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A Study on the Establishment of a New Quarantine System in the COVID-19 Era

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Abstract

Currently, the cumulative number of confirmed cases from the coronavirus in Korea is 30.17 million, and the cumulative number of deaths also reaches 33,444 (as of January 31, 2023). Therefore, this study aims to conduct an empirical analysis on the establishment of quarantine systems in major domestic cities as it is necessary to analyze the influencing factors of COVID-19 and discuss policy directions necessary to establish an effective quarantine system in the future. Among them, 16 cities in Korea with a relatively weak quarantine infrastructure were compared with the interrelationship between "number of upper-level hospitals", "number of urban populations", "number of infected", and "number of deaths", and ultimately the results of quarantine for each local government.

In conclusion, the average population of 16 cities is 0.792 million, and the average number of infected people is 0.458 million, and the average cumulative infection rate is 57.8%. Seven cities exceed the average cumulative infection rate: Suwon (61.6%), Yongin (59.1%), Seongnam (61.8%), Hwaseong (65.6%), Anyang (60.7%), Cheonan (62.9%), and Jeonju (62.9%). In addition, despite the establishment of excellent treatment facilities in the city (ave=0.0129), the ratio of "accumulated deaths" (ave=0.11%) was high in Changwon (0.12%/0.0193), Ansan (0.12%/0.0138), Cheongju (0.11%/0.0174), and the ratio of "accumulative deaths" was low (0.09%) despite the construction of relatively poor treatment facilities. Through the results of this study, we expect a paradigm shift in the infectious disease management system in major cities in Korea after post-COVID-19.

Keywords: *COVID-19, Time series, Rate & Rank Analysis, Coronavirus, UV*

1. Introduction

It is no exaggeration to say that the global health and medical policy issues over the past three years have resulted in the "coronavirus." As the coronavirus broke out in earnest, the Ministry of Health and Welfare began to expand its national quarantine network against the coronavirus by announcing the operation of the Central Accident Management Headquarters and the Selection Clinic as part of the "COVID-19" measures in January 2020 [1]. However, so far, the cumulative number of confirmed cases from the coronavirus has reached 30.17 million, and the cumulative number of deaths has also reached 33,444 (as of January 31, 2023). According to World Omitter, Korea is the seventh country in the world among the countries where the number of confirmed cases has exceeded 30 million since the coronavirus epidemic, and the 34th in the cumulative number of deaths [2-4]. Currently, not only Korea but also countries around the world are actively discussing the reorganization of the national quarantine system against COVID-19, and among them, policy capabilities are focusing on establishing a new quarantine system centered on large cities with concentrated populations.

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Therefore, this discussion aims to examine the current status and problems of the establishment of quarantine infrastructure in major cities after "With Corona" and suggest improvement measures [5-7].

2. Study Method

In order to effectively analyze the influencing factors of the coronavirus, this study targeted cities with more than 500,000 urban populations designated as "special cities" after January 2022. In particular, we compared the interrelationship between "number of upper-level hospitals", "number of urban population", "number of infected people", and "number of deaths" to implement the three quarantine strategies called "K-quarantine" [8-10].

Figure 1 is study method about An Analysis of Coronavirus Outbreak Status in Major Cities in Korea.

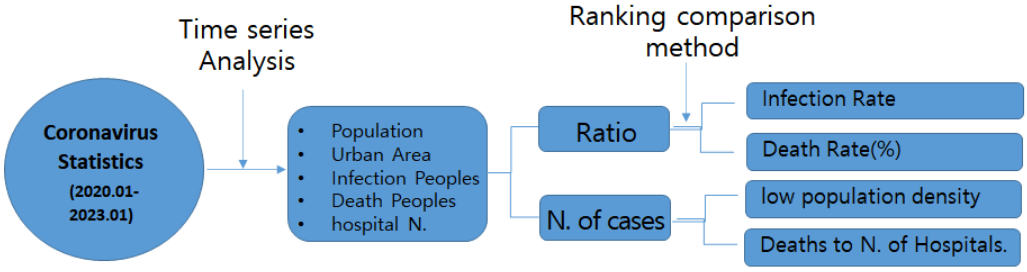

Figure 1. Study method

3. Results

3.1 Basic status Analysis

The study aims to focus on deriving implications for the operation and reorganization of the regional quarantine system through statistics related to COVID-19 infections and deaths in Suwon, Goyang, Yongin, and Changwon, which have recently been designated as special cities with more than 1 million people. To this end, data related to COVID-19 by 16 cities were composed through various data such as the Ministry of Government Administration and Home Affairs, the Ministry of Health and Welfare, the Health and Evaluation Institute, and local government websites, and analyzed through time series, frequency, and ratio analysis.

Table 1 is Current Status and Characteristics of Coronavirus Outbreaks in Major Cities in Korea.

Table 1. Current Status and Characteristics of Coronavirus Outbreaks in Major Cities in Korea

Province Division	City Name	Total population	Urban Area(m^2)	N. Infection Peoples(acc)	N. Death Peoples(acc)	Advanced hospital	General hospital
Gyeonggi	Suwon-City	1,190,964	121.09	734,009	674	1	5
	Goyang-City	1,076,535	268.09	624,648	826	0	6
	Yongin-City	1,074,971	591.24	635,732	504	0	4
	Seongnam-City	922,518	141.63	569,913	588	1	6
	Bucheon-City	790,128	53.45	457,166	679	1	5
	Hwaseong-City	910,814	697.77	597,065	601	0	3
	Namyangju-City	737,353	458.14	405,257	601	0	3
	Ansan-City	641,660	156.41	371,939	436	1	4
	Anyang-City	548,228	58.48	332,660	258	1	2
	Pyeongtaek-City	578,529	458.26	308,465	297	0	4
Chungnam	Cheonan-City	657,559	636.08	413,815	493	2	2
Chungbuk	Cheongju-City	849,573	940.84	402,957	461	1	6
Jeonbuk	Jeonju-City	651,495	206.04	409,694	381	1	5
Gyeongnam	Changwon-City	1,021,487	749.04	480,508	571	1	9

	Gimhae-City	535,129	463.52	303,253	211	0	5
Gyeongbuk	Pohang-City	496,650	1130.08	282,285	377	0	5
Sum (Average)		**12,683,593 (792,724.6)**	**7,130 (445.6)**	**7,329,366 (458,085.4)**	**7,958 (497.4)**	**10 (0.6)**	**74 (4.6)**

3.2 Cumulative infection rate Analysis

Except for special cities and metropolitan cities, there are a total of 16 cities nationwide, including 4 special cities. The average population of 16 cities is 0.792 million, and the cumulative number of infected people is 73.29 million, and the average cumulative infection rate is 57.8%. Seven cities exceed the average cumulative infection rate: Suwon (61.6%), Yongin (59.1%), Seongnam (61.8%), Hwaseong (65.6%), Anyang (60.7%), Cheonan (62.9%), and Jeonju (62.9%). Changwon City showed the lowest cumulative proportion of infected people at 47.0%, and Hwaseong City showed the highest proportion of infected people at 65.6%.

Figure 2 is Analysis result of Cumulative infection Rate.(2020.01-2023.01)

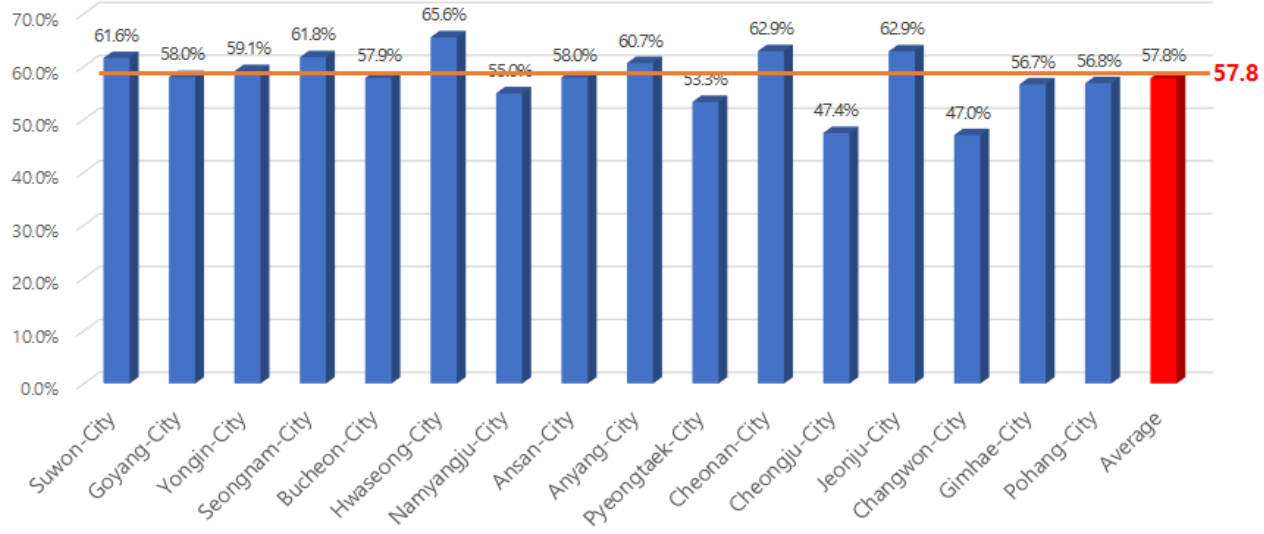

Figure 2. Cumulative infection rate analysis

3.3 Infection Peoples(acc) & Low Population Density's Analysis

The ratio of "cumulative deaths" between four special city groups, including Suwon City, and 12 city groups, including Seongnam City, with a population of 500,000 or more, was the same at 0.11% for both groups. It is judged that the relationship between the "number of urban populations" and "cumulative deaths" is not significant. However, as a result of examining the correlation between the "number of infected people" and "accumulated deaths" according to the "low density" ratio, which is the biggest factor of infection-mediated contact frequency, Pohang (0.13%/0.0040), Changwon (0.12%/0.0016), Cheonan (0.15%), and Cheongju (0.12%/0.00%). On the other hand, Anyang (0.08%/0.0002), Suwon (0.09%/0.0002), and Seongnam (0.10%/0.0002) showed low "accumulative death toll" even though they were relatively densely populated areas.

Figure 3 is Analysis result of Infection Peoples(acc) & Low Population Density.

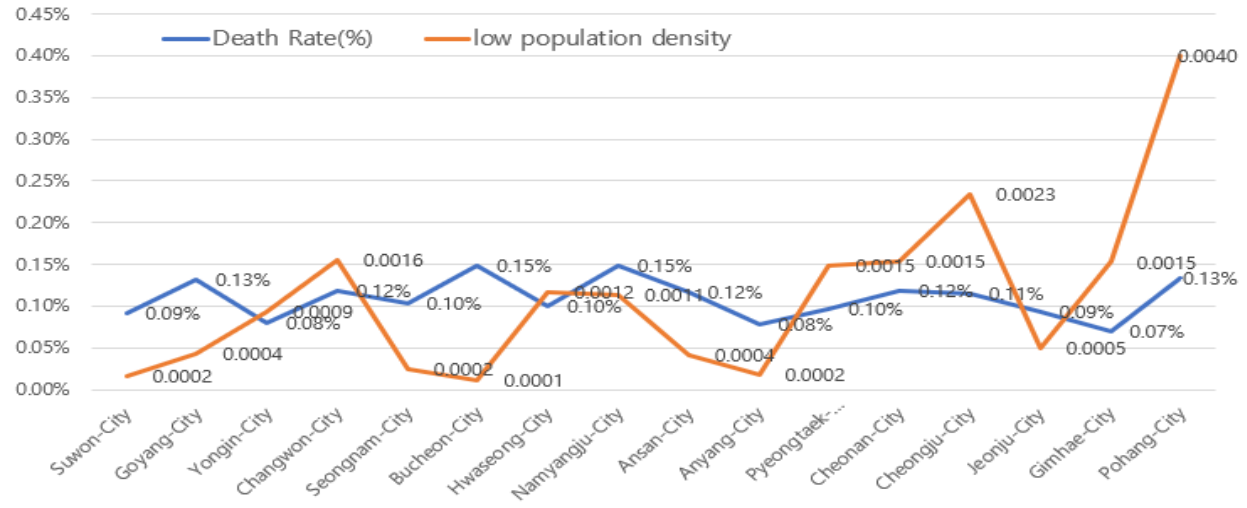

Figure 3. N. Infection Peoples(acc) & Low Population Density

3.3 Analysis of Death Rate & Deaths to N. of Hospitals

In the above, the differentiation of the COVID-19 quarantine management system by city has been described through the correlation between the "number of cumulative deaths" and the "low population density area." However, this differentiation can once again verify the difference in the quarantine management system described above by verifying the relationship with the cumulative number of deaths according to treatment facilities such as advanced hospitals and general hospitals, which are major facilities related to COVID-19. Therefore, if the upper hospitals and general hospital facilities are weighted by 2 and 1, respectively, and divided by the "accumulative death toll", the proportion of deaths compared to quarantine facilities is derived, and the difference can be seen more clearly.

As a result, despite the establishment of excellent treatment facilities in the city (ave=0.0129), the high "accumulated death" rate (ave=0.11%) is Changwon (0.12%/0.0193), Ansan (0.12%/0.0138), and Cheongju (0.11%/0.0174), and despite the relatively poor treatment facilities, the "accumulated death rate" is low are Yongin (0.08%/0.0079) and Suwon (0.09%/0.0104).

Figure 4 is Analysis result of Death Rate(%) & Deaths to N. of Hospitals.

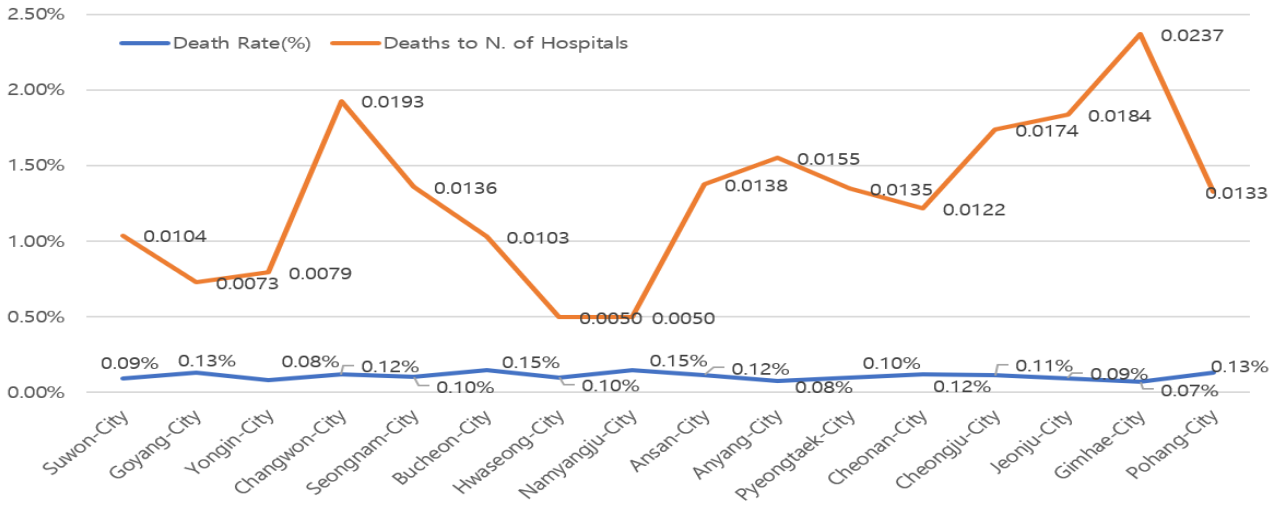

Figure 4. Cumulative infection rate analysis

3.4 Analysis of Death Rate & Deaths to N. of Hospitals

Suwon-city, Goyang- city, Yongin- city, Seongnam- city, Hwaseong- city, Anyang- city, Ansan- cty, and Jeonju- city have a relatively high infection rate (ave=57.8%) due to the large urban population (ave=79.2 million) and high population density (ave=0.11). In particular, Suwon, Seongnam, Hwaseong, Jeonju, and Anyang have a very high proportion of confirmed cases to the population of more than 60%, indicating that the proportion of infected people could increase rapidly in the future when the modified coronavirus such as Omicron spreads. In addition, Namyangju- city, Cheongju- city, Changwon- city, Pohang- city, and Cheonan-si have relatively high mortality rates despite their low-density population areas, and it is urgent to review the city's quarantine system. In addition, as a result of relatively insufficient severe treatment facilities compared to other cities, areas with a high mortality or infection rate were Hwaseong- city, Namyangju- city, Yongin-city, and Suwon- city.

Table 2 is Ratio and ranking analysis of coronavirus infection and death status in major cities in Korea

Table 2. Rate and Rank Analysis

Province Division	City Name	Total population	Infection Rate(%) (Ranking)	Death Rate(%) (Ranking)	low population density (Ranking)	Deaths to N. of Hospitals. (Ranking)
Gyeonggi	Suwon-City	1,190,964	61.6(5)	0.092(13)	0.0002(13)	0.0104(11)
	Goyang-City	1,076,535	58.0(8)	0.132(4)	0.0004(11)	0.0073(14)
	Yongin-City	1,074,971	59.1(7)	0.079(14)	0.0009(9)	0.0079(13)
	Seongnam-City	922,518	61.8(4)	0.103(9)	0.0002(13)	0.0136(7)
	Bucheon-City	790,128	57.9(10)	0.149(1)	0.0001(16)	0.0103(12)
	Hwaseong-City	910,814	65.6(1)	0.101(10)	0.0012(7)	0.0050(15)
	Namyangju-City	737,353	55.0(14)	0.148(2)	0.0011(8)	0.0050(15)
	Ansan-City	641,660	58.0(8)	0.117(7)	0.0004(11)	0.0138(6)
	Anyang-City	548,228	60.7(6)	0.078(15)	0.0002(13)	0.0155(5)
	Pyeongtaek-City	578,529	53.3(13)	0.096(11)	0.0015(4)	0.0135(8)
Chungnam	Cheonan-City	657,559	62.9(2)	0.119(5)	0.0015(4)	0.0122(10)
Chungbuk	Cheongju-City	849,573	47.4(15)	0.114(8)	0.0023(2)	0.0174(4)
Jeonbuk	Jeonju-City	651,495	62.9(2)	0.093(12)	0.0005(10)	0.0184(3)
Gyeongnam	Changwon-City	1,021,487	47.0(16)	0.119(5)	0.0016(3)	0.0193(2)
	Gimhae-City	535,129	56.7(12)	0.070(16)	0.0015(4)	0.0237(1)
Gyeongbuk	Pohang-City	496,650	56.8(11)	0.134(3)	0.0040(1)	0.0133(9)
Sum		**12,683,593**		**1.74%**	**0.0177**	**0.2063**
(Average)		**(792,724.6)**	**(57.8%)**	**(0.11%)**	**(0.0011)**	**(0.0129)**

4. Conclusion

Recently, the U.S. Centers for Disease Control and Prevention (CDC) explained that using Far UV-C 222 nm is the most direct and effective sterilization effect, and in the case of pandemics such as coronavirus, it often spreads into droplets or air when people face-to-face, so it can only quickly sterilize the entire space. This can be seen as emphasizing that it is important to establish a macro control system such as an air infection control system while minimizing quarantine in order to control the spread of mutated viruses in the future, away from the traditional micro approach such as "Testing-Tracing-Treatment". Therefore, considering the repetitive pandemic situation in the post-corona era, it is urgent to consider the regional quarantine system to overcome the fatal limitations of infection control for vulnerable groups in high-risk living facilities due to the increase in complex multi-facilities and ultra-aging. However, it is important to take a strategic approach considering the characteristics of individual cities and medical infrastructure.

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