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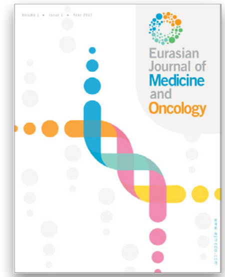

Research Article

The Impacts of Covariates on Spatial Distribution of Corona Virus 2019 (COVID-19): What Do the Data Show through ANCOVA and MANCOVA?

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Abstract

Objectives: In late December 2019, a group of cases with 2019 Novel Coronavirus pneumonia (SARS-COV-2) in Wuhan, China, raised worldwide concern. This novel virus is turning into a global nightmare and a serious health problem. Even though an accurate estimate of the case-fatality risk is difficult; this research is useful to mitigate the spatial pattern of COVID-19. In this study, we aim to assess the impacts of covariates (age, sex, blood type, and disease severity, patients' previous health history , transmission type, and location) on the spatial distribution of COVID-19.

Methods: Relevant data were obtained from the World Health Organization released by March 18, 2020 and some other information from published studies were taken into consideration. The data were analyzed using descriptive statistics, t-test, Analysis of Covariance (ANCOVA) and Multivariate Analysis of Covariance (MANCOVA) through STATA packages.

Results: The spatial pattern of COVID-19 is varying with more than a half-million confirmed cases and thousands of deaths worldwide. . The result of the study has also shown that the spatial pattern of COVID-19 is fluctuating and reflected the large confirmed cases and deaths of the Republic of China, Italy, USA and Iran. There is also evidence that age and population density variation has a statistically significant association with deaths due to COVID-19 (Fcal=133.909 and P-value= 0.000*). The result also highlighted a statistically significant difference between male and female patients affected by COVID-19. The infection fatality rate in 0-9 years is almost nonexistent; whereas for patients over the age of 50 it is relatively suffering.. There is also statistical evidence of the outbreak of the epidemic that in Europe, America and the Western Pacific Region the local transmission is predominant, while in Africa and in other regional areas most cases are fugitive. Despite some variation in initial symptoms, most COVID-19 patients have a fever and respiratory symptoms. Social distancing and special care are recommended for elderly people and patients with smoking habits, diabetes, and cancer . The state and private media should try to raise awareness about the transmission of the disease. Healthcare providers should follow up with subsequent reports on time as the situation is likely to change.

Keywords: COVID-19, covariates, spatial distribution, transmission and MANCOVA

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The latest threat to global health is the ongoing outbreak of respiratory disease recently called Coronavirus Disease 2019 (Covid-19). Covid-19 was recognized in December 2019[1] Coronavirus disease 2019 (COVID-19) is a respiratory disease caused by a novel and potential Corona Virus that started in Wuhan, China and rapidly spread in China and out of the country and became an epidemic.[1-3] The World Health Organization (WHO) declared COVID-19 outbreak as a pandemic on March 12th 2020.[3]

The spatial distribution of COVID-19 is high where the overall case-fatality rate is about 2.3% but reaches 8.0% in patients aged 70 to 79 years and 14.8% in those aged >80 years.

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[4, 6] France is now facing the COVID-19 wave with more than 4500 cases, as of March 14, 2020.[5, 7] Since the outbreak of COVID-19, the virus had spread rapidly throughout China and to several other countries within a month, including Italy,[15] the United States,[16] and Germany.[17] Consequently, COVID-19 has now been identified as severe worldwide, although the highest cases were reported in China, Italy, the United States, Germany and others.

Following the recent emergence of COVID-19, passenger screening is being used to limit the further spread of the disease, and symptom screening has become a ubiquitous tool in the global response. Previously, we developed a mathematical model to understand factors governing the effectiveness of passenger screening to prevent the spread of emerging pathogens (Gostic et al., 2015). Here, we estimate the impact of different screening programs in light of available information on key COVID-19 life history and epidemiological parameters.[14]

Chinese experts recommend that patients diagnosed with mild, moderate and severe COVID-19 pneumonia and who do not have chloroquine contraindications should be treated with 500 mg chloroquine twice a day for ten days.[8-11] Knowing the spatial distribution and identification of sex, age, population density and transmission type (local transmission and imported cases) are important to reduce the spread of COVID-19.

An accurate assessing the impact and relationship of the covariant on the spatial distribution of COVID-19, is useful for others to control this epidemic.

Statement of the Problem

The COVID-19 has been declared as an epidemic and has become a major global health threat. As of March 16, 2020, 164.837 cases and 6.470 deaths have been confirmed worldwide. The global spread has been rapid, with 146 countries currently reporting at least one case. COVID-19 is the most common epidemic across the globe with the largest and most serious clusters of every disease that has ever occurred. COVID-19 is becoming a global problem where the world failed to solve serious problems and death has become serious due to this epidemic. Global spread has been rapid, with almost more than 150 countries now reporting at least one case. Despite aggressive containment efforts, the disease continues to spread and the number of patients affected is growing. Today, this problem is turning into a nightmare for all the leading countries, politicians and religious that rely on daring problems. Therefore, the objective of this study is to assess the impact of covariates (age, sex, blood type, population density) on the spatial distribution of COVID-19.

Objective of the Study

The objective of the study is to determine the Impact of Covariates on the Spatial Distribution of COVID-19.

Methods

Study Area and Period

This study mainly considers almost the entire world where the outbreak of this virus has become a huge problem. The Western Pacific Region, European Region, South East Asia, and the Eastern Mediterranean Region, Regions of the Americas, African Region, and other regions are considered in the study. Additionally, the number of COVID-19 confirmed cases and deaths is taken into consideration in each country under each region. The study period incorporates all relevant information since the outbreak of this epidemic up to March 18, 2020 (Coronavirus Disease 2019 (COVID-19)), WHO). The data discussed in this study area are based on relevant information from the moment this outbreak started until the time this research was finalized. Most data on all of this was obtained from the WHO, health organizations and others.

Source of Data

The data incorporated in this study include all the information reported by the World Health Organization until 18 March 2020. This report covers all continents, countries, regions. This report takes into account the confirmed COVID-19 cases and deaths due to COVID-19, along with the type of transmission. Additionally, relevant information on COVID-19 patients such as the age and sex of the respondents is collected directly.[12, 13] The high mortality rate of COVID-19 is mostly seen in men over the age of 50 , more vulnerable to cardiovascular diseases. Compared to the other age group, olderCOVID-19 patients are more susceptible to mortality than any age group.

Source:[14] [*WHO-China Joint Mission and Chinese Journal of* Chinese CCDC, 2020]. This information is attained based on 55.924 laboratory confirmed cases and 72.314 confirmed, suspected, and asymptomatic COVID-19 cases.

Death Rate = f/N

f indicates the number of deaths and N indicates the total number of cases due to COVID-19.

The summary table given in Table 2, reveals the main signs and symptoms obtained based on clinical studies and characteristics of 2019 Corona Disease, where we can note that the main signs and symptoms of COVID-19 are fever and cough (Table 2). The table involves the main signs and symptoms of COVID-19 and the high susceptible blood type as shown in Table 2.

Identification of Covariates

Predicted Variable: COVID-19 (Confirmed Cases and Deaths)

Independent Variables: Sex, Age, Population density, type of transmission and type of Region. To achieve the proposed objective, descriptive and inferential statistical methods (t-test, ANCOVA and MANCOVA) are taken into account. They examined data are scrutinized using the STATA and R packages.

Results

In this section, the results of both descriptive and inferential statistics are summarized and conclusions are also drawn. These descriptive statistics are frequency distribution, while the inferential statistics are t-test, chi-square test, ANCOVA and MANCOVA. The mortality by age varies due to COVID-19. Additionally, the spatial distribution of the COVID-19 confirmed cases and deaths varies with high spread. As indicated in the Table below the largest confirmed cases and deaths were observed in the Western Pacific Region and the European Region, respectively.

Results of Descriptive Statistics

To assess the status of COVID-19 various descriptive statistics is considered. The result of Table 3 has been reflected as the leading European and the Western Pacific Regions in confirmed cases and COVID-19 deaths. As noted in Table 3, the spatial distribution of COVID-19 in both the number of confirmed cases and deaths varies spatially across the globe, reflecting the European region with high confirmed COVID-19 cases and deaths.

As in Table 4, China, Italy, Spain, France and Iran are the countries with the highest number of COVID-19 cases resulting in the highest deaths in this pandemic. The deaths and confirmed cases of COVID-19 are truly painful in the the Western Pacific and European regions (Table 4). Up to the last date of this study Italy ranks first in confirmed cases and deaths due to this virus, while China ranks second.

As shown in Table 5, the most common type of transmissionin the the world is local transmission, especially in the Western Pacific Region, European Region, USA, and Eastern Mediterranean, and wereas in South Eastern Asia, Africa and the other territories the transmission is widely imported (Table 5).

As shown in Figure 1, the majority of the spread of COVID-19 is due to the local transmission where the majority of cases observed in Africa and the other territories. This suggests that caution must be exercised to combat this novel virus by reducing the spatial distribution of COVID-19.

Result of the Inferential Statistics

The following section shows the result obtained from statistical tests. Table 5 below reveals a statistically significant association between the region type and the transmission

Table 1. Summary of Previous Works on Death Rates of COVID-19 Patients on Sex, Age and Previous Heath Status

Age Category	Death Rate of All Confirmed Cases (%)	Sex	Death Rate of All Confirmed Cases (%)
80+	14.8	Male	2.8
70-79	8.0		
60-69	3.6		
50-59	1.3		
40-49	0.4		
30-39	0.2	Female	1.7
20-29	0.2		
10-19	0.2		
0-9	no fatalities		
Death due to preexisting conditions of the COVID-19 Confirmed Cases			
Pre-Existing Condition	**Death Rate Confirmed Cases (%)**	**Death Rate All Cases Remark (%)**	
Cardiovascular disease	13.2	10.5	
Diabetes	9.2	7.3	
Chronic respiratory disease	8.0	6.3	
Hypertension	8.4	6.0	
Cancer	7.6	5.6	
no pre-existing conditions	-	0.9	

Table 2. Review on Summary of Clinical Studies and Its Characteristics of Coronavirus Disease 2019

Author	**Huang et al.**[18]	**Chen et al.**[19]	**Li et al.**[20]	**Song et al.**[21]	**Chen et al.**[22]	**Wang et al.**[23]
Study setting	Wuhan Jinyintan Hospital from Dec 16, 2019 to Jan 2, 2020	Wuhan Jinyintan Hospital from Jan 1 to Jan 20, 2020	Hospitals in Wuhan on Jan 22, 2020	Shanghai Public Health Clinical Center from Jan 20 to Jan 27, 2020	Tongji Hospital from Jan 14 to Jan 29, 2020	Zhongnan Hospital of Wuhan University from January 1 to January 28, 2020 follow up to Feb 3, 2020
City (Total Number of Patients)	Wuhan, China (41)	Wuhan, China (99)	Wuhan, China (425)	Shanghai, China (51)	Wuhan, China (29)	Wuhan, China (138)
Age, mean (IQR)	49 (41-58)	55.5±13.1	56(26-82)	49±16	56 (26-79)	56 (42-68)
Gender, male	30 (73%)	67 (68%)	31 (66%)	25 (49%)	21(72%)	75 (54.3)
Exposure history, cases	27 (66%) exposed to Huanan seafood wholesale market	49 (49%) exposed to Huanan Seafood wholesale	26 (55%) exposed to Huanan Seafood Wholesale market	50 (98%) exposed to Huanan Seafood Wholesale market	2 (7%) exposed to Huanan Seafood Wholesale market	12 (8.7%) exposed to Huanan Seafood Wholesale market
Signs and symptoms	Fever, 40 (98%) Cough, 31 (76%) Myalgia or fatigue, 18 (44%) Sputum production, 11/39 (28%) Headache, 3/38 (8%) Hemoptysis, 2/39 (5%) Diarrhea, 1/38 (3%), Dyspnea, 22/40 (55%)	Fever, 82 (83%) Cough, 81 (82%) Shortness of breath, 31(31%) Muscle ache, 11 (11%) Confusion, 9 (9%) Headache, 8 (8%) Sore throat, 5 (5%) Rhinorrhea, 4 (4%) Chest pain, 2 (2%) Diarrhea, 2 (2%) Nausea and vomiting, 1 (1%)	Fever, with or without recorded temperature	Fever, 49 (96%) Cough, 24 (47%) Phlegm, 10 (20%) Myalgia or fatigue, 16 (31%) Headache and Dizziness, 8 (16%) Dyspnea or chest pain, 7 (14%) Loss of appetite, 9 (18%) Diarrhea 5, (10%) Stuffy and runny nose, 2 (4%) Sore throat, 3 (6%) Nausea and vomiting, 3 (6%)	Fever, 28 (97%) Cough or expectoration, 21 (72%) Dyspnea, 17 (59%) Myalgia or fatigue, 12 (41%) Headache, 2 (7%) Diarrhea, 4 (14%)	Fever, 136 (98.6%) Fatigue, 96 (69.6%) Dry cough, 82 (59.4%) Anorexia, 55 (39.9%) Myalgia, 48 (34.8%) Dyspnea, 43 (31.2%) Expectoration, 37 (26.8%) Pharyngalgia, 24 (17.4%) Diarrhea, 14 (10.1%) Nausea, 14 (10.1%) Dizziness, 13 (9.4%) Headache, 9 (6.5%) Vomiting, 5 (3.6%), Abdominal pain, 3 (2.2%)
Authors	Fang Jiang et al.[25]		Jiao Zhao et al.[26]			
Topics	Review of the Clinical Characteristics of Coronavirus Disease 2019 (COVID-19)		Relationship between the ABO Blood Group and the COVID-19 Susceptibility The result of this study reveals Blood type A are more vulnerable to COVID 19. People with blood group A have a significantly higher risk for acquiring COVID-19 compared with non-A blood groups, whereas blood group O has a significantly lower risk for the infection compared with non-O blood groups.			

type. Additionally, this is also tested strongly using the Chi-Square correlation test as there is a statistically significant association between region type and the transmission type (Table 6).

The result of the t-test has shown us that there is a statistically significant difference between the mean number of deaths and confirmed COVID-19 cases. The result shown in the table showed that there is a statistically significant difference between the average number of confirmed COVID-19 cases and the number of people who died from this novel virus (Table 7).

In addition, the impact of population density on confirmed COVID-19 cases and deaths is also supported and evaluated using the MANCOVA, as shown in Table 8. The result of the study revealed and indicated that age alters the COVID-19 infection fatality rate. This reveals that population density has highly increased mortality and that confirmed COVID-19 cases are also spreading at a high rate (Table 8).

Moreover, 36 clinical COVID-19 patients, 15 males and 21 females, were evaluated to further support the result based on the obtained data.[12] Two parameters (sex and age) were taken into account, for which all patient ages are highly variable, including children, adolescents and the elderly. As noted in Table 9, the result from ANCOVA indicates that the age variation has a statistically significant difference that will be affected by COVID-19 confirmed cases; where the gender variation is at the %5 significance level and is not statistically significant with the confirmed COVID-19 cases. This result is also more consistent with other findings showing that the infection mortality rate is almost insignificant in the age group of children (0-9 years old), and the infection mortality rate of the patients aged 50-59 is approximately 0.60, for over 60-69 age groups, and 2.2% and %5.1 for 70-79 age and 70-79 age groups respectively. groups whereas their infection fatality ratio is 2.2% and 5.1% respectively. The infection fatality ratio is worst for the COVID-19 patients for age group over 80. Additionally, Jiao Zhao et al.[26] also convincingly

Table 3. Descriptive Statistics on the Spatial Distribution of COVID-19 by Region

Region	Confirmed COVID-19 Cases	Deaths
Western Pacific Region	92.148	3384
European Region	369.376	3956
Southeast Asia	601	10
Eastern Mediterranean Region (EM)	19569	1150
Regions of the Americans	7149	95
African Region	270	4
Other Territory	230	1
world	489.343	8600

Table 4. Descriptive Statistics on the Spatial Distribution of COVID-19 Based on the Country

Region	Country	Confirmed COVID-19	Deaths
Western Pacific Region	China	81, 155	3244
	Republic Korea	8404	87
	Japan	844	32
	Philippines	232	12
European Region	Italy	318532	2848
	Spain	13165	673
	France	8731	202
	Germany	8600	13
	Switzerland	3100	19
	UK	2361	60
	Netherlands	1997	62
	Belgium	1887	23
South East Asia	Thailand	207	1
	Indonesia	172	5
	India	160	4
Eastern Mediterranean	Iran	17347	1123
Region	Iraq	184	13
	Lebanon	141	3
Regions of the Americans	USA	5358	75
	Canada	544	1
	Argentina	74	2
	Ecuador	79	2
	Dominican Republic	37	12
Africa	south Africa	73	0
	ALGERIA	71	4
	Senegal	28	0
Other Territory	Faroe Islands	83	0
	Guadeloupe	30	0
	Martinique	16	0

Table 5. Cross Tabulation of the transmission type of COVID-19 by country

	Local Transmission	Imported Cases Only	Total
Region Type			
Western Pacific	11	1	12
European	39	13	52
Eastern Mediterranean	6	2	8
USA	15	12	27
Southeast Asia	6	2	8
African	6	19	25
Others	3	15	18
Total	86	64	150

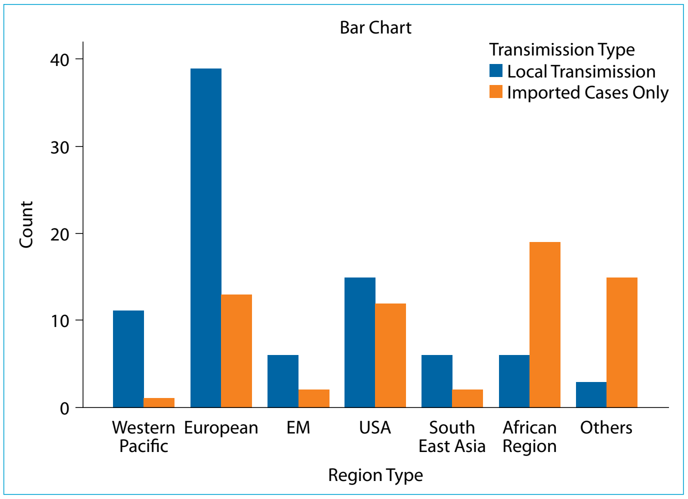

Figure 1. The transmission type versus region type.

Table 6. Test for Association between the Region Type and Transmission Type (Local Transmission and Imported Cases Only)

Test of Statistics	Value	DF	p
Pearson Chi-Square	38.018	6	0.000*

reported that blood type A patients are more vulnerable to COVID-19 than the other, however, we did not assess this issue due to data scarcity in this study.

Conclusion

This article addresses impacts of covariates (age, sex, blood type, patients' previous health history, and population density) on the spatial distribution of COVID-19. The spatial distribution of COVID-19 is inconsistent between both regions and countries. The aim of this study is not to provide precise information about the virus outbreak , rather to provide information about the recent distribution of the epidemic. The high infection mortality rate is observed in China, Italy, Iran and the USA, which are also defined as the hot spot areas of COVID-19. The result of the study also pointed out that there is a statistically significant difference between men and women affected by this epidemic, with other studies showing that male patients who smoke are vulnerable to the disease. The result of ANCOVA also revealed that the age variation associated with COVIS-19 WAS statistically significant. The result obtained through multivariate analysis of covariance showed that there was a statistically significant relationship between the population density and confirmed COVID-19 cases. Special attention is required for elderly people infected with COVID-19. The government of each country should work vigorously with its community, especially on the type of transmission in imported cases and local transmission. Despite some

Table 7. Results of Paired Sample T test on Mean Difference of Confirmed COVID-19 Cases and Deaths

	Paired Differences			t-test	DF	Sig. (2-tailed)
	Mean	95% Confidence Interval of the Difference				
		Lower	Upper			
Confirmed COVID-cases Versus Deaths	385	161.34852	608.65148	3.894	9	0.004

Table 8. MANCOVA results to see the effects of age on confirmed COVID-19 cases and Deaths (Inter-Subject Effects Tests)

Source of variation	Dependent Variable	Type III Sum of Squares	DF	Mean Square	F	Sig.
Corrected Model	Confirmed COVID-Cases	107155293370.132a	1	107155293370.132	133.909	0.000
	Deaths	9882694.280b	1	9882694.280	6.189	0.055
Intercept	Confirmed COVID-Cases	15501246.622	1	15501246.622	0.019	0.895
	Deaths	1532870.896	1	1532870.896	0.960	0.372
Population density	Confirmed COVID-Cases	107155293370.133	1	107155293370.133	133.909	0.000
	Deaths	9882694.280	1	9882694.280	6.189	0.055
Error	Confirmed COVID-Cases	4001049208.725	5	800209841.745		
	Deaths	7984625.435	5	1596925.087		
Total	Confirmed COVID-Cases	145364424243.000	7			
	Deaths	28433034.000	7			
Corrected Total	Confirmed COVID-Cases	111156342578.857	6			
	Deaths	17867319.714	6			

a. R Squared = .964 (Adjusted R Squared = .957); b. R Squared = .553 (Adjusted R Squared = .464).

Table 9. ANCOVA sex and age results in COVID-19 confirmed cases

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected model	547.624a	2	273.812	2.707	0.082
Intercept	756.834	1	756.834	7.484	0.010
Age	523.596	1	523.596	5.177	0.030
Sex	97.614	1	97.614	0.965	0.333
Error	3337.376	33	101.133		
Total	16206.000	36			
Corrected total	3885.000	35			

a. R Squared = 0.141 (Adjusted R Squared = 0.089).

variation in initial symptoms, most COVID-19 patients have fever and respiratory symptoms. As the situation will change rapidly, healthcare providers should follow up with subsequent reports. More studies are needed to support the claim that blood type A is more v and Type 0 is less vulnerable to COVID-19.[26]

Disclosures

Peer-review: Externally peer-reviewed.

Conflict of Interest: None declared.

Limitation of the Study: This study only considers the data up to the late march 18, 2020. Therefore, relevant information of COVID 19 since March 18, 2020 needs another future work.

Declaration: I declare this work can contribute on the mitigation of COVID 19.

Ethics approval and consent to participate: This review work is only done by the author so as to contribute for the rest of the world. Additionally, the results are fully based on the latest information published in the world.

Consent for publication: This work is great sound and especially makes a strong contribution for the publication especially in mitigation mechanisms of COVID-19.

Availability of data and materials: The data corresponding to this work is directly obtained from the world health organizations and some more important research articles published through reputable journals. Therefore, this result is more genuine and contributes to combat this COVID-19.

Competing interests: I believe and have a more interest if this work is soon released for the public so that they can mitigate themselves from this virus.

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