Correlation between the migration scale index and the number of new confirmed Novel Coronavirus Pneumonia cases in China

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Abstract

Background: In late December, 2019, patients of atypical pneumonia due to an unidentified microbial agent were reported in Wuhan, Hubei Province, China. Subsequently, a novel coronavirus was identified as the causative pathogen which was named 2019 novel coronavirus (2019-nCoV). As of Feb 12, 2020, more than 44,000 cases of 2019-nCoV infection have been confirmed in China and continue to expand. Provinces, municipalities and autonomous regions of China have launched first-level response to major public health emergencies one after another from Jan 23, 2020, which means restricting movement of people among provinces, municipalities and autonomous regions. The aim of this study was to explore the correlation between the migration scale index and the number of confirmed Novel Coronavirus Pneumonia (NCP) cases and to depict the effect of restricting population movement.

Methods: Excel 2010 was used to demonstrate the temporal distribution at the day level and SPSS 23.0 was used to analyze the correlation between the migration scale index and the number of confirmed NCP cases.

Results: Since January 23, 2020, Wuhan migration scale index has dropped significantly and since January 26, 2020, Hubei province migration scale index has dropped significantly. New confirmed NCP cases per day in China except Wuhan gradually increased since January 24, 2020, and showed a downward trend from February 6, 2020. New confirmed NCP cases per day in China except Hubei province gradually increased since January 24, 2020, and maintained at a high level from January 24, 2020 to February 4, 2020, then showed a downward trend. Wuhan emigration scale index from January 9 to January 22, January 10 to January 23 and January 11 to January 24 was correlated with the number of new confirmed NCP cases per day in China except Wuhan from January 22 to February 4. Hubei province emigration scale index from January 10 to January 23 and January 11 to January 24 was correlated with the number of new confirmed NCP cases per day in China except Hubei province from January 22 to February 4.

Conclusions: People who left Wuhan from January 9 to January 22 may lead to the outbreak in China except Wuhan and people who left Hubei province from January 10 to January 24 may lead to the outbreak in China except Hubei province. "Wuhan lockdown" and Hubei province launching first-level response to major public health emergencies may have had a good effect the control NCP epidemic. Because there were still new confirmed NCP cases in China except Wuhan and in China except Hubei province and this may indicate that the occurrence of second-generation cases.

Background

On Dec 31, 2019, Wuhan, China reported an outbreak of atypical pneumonia caused by the 2019 novel coronavirus (2019-nCoV) and cases have been exported to other Chinese provinces, as well as internationally^[1]. The atypical pneumonia caused by 2019-nCoV has been tentatively named as Novel

Coronavirus Pneumonia(NCP)^[2] and the World Health Organization named the disease coronavirus disease 2019 (abbreviated “COVID–19”) on February 11, 2020^[3].

The virus has spread to all prefectures of Hubei province outside Wuhan and all provinces of China have also reported cases outside of Hubei province. Currently, most cases are related to Wuhan and others were caused by patients from Wuhan^[4].

Following the confirmed NCP cases reported in Zhejiang province, Guangdong province, Shanghai and other provinces in China reported NCP cases one after another from January 20, 2020.

In order to control the epidemic of NCP, Wuhan Municipal People’s Government issued a notice saying that citizens should not leave Wuhan for no special reason and the airport and train station from Wuhan corridor were temporarily closed from January 23, 2020 which called “Wuhan lockdown”. In addition, Wuhan’s urban bus, subway, ferry, and long-distance passenger transportation were suspended^[5]. Zhejiang province launched first-level response to major public health emergencies from Jan 23.2020 and subsequently other provinces,municipalities and autonomous regions in China launched first-level response to major public health emergencies one after another, which means movement of people among provinces, municipalities and autonomous regions were restricted^[6].

Migration scale index reflects the scale of the population migration from a city or a province, which can be compared horizontally among cities or provinces ^[7].

To explore the correlation between migration scale index and the number of confirmed NCP cases, we conducted this study. At the same time, we depict the effect of “Wuhan lockdown” and Hubei province launching first-level response to major public health emergencies on the control of NCP epidemic.

Methods

Data Sources

Data of confirmed NCP cases were extracted from the official websites of National Health Commission of the People’s Republic of China and Health Committee of provinces. Data of migration scale index were extracted from Baidu migration (<http://qianxi.baidu.com/>). The migration scale indexes of Wuhan and Hubei province from January 1, 2020 to February 12, 2020 were used in this study.

Case Definition

The diagnosis of NCP is based on the Diagnosis and treatment plan of pneumonia caused by novel coronavirus (trial version 5) established by National Health Commission of the People’s Republic of China ^[8].

Pearson correlation analysis

SPSS 23.0 software was used for Pearson correlation analysis and the significance level used was $p \leq 0.05$. Based on the incubation period of illness from MERS and SARS coronaviruses, CDC believes that symptoms of 2019-nCoV infection occur within 2 to 14 days following infection^[9]. The Diagnosis and treatment plan of pneumonia caused by novel coronavirus (trial version 5) says the longest incubation period of NCP was 14 days^[8] and due to the lag effect NCP onset, we used 14 days' emigration scale data from January 1, 2020 to February 2, 2020 and new confirmed cases per day to analyze the correlation. Considering that NCP originated from Wuhan who is the capital city of Hubei province, then spread to Hubei province, an outbreak occurred in Hubei province^[4] and following the confirmed NCP cases reported in Zhejiang province, Guangdong province, Shanghai and other Chinese provinces reported NCP cases one after another from January 20, 2020. Therefore, we made two Pearson correlation analyses. They were Pearson correlation analysis between Wuhan migration scale index and the number of new confirmed NCP cases in China except Wuhan from January 20 to February 2 and Pearson correlation analysis between Hubei province migration scale index and the number of new confirmed NCP cases in China except Hubei province from January 20 to February 2.

Results

Temporal Pattern

Since January 23, 2020, Wuhan migration scale index has dropped significantly and since January 26, 2020, Hubei province migration scale index has dropped significantly. New confirmed NCP cases per day in China except Wuhan gradually increased since January 24, 2020, and showed a downward trend from February 6, 2020. New confirmed NCP cases per day in Wuhan continued to increase since January 27, 2020, and maintained at a high level without a downward trend. New confirmed NCP cases per day in China except Hubei province gradually increased since January 24, 2020, and maintained at a high level from January 24, 2020 to February 4, 2020, then showed a downward trend. New confirmed NCP cases per day in Hubei province continued to increase since January 24, 2020, and maintained at a high level without a downward trend (Table 1 and Table 2, Figure 1 and Figure 2).

Pearson correlation analysis

Wuhan emigration scale index from January 9 to January 22, January 10 to January 23 and January 11 to January 24 was correlated with the number of new confirmed NCP cases per day in China except Wuhan from January 20 to February 2. Hubei province emigration scale index from January 10 to January 23 and January 11 to January 24 was correlated with the number of new confirmed NCP cases per day in China except Hubei province from January 20 to February 2 (Table 3).

Discussion

In December 2019, a cluster of acute respiratory illness, now known as novel coronavirus pneumonia (NCP), occurred in Wuhan, Hubei Province, China^[10–14]. The disease has rapidly spread from Wuhan to

other areas. As of Feb 12, 2020, a total of 44763 NCP cases in China have been confirmed. Internationally, cases have been reported in 24 countries and 5 continents^[15]. While the origin of the 2019-nCoV is still being investigated, current evidence suggests spread to humans occurred via transmission from wild animals illegally sold in the Huanan Seafood Wholesale Market^[16].

The 2019-nCoV has impacted multiple countries, caused severe illness, and sustained person-to-person transmission making it a concerning and serious public health threat^[9]. Previous study suggested that rapid person-to-person transmission of 2019-nCoV may have occurred^[17].

However, how easily the virus is transmitted between persons is currently unclear^[16].

January 24, 2020 is the Chinese New Year. It is a tradition for Chinese people that migrant workers return home before the Spring Festival. According to the mayor of Wuhan, more than five million people have left the city because of the Spring Festival and the outbreak of NCP^[18].

To control the epidemic of NCP, Wuhan Municipal People's Government issued a notice saying that citizens should not leave Wuhan for no special reason and the airport and train station from Wuhan corridor were temporarily closed from January 23, 2020 which we called "Wuhan lockdown". In addition, Wuhan's urban bus, subway, ferry, and long-distance passenger transportation were suspended^[5]. Subsequently, Hubei province launched first-level response to major public health emergencies, which means movement of people among provinces, municipalities and autonomous regions were restricted^[6]. Our study found that Wuhan migration scale index has dropped significantly since "Wuhan lockdown" and Hubei province migration scale index has dropped significantly since Hubei province launching first-level response to major public health emergencies.

Our study also found that Wuhan emigration scale index from January 9 to January 22, January 10 to January 23 and January 11 to January 24 was correlated with the number of new confirmed NCP cases per day in China except Wuhan from January 20 to February 2. This suggests that people who left Wuhan from January 9 to January 24 may lead to the outbreak in China except Wuhan. Meanwhile, our study found that Hubei province emigration scale index from January 10 to January 23 and January 11 to January 24 was correlated with the number of new confirmed NCP cases per day in China except Hubei province from January 20 to February 2. This suggests that people who left Hubei province from January 10 to January 24 may lead to the outbreak in China except Hubei province.

Calculated on January 24, 2020, after a long incubation period is February 7, 2020. Our study found that new confirmed NCP cases per day in China except Wuhan showed a downward trend from February 6, 2020 and new confirmed NCP cases per day in China except Hubei province showed a downward trend from February 4, 2020. This may indicate that "Wuhan lockdown" and Hubei province launching first-level response to major public health emergencies have had a good effect on the control NCP epidemic. This may also indicate that the occurrence of second-generation cases because there were still new confirmed NCP cases in China except Wuhan and in China except Hubei province after February 7, 2020.

In spite of the above findings, the limitations in our study should be considered. First, the emigration scale of Wuhan and Hubei province should include migration to other countries. However our study only included the number of new NCP cases in China (including Hong Kong, Macau and Taiwan) and didn't include the number of new NCP cases abroad. Secondly, the number of onset per day should be used in the natural process of disease research. However, the number of new confirmed NCP cases per day was used in this study. Thirdly, we did not explore the correlation between the number of moving into each province from Wuhan or Hubei and the number of new confirmed NCP cases in each province, we will do further work to explore the correlation between the number of moving into each province from Wuhan or Hubei and the number of new confirmed NCP cases in each province.

Conclusions

Our study found that people who left Wuhan from January 9 to January 22 may lead to the outbreak in China except Wuhan and people who left Hubei province from January 10 to January 24 may lead to the outbreak in China except Hubei province. "Wuhan lockdown" and Hubei province launching first-level response to major public health emergencies may have had a good effect the control NCP epidemic. Because there were still new confirmed NCP cases in China except Wuhan and in China except Hubei province and this may indicate that the occurrence of second-generation cases.

Abbreviations

NCP: Novel Coronavirus Pneumonia; COVID-19: Coronavirus Disease 2019.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

The datasets used and analyzed during the current study is available from the corresponding author Huijie Chen(E-mail:chj1317@126.com) on reasonable request.

Competing Interests

The authors declare that they have no conflict of interest.

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Authors' Contributions

Conceived and designed the experiments: HC, YC, BS. Performed the experiments: HC, YC, ZI, LW,PW. Analyzed the data: HC, YC, YL, YQ, SZ. Collect the data: HC, SZ, LZ, XY, FL. Wrote the paper: HC,YC. All authors read and approved the final manuscript.

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Tables

Table 1 Wuhan emigration scale index and new confirmed NCP cases in Wuhan and in China except Wuhan

	Wuhan emigration scale index	New confirmed NCP cases in Wuhan	New confirmed NCP cases in China except Wuhan
1- Jan	3.46		
2- Jan	3.52		
3- Jan	5.52		
4- Jan	6.10		
5- Jan	5.32		
6- Jan	5.60		
7- Jan	6.41		
8- Jan	7.34		
9- Jan	8.14		
10- Jan	6.62		
11- Jan	7.56		
12- Jan	6.22	41	
13- Jan	5.76	0	
14- Jan	5.46	0	
15- Jan	5.91	0	
16- Jan	6.00	0	
17- Jan	6.44	4	
18- Jan	7.71	17	
19-	7.41	59	

Jan			
20-Jan	8.31	77	21
21-Jan	10.74	60	77
22-Jan	11.84	105	33
23-Jan	11.14	81	80
24-Jan	3.89	51	202
25-Jan	1.30	77	405
26-Jan	0.66	46	640
27-Jan	0.43	80	705
28-Jan	0.32	892	897
29-Jan	0.26	315	1053
30-Jan	0.24	356	1477
31-Jan	0.24	378	1603
1-Feb	0.24	576	1503
2-Feb	0.46	894	1705
3-Feb	0.21	1033	2533
4-Feb	0.23	1242	1225
5-Feb	0.28	1967	1645
6-Feb	0.28	1766	2229
7-Feb	0.27	1501	1631

8-Feb	0.28	1985	1418
9-Feb	0.29	1379	1244
10-Feb	0.27	1920	1054
11-Feb	0.27	1552	931
12-Feb	0.29	1104	915

Table 2 Hubei province emigration scale index and new confirmed NCP cases in Hubei province and in China except Hubei province

	Hubei province emigration scale index	New confirmed NCP cases in Hubei province	New confirmed NCP cases in China except Hubei province
1- Jan	2.56		
2- Jan	3.13		
3- Jan	4.26		
4- Jan	4.88		
5- Jan	4.58		
6- Jan	4.67		
7- Jan	5.11		
8- Jan	5.77		
9- Jan	6.32		
10- Jan	5.30		
11- Jan	5.16		
12- Jan	4.69	41	
13- Jan	4.69	0	
14- Jan	4.60	0	
15- Jan	4.86	0	
16- Jan	4.85	0	
17- Jan	5.10	4	
18- Jan	5.42	17	
19-	5.49	59	

Jan			
20-Jan	6.03	77	21
21-Jan	7.21	60	65
22-Jan	6.80	105	33
23-Jan	6.21	69	92
24-Jan	4.59	105	148
25-Jan	4.39	180	302
26-Jan	5.20	329	357
27-Jan	1.98	365	420
28-Jan	0.87	1291	498
29-Jan	0.54	840	528
30-Jan	0.40	1032	801
31-Jan	0.37	1220	761
1-Feb	0.33	1347	732
2-Feb	0.48	1921	678
3-Feb	0.34	2103	743
4-Feb	0.32	2345	842
5-Feb	0.31	3156	752
6-Feb	0.31	2987	712
7-Feb	0.30	2447	685

8-Feb	0.31	2841	562
9-Feb	0.32	2147	476
10-Feb	0.33	2531	443
11-Feb	0.32	2097	386
12-Feb	0.34	1638	381

Table 3 Pearson correlation analysis between migration scale index and the number of new confirmed NCP cases

Date range	r value ^a	<i>p</i> ^a	r value ^b	<i>p</i> ^b
1 Jan-14 Jan	0.484	0.080	0.526	0.053
2 Jan-15 Jan	0.256	0.377	0.301	0.296
3 Jan-16 Jan	-0.041	0.889	0.019	0.947
4 Jan-17 Jan	-0.186	0.524	-0.195	0.505
5 Jan-18 Jan	-0.034	0.909	-0.222	0.446
6 Jan-19 Jan	-0.043	0.884	-0.257	0.375
7 Jan-20 Jan	0.142	0.628	-0.121	0.681
8 Jan-21 Jan	0.443	0.113	0.217	0.457
9 Jan-22 Jan	0.642	0.013*	0.489	0.076
10 Jan-23 Jan	0.839	0.000*	0.821	0.000*
11 Jan-24 Jan	0.545	0.044*	0.763	0.002*
12 Jan-25 Jan	0.190	0.515	0.522	0.056
13 Jan-26 Jan	-0.170	0.561	0.304	0.291
14 Jan-27 Jan	-0.463	0.095	-0.156	0.595
15 Jan-28 Jan	-0.639	0.014	-0.412	0.143
16 Jan-29 Jan	-0.745	0.002	-0.599	0.024
17 Jan-30 Jan	-0.812	0.000	-0.809	0.000
18 Jan-31 Jan	-0.858	0.000	-0.899	0.000
19 Jan-1 Feb	-0.846	0.000	-0.944	0.000
20 Jan-2 Feb	-0.785	0.001	-0.942	0.000

Note: “a” refer to Pearson correlation analysis between Wuhan emigration scale index and the number of new confirmed NCP cases in China except Wuhan per day from 20 Jan to 2 Feb.

“b”refer to Pearson correlation analysis between Hubei province emigration scale index and the number of new confirmed NCP cases in China except Hubei province per day from 20 Jan to 2 Feb.

“*” means significant at the level of $p < 0.05$.

Figures

Figure 1. Temporal distribution of Wuhan emigration scale index and new confirmed NCP cases in Wuhan and in China except Wuhan

Figure 1

Figure 1. Temporal distribution of Wuhan emigration scale index and new confirmed NCP cases in Wuhan and in China except Wuhan

Figure 2. Temporal distribution of Hubei province emigration scale index and new confirmed NCP cases in Hubei province and in China except Hubei province

Figure 2

Figure 2.Temporal distribution of Hubei province emigration scale index and new confirmed NCP cases in Hubei province and in China except Hubei province

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