

Research on Covid-19 Impact on China's Medical Devices Industry's Supply Chain

Fangyi Hu^{*,†}

Department of Industrial engineering, University of Miami, Miami, United state College of engineering, University of Miami, Miami, Floria ,United state

*Corresponding author: Fxh201@miami.edu

Abstract. Covid is the most important black swan event that happened in recent years. As covid changed the consumption habit of medical devices, and the crisis has made people reflect on the minimal storage supply chain strategy. This will reshape the medical devices industry dramatically. Therefore, industry players are looking for new revenue sources. Thus, prevention will become the unique growth point. This paper used the comparative analysis and the focus group and discovered that China first experienced a shock after the covid. However, China recovered quickly, and export in China benefited from it since Covid-19 spread to the whole world. China's medical devices have great potential, and China will not be replaced even in the low-end medical devices market. Generally, the more severe the covid outside China, the more supply will be exported. This paper will also help companies to prepare for other unexpected events. This industry will greatly change the supply chain and is also worth investing in among the generally slow macroeconomy growth.

Keywords: Covid-19; China's Medical Devices Industry; Supply chain.

1. Introduction

1.1 Research background

The supply chain has been the protagonist due to the outbreak of covid-19. As the biggest Personal protective equipment (PPE) manufacturer, China experienced a mask shortage during the initial explosion. As covid-19 continues, the demand for PPE is growing rapidly, especially in China due to its policy. China's economic growth slacked, but the size of the medical devices is growing quickly. The Chinese medical devices market has grown 18% in the recent 5 years, while the world average continuous annual growth rate is roughly 5%. This indicates that China's medical devices have great potential. Research on the supply chain of medical devices during the pandemic does not only serve this non-recurring situation but also can be applied to crises like climate change and financial crises. This is fundamental to the sustainable development of this industry and the life quality of common people. As a virus-caused contagious disease, Covid-19 is a kind of severe acute respiratory syndrome coronavirus 2.

The global economy was impacted negatively by Covid-19. The global GDP contracted by roughly 3.3% in 2019-2020, the most serious economic contraction since the Great Depression. In 2021, the global economy will be expected to restore its vitality. Still, the process will take longer as uneven, and differences in vaccine availability and coverage could threaten recovery in most parts of the world. The lockdown and covid isolation policies make it hard for manufacturers to produce products at full capacity. Therefore, the unemployment rate increased. Although this problem is in gradual recovery after the pandemic, the impact of covid on the consumers' hearts is long-lasting. People are crazy about storing food and protective equipment. But they contract other expenses in fear of future unemployment and the uncertainty brought by the pandemic. Reducing costs will make it hard for the economy to recover fast because inventories will increase, and production will decrease without consumption. The message is delivered through the supply chain, and people are losing their jobs or reducing their working time. This phenomenon will lead to more pessimistic expectations, and the whole economy will have a series of relapses. Therefore, it can be expected that the recovery from Covid-19 will take more time than expected. In this environment, the medical devices industry's growth is attractive to the capital and manufacturer. However, as more participants crowded the

market and the recovery of international trade, it is crucial to analyze the supply chain behind it to get a better insight into the industry. Through this, capital and manufacturer can better meet the real demands, and the market will be more efficient.

We can see from the table that China has a larger population than the United States, and its healthcare spending is lower than United states. There is a lot of space for healthcare expenditures to grow.

Table 1. Basic information about China and the United States

	CHINA	UNITED STATES
Population	1367485388	321368864
Total healthcare spending	\$574 billion	\$3 trillion
Healthcare expenditures total (% of GDP)	5.50%	17.10%
Expenditures on healthcare	Government:56% Private:44%	Government:48% Private:52%
Size of medical device market (USD)	\$8.7 billion	\$147.7 billion
Number of hospital beds	3.8 per 1000 people	2.9 per 1000 people

1.2 Literature review

Kovacs proposed that a lean supply chain should learn from the humanitarian supply chain to face covid and other potential challenges [1]. Ivanov found that supply chain disruption's drivers and policy implication is unclear since it varies among industries [2]. Miroudot analyzed that, in a VUCA world, agile manufacturing has replaced lean manufacturing, and firms need to develop dynamic capabilities to remain competitive. Miroudot also mentioned the complexity of the supply chain [3].

A considerable amount of literature has been published on the covid impact of the supply chain. These studies mainly focused on the covid-19 effect on the whole world rather than on a particular country. However, it is critical to understand China's supply chain disruption and its measures to recover because China is both the biggest PPE manufacturer worldwide and the first country to resume production after the outbreak of Covid-1. China's planning put health and innovation important. Although the Chinese low-end value market is competitive, high-end medical devices do not develop fully. It is the area where imported products dominate. It is not possible to innovate the products all by local manufacturers. The cost and the time will be much longer than they should be.

1.3 Research framework

This paper will first explore the basic framework of the medical devices industry in China. Then the passage will compare China's medical devices with the world's medical devices to discover what helps Anina's medical devices recover rapidly. Finally, this research will extract some useful methods for reference when facing other crises and facing potential challenges in the future. The Chinese medical devices market accounts for around 20% of the global market. It has grown for 5 years and still has a large potential. Many factors cause this. Initially, China is experiencing an aging population, leading to many chronic diseases. Secondly, the old are richer than before, and their deposit and expenses will make it possible to spend more on healthcare. Thirdly, unlike in other countries, the policy lowers the price of drugs, which means that it is not lucrative to produce medicines. Therefore, industry players are looking for new revenue sources. Thus, prevention will become the unique growth point.

2. Methods

2.1 Comparative analysis

Comparative analysis is a common method of analysis. This method mainly compares two or more things and discovers their differences and similarities [4]. This paper compares the recovery time after the disruption due to covid-19 in different countries to distinguish those with great resilience. Also, this research will compare the production output after covid with the items before the covid to see what impact covid has brought to this country. Some countries suffer from severe supply chain disruption because of the fast spread of the covid. In contrast, some countries will produce more to meet the demands of the whole world. The passage will further compare the measures taken to protect people and recover production by distinguishing what makes this huge difference. Besides, other factors like infrastructure and people's consciousness should be considered to analyze the problem comprehensively. That is to say, historical and demographical factors should also be included rather than mere measures applied during the pandemic. After the comparative analysis, the research will bring some questions that public materials cannot solve. And this leads to the second research method.

2.2 Focus group

The focus group purpose is mainly group interviews. This way of generating data is primarily through the interaction between participants. The benefit of this approach is that it will allow the researcher to comprehend something beyond the facts and the numbers obtained via secondary materials study. After the results are delivered by comparative analysis, this paper will draw some questions to discuss in the focus group. The members in the focus group are the participants in China's supply chain. During their conversation, the author will write down some details not shown in the public information. The sample was representative of gender and age. To identify their opinions about the measures taken to resume production, the participants were asked to write down their views at first without disturbs from others.

Then the researcher will just let them talk randomly to know their major concern about the industry. Finally, the researcher will raise some questions after hearing the whole process. In this focus group study, there is a potential for bias from the demographical perspective since, due to the covid, the participant is all from Shanghai. Another major source of uncertainty is the method used to analyze the results. This method is qualitative, not quantitative, which may not be so concise.

3. Results

3.1 Trend of medical devices in the post-covid era

Figure 1 shows that there has been a steep rise in China's medical devices industry market size since 2015. Chinese medical devices have experienced rapid growth since 2015. However, due to the outbreak of covid, both local and worldwide demand for medical devices has increased dramatically. Therefore, we see that the growth trend remains the same. China's compound annual growth rate (CAGR) is 18%, much higher than the worldwide CAGR [5].

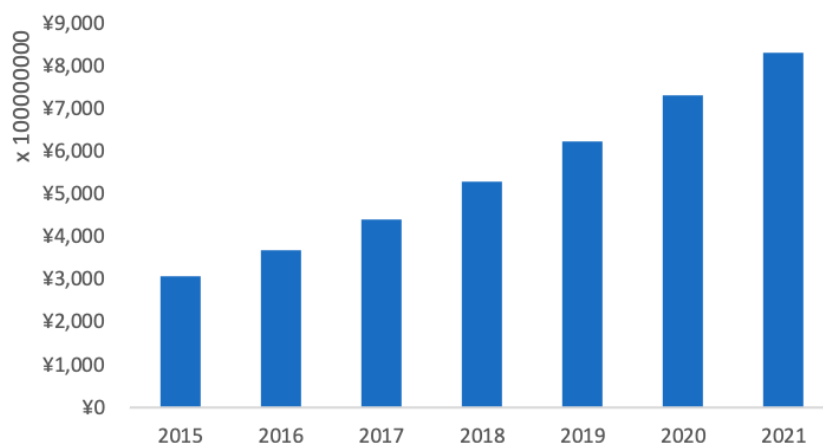


Fig. 1 China's medical devices industry market size
(Photo credit: Original)

Figure 2 reveals that the number of manufacturers slightly increased from 2012 to 2019. What is striking in this chart is the rapid increase in 2020. Two reasons mainly cause this. Firstly, the price leap makes the industry profitable. Therefore, entering the industry is lucrative, and many manufacturers crowded in to share the profit. Secondly, the lockdown policy in China makes it hard to transport goods manufactured in another province, which creates an opportunity for the local producer. Previously, the entry barrier was higher since the large manufacturer may have a scale effect to defeat the new entry. Also interesting in this chart is the slight fall in 2016. This is caused by tightened regulation. This signals that regulation is a crucial factor in the number of manufacturers [6].

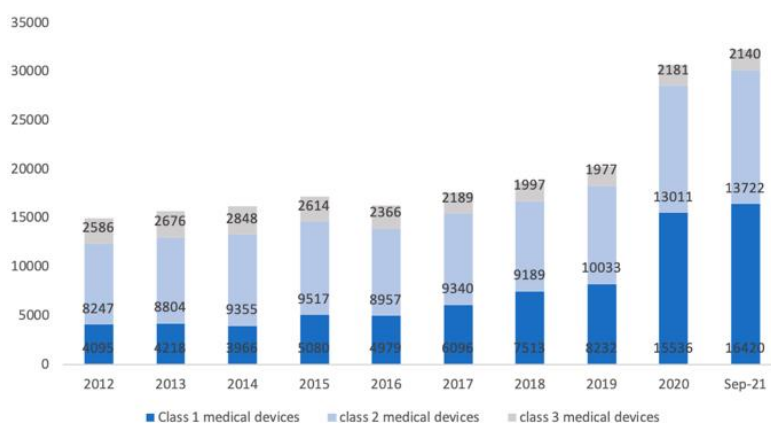


Fig. 2 Number of manufactures
(Photo credit: Original)

What can be seen in figure 3 is that except for Guangdong Province, the number of manufacturers in the other 9 provinces is divided relatively evenly. Guangdong has a history of manufacturing goods, which is critical to export after controlling the covid in China. It is not economically beneficial to have such a diversified production distribution according to the original lean supply chain methods. There are four key regions in the domestic industry. Firstly it is the place centered around Beijing. Second, it is around Shanghai, the Pearl River Delta, and Central China, like Sichuan [7].

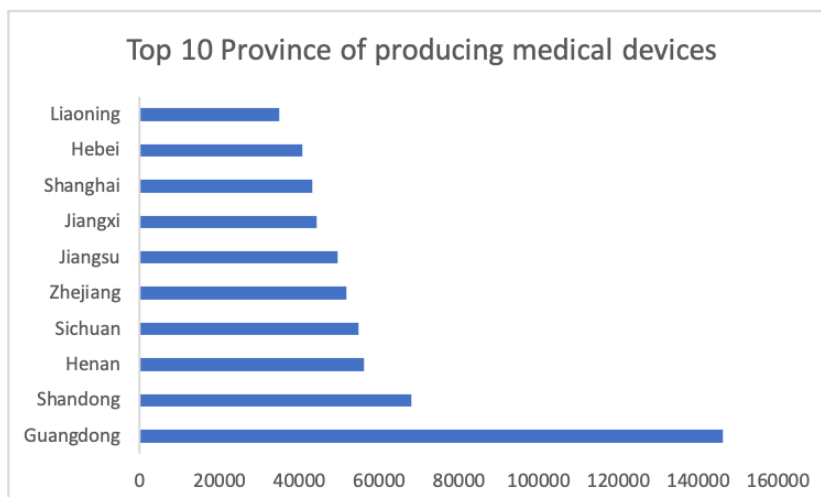


Fig. 3 Top 10 Province producing medical devices
(Photo credit: Original)



Fig. 4 geographical distribution of top 10 province
(Photo credit: Original)

3.2 Public Consumption and manufacture pattern analysis after covid-19

Covid-19 brings an unprecedented crisis all over the world. Up to date, About two million people have been infected, and over 10 thousand people were died because of the covid-19. Covid-19 has made the MedTech industry a central stage in this world. Everybody is eager to store PPE, and hospitals' demand for diagnostic tests, personal protective equipment (PPE), ventilators, and other critical medical supplies increased dramatically. Demand for those protective equipment rockets and many new companies coming into the industry to meet the needs is great for relieving stress. This can be expected. However, there is unexpected patient behavior reported. Recent research shows that hospitals reported about a 70% drop in heart attacks in some hard-hit areas. Demand decreased; therefore, some existing companies stopped producing such medical devices and concentrated their resources on protective equipment. However, the driver for such a drop is unclear. If it is caused by the change of lifestyle caused by the pandemic—for example, common triggers like abrupt physical exertion are eliminated—then it is okay to produce fewer medical devices for heart attacks. But it can also be explained that many people are afraid to go to hospitals because of the covid. In the next period, MedTech should consider activating a supply contingency plan. The first is to move supplies to areas where stocks are most scarce and to take reasonable measures to ensure the health and safety of workers on the production floor, however, in the long run. The medical device manufacturer should plan for the future demographically and prepare for the rebound of demands for other devices.

3.3 Characteristics of Chinese medical devices consumption

The Chinese medical devices industry is a large market that is still growing. In 2019, its income was 629 billion yuan, almost doubled since 2015. In 2020, many new demands for medical devices appeared because of the covid-19. Those demands include medical masks, nucleic acid test kits, and ECMO machines.

Due to the policy impact and government regulation, the demand for masks and nucleic acid test kits in China is greater than in other countries.

Most Chinese domestic manufacturers are producing lower-value added devices like low-value consumables. These manufacturers are small to medium-sized companies dominating the middle-end and low-end market. By contrast, high-end devices rely heavily on imports, and the dominator is a foreign brand. But its portion has been increasing from 20% to 30%. Because of the covid, the export number increased dramatically. Regulations have been tightened since the state Council inspected more medical devices produced in foreign countries, which favored domestic productions. However, due to Covid-19, some provinces have relaxed the requirements for some innovative products with urgent needs since import is a crucial source to disseminate new technology.

3.4 Why China experience an increase in export in 2020

Covid-19 is testing the resilience of the supply chain. There is a time lag in the covid-19 between China and other countries. China is the first country to witness the outbreak of the covid-19. While other countries are experiencing a spike in the infection rate, China is on the road to recovery. It takes about 70 to 80 days for China to recover to the new norm.

The Chinese government is taking several measures to recover the economy. The information available could also help accelerate the recovery. This enables companies to make decisions and plans based on reality. The government can also provide assistance to promote economic recovery, including relaxed social insurance obligations, subsidies for small and medium-sized enterprises, tax breaks, and lower electricity bills. These can help reduce the financial burden on businesses and put the masses back to work. With the rapid development of logistics and freight services and the availability and pricing of raw materials becoming more certain, confidence in the supply chain began to grow dramatically. This improves confidence in production forecasts and enables companies to commit to delivery schedules. Finally, real-time information on the dynamics of the outbreak can help factories monitor and improve workplace health and safety to contain the virus.

4. Discussion

In this section, we aim to solve the problem of why China experience an increase of balance (export - import) and the implication of this.

This paper collected data from China customs to collect monthly imports and exports data. Because it is hard to get first-hand data, this paper will use the data of all goods and services rather than the import and export data of the medical devices industry [7-9]. In addition, the most recent data is about the data on Dec 2021 since the data is released annually. Also, the author gathered data from WHO websites about the new Covid case from 2019 to now [10]. This paper will do a linear regression to explore the relationship between them

Before jumping into the regression process, this paper will make some assumptions. From the previous analysis, it is reasonable to hypothesize that the balance will increase when Covid outside China is more severe than in China. To measure the severity of Covid-19 in non-China countries with China, this paper used the ratio of the new cases worldwide except in China and new cases in China. Therefore, this ratio will be the independent variable, while the dependent variable will be the balance. Data collected are shown in the following table.

Table 2. Monthly data for balance and ratio of Non-China's new case and China's new case

Date	Balance	Non-China new case/ China new case
2019.12	47294	1
2020.01	54732	1
2020.02	-61943	0.01450617
2020.03	20042	0.0842699
2020.04	45049	235.969899
2020.05	62237	1264.93545
2020.06	45546	14699.7259
2020.07	61401	6521.20396
2020.08	58202	2581.88421
2020.09	36575	3423.75237
2020.1	58146	13250.5137
2020.11	75551	14555.8157
2020.12	78174	10851.1819
2021.01	61660	5944.0293
2021.02	35334	4700.01403
2021.03	11782	11036.1698
2021.04	40890	16873.6659
2021.05	43283	25574.4297
2021.06	50143	2674.24964
2021.07	55889	1553.05165
2021.08	59133	7415.30582
2021.09	67778	8225.60922
2021.1	84671	10176.0435
2021.11	71764	9898.66889
2021.12	94382	8399.51117

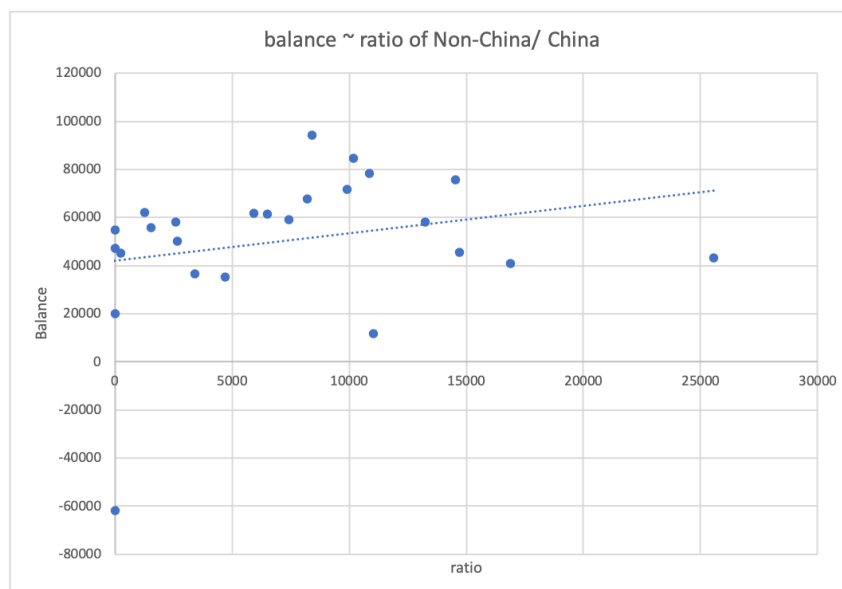


Fig. 5 Linear regression of balance and ratio
(Photo credit: Original)

The graph shows that the ratio increase generally indicates that Covid-19 outside China is worse than that in China. The balance generally increases. The finding fits with intuition. What is worth exploring is those dots deviates from the mass.

First, the dot below the X-axis happened on Feb 2020. At that time, covid had just erupted in China, and a locked-down policy was implemented all over China. Therefore, few factories are operating. The export decreased dramatically, which explains why the balance is below zero. At that time, China, labeled the world factory, could not supply sufficient medical devices to meet the nation's demand, not alone exporting to support other countries. The import rocketed, and export descended, causing these unusual points. Also, we could see a point far below the trend line. That represents May 2021. After that time, the ratio decreased quickly. However, this does not mean that the Covid outside China was well controlled. However, many places just relaxed the policy related to Covid-19. After the relaxation, the factories can resume production and meet increasing demands. Therefore, aside from Covid-19, the government's attitude towards Covid matters. It's still the dynamics between the demand and supply. As long as the local factories recover, the demand for imports from non-China countries will decrease. Thus, China's export of goods and services will descend.

However, we have to point out that the number reported by the WHO may not report the real situation, which may cause some bias. As revealed by surveys in cities like Palo Alto and San Francisco's Oceanside, there are high levels of SARS-CoV-2 in wastewater. According to the levels in the past, the levels in the survey indicated that the new case is rocketing, not the same as the reported decreasing number. This is not necessarily the mistake of the government. A reasonable explanation might be that home testing made this discrepancy. People test positive, but they are not reported to the government. Also, more people decide to recover on their own rather than go to the hospital for various reasons. Therefore, this paper has to point out that the data collected may not reflect the real situation, which might cause some bias. If we correct that qualitatively, the ratio may increase, which means the slope will not be as steep as it is now. This means the impact of covid to the balance will be milder in the real world than we expected.

Finally, this paper will discuss the impact of Covid on the medical devices manufacturer in China. After the focus group interview, aside from the intuitive results, as shown before, there is another point worth noticing. As analyzed before, China's medical devices will have more growth potential than high-end medical devices since it is weak in this field. Some people may be worried that low-end medical device manufacturing will be replaced by the Southeast Asian countries where the labor force is cheaper than in China. However, those working in the industry say that the covid shows that China, as the world factory, is more stable than other Southeast Asian countries. As covid impacted the world, China stabilized its supply chain in a relatively short period, which is crucial to the whole industry's stability. Therefore, the worry of Southeast Asian countries replacing China in the low-end industry can be relieved.

5. Conclusion

This paper finds out that as Covid-19 changes people's consumption habits of medical devices, the Chinese medical devices industry will expect high growth in the following years. China suffered some losses due to Covid-19 at first. After a few months, however, China experienced a rocket in the balance. The linear regression result indicates a causal relationship between Covid-19 and the balance increase. The most obvious finding from this study is that there's no perfect substitute for China, even in low-end medical device manufacturing. These findings suggest that the medical devices industry is a good industry to enter when the whole economy slows its growth.

This research shows that there is high growth potential in high-end medical devices, and there would be opportunities for local and international companies. Also, low-end medical devices are still worth investing in since China's stability shown in the Covid reveals that there is no substitute for China. Also, it is unstoppable to see the localization of factories after the covid to manage the risk. Also, this method can help fend off other risks, such as the financial crisis or war.

A limitation of this study is that the paper lacks some primary data since it is hard to get first-hand data. Also, there is some bias in the number of new cases since people may not report if they are positive. Notwithstanding these limitations, the study suggests that government policy significantly

impacts the import and export of goods and services. Those industry players should pay attention to the recent updates on the policy. If the situation permits, the author hopes to acquire the import and export data for the medical devices to do more detailed research.

References

- [1] G. Kovács and I. Falagara Sigala, “Lessons Learned from Humanitarian Logistics to Manage Supply Chain Disruptions.” *Journal of Supply Chain Management*, vol. 57, no. 1, Jan. 2021, pp. 41–49. DOI: <https://doi.org/10.1111/jscm.12253>.
- [2] D. Ivanov, “Predicting the Impacts of Epidemic Outbreaks on Global Supply Chains: A Simulation-Based Analysis on the Coronavirus Outbreak (COVID-19/SARS-CoV-2) Case.” *Transportation Research Part E: Logistics and Transportation Review*, vol. 136, Apr. 2020, p. 101922. DOI: <https://doi.org/10.1016/j.tre.2020.101922>.
- [3] S. Miroudot, “Reshaping the Policy Debate on the Implications of COVID-19 for Global Supply Chains.” *Journal of International Business Policy*, vol. 3, no. 4, Dec. 2020, pp. 430–42. DOI: <https://doi.org/10.1057/s42214-020-00074-6>.
- [4] “Predicting the Impacts of Epidemic Outbreaks on Global Supply Chains: A Simulation-Based Analysis on the Coronavirus Outbreak (COVID-19/SARS-CoV-2) Case.” *Transportation Research Part E: Logistics and Transportation Review*, vol. 136, Apr. 2020, p. 101922. DOI: <https://doi.org/10.1016/j.tre.2020.101922>.
- [5] Ju Xiaoyu. Blocks under the chain technology optimization of emergency medical supplies system [J]. *Journal of logistics technology*, 2022, (5) : 63-67. The DOI: 10.13714 / j.carol carroll nki. 1002-3100.2022.05.019.
- [6] Annual Report on Drug Administration Statistics, Central People’s Government of the People’s Republic of China (Q3 2021), 2022.03.18, 2022.08.18, <https://www.nmpa.gov.cn/zwgk/tjxx/tjnb/20220318160852122.html>
- [7] General administration of customs People’s republic of China + Summary of Imports and Exports (In USD) B : Monthly+2022-03-18+2022-09-07+ <http://english.customs.gov.cn/Statics/bb598fd1-56f0-4e6e-b087-6237c12d310c.html>
- [8] Liu Yueqiao. COVID - 19 of global epidemics and the effect of supply chain and to deal with [J]. *Modern commercial and trade industry*, 2022 lancet (16) : 40 and 41. DOI: 10.19311 / j.carol carroll nki. 1672-3198.2022.16.015.
- [9] Wang Fang, Li Xudong, Li Qiang. Major outbreaks of medical supplies chain management perfect and block application study [J]. *Journal of supply chain management*, 2022, 3 (5) : 85-96. The DOI: 10.19868 / j.carol carroll nki gylg. 2022.05.006.
- [10] WHO, WHO Coronavirus (COVID-19) Dashboard, 2021.08.19, 2021.08.10, <https://covid19.who.int/data>