

Spatiotemporal Data Analysis of Health Care Institutions in China Under COVID-19

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Abstract

The outbreak of COVID-19 epidemic has tested the emergency response capability and the strength of medical and health system in every country when the crisis is coming. The rapidly and effective response of Chinese government has made important contributions and provided a successful reference for other countries all of world. China's health care system plays a vital role in overall process. Based on the statistical data, the health care system areal distribution is analyzed with the spatiotemporal analysis method and the data visualization processing can better understand the spatiotemporal distribution of China's medical and health institutions.

Keywords

Medical Care; Spatiotemporal Analysis; Machine Learning; Mortality.

1. Introduction

In 2020, the COVID-19 epidemic continues to spread and has affected more than 200 countries and regions around the world. It has not only posed a huge threat to the life and health of people in all countries, but also brought a huge challenge to global public health security. Therefore, the medical and health system has attracted more people's attention. The influence of COVID-19 crisis is more complexity and stranger than the SARS epidemic, which has led to many medical resources is severe overloading on a health care system even in relatively rich in developed countries. What's more, some countries have more than 10% of health care workers are infected [1].

China has made all-out efforts to tackle the epidemic and taken the most thorough and rigorous prevention and treatment measures and then scored a phased victory. WHO Director-General Tedros said that the speed and scale of China's actions are rarely seen in the world. Many experts and scholars have studied the medical and health system in China. However, there is no report on the research using the method of spatiotemporal data [2] analysis.

Using the spatiotemporal method to study and visualize can well discover the changes of medical and health institutions in various regions of China. It is great significance to the timely prevention and treatment of infectious diseases and health public events based on the spatiotemporal evolution [3] of China's medical and health institutions.

2. Methods

2.1. Datasource

The research data used in this work was taken from China Statistical Yearbook (2001-2019) [4]. The original statistical data of energy consumption has the characteristics of large amount

of data and long recording time. The huge database is very susceptible to the disturbance of noise data, vacant data and inconsistent data. The original data collected can be sorted to improve the quality of the data and the efficiency and accuracy of data analysis process.

Medical and health institutions are medical units can provide medical services, public health services or engage in medical research and medical training authorized by the Chinese administrative department. It includes hospitals, grass-roots medical and health institutions, specialized public health institutions and other medical and health institutions.

2.2. Standardization

Data standardization processing [5, 6] is a basic work of data mining. Different evaluation indexes often have different dimensions and units. Different methods result in different analysis conclusions. In order to eliminate the dimensional influence among indexes, data standardization processing is needed to solve the comparability among data indexes. After the standardization of the original data, each index is in the same order of magnitude, which is suitable for comprehensive comparative evaluation. In this work, data is dealt with by the means of the standardized. The data of medical and health institutions is 31 provinces, autonomous regions and municipalities. Linear transformation of the original data is carried out to map the result values to [0-1], and the specific formula is as follows:

$$x^* = \frac{x - \min}{\max - \min}$$

Where, max is the maximum value of sample data and min is the minimum value of sample data. To standardize is to limit the data to a certain range. Firstly, the standardization is for the convenience of subsequent data processing. Secondly, the standardization can ensure much faster to convergence during program running. The specific function of standardization is to conclude the distribution of uniform samples.

2.3. Spatiotemporal Data Analysis

Medical and health institutions are both with temporal and spatial attributes at the same time, so they are also called temporal and spatial data. They are spatial data with time elements and changing with time. They are an expression of important elements information in the earth environment [7-9]. Concretely speaking, spatiotemporal big data includes many types, such as population density, population migration, intelligent transportation, energy and resource distribution, meteorological information and so on. Big data of time [10] and space dynamic analysis has become one of the major requirements. According to the actual situation, data resources would be collected and spatial information would be processed, data engine would be built and applied in system development. Based on the data characteristics and business processes, the analysis platform provides customized development services, including customized visual theme styles, visual page content layout, visual charts and interactive patterns.

3. Results and Discussion

As can be seen from the figure below, the number of medical and health institutions in 31 provinces, municipalities and autonomous regions in China has witnessed rapid development and growth from 2008 to 2009. Especially, many parts of central and southern China were hit by massive snowstorms. Unfortunately, an 8.0-magnitude earthquake hit the Wenchuan county in Sichuan Province in 2008. Luckily, Beijing successfully hosted the Olympic Games and Paralympic Games in 2008. After major disasters, China's medical and health services have undergone major tests, but also made development and breakthroughs in difficulties. China's

GDP growth rate exceeded 8.5% in 2009, the highest in the world, and China's economy surpassed Japan's to become the second largest in the world [11].

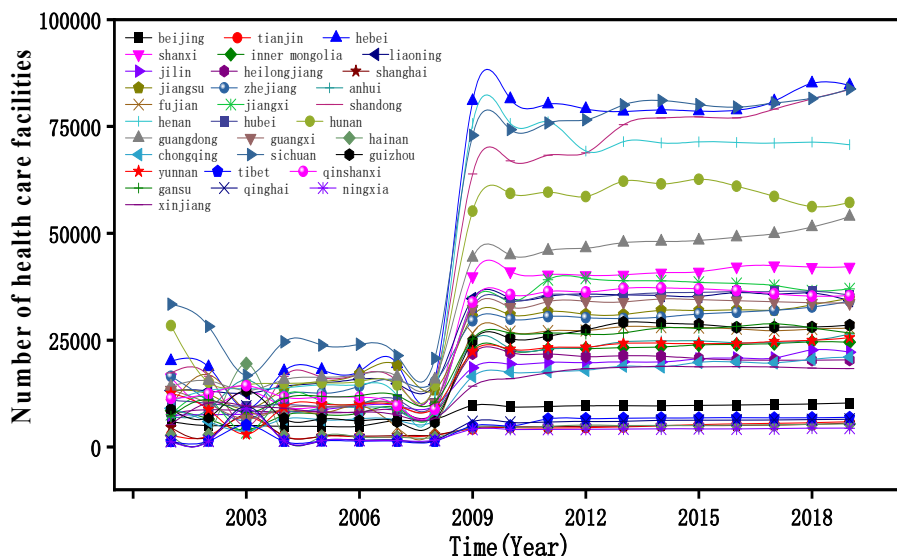


Figure 1. Trends of health care institutions

According to the chart, Hebei province had the most medical and health institutions in 2019, with 84,651. There were more than 50,000 in six provinces: Hebei, Sichuan, Anhui, Shandong, Hunan and Guangdong. The lowest was in Ningxia Hui Autonomous Region, Hainan, Shanghai and Tianjin, the lowest was in Ningxia Hui Autonomous Region, with 4,397. The number of medical and health institutions is closely related to the population, the level of economic development and the rate of urbanization. Therefore, the number of health care institutions per capita is analyzed by incorporating population into the model in next step.

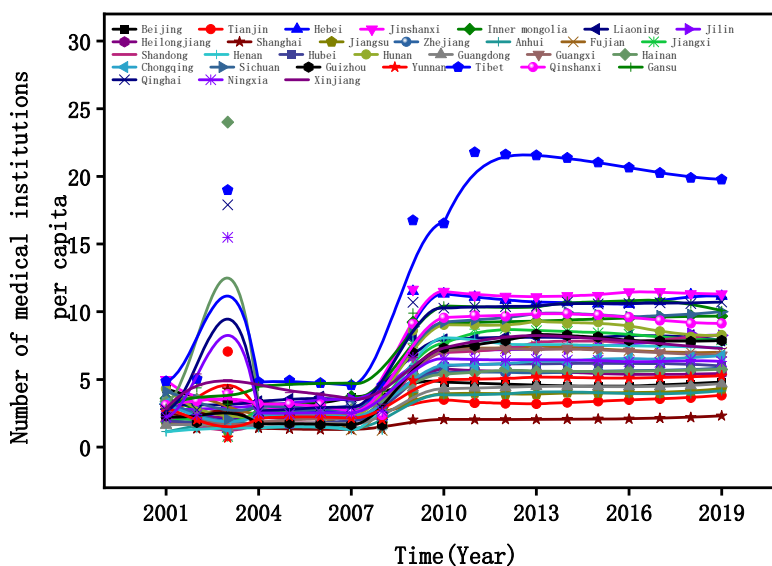


Figure 2. Trend of medical institutions per capita in the region

In terms of medical and health institutions per capita, Tibet Autonomous Region is ranked first in 2019, followed by Shanxi, Hebei, Qinghai, Gansu and Sichuan, with more than 10 medical and health institutions per 10,000 people. Especially, medical and health institutions have sprung up like bamboo shoots after a spring rain and achieved great development since 2008. But

China's share of GDP in health care ranks the 123rd in the world and the 28th from the bottom. It is less than a fraction of that of the United States and less than half that of big European countries. Shanghai, Tianjin, Anhui and Jiangsu provinces have fewer than 5 medical and health facilities per 10,000 people, which is largely related to regional economic development and urbanization. Obviously, this also shows that the more developed the economy is, the higher the degree of urbanization is, and the lower the medical and health institutions per 10,000 people are.

The data of medical and health institutions is standardized, and then visualized by R Program software to obtain the spatial and temporal evolution of medical and health institutions in China. The spatial and temporal distribution of 2001, 2006, 2011, 2016 and 2019 are mapped as follows:

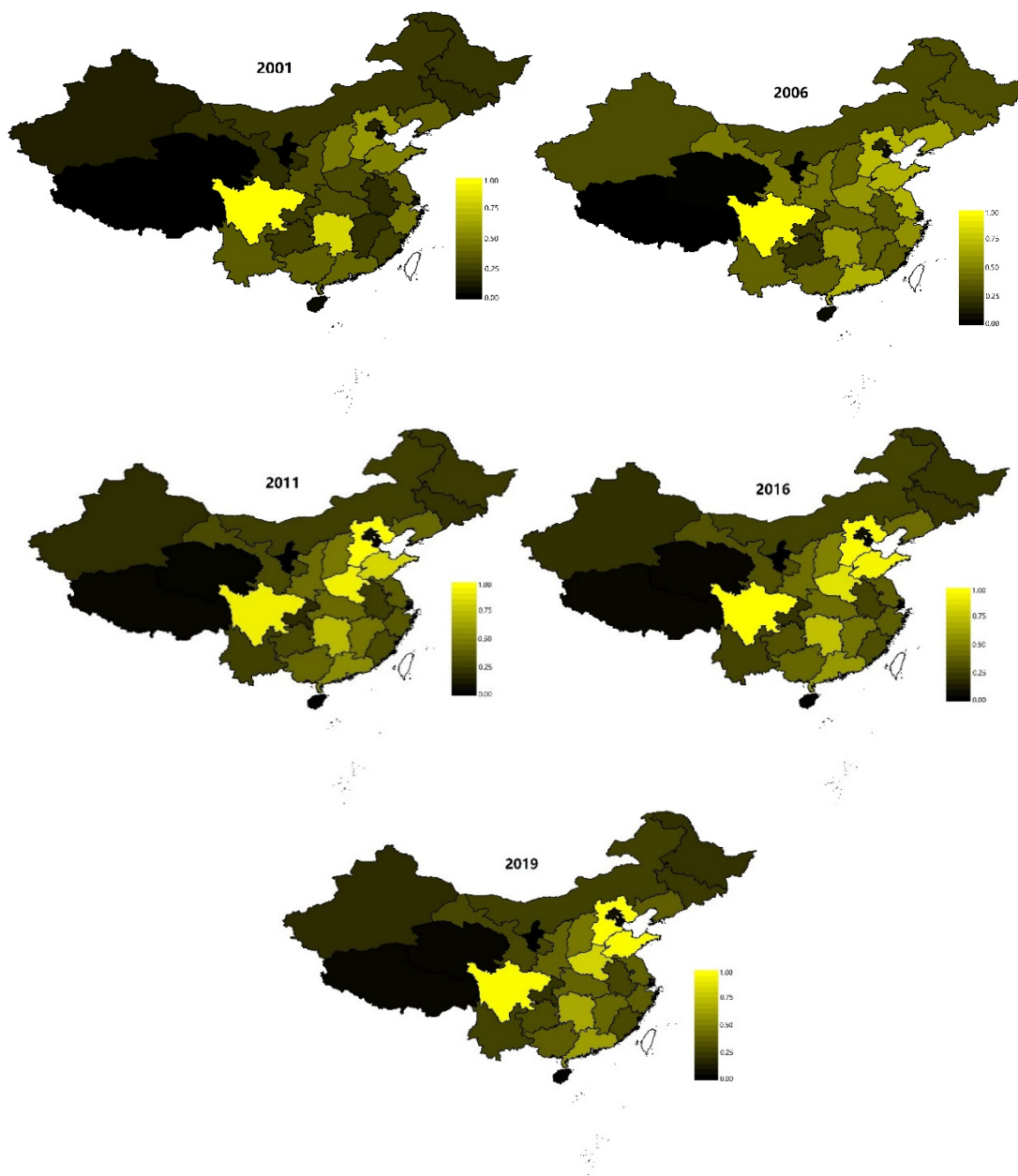


Figure 3. Spatial and temporal evolution of medical institutions in China

Through the Chinese medical and health institutions regional space-time evolution on the map, it can be seen that the top three of the number of medical institutions are Sichuan province, Hunan and Hebei province in 2001. The big number of medical institutions corresponding is yellow highlight area. The bottom three provinces are Ningxia hui autonomous region, Tibet

autonomous region and Qinghai province, which are all the western region. Hunan province was replaced by Jiangsu province in the top three in 2006. The bottom three remained the same as 2001 with a slight change in the order. Henan province replaced Jiangsu province in the top position in 2011 while Tibet autonomous region and Qinghai province were replaced by Shanghai city and Tianjin city in the bottom three. Shandong province replaced Henan province into third place in 2016, and Hainan province replaced Tianjin city into third from the bottom. There is little difference between 2019 and the top three and the bottom three of 2011.

Table 1. The top three and the bottom three under their standardized values

	2001	value	2006	value	2011	value	2016	value	2019	value
Top three	Sichuan	1	Sichuan	1	Hebei	1	Sichuan	1	Hebei	1
	Hunan	0.8448	Hebei	0.7228	Henan	0.9467	Hebei	0.9905	Sichuan	0.9888
	Hebei	0.5865	Jiangsu	0.6968	Sichuan	0.9425	Shandong	0.9666	Shandong	0.9871
Bottom three	Ningxia	0	Tibet	0	Ningxia	0	Ningxia	0	Ningxia	0
	Tibet	0.0007	Ningxia	0.009	Shanghai	0.008	Shanghai	0.0101	Hainan	0.0127
	Qinghai	0.0055	Qinghai	0.013	Tianjin	0.0039	Hainan	0.0118	Shanghai	0.015

From the point of view of quantity, the eastern region is much more than the western region, which has a great relationship with the regional economic development. Population is also a key factor affecting the number of medical institutions. Sichuan, Henan, Shandong and Hebei province are all populous provinces.

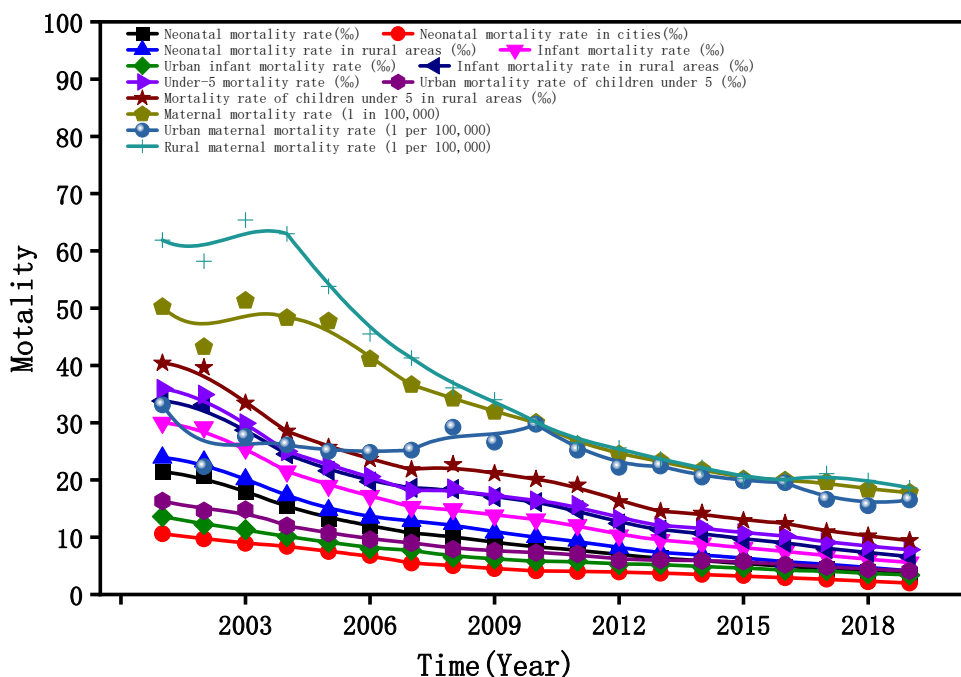


Figure 4. Neonatal and maternal deaths

The mortality rates of 12 indicators are all decreasing year by year, especially in rural areas. The urban maternal mortality rate fluctuated slightly, but shows an overall downward trend. The urban neonatal mortality rate is the lowest, followed by the urban infant mortality rate and under-five mortality rate. The decline of these indicators has a lot to do with the continuous improvement of China's medical and health system, and medical and health institutions play a key role.

4. Conclusion

Chinese medical and health institutions have played a vital role in resisting the COVID-19 crisis spread. Chinese medical and health institutions have developed rapidly since 2008 and achieved great results in reducing the rate of newborn infant mortality and maternal mortality. The number of medical and health institutions in China's provinces and municipalities is unevenly distributed. There is a positive correlation between the number of medical and health institutions and the population. However, in terms of per capita medical and health institutions, per capita resources in the western region are higher than those in the eastern part of China. Urban conditions are superior to rural living conditions, and as a result, urban infant mortality rates are lower than rural infant mortality rates, the same as are maternal mortality rates. The increasing in rural health care facilities has significantly reduced infant and maternal mortality rates in rural areas. Therefore, accelerating rural development and improving rural medical conditions are also important links during China's rural revitalization.

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