of Engineering announced that the unknown virus was a new type of coronavirus and World Health Organization (WHO) tentatively named the virus as a 2019-new/novel coronavirus (2019-nCoV) (Lu et al., 2020). On 11th February 2020 WHO announced the official name of the virus as "Corona Virus Disease 2019" (COVID-19). The virus spreads through discharge from the nose, droplets of saliva when an infected person sneezes or coughs. The patients may have upper and lower respiratory tract, respiratory stress syndrome, hypoxemia, acute kidney injury, arrhythmia, and acute cardiac injury which may lead to multiple organ failure and finally cause death (Harapan et al., 2020). By examining at the spread and severity of the virus on 30th January 2020 as per the International Health Regulations WHO declared the COVID-19 as a Public Health Emergency of International Concern (Cascella et al., 2020) .

Almost every country has been affected by COVID-19. As of 4th September 2020, the total world-wide cases of COVID-19 were 26.50 million, out of which 18.69 million people have been recovered and 873,822 117 died[1]. Every country has a different infection, recovery, and fatality rates caused by COVID-19. For instance, San Marino has the highest deaths per million (1,237) followed by Belgium, Peru, Andorra, Spain, United Kingdom, Italy, Sweden, Chile, and the USA. Conversely, Qatar has the highest per million recoveries (4,142), followed by French Guiana, Bahrain, San Marino, Chile, Kuwait, Oman, Vatican City, Panama, and Brazil[2]. Every country has adopted diverse health policies to combat the ill impacts of COVID-19. As of 4th September 2020,

[1] https://www.worldometers.info/coronavirus/
[2] Authors' calculations using data from https://www.worldometers.info/coronavirus/

no vaccine is available to prevent the COVID-19, however, antiviral drugs mixed with antibiotic treatment have also been used to treat COVID-19 patients (Huang et al., 2020). In addition, some socioeconomic factors, genetics, diseases history, level of immunity, and habits can affect the recovery of the COVID-19 patients.

The rationale for using Pakistan as a case study (because of the better and easy data collection) was to explore the factors which were associated with the expedited recovery from the COVID-19. Secondly, the impact of COVID-19 can vary among countries because of their heterogeneous characteristics such as government strategies, health facilities, epidemiological, clinical, and socioeconomic factors (Stojkoski et al., 2020). As of 4th September 2020, Pakistan[3] has 8,909 total active cases of COVID-19, total recoveries 282,268, and deaths 6,335. According to the total recoveries, Pakistan ranks 12th country of the world. The government has taken various steps to control the spread of the COVID-19 such as shutting down and limiting the flight operations (Abid et al., 2020), complete lockdown, regional lockdown (smart lockdown), compulsory wearing masks, social distancing, and increasing the awareness among people about the virus. Moreover, almost free medical treatment has been given to the patients, new field hospitals were built, tests for the COVID-19 have been subsidized in public hospitals. The government's actions led to a positive impact on the recovery rate and the smart lockdown has reduced the spread of the COVID-19 in Pakistan.

Besides the government's efforts, socio-economic factors of patients such as the area of living, race, obesity, gender, age, habits (exercising and smoking), marital status, the educational and economic background can also play a vital role in recovering from the COVID-19. Therefore, it is

[3] http://covid.gov.pk/stats/pakistan

immensely important for policymakers to understand the impact of these factors so that appropriate measures can be taken to increase the recovery rate or to reduce the fatality rate of COVID-19. A few studies such as N. Chen et al., (2020), T. Chen et al., (2020), and Huang et al., (2020) have found clinical and epidemiological features of the deceased and recovered COVID-19 patients in China. However, socioeconomic and habitual factors associated with the recovery are unexplored in Pakistan. To our knowledge, this is the first study focusing on Pakistan and exploring the relationship between corona recovery and socio-economic and habitual factors. We collected the data from 170 corona recovered patients through social media during the time of lockdown and applied multiple linear regression for the statistical analysis. The paper is organized as follows, section 2 reviews the earlier studies, section 3 discusses data and variables, section 4 explains the methods used for the analysis, section 5 discusses the results and section 6 concludes the paper.

2. Literature Review

Literature regarding the determinants of COVID-19 is scarce mainly because of the emerging situation of the novel virus. However, few studies have attempted to explore the relationship between socioeconomic determinants and COVID-19. For instance, in China, Jin et al., (2020) using a publicly available data set of COVID 19 found that deceased patients were significantly older (65 years and above) than survivors (35-57 years). In addition, they found that almost 65% of deceased patients had one of the serious illnesses such as chronic obstructive pulmonary disease (COPD), diabetes, cardiovascular disease, and hypertension. However, that study used the simple statistics (mean, median, and standard deviation) and did not established the significant association between the socio-economic/clinical factors and COVID-19 survivors, as we have done in our study.

In another study in China, T. Chen et al., (2020) found that clinical factors were mainly responsible for patients' deaths due to COVID-19. However, they also explored the social factors which can affect the fatality rate, e.g male patients aged above than 60 were noted at higher risk of dying of COVID-19. The researchers used the data from 113 deceased patients and applied simple statistics such as mean, median, standard deviation, t, and χ^2 tests to report the results. Similarly, N. Chen et al., (2020) in China stated the epidemiological and clinical characteristics of COVID-19 deceased patients. Using data from 99 deceased patients they found that co-infection, old age, hypertension, and smoking history were the serious risk factors. Regarding smoking as a risk factor, a few review articles such as Alqahtani et al., (2020); Farsalinos, Barbouni, and Niaura, (2020); and Farsalinos, et al., (2020) have summarized that there was a positive association between smoking and fatality rate, implying that people who smoke are at greater risk of dying of COVID-19. However, Berlin et al., (2020) placed emphasis on investigating the role of smoking in the COVID-19 pandemic.

Likewise, Cai et al., (2020) in China explored the relationship between obesity and the severity of COVID-19 disease. They collected data from 383 patients of COVID-19 and applied multivariable logistic regression to examine the factors associated with the severity of COVID-19. The authors found that patients who were overweight had 1.84 times and those who were obese had 3.4 times more probability to develop severe COVID-19. Similarly, Stefan et al., (2020) found that older age (above 65), pre-existing diseases (cardiovascular disease, hypertension, diabetes, hypertension, and cancer), and obesity may be associated with the severity of the COVID-19. However, they used a small sample of 24 patients only and implemented simple statistics to explore the factors associated with the severity of the COVID-19 which may lead to weak estimates.

There are few studies which had been carried out at the national or at the macro level such as Stojkoski et al., (2020) and Coccia, (2020) which explored the factors that can affect the COVID-19. However, we have only included the individual level studies because of their direct relevance to our study.

To our knowledge, to date (4th September 2020) no study has found the socio-economic and habitual determinants of COVID-19 recovery in Pakistan. Most of the studies have been carried out in China where mostly epidemiological and clinical factors have been explored. As we have stated earlier, the factors which can affect the COVID-19 recovery or fatality rate may differ from country to country because of the heterogeneous environment. Therefore, we believe our study contributes to the existing literature significantly and provides in-depth insight for policymakers. The countries that match with Pakistan in terms of customs, environment, economic conditions, and other population characteristics such as India, Bangladesh, Nepal, Iran, and Afghanistan that may also get policy directions from our study.

3. **Methods**

3.1 Data

A short questionnaire was developed to collect the data. The generated link was sent to the COVID-19 recovered patients through different social media channels such as Email, WhatsApp, Facebook, and other communication sources. We asked 34 questions which could have taken around 7 minutes to answers. Only those patients were contacted who were willing to participate in the research study, they were further requested to provide consent to use their data for research purposes only. They also had options to exit the survey at any point as well as they had the option to hide their identities or personal data. In total, we collected data from 229 respondents, out of

which we dropped incomplete cases and were left with 170 observations. The respondents were mainly from big cities of Pakistan such as Karachi, Lahore, Faisalabad, and Peshawar. In total, we collected data from almost twenty cities of Pakistan. The questionnaire was also translated to the Pakistani national language (Urdu) so that the maximum patients could understand the questions. However, we have a highly educated cohort with the mean schooling years of 14. Secondly, our sample has the mean household expenditure (a proxy of income) equal to PKR 65,565 (USD 396 (exchange rate 4th September 2020)), this is higher than the average national household expenditures PKR 41,545 (USD 251 (exchange rate 4th September 2020))[4]. Because the data were collected through the internet, only those patients were contacted who were able to operate and afford expensive gadgets. Therefore, our sample is also considered a resourceful sample and have less variation in education and income. There was thus a beneficial trade-off between bias and homogeneity of patients considered.

3.2 Variables

The dependent variable "Disease Days" was generated by subtracting the date of diagnosis from the date of recovery. Both dates were available as per the laboratory test results. The variable was a continuous variable with a minimum of 10 days and a maximum of 43 recovery days. The mean recovery days were 21 with a standard deviation of 5.6. All other variables are given in the table 1 and 2 were considered as independent variables. Only schooling years and household expenditures were considered as continuous variables and the remaining variables were considered as categorical variables. The minimum age of the respondents was 17 and the maximum age was

[4] https://www.ceicdata.com/en/pakistan/household-integrated-economic-survey-average-monthly-income-household/average-monthly-income-household

77 years (meaning that patients can survive even in the age of 77). However, the virus can cause death to a patient of any age, race, gender, weight, education, and income group.

We have taken two habitual variables such as currently smoking and exercising refer to table 2 for details. Moreover, we have included other variables such as area, gender, marital status, admitted to the hospital, medicine taken, and any other pre-existing diseases. We calculated the body mass index (BMI) using the respondents' weight and height and categorized them as follows, underweight means below 18.5 BMI, healthy or normal weight ranges 18.5 to 24.9 BMI, overweight ranges 25 to 29.9 BMI, and obese means 30 and above than 30 BMI, the number of respondents in each category can be seen in table 2.

3.3 Statistical analysis

For statistical analysis, we applied multiple linear regression to examine the association between COVID-19 recovery days and the independent variables. The regression predicts, how many days a patient would require to be COVID-19 negative. The linear regression is widely used in the literature and recently few studies such as Ayyoubzadeh et al., (2020), Kass et al., (2020), and Xiong et al., (2020) have used this method for predicting the impact of various factors upon COVID-19. Equation 1 represents the econometric expression:

$$y_i = \beta_0 + \beta_i x_i + \varepsilon \qquad (1)$$

Where,

y_i = Disease days (the number of days a respondent was COVID-19 positive)

β_0 = Intercept terms / constant term

β_i = The coefficients of independent variables

x_i = All explanatory variables (Age, Gender, Education, living area, Marital status, log of income, any other disease, exercise, hospital admission, medicine taken, smoking, and BMI)

The assumptions of linear regression [a) Linear in parameters b) zero mean of the residuals c) homoscedasticity d) no autocorrelation of residuals and e) independent variables and residuals were uncorrelated and f) multicollinearity] were fulfilled and can be seen in the appendix figure A1. The analysis was carried out using RStudio and mainly two packages, "dplyr" and "tidyverse".

4. Results and discussion

Table 1 and 2 present a description of the variables. The tables are self-explanatory and show our respondents' typology.

Table 1. Description of the continuous variables

Continuous Variables	**Observations**	**Mean**	**Std. Deviation**	**Min**	**Max**
Disease days (Dependent Variable)	170	21.42	5.656	10	43
Schooling Years	170	14.95	2.07	8	20
Monthly exp (PKR)	170	65,565	47,053	10,000	300,000

Note: Authors' calculations

Table 2. Description of the categorical variables

Factors Variables	**Frequencies**		**Total**
Age	Age 17-25 = 33 (19.4%)	Age 36-45 = 35 (20.6%)	170
	Age 26-35 = 81 (47.6%)	Age 46-above = 21 (12.4%)	
Gender	Male = 121 (71.2%)	Female = 49 (28.8%)	170
Area	Urban = 128 (75.3%)	Rural = 42 (24.7%)	170

Marital Status	Single = 60 (35.3%)	Married = 110 (64.7%)	170
Any other disease	Yes = 60 (35.3%)	No = 110 (64.7%)	170
Light exercise (walk)	Yes = 65 (38.2%)	No = 105 (61.8%)	170
Admitted to the hospital	Yes = 18 (10.6%)	No =152 (89.4%)	170
Medicine taken	Yes = 153 (90.0%)	No = 17 (10.0%)	170
Smoking	Yes = 38 (22.4%)	No = 132 (77.6%)	170
BMI-categories	Normal BMI = 76 (44.7%) Obese = 34 (20.0%)	Under BMI = 3 (1.8%) Over BMI = 57 (33.5%)	170

Note: Authors' calculations

Table 3 presents the main results of multiple linear regression, we assume that everyone recovers from COVID-19 because of our data limitation. We found patients aged 36 to 45 years old take 3 more days to recover (95% C.I = -0.33 - 6.05) as compared to the 17 to 25 aged patients. Likewise, patients aged 46 and above take 7 more days to recover (95% C.I = 3.62 – 10.93) from COVID-19 as compared to 17 to 25 years old. Perhaps due to the low immunity against the virus, the findings are similar to various studies such as Jin et al., (2020) and T. Chen et al., (2020). Interestingly, patients living in urban areas recover 1.5 days quicker (95% C.I = -3.34– 0.27) than those who live in rural areas. This may be because of the availability of better health facilities in urban areas. Similarly, the patients who had any pre-existing disease (e.g diabetes, cardiovascular disease, liver infection, and hypertension) take 1.7 more days to recover (95% C.I = -0.22 – 3.72) as compared to those who do not have any other pre-existing condition. The findings accord with the earlier studies (Jin et al., (2020) and T. Chen et al., (2020)) which have found that patients with pre-existing conditions were at more risk.

Interestingly, patients who currently smoke take 2 more days to recover (95% C.I = 0.03 – 3.88) as compared to the non-smoker. Smoking is a major risk factor for lung diseases, bacterial, and viral infections (Berlin et al., 2020), and can cause severe damage to health. Finally, obese patients (having more than and equal to 30 BMI) take 2.6 more days to recover (95% C.I = 0.51– 4.66) as compared to those patients who have normal weight (BMI 18.5 to 29.5). Obesity can be an increased risk of respiratory infections and may slow down the recovery process. Our findings are consistent with Cai et al., (2020) and Stefan et al., (2020).

Surprisingly, income and education remain insignificant, implying that income and education do not expedite the recovery from the COVID-19 in Pakistan. Possibly, because of two main reasons i) most of the medicine and testing were subsidized by the government of Pakistan, hence, belonging to the lower or higher income groups may not affect the recovery process significantly. The second reason could be our data limitation, as stated earlier we had mostly higher income data and low variation in the data may not produce the significant results. Likewise, better education may save people from getting an infection because of better strategies, awareness, or following the guidelines. However, once educated people get infected they may have an equal chance of recovery to the less educated people.

Table 3. Multiple linear regression results

Variables	estimate	std. error	t-statistic	P-values	95% C.I	
					Lower	Upper
Age 26-35	0.443	1.225	0.362	0.718	-1.98	2.86
Age 36-45	2.855*	1.616	1.766	0.079	-0.34	6.05
Age 46-above	7.274***	1.851	3.929	0.000	3.62	10.93

Age 17-25 (reference category)						
Gender Male	-0.324	0.899	-0.36	0.72	-2.10	1.45
Year of schooling	-0.135	0.205	-0.657	0.512	-0.54	0.27
Area Urban	-1.537*	0.915	-1.68	0.095	-3.34	0.27
Marital status Single	0.79	1.06	0.745	0.457	-1.30	2.88
Log Income (proxy)	0.367	0.703	0.523	0.602	-1.02	1.76
Any other disease Yes	1.750*	1.001	1.748	0.082	-0.23	3.73
Exercise Yes	-0.726	0.805	-0.903	0.368	-2.32	0.86
Hospital admission Yes	-0.163	1.375	-0.118	0.906	-2.88	2.55
Medicine taken Yes	-0.107	1.331	-0.081	0.936	-2.74	2.52
Smoking Yes	1.957**	0.973	2.011	0.046	0.03	3.88
Obese	2.585**	1.049	2.465	0.015	0.51	4.66
Over weight	0.469	0.946	0.496	0.621	-1.40	2.34
Under weight	-1.636	3.102	-0.527	0.599	-7.76	4.49
Normal Weight (reference category)						
(Intercept)	17.534**	7.689	2.28	0.024	2.34	32.73
Observations	170					
R^2	0.306					
Adjusted R^2	0.234					
Residual Std. Error	4.953 (df = 153)					
F Statistic	4.221*** (df = 16; 153)					

Note: Authors' calculation, C. I= Confidence intervals, P-value <0.005 ***, < 0.05 ** < 0.10 *

The recovery or survival from the COVID-19 depends upon the severity of the disease as well. If the virus has infected the patient severely the recovery may take months or even lead to death. Our cohort mainly experienced fever and tiredness, followed by loss of taste and smell, body aches, headache, cough and sneezing, sore throat, diarrhea, difficulty in breathing, and chest pain. Figure 1 shows the symptoms which patients had experienced during COVID-19.

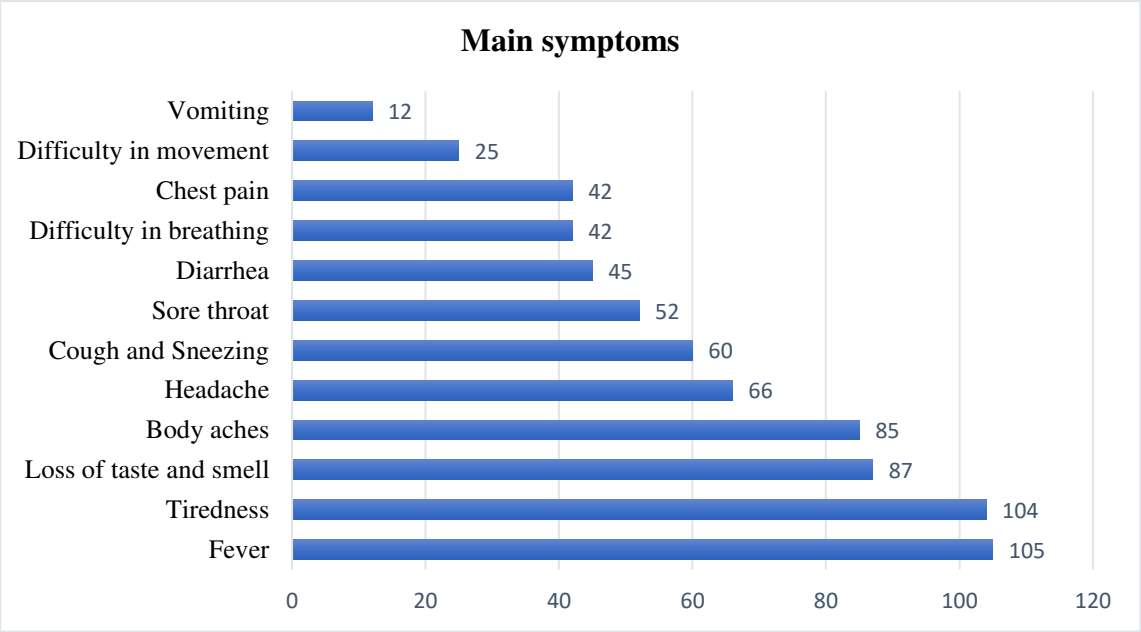

Figure 1. Symptoms of COVID-19 patients in our cohort.

5. Conclusions

COVID-19 has imposed substantial health and economic burdens on every country. As of 4th September 2020, no vaccination against COVID-19 is available on the market. However, around 20 vaccines are under development currently (Evans, 2020) which could potentially be available soon. Therefore, extra care should be taken to lower the spread of the virus by following the guidelines introduced by the WHO and local governments. Currently, every country is trying to increase the recovery rate of coronavirus by adopting numerous health strategies such as test, track, and trace whilst maintaining stringent hygiene and social distancing. Researchers are still

attempting to identify the factors which can reduce the adverse impact of COVID-19 upon the global community. A few studies have attempted to find the epidemiological and clinical features of deceased and survivors of COVID-19 patients. However, the association between the COVID-19 and patients' socioeconomic attributes are still unexplored, especially in Pakistan. It is immensely important for policymakers to understand the impact of the socioeconomic factors on COVID-19 so that appropriate measures can be adopted for current and future pandemic responses.

We found that old age, having pre-existing diseases, smoking, and obesity slows down the recovery process from COVID-19 in Pakistan. We suggest that the government of Pakistan should provide extra care to older age patients and those who have pre-existing diseases especially diabetes, cardiovascular diseases, hypertension, and respiratory diseases. Moreover, the government should adopt the smoking cessation policies as well as encourage those policies which can lower the obesity in the country to enhance the recovery rate in Pakistan. Our results are likely to be applicable to policy setters in many other countries around the world.

Ethical Statement

We hereby declare that; The paper reflects the authors' own research and analysis in a truthful and complete manner. The results are appropriately placed in the context of prior and existing research. In addition, no animal or human were harmed, no blood samples were collected, no clinical trials were carried out, identity of the respondents kept confidential, and prior consent from the respondents were taken**.**

Disclosure Statement

We have no competing or financial interest to declare

References

Abid, K., Bari, Y. A., Younas, M., Tahir Javaid, S., & Imran, A. (2020). Progress of COVID-19 Epidemic in Pakistan. *Asia-Pacific Journal of Public Health*. https://doi.org/10.1177/1010539520927259

Alqahtani, J. S., Oyelade, T., Aldhahir, A. M., Alghamdi, S. M., Almehmadi, M., Alqahtani, A. S., Quaderi, S., Mandal, S., & Hurst, J. R. (2020). Prevalence, Severity and Mortality associated with COPD and Smoking in patients with COVID-19: A Rapid Systematic Review and Meta-Analysis. *PLOS ONE*, *15*(5), e0233147. https://doi.org/10.1371/journal.pone.0233147

Ayyoubzadeh, S. M., Ayyoubzadeh, S. M., Zahedi, H., Ahmadi, M., & Kalhori, S. R. N. (2020). Predicting COVID-19 Incidence Through Analysis of Google Trends Data in Iran: Data Mining and Deep Learning Pilot Study. *JMIR Public Health and Surveillance*, *6*(2), e18828. https://doi.org/10.2196/18828

Berlin, I., Thomas, D., Le Faou, A.-L., & Cornuz, J. (2020). COVID-19 and Smoking. *Nicotine & Tobacco Research*, *22*(9), 1650–1652. https://doi.org/10.1093/ntr/ntaa059

Cai, Q., Chen, F., Wang, T., Luo, F., Liu, X., Wu, Q., He, Q., Wang, Z., Liu, Y., Liu, L., Chen, J., & Xu, L. (2020). Obesity and COVID-19 Severity in a Designated Hospital in Shenzhen, China. *Diabetes Care*, *43*(7), 1392–1398. https://doi.org/10.2337/dc20-0576

Cascella, M., Rajnik, M., Cuomo, A., Dulebohn, S. C., & Di Napoli, R. (2020). Features, Evaluation, and Treatment of Coronavirus (COVID-19). In *StatPearls*. StatPearls Publishing. http://www.ncbi.nlm.nih.gov/books/NBK554776/

Chen, N., Zhou, M., Dong, X., Qu, J., Gong, F., Han, Y., Qiu, Y., Wang, J., Liu, Y., Wei, Y., Xia, J., Yu, T., Zhang, X., & Zhang, L. (2020). Epidemiological and clinical

characteristics of 99 cases of 2019 novel coronavirus pneumonia in Wuhan, China: A descriptive study. *The Lancet*, *395*(10223), 507–513. https://doi.org/10.1016/S0140-6736(20)30211-7

Chen, T., Wu, D., Chen, H., Yan, W., Yang, D., Chen, G., Ma, K., Xu, D., Yu, H., Wang, H., Wang, T., Guo, W., Chen, J., Ding, C., Zhang, X., Huang, J., Han, M., Li, S., Luo, X., … Ning, Q. (2020). Clinical characteristics of 113 deceased patients with coronavirus disease 2019: Retrospective study. *BMJ*, *368*. https://doi.org/10.1136/bmj.m1091

Coccia, M. (2020). Factors determining the diffusion of COVID-19 and suggested strategy to prevent future accelerated viral infectivity similar to COVID. *Science of The Total Environment*, *729*, 138474. https://doi.org/10.1016/j.scitotenv.2020.138474

Evans, O. (2020). Socio-economic impacts of novel coronavirus: The policy solutions. *BizEcons Quarterly*, *7*, 3–12.

Farsalinos, K., Barbouni, A., & Niaura, R. (2020). Systematic review of the prevalence of current smoking among hospitalized COVID-19 patients in China: Could nicotine be a therapeutic option? *Internal and Emergency Medicine*, *15*(5), 845–852. https://doi.org/10.1007/s11739-020-02355-7

Farsalinos, K., Barbouni, A., Poulas, K., Polosa, R., Caponnetto, P., & Niaura, R. (2020). Current smoking, former smoking, and adverse outcome among hospitalized COVID-19 patients: A systematic review and meta-analysis. *Therapeutic Advances in Chronic Disease*, *11*, 2040622320935765. https://doi.org/10.1177/2040622320935765

Harapan, H., Itoh, N., Yufika, A., Winardi, W., Keam, S., Te, H., Megawati, D., Hayati, Z., Wagner, A. L., & Mudatsir, M. (2020). Coronavirus disease 2019 (COVID-19): A

literature review. *Journal of Infection and Public Health*, *13*(5), 667–673. https://doi.org/10.1016/j.jiph.2020.03.019

Huang, C., Wang, Y., Li, X., Ren, L., Zhao, J., Hu, Y., Zhang, L., Fan, G., Xu, J., Gu, X., Cheng, Z., Yu, T., Xia, J., Wei, Y., Wu, W., Xie, X., Yin, W., Li, H., Liu, M., … Cao, B. (2020). Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *The Lancet*, *395*(10223), 497–506. https://doi.org/10.1016/S0140-6736(20)30183-5

Jin, J.-M., Bai, P., He, W., Wu, F., Liu, X.-F., Han, D.-M., Liu, S., & Yang, J.-K. (2020). Gender Differences in Patients With COVID-19: Focus on Severity and Mortality. *Frontiers in Public Health*, *8*. https://doi.org/10.3389/fpubh.2020.00152

Kass, D. A., Duggal, P., & Cingolani, O. (2020). Obesity could shift severe COVID-19 disease to younger ages. *Lancet (London, England)*, *395*(10236), 1544–1545. https://doi.org/10.1016/S0140-6736(20)31024-2

Lu, H., Stratton, C. W., & Tang, Y.-W. (2020). Outbreak of pneumonia of unknown etiology in Wuhan, China: The mystery and the miracle. *Journal of Medical Virology*, *92*(4), 401–402. https://doi.org/10.1002/jmv.25678

Stefan, N., Birkenfeld, A. L., Schulze, M. B., & Ludwig, D. S. (2020). Obesity and impaired metabolic health in patients with COVID-19. *Nature Reviews Endocrinology*, *16*(7), 341–342. https://doi.org/10.1038/s41574-020-0364-6

Stojkoski, V., Utkovski, Z., Jolakoski, P., Tevdovski, D., & Kocarev, L. (2020). The socio-economic determinants of the coronavirus disease (COVID-19) pandemic. *ArXiv:2004.07947 [Physics, q-Fin, Stat]*. http://arxiv.org/abs/2004.07947

Xiong, Y., Sun, D., Liu, Y., Fan, Y., Zhao, L., Li, X., & Zhu, W. (2020). Clinical and High-Resolution CT Features of the COVID-19 Infection: Comparison of the Initial and

Follow-up Changes. *Investigative Radiology*.

https://doi.org/10.1097/RLI.0000000000000674

Appendix

Figure A1 shows the assumption of multiple linear regression holds.

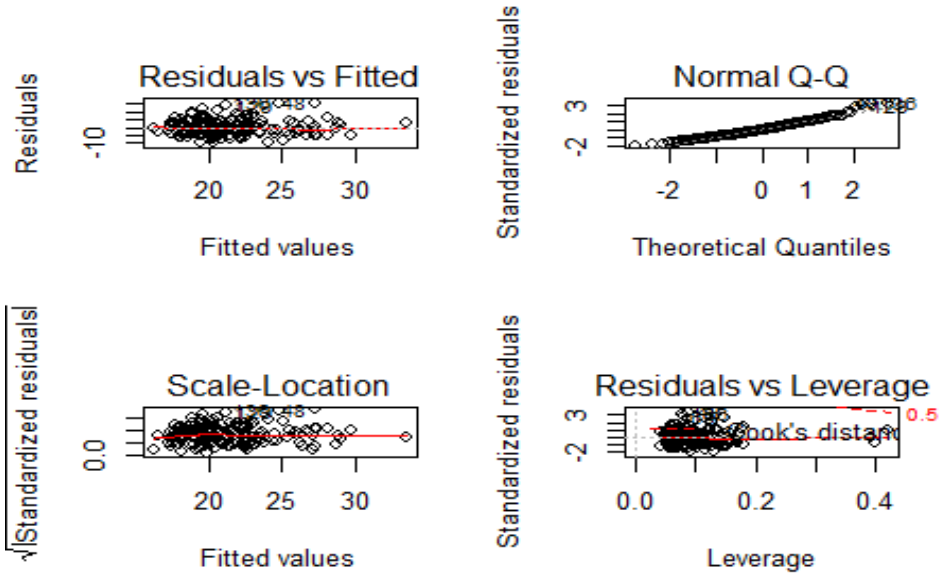

Figure A1. multiple linear regression assumptions