Do Weather Temperature and Median-age affect COVID-19 Transmission?

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Abstract

It was observed that the coldest countries and the eldest in terms of median-age were most distressed by COVID-19 pandemic, while the warmest countries and that have younger-aged population were the least affected. Therefore, this study utilized the non-linear least squares method to estimate the impact of weather temperatures and median age on COVID-19 cases per million in thirty-nine countries divided into two groups. The first group composed of twenty-four countries that announced the first COVID-19 case in January 2020, while the second group contains fifteen countries that witnessed the pandemic for the first time in February of the same year. The study revealed some major findings, which are: COVID-19 cases per million were not significantly affected by weather temperature or the median age in "January-group" countries (after 72.67 days on average), while COVID-19 cases per million increased significantly by decreasing temperatures, and increasing the median age in case of "February-group" countries (after an average of 44.80 days). This means that weather temperature and median age may influence the transmission rates of COVID-19 in its early stages, while weather temperature or median age no longer have effects in the advanced stages of the pandemic.

Keywords: COVID-19, SARS-CoV-2, Weather Temperature, Median Age

1. Introduction

There is no doubt that the containment of COVID-19 pandemic caused by the emerging coronavirus (SARS-CoV-2) is currently the first concern worldwide. Since the characteristics of this pandemic that started in Wuhan, China in late 2019, made it difficult even by the most advanced health systems to control over it. This pandemic, which has spread to most countries of the world due its extremely high transmission rate of 2-2.5 (WHO, 2020-1), not only more targets the elder age categories, but it may

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also target specific places in the world, but rather specific areas in the country itself.

The number of COVID-19 cases globally as of April 10, 2020, at 14:27 GMT, was 1,625,213 cases, of which, 22% recovered, 5.95% died, and 71.47% were still active. According to official statistics, China, the source of the pandemic, managed to close 94.56% of cases with recovery, 4.07% with deaths (two cases per one million), and only 1.36% of cases were still active. While the USA topped the most affected countries' list, with a number of cases amounted to 470,175, represented 28.93% of global cases, of which 90.9% cases were still active. Furthermore, the combined COVID-19 cases in Spain, Italy, Germany and France accounted for 33.09% of global cases as of study time (WORLDMETERS, 2020).

This paper investigates the impact of weather temperatures and median age individually on the number of COVID-19 cases per million.

2. Literature

2.1 Effect of temperature on COVID-19 transmission

A number of studies (Wang, Tang, Feng, & Lv, April 3, 2020; Sajadi & et. al., 2020; Chan, Peiris, Poon, & Seto, 2011; Casanova, Jeon, Rutala, Weber, & Sobsy, 2010; Altamimi & Ahmd, 2019) have proven that temperature and high relative humidity reduce the transmission rate of coronaviruses.

(Gundy & Gebra, 2009) have demonstrated that the activity of SARS virus in water is highly dependent on temperature, as the virus is rapidly inactivated in water at a temperature of 23°C for ten days compared to more than 100 days at a temperature of 4°C. In 2010 (Casanova, Jeon, Rutala, Weber, & Sobsy, 2010) recorded that SARS Cov was inactivated faster at 20°C compared to 4°C at all levels of relative humidity (above 20%), and that virus was inactivated faster at 40°C than 20°C. (Chan, Peiris, Poon, & Seto, 2011) explained in 2011 that SARS Cov virus retain its vitality for more than five days on surfaces at a temperature of 22-25°C and relative humidity between 40-50 %, But the virus soon loses its vitality at higher temperatures and relative humidity (such as 38°C, and relative humidity above 95%).

Although, research is still being carried out on the thermal tolerance of SARS-CoV-2, (Wang, Tang, Feng, & Lv, 2020) concluded that a temperature increase of 1°C and a rise in relative humidity by one degree would reduce the effective daily reproductive number of SARS-CoV-2 by 0.0225 and 0.0158, respectively. In the same vein, Sajadi & et. al. (2020)

concluded that countries that witnessed a significant transmission of COVID-19 are roughly distributed along the 30-50 N' corridor, which are countries with consistently climate patterns with temperatures ranging from 5-11°C, combined with low specific (3-6 g / kg) and absolute humidity (4-7 g / kg).

2.2 **Age categories most affected by COVID-19**

Several reports and studies have shown that elder age categories are more susceptible to COVID-19 ((WHO), 2020-1; Wei & Lessler, 2020); Ropert Koch Institut, 2020 (WHO), 2020-2; Kassem, 2020).

3. Material and Methods

To achieve the study's objectives, thirty-nine countries were chosen and divided into two groups, twenty-four of which were declared the first COVID-19 case in January 2020, namely: the USA, Italy, Spain, China, Germany, France, UK, South Korea, Australia, Sweden, Malaysia, Japan, Russia, Philippines, Thailand, Finland, Singapore, Hong Kong, Taiwan, Vietnam, Sri Lanka, Cambodia, Macau and Nepal. While fifteen countries witnessed COVID-19 pandemic for the first time on February at the same year, which were: Iran, Switzerland, Belgium, Netherlands, Austria, Brazil, Israel, Norway, Ireland, Czech Republic, Denmark, Argentina, Egypt, Iraq and Lebanon.

Afterward, the temperature average in the most affected cities within the study's two groups from the day of declaring the first case to April 5, 2020 were calculated (as shown in tables 3 and 6). Utilizing non-linear least squares method (Hansen, 2000), the relationships between cases of COVID-19 per million as a dependent variable for each of the study's two groups, and the average temperatures in the most affected cities and median age as independent variables were estimated individually.

4. Description of the study Sample

4.1 **Countries that reported the first case of COVID-19 in January 2020**

Table (1) shows the most affected cities by COVID-19 in the twenty-four countries that witnessed the pandemic for the first time in January 2020. It is noteworthy that COVID-19 cases are mostly concentrated in the central and northern areas in these countries that represent capitals, densely populated cities, economic and financial centers, especially in developed countries. For instance, California, the USA's economic capital, was the most affected in the far northeast. Likewise, the province of Lampodria in

northern Italy, the responsible for 40% of industrial production[2] was the most effected Italian area. Furthermore, COVID-19 has swept through Madrid, the Spanish capital, and the most important financial and economic center[3]. As well, the pandemic was concentrated in Wuhan, the transportation and industry hub in central China[4], and the capital of China's Hubei Province, the source of the SARS-CoV-2 virus. In Germany, the province of Bavaria, the second largest German province in terms of population, the producer of 18% of the gross German domestic product[5] was the most affected. As for France, the pandemic targeted Ile-de-France region in north-central France, which is the richest region in Europe, and the most important French and European region in terms of research, development and innovation. In like manner, the pandemic was concentrated in London, the British capital, As well in Diego, the third largest city in South Korea, besides Stockholm, the Swedish capital, and in capitals of the remain countries in this group.

Tables (1) and (2) show that, despite the "January-group" countries experienced the pandemic at close times, however, these countries varied in the total number of COVID-19 cases, which averaged about 38 thousand, with a minimum of nine only in Nepal, and a maximum of about 312 thousand in the USA in the last update of this study's data on April 5, 2020 at 6:49 GMT. Further, the study countries also varied in infection and death rates, and the number of virus detection tests per million citizens. Tables (2) and (3) show that the "January-group" countries differed in average weather temperatures during the pandemic days until the fifth of April 2020. The average temperatures in these countries reached about 14.68°C with a minimum of -1.83 in Finland, and a maximum of 30.50 in Thailand.

[2] BBC News (2020), Coronavirus: **Italian economy takes a body blow**, available at: https://www.bbc.com/news/business-51650974, (Accessed: 3 April 2002)

[3] European Commission, **Internal Market, Industry, Entrepreneurship and SMEs,** Available at: https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/madrid, (Last accessed: 8 April, 2020)

[4] South China Morning Post (2020), **Why Wuhan is so important to China's economy and the potential impact of coronavirus**, Available at: https://www.scmp.com/economy/china-economy/article/3047426/explained-why-wuhan-so-important-chinas-economy-and-potential, (Accessed: 7 April, 2020)

[5] European Commission, **Internal Market, Industry, Entrepreneurship and SMEs,** Available at: https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/bavaria, (Last accessed: 7 April, 2020)

Table 1: Total cases and most effected cities in 24 countries that first experienced COVID-19 in January 2020

Countries	1st case	Days till 5th of April	Total cases	Cases per 1M	Most effected cites
USA	20/01/2020	76	311,637	941	New York
Spain	30/01/2020	66	126,168	2699	Madrid
Italy	29/01/2020	67	124,632	2061	Lombardy
Germany	26/01/2020	70	96,092	1147	Munich, Bavaria
France	23/01/2020	73	89,953	1378	Il de France; Paris
China	10/01/2020	86	81,669	57	Wuhan (Hubei)
UK	30/01/2020	66	41,903	617	London
S. Korea	19/01/2020	77	10,237	200	Daegu Metropolitan City
Sweden	30/01/2020	66	6,443	638	Stockholm
Australia	24/01/2020	72	5,635	221	New south wales; Sydney
Russia	30/01/2020	66	4,731	32	Mosco
Malaysia	24/01/2020	72	3,483	108	Selangor, Shah Alam
Japan	14/01/2020	82	3,139	25	Kanto; Tokyo
Philippines	29/01/2020	67	3,094	28	Manila
Thailand	12/01/2020	84	2,169	31	Bangkok
Finland	28/01/2020	68	1,927	348	Uusimaa
Singapore	22/01/2020	74	1,189	203	Singapore
Hong-Kong	22/01/2020	74	862	115	Hong Kong capital city-state
Taiwan	20/01/2020	76	363	15	Taipei
Vietnam	22/01/2020	74	240	2	Hanoi
Sri Lanka	26/01/2020	70	166	8	Sri Jayawardenepura Kotte
Cambodia	26/01/2020	70	114	7	Phnom Penh
Macao	21/01/2020	75	44	68	Municipality of Macau
Nepal	23/01/2020	73	9	0.3	Kathmandu

Sources: https://www.worldometers.info/ (Last accessed; 5th April, 2020, 06:49 GMT).

Table 2: COVID-19 spread indicators, Weather temperatures and median age in 24 countries that first experienced COVID-19 in January 2020

	days till 5th April, 2020(1)	Total cases (1)	Deaths per 1M (1)	Cases per 1M (1)	Weather temperature (2)	Median Age (3)	Population (M) (1)	Tests per 1M (1)
Average	72.67	38162.46	37.21	456.22	14.68	37.33	120.4929	4666
Minimum	66.00	9	0	0.30	-1.83	23.40	0.647194	52
Maximum	86.00	311637	256	2699.00	30.50	46.90	1432.789	12005

Sources:

1) https://www.worldometers.info/ (Last accessed; 5th April, 2020, 06:49 GMT).
2) https://www.accuweather.com
3) http://world.bymap.org/MedianAge.html, 2016 estimation, (last accessed 5th April, 2020).

Table 3: Average temperature and median age in 24 countries that first experienced COVID-19 in January 2020

Most effected cites	Temperature at [1]							Median Age[4]
	First case-day		February [2]		April 5, 2020		Monthly average temp. [3]	
	High	Low	High	Low	High	Low		
New York, USA	-1	-7	2	-3	11	5	1.8	37.9
Madrid, Spain	11	8	14	8	16	5	10.3	42.3
Lombardy, Italy	8	-2	13	0	17	4	6.7	45.1
Munich, Bavaria, Germany	9	-3	13	6	16	0	6.8	46.8
Il de France; Paris, France	4	-1	13	9	9	2	6.0	41.2
Wuhan (Hubei), China	8	0	13	4	13	6	7.3	37.1
London, England	12	5	10	3	8	2	6.7	40.5
Daegu Metropolitan City, S. Korea	9	-4	8	-2	18	4	5.5	41.2
Stockholm, Sweden	3	-2	5	-4	2	-4	0.0	41.2
New south wales; Sydney, Australia	32	22	29	19	26	20	24.7	36.8
Mosco, Russia	0	-1	1	-3	2	-4	-0.8	39.3
Selangor, Shah Alam, Malaysia	36	25	35	25	35	26	30.3	28.2
Kanto; Tokyo, Japan	14	5	11	5	10	8	8.8	46.9
Manila, Philippines	30	24	32	25	34	27	28.7	23.4
Bangkok, Thailand	34	26	35	25	36	27	30.5	37.2
Uusimaa, Finland	3	0	0	-9	2	-7	-1.8	42.4
Singapore, Singapore	32	26	31	26	35	27	29.5	34.3
Hong Kong capital city-state	19	14	26	17	21	20	19.5	44.0
Taipei, Taiwan	20	14	20	15	24	19	18.7	40.2
Hanoi, Vietnam	24	18	24	17	25	17	20.8	30.1
Sri Jayawardenepura Kotte, Sri Lanka	32	24	33	26	34	26	29.2	32.5
Phnom Penh, Cambodia	34	23	35	23	38	27	30.0	24.9
Municipality of Macau, Macao	22	15	21	14	20	18	18.3	38.7
Kathmandu, Nepal	18	2	23	7	29	11	15.0	23.6

Sources:

1) https://www.accuweather.com/en/es/madrid/308526/weather-forecast/308526
2) At the same first case-day, but in February
3) The mean of the lower and upper temperatures in six observations from the first case-day in January until 5th April, 2020
4) http://world.bymap.org/MedianAge.html, 2016 estimation, (last accessed 5th April, 2020).

On the other hand, it is clear from Table (2) that the median age in the "January-group" countries has reached about 37.33 years, with a minimum of 23.40 years in Philippines, and a maximum of 46.90 years in Japan.

4.2 Countries that reported the first case of COVID-19 in January 2020

It is clear from Table (4) that, unlike the "holy city of Qom" in Iran, the COVID-19 pandemic was mainly concentrated in the capitals of countries that witnessed the pandemic in February 2020.

Table 4: Total cases and most effected cities in 15 countries that first experienced COVID-19 in February 2020

Countries	1st case	Days till 5th of April	Total cases	Cases per 1M	Most effected cites
Iran	18/02/2020	47	55,743	664	Qom
Switzerland	24/02/2020	41	20,505	2,369	Bern
Belgium	03/02/2020	62	18,431	1,590	Brussel
Holland	26/02/2020	39	16,627	970	Amsterdam
Austria	24/02/2020	41	11,781	1,308	Vienna
Brazil	24/02/2020	41	10,360	49	Brasilia
Israel	20/02/2020	45	8,018	926	Tal Aviv
Norway	25/02/2020	40	5,550	1,024	Oslo
Ireland	28/02/2020	37	4,604	932	Dublin
Czech R.	29/02/2020	36	4,475	418	Prague
Denmark	26/02/2020	39	4,077	704	Copenhagen
Argentina	02/02/2020	63	1,451	32	Buenos Aires
Egypt	13/02/2020	52	1,070	10	Cairo
Iraq	21/02/2020	44	878	22	Baghdad
Lebanon	20/02/2020	45	520	76	Beirut

Sources: https://www.worldometers.info/ (Last accessed; 5th April, 2020, 06:49 GMT).

It appears from Tables (4), (5) that despite the participation of all countries in this group at the beginning of the pandemic in February 2020, however, these countries also varied in the number of cases of COVID-19, which averaged about 10.94 thousand cases, with a minimum of only 520 cases in the case of Lebanon, and about 55.74 thousand in Iran as a maximum on the fifth of April 2020 at 6:49 GMT. The countries of this group also varied in infection and death rates, and the number of COVID-19 detection tests per million citizens.

Tables (5) and (6) show that the countries that witnessed the pandemic in February differed in the average weather temperatures during the pandemic days until the fifth of April 2020. The average temperatures in these countries reached about 12.34 degrees Celsius, with a minimum of 3.50 in Norway, and a maximum 24.50 in Argentina. On the other hand, Table (5) shows that the median age in the countries of this group reached 34.96 years, with a minimum of 19.90 years in Iraq, and a maximum of 43.80 years in Austria.

Table 5: COVID-19 spread indicators, Weather temperatures and median age in 15 countries that first experienced COVID-19 in February 2020

	days till 5th April, 2020 (1)	Total cases (1)	Deaths per 1M (1)	Cases per 1M (1)	Weather temperature (2)	Median Age (3)	Population (M) (1)	Tests per 1M (1)
Average	44.80	10939.33	28.72	739.6	12.34	34.96	38.43	6409.73
Minimum	36	520	0.1	10	3.50	19.90	4.94	188
Maximum	63	55743	111	2369	24.50	43.80	211.43	19528

Sources:

1) https://www.worldometers.info/ (Last accessed; 5th April, 2020, 06:49 GMT).
2) https://www.accuweather.com
3) http://world.bymap.org/MedianAge.html, 2016 estimation, (last accessed 5th April, 2020).

Table 6: Average temperature and median age in 15 countries that first experienced COVID-19 in February 2020

Most effected cites	Temperature at (1) First case-day High	First case-day Low	February (2) High	February (2) Low	April 5, 2020 High	April 5, 2020 Low	Median Age(4) First case-day High	Most effected cites February (2) Low
Qom	16	1	21	11	20	8	12.83	29.2
Bern	9	2	18	2	18	-2	7.83	42.2
Brussel	11	6	8	2	22	5	9.00	41.1
Amsterdam	7	2	11	1	20	5	7.67	42.5
Vienna	10	4	8	-3	17	-1	5.83	43.8
Brasilia	26	21	25	20	31	22	24.17	31.6
Tal Aviv	14	8	8	5	28	12	12.50	29.7
Oslo	1	-4	9	2	10	3	3.50	39.1
Dublin	13	3	9	4	15	6	8.33	36.4
Prague	8	-1	8	-1	16	5	5.83	41.7
Copenhagen	7	3	8	2	11	5	6.00	42.0
Buenos Aires	32	22	31	24	24	14	24.50	31.5
Cairo	24	13	18	13	29	15	18.67	23.8
Baghdad	23	7	22	8	30	18	18.00	19.9
Beirut	17	14	13	9	16	34	17.17	29.9

Sources:

1) https://www.accuweather.com/en/es/madrid/308526/weather-forecast/308526
2) At the same first case-day, but in February
3) The mean of the lower and upper temperatures in six observations from the first case-day in January until 5th April, 2020
4) http://world.bymap.org/MedianAge.html, 2016 estimation, (last accessed 5th April, 2020).

5. Results

5.1 Relationship between COVID-19 cases per million and temperature in "January-group" countries

The exponential function was suggested as in equation (1) to represent the relationship between the number of COVID-19 cases per million as a proxy of transmission as a dependent variable (y), and the weather temperature as an independent variable (x).

$$y_i = \alpha e^{\beta Xi} \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where:

y_i: Number of cases of COVID-19 in country i.

α, β: The model parameters

x_i: Average temperature in the country "i" since the beginning of the first case in January 2002, and until the fifth of April 2020.

Taking the natural logarithm of both sides of equation (1), the following equivalent equation can be obtained:

$$ln\ y_i = \ln \alpha + \beta x_i \ldots\ldots\ldots\ldots\ldots (2)$$

Where it was possible by converting to equation (2), obtaining a formula for a linear regression model, to which the error component ε can be added, to become as follows:

$$y'_i = \alpha' + \beta x_i + \varepsilon \ldots\ldots\ldots\ldots (3)$$

By applying the non-linear least square method using the mathematical formula as in equation (3), the relationship parameters between the total number of COVID-19 cases in the "January-group" countries, and weather temperatures were estimated as in table (7).

Table 7: Regression model between COVID-19 cases and weather temperature in countries that first experienced COVID-19 in January 2020

Parameters	Values
No. of observations	24
Adjusted R Square	0.0798
F	1.91
Probability > F	0.1810
Intercept (Standard Error)	5.4586 (1.6039)
P-value	0.181
Temperature (X) (Standard Error)	-0.12081 (0.0874)
P-value	0.003

Sources: Tables (1) and (3), Using STATA 13.1.

The results in table (7) showed an inverse relationship between the number of cases of COVID-19 per million and temperatures in this group of countries, despite the lack of statistical significance for this relationship.

5.2 Relationship between COVID-19 cases per million and median age in "January-group" countries

Utilizing the same exponential formula previously described in equations (1, 2, and 3), it was possible to estimate the parameters of the relationship between COVID-19 cases per million and the median age as in Table (8).

Where the results revealed a positive non-statistically significant relationship between COVID-19 cases per million and median age in "January-group" countries.

Table 8: Regression model between COVID-19 cases and median age in 24 countries that first experienced COVID-19 in January 2020

Parameters	Values
No. of observations	24
Adjusted R Square	0.0373
F	1.89
Probability > F	0.1828
Intercept (Standard Error)	-3.56608 (5.3578)
P-value	0.513
Median age (X) (Standard Error)	0.19425 (0.1412)
P-value	0.183

Sources: Tables (1) and (3), Using STATA 13.1.

5.3 Relationship between COVID-19 cases per million and temperature in "February-group" countries

As well, employing the same exponential formula previously described in equations (1, 2, and 3), the parameters of the relationship between COVID-19 cases per million and temperature was estimated as in Table (9). Where the results revealed a reverse statistically significant relationship between COVID-19 cases per million and temperature in "February-group" countries.

Substitution by the model (2) parameters as in table (9):

$$lny_i = 8.466 - 0.222\, x_i \ldots\ldots\ldots\ldots (4)$$

Applying e on both sides:

$$y_i = (e^{-0.222})^x + e^{8.466} = EXP\,(-0.222)^x + EXP\,(8.466) \ldots\ldots\ldots\ldots (5)$$

Equation (5) can be used for predicting the development of COVID-19 cases numbers in light of temperature as shown in Appendix (1).

Table 9: Regression model between COVID-19 cases and temperature in 15 countries that first experienced COVID-19 in February 2020

Parameters	Values
No. of observations	15
Adjusted R Square	0.6599
F	18.17
Probability > F	0.0001
Intercept (Standard Error)	8.46565 (0.5812)
P-value	0.000
Median age (X) (Standard Error)	-0.22152 (0.0417)
P-value	0.000

Sources: Tables (4) and (6), Using STATA 13.1.

5.4 Relationship between COVID-19 cases per million and temperature in "February-group" countries

The same manner, using the same exponential formula previously described in equations (1, 2, and 3), the relationship between COVID-19 cases per million and median age was estimated as in Table (10).

Table 10: Regression model between COVID-19 cases and temperature in 15 countries that first experienced COVID-19 in February 2020

Parameters	Values
No. of observations	15
Adjusted R Square	0.5969
F	21.73
Probability > F	0.0004
Intercept (Standard Error)	-0.80334 (1.4320)
P-value	0.584
Median age (X) (Standard Error)	0.18691 (0.0410)
P-value	0.000

Sources: Tables (4) and (6), Using STATA 13.1.

Where the results revealed a positive statistically significant relationship between COVID-19 cases per million and median age in "February-group" countries.

Substitution by the model (2) parameters as in table (10):

$$lny_i = -0.803 + 0.187\, x_i \ldots\ldots\ldots\ldots (6)$$

Applying e on both sides:

$$y_i = (e^{0.187})^x + e^{(-0.803)} = EXP\ (0.187)^x + EXP\ (-0.803) \ldots\ldots\ldots\ldots (7)$$

Furthermore, Equation (7) can be used for predicting the development of COVID-19 cases numbers in light of median age as shown in Appendix (2).

6. Discussion

Although the results of the study show that COVID-19 cases per million have increased in countries that have lower weather temperature, as well in countries have higher median age. However, this relationship is not absolute, but rather is related to the number of days since the first case appeared. Where the lower the time from the pandemic starting day, the higher the impact of temperature and median age on the transmission rates. In other words, temperature and median age affect COVID-19 transmission in its early stages, but when cases per million reach a critical mass after successive exponential increase, these two factors no longer have significant influence on the pandemic transmission.

Besides temperature and median age, there are other important factors that have worsened the situation in countries that were heavily invaded by COVID-19, such as the USA, Spain, and Italy, such as the delay in applying mitigation measures for instance. On the contrary to similar countries in terms of temperature at the earliest time of the pandemic i.e. China and South Korea or even Japan that have the higher median age among all the thirty-nine countries in this study, and managed to flatten the exponential growth curve of the pandemic by distinguished mechanisms of early mitigation measures they have applied and utilization of big data techniques in containing the pandemic from its primarily sources.

Referring to the prediction appendices numbers (1), (2), it turns out from table (11) that the number of COVID-19 cases per million in Iran, Switzerland, Belgium, and Israel were higher than its expected values, whether in terms of temperature or median age. As for Norway and Ireland, the registered cases per million were higher than expected in terms of median age, although they were lower than expected as regards to temperature. On the other hand, COVID-19 cases per million in Austria, Czech Republic, Denmark, Egypt and Lebanon were lower than expected in light of both temperature and median age. Almost in like manner, the pandemic cases per million in Netherlands, Brazil, and Argentina were lower than expected pertaining to median age, although these rates were

slightly higher than expected as far as temperature. As for Iraq, COVID-19 cases per million were lower than expected in the light of temperature, although these rates were slightly higher than expected according to the median age.

Table 11: Observed and estimated COVID-19 cases per million in terms of temperature and median age in the "February-group" countries*

Countries	Temperature	Median age	Observed COVID-19 cases per 1M	Estimated COVID-19 cases per 1M, in terms of	
				Temp.	M. age
Iran	12.83	29.2	664	313	102
Switzerland	7.83	42.2	2,369	941	1154
Belgium	9.00	41.1	1,590	770	955
Holland	7.67	42.5	970	921	1163
Austria	5.83	43.8	1,308	1456	1661
Brazil	24.17	31.6	49	28	175
Israel	12.50	29.7	926	411	121
Norway	3.50	39.1	1,024	2044	658
Ireland	8.33	36.4	932	1001	378
Czech R.	5.83	41.7	418	1456	1141
Denmark	6.00	42	704	1498	1149
Argentina	24.50	31.5	32	29	174
Egypt	18.67	23.8	10	83	40
Iraq	18.00	19.9	22	104	19
Lebanon	17.17	29.9	76	131	122

Sources: Author, Tables (4, 6) and Tables (1, 2-Annex).

* For April 5, 2020

Observed cases / million is less than estimated

Observed cases / million is slightly higher than estimated

Observed cases / million is higher than estimated

This study's results assume that the data provided by countries to the international organizations are correct and accurate. But in case of assuming that the differences between the observed and expected COVID-19 cases in Table (11) are due to underestimation or underreporting, the number of expected total cases per million in some of these countries can be estimated as in table (12).

Generally, the results of this study may raise the question about the extent of the specialty of COVID-19, and its focus on geographical areas in which the major industrial countries concentrate, especially the economic and financial centers. It's highly recommended that the relationship between COVID-19 cases per million and temperature and median age to be estimated at different time periods thereafter, in order to monitor the

phenomenon at other time periods, either in later stages or more early than that observed in this study.

Table 12: Observed and estimated total COVID-19 cases in some "February-group" countries on April 5, 2020

Countries	Total COVID-19 observed cases	Total COVID-19 estimated cases	
		Minimum	Maximum
Netherlands	16,627	NA	19930
Austria	11,781	13110	14964
Norway	5,550	NA	11078
Ireland	4,604	4943	NA
Czech R.	4,475	12213	15583
Denmark	4,077	6654	8675
Argentina	1,451	NA	7900
Egypt	1,070	4244	8832
Iraq	878	NA	4151
Lebanon	520	832	898

Sources: Author, Tables (4 and 11).

7. Conclusion

There are several factors that affect the increasingly transmission of COVID-19, among these factors are the decrease in weather temperature and the increase in the median age of the population. Although, temperature and median age may affect the rates of COVID-19 prevalence in its early stages, but when cases per million reach a critical mass after successive exponential increase, these two factors no longer have significant influence on the pandemic transmission.

8. References

(WHO), W. H. (2020-1). *Coronavirus disease 2019 (COVID-19): WHO Thailand Situation Report- 23 March 2020.* Geneva: WHO.

(WHO), W. H. (2020-2). *Report on the WHO-China Joint Mission on Coronavirus Disease 2019 (COVID-19).* Geneva: WHO.

Altamimi, A., & Ahmd, E. A. (2019). Climate Factors and Incidence of Middle East Respiratory Syndrome Coronavirus. *Journal of Infection and Public Health*.

Casanova, L. M., Jeon, S., Rutala, W. A., Weber, D. J., & Sobsy, M. D. (2010). Effects of Air Temperature and Relative Humidity on Coronavirus Survival on Surfaces. *Applied and Environmental Microbiology*, 2712-2717.

Chan, H. K., Peiris, J. M., Poon, L. M., & Seto, H. W. (2011). The Effects of Temperature and Relative Humidity on the Viability of the SARS Coronavirus. *Advances in Virology*.

Gundy, P., & Gebra, C. (2009). Survival of Coronavirus in Water and Wastewater. *Food Environ Virol, 1:10*(14).

Hansen, B. E. (2000). *Econometrics.* Wisconsion: University of Wisconsion .

Kassem, A. Z. (2020). *"COVID-19" in the World and Egypt: Population Pyramids and Recovery Rates.* DOI: 10.13140/RG.2.2.25449.24169/5.

Ropert Koch Institut. (2020). *Coronavirus Disease 2019 (COVID-19): Daily Situation Report of the Ropert Kock Institut.* Available at: https://www.rki.de.

Sajadi, M., & et. al. (2020). Temperature, Humidity and latitude analysis to predict potential sread and seasonality for COVID-19. *Available at: http://ssrn.com/abstract=3550308*.

Wang, J., Tang, K., Feng, K., & Lv, W. (2020). High Temperature and high Humidity Reduce the Transmission of COVID-19.

Wang, J., Tang, K., Feng, K., & Lv, W. (April 3, 2020). High Temperature and high Humidity Reduce the Transmission of COVID-19.

Wei, L., & Lessler, J. (2020). *Epidemiology and Transmission of COVID-19 in Shenzhen China: Analysis of 391 cases and 1286 of thier contacts.* http://researchgate.net/publication/339716563_Epidemiology_ and _Transmission _of _COVID-19 _in_ Shenzhen _China_ Analysis _of _391 _cases_ and _1286_ of_ thier_ contacts.

Electronic sources:

(ACCUWEATHER) https://www.accuweather.com

BBC News (2020), Coronavirus: Italian economy takes a body blow**, available at: https://www.bbc.com/news/business-51650974, (Accessed: 3 April 2002)**

(CITYPOPULATION) https://www.citypopulation.de

European Commission, **Internal Market, Industry, Entrepreneurship and SMEs,** Available at: https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/ile-de-france, (Last accessed: 7 April, 2020)

European Commission, **Internal Market, Industry, Entrepreneurship and SMEs,** Available at: https://ec.europa.eu/growth/tools-databases/regional-innovation-monitor/base-profile/bavaria, (Last accessed: 7 April, 2020)

Eurostat, **First population estimates: EU population up to over 513 million on 1 January 2019 More death than birth,** (Brussels, Eurostat News release, 114/2019, 10 July 2019), available at: https://ec.europa.eu/eurostat/documents/2995521/9967985/3-10072019-BP-EN.pdf/e152399b-cb9e-4a42-a155-c5de6dfe25d1

Organization of Economic Cooperation and Development (OCED), **Lombardy, Italy**, (Paris, OCED, without year), available at: https://www.oecd.org/fr/sites/eduimhe/49008527.pdf

South China Morning Post (2020), **Why Wuhan is so important to China's economy and the potential impact of coronavirus**, Available at: https://www.scmp.com/economy/china-economy/article/3047426/explained-why-wuhan-so-important-chinas-economy-and-potential, (Accessed: 7 April, 2020)

(WORLDMETERS) https://worldpopulationreview.com

(WORLDPOPULATIONREVIEW) https://worldpopulationreview.com/world-cities/madrid-population/

(WORLD.BYMAP), http://world.bymap.org/MedianAge.html

Appendices

*Appendix (1): Prediction table of COVID-19 cases per million and temperature after 44.80 days of COVID-19 pandemic**

Temp. °c	Cases per 1M	Temp. °c	Cases per 1M	Temp. °c	Cases per 1M
-5	17223	13	317	31	6
-4	13794	14	254	32	5
-3	11048	15	203	33	4
-2	8848	16	163	34	3
-1	7087	17	130	35	2
0	5676	18	104	36	2
1	4546	19	84	37	2
2	3641	20	67	38	1
3	2916	21	54	39	1
4	2336	22	43	40	1
5	1871	23	34	41	1
6	1498	24	28	42	1
7	1200	25	22	43	0.4
8	961	26	18	44	0.3
9	770	27	14	45	0.3
10	616	28	11	46	0.2
11	494	29	9	47	0.2
12	395	30	7	48	0.1

Sources: Author, Table (6) and equation (5).

* For a community with an average population of 38.43 million and an average age of 34.96 years.

*Appendix (2): Prediction table of COVID-19 cases per million and median age after 44.80 days of COVID-19 pandemic**

M. age	Cases per 1M	M. age	Cases per 1M	M. age	Cases per 1M
20	19	31	147	42	1149
21	23	32	177	43	1385
22	27	33	214	44	1669
23	33	34	258	45	2013
24	40	35	310	46	2426
25	48	36	374	47	2925
26	58	37	451	48	3526
27	70	38	544	49	4250
28	84	39	656	50	5124
29	101	40	790	51	6177
30	122	41	953	52	7446

Sources: Author, Tables (6) and equation (7).

* For a community with an average population of 38.43 million and an average temperature of 12.34 °c.