Nucleic Acid Normalization Testing in China: A Feasibility Analysis

Yang Yu(✉)

University College London, London WC1E 6BT, UK
yangyu_2022ucl@163.com

Abstract. Since the COVID-19 pandemic outbreak at the end of 2019, the Chinese government has adhered to the principle of putting people's lives first and actively carried out pandemic prevention efforts. Several rounds of large-scale nucleic acid testing have been conducted in several regions so far, and normalized nucleic acid testing is gradually being implemented. In the academic community, the causes behind China's adoption of regular and large-scale nucleic acid testing have not been methodically and thoroughly examined. Consequently, this study is dedicated to analyzing the feasibility of the normalization of nucleic acid testing in China. By summarizing the relevant literature through content analysis, it is argued that the normalization of nucleic acid testing in China is driven by a variety of factors, including the policy base, practical needs, technical support, and citizen participation in China. In the future, the government should promptly inform the populace about pandemic prevention, and pandemic prevention workers should work to advance the technology and effectiveness of nucleic acid testing to further consolidate the outcomes of pandemic prevention and raise the standard of living of the populace.

Keywords: COVID-19 pandemic · Nucleic Acid Testing Normalization · Public Health Emergencies · Law · Government

1 Introduction

The current COVID-19 pandemic outbreak is three years away from the end of 2019, and most countries around the world are adopting more relaxed pandemic prevention policies. Global COVID-19 is currently in the pandemic stage, there is an outbreak of confirmed cases in China's neighboring countries and regions, and the number of new local confirmed cases and asymptomatic infections in China is rapidly increasing. These factors combine to create a serious and complex situation for pandemic prevention and control [1]. The constant mutation of viral strains makes prevention and control more difficult, and how to exchange the lowest cost of prevention and control for the greatest effectiveness has become the focus of the government's public health emergency response [2]. Based on this complex situation, this study argues that it is reasonable for routine nucleic acid testing to be implemented on a large scale in China as one of the government's measures to respond to public health emergencies. The reasons why

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normalized nucleic acid testing can be implemented in China have rarely been systematically analyzed by academics. To fill this gap, this study adopts a content analysis method to summarize and analyze the available literature to illustrate the feasibility of normalizing nucleic acid testing in China. This can provide ideas, methods and experiences for the prevention and control of domestic and global pandemics, and has important implications for the future precise control of other infectious diseases that may spread on a wide scale.

2 Background

2.1 Global Pandemic Situation Description

According to the WHO, there have been 630,387,858 confirmed cases of COVID-19 pneumonia worldwide as of 00:18 BST on 10 November 2022 (5:18 PM CET on 9 November 2022) [3]. Regionally, Europe and Americas reported 262,088,023 and 180,429,028 cumulative confirmed cases respectively, ranking first and second globally [3]. As can be seen in Fig. 1, these two regions accounted for 70.2% of the cumulative confirmed cases globally. In third place is the Western Pacific, which has reported 94,824,020 confirmed cases, accounting for 15% of the global confirmed cases [3]. South-East Asia, Eastern Mediterranean, and Africa regions together accounted for 14.8% of the confirmed cases worldwide. These data indicate that three regions, Europe, Americas, and Western Pacific, have the highest number of patients infected with COVID-19 globally.

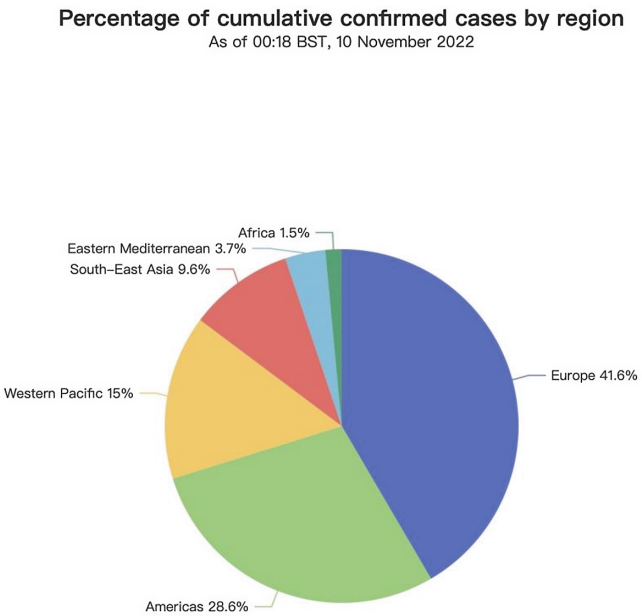

Fig. 1. Cumulative percentage of confirmed COVID-19 cases by region worldwide as of 10 November 2022, 00:18 BST [3]

In contrast, the pandemic in South-East Asia, Eastern Mediterranean, and Africa are relatively well controlled.

2.2 CHINA'S Pandemic Situation Description

On 12 December 2019, 27 cases of viral pneumonia were reported by the Wuhan Municipal Health Commission (WMHC) in China. Most of these patients had a recent history of exposure to wildlife at the South China Wholesale Seafood Market in Wuhan, China. In January 2020, professionals collected 515 environmental samples from businesses associated with the patients and nearby, and a further 70 samples from wildlife shops in seafood markets, which were shipped to the National Institute of Viral Diseases Control and Prevention, China CDC for testing. On 12 January 2020, PCR results showed that 33 out of 585 samples tested positive for 2019-nCoV and the virus was successfully isolated from the positive samples, suggesting that the virus originated from wild animals sold in seafood markets in southern China [4]. However, this judgement was challenged by a report from The Lancet detailing the first 41 infected patients hospitalized between 16 December 2019 and 2 January 2020 [5]. Furthermore, the report noted that 13 of the 41 cases discussed in the study did not report a link to seafood markets and therefore an epidemiological link between the first patients and the later cases could not be considered.

Daniel Lucey, an infectious disease expert at Georgetown University, claims that the first human infections must have occurred in November 2019, in the event that the data reported in China are accurate, because the virus has an incubation period and it takes some time for patients to appear with symptoms after contracting the virus. If this is the case, the virus may have been silently spreading among people in Wuhan, and there may even be cases elsewhere, before the cluster of cases in the South China wholesale seafood market was discovered in late December [6]. But as for the origin of the virus, Lucey had asserted that the outbreak did not originate in the Wuhan South China Seafood Market. In an email to ScienceInsider, Bin Cao of Capital Medical University, a pulmonologist and corresponding author of the Lancet article, wrote that the seafood market was not the only source of the virus. But to be honest, the source of the virus is still unknown [6].

Due to the rapid spread and onset of COVID-19, China, as the first country to report COVID-19, has been experiencing high numbers of confirmed cases in the early pandemic period [7]. However, since the onset of the pandemic, China has always insisted that people come first and life comes first, putting people's lives and health first as the fundamental starting point and anchor point of all prevention and control initiatives in China. As a result, the Chinese government has taken various preventive measures to coordinate the national fight against the COVID-19 pandemic in mainland China. In this process, the National Health Commission of the People's Republic of China has taken a prominent leadership role. Established in 2018, the National Health Commission is a cabinet-level executive department of the State Council, responsible for national health affairs and the formulation of national health policies, and is led by a cabinet-level minister of the State Council [8]. According to the National Health Commission of the People's Republic of China, as of 24:00, Beijing time on 9 November 2022, 31 provinces (autonomous regions and municipalities directly under the Central Government) and

the Xinjiang Production and Construction Corps reported a cumulative total of 267,544 confirmed cases of COVID-19 pneumonia in mainland China, accounting for only 0.19% of the population in mainland China [9]. Besides, a total of 8,395,118 confirmed cases were reported in Hong Kong, Macao, and Taiwan in mainland China [9]. (Data note: The cumulative number of confirmed cases in China reported by WHO includes the cumulative number of confirmed cases in Hong Kong, China, Macao, China, and Taiwan, China. However, since Hong Kong, Macao, and Taiwan in China do not adopt the same COVID-19 control measures as mainland China, this study only discusses the cumulative number of confirmed cases in mainland China to clarify the effectiveness of COVID-19 prevention and control measures in mainland China. This paper firmly adheres to the one-China principle and Hong Kong, China, Macao, China, and Taiwan, China are all inseparable parts of China.)

In addition to calculating the cumulative number of confirmed cases, the percentage of confirmed cases based on the total number of nationals in each country is a better indication of the effectiveness of prevention measures. This is because there are significant differences in population bases across the globe, and it is not fair to countries with large population bases to describe the spread of COVID-19 only in terms of the cumulative number of confirmed cases at the national level. This is because a larger number of nationals means more people are likely to be ill. For example, assuming that country A has a population of 40,000 and that they are not taking any measures against COVID-19, the cumulative number of confirmed cases in that country would be only 40,000, even if all their nationals were infected with COVID-19. For this country, the proportion of confirmed cases is 100% and COVID-19 is not under any control. However, assuming that country B has a population of 500 million and has taken some level of control measures to keep the cumulative number of confirmed cases below 50,000. Then the proportion of confirmed cases in that country is 0.01%, which indicates that COVID-19 is relatively well controlled in that country. In terms of cumulative confirmed cases, the number of confirmed cases in country B is indeed close to 10,000 more than in country A. However, from the point of view of effectiveness, the control measures taken in country B were much more effective than in country A and controlled the spread of COVID-19.

Since the COVID-19 pandemic outbreak in late 2019, local governments at all levels, under the leadership of the Communist Party of China and the state, have been exploring ways to respond to the pandemic, and the prevention and control posture for the COVID-19 pandemic has gradually shifted from the early emergency state of suppression and containment "city closure" to a permanent pandemic prevention and control decision of "precise control and effective treatment" [2]. In 2022, COVID-19 remains in the pandemic stage. The Chinese government has further developed the pandemic prevention and control policy into a general strategy of "external prevention of importation and internal prevention of rebound" and a general policy of "dynamic zero" [2]. Under the guidance of this policy, several rounds of large-scale nucleic acid campaigns have been carried out in many parts of China, and milestones have been achieved.

3 Process of Analysis

3.1 Policy Basis

The normalization of nucleic acid testing is a government requirement to respond to public health emergencies. The COVID-19 pandemic at the end of 2019 was a major public health emergency with the greatest difficulty in prevention and control, the fastest spread, the widest spread, and the greatest social impact since the founding of China [10]. A public emergency is an emergency event that occurs suddenly and causes or is likely to cause significant casualties, property damage, ecological and environmental damage, and serious social harm, endangering public safety. A public health emergency is a type of public emergency that mainly includes infectious disease pandemics, mass unexplained diseases, food safety, and occupational hazards, animal pandemic, and other events that seriously affect public health and life safety [11]. Public health emergencies are one of the important factors affecting the development of human socio-economic order, with suddenness, public attributes, and serious social hazards [12]. The pandemic has had different degrees of impact on China's economic development, social order, and the lives and safety of its citizens.

As the Chinese government has the functions of safeguarding people's democracy and the country's long-term stability, organizing socialist economic construction, and strengthening social construction, these functions require the government to promote the normal development of the country's economic and social order and protect the lives and various legitimate rights and interests of citizens. It is therefore the responsibility of governments at all levels to implement pandemic prevention measures to deal with the impact of the COVID-19 pandemic on various areas of the country. Large-scale nucleic acid testing, as a prerequisite and effective means of precise prevention and control, is one of the effective measures for the government to fulfill its functions.

COVID-19 is included in the law as a B Class infectious disease, and the law requires citizens to participate in the prevention and treatment of infectious diseases. On 20 January 2020, China's National Health Commission issued Announcement No. 1: With the approval of the State Council, pneumonia caused by COVID-19 infection is included as a B Class infectious disease under the Law of the People's Republic of China on the Prevention and Treatment of Infectious Diseases, and the preventive and control measures for A Class infectious diseases are adopted [13].

The Law of the People's Republic of China on the Prevention and Treatment of Infectious Diseases was enacted to prevent, control and eliminate the occurrence and prevalence of infectious diseases and to safeguard human health and public health [14]. This law used an enumeration method to stipulate the classification of infectious diseases, dividing them into Classes A, B and C.

> *"A Class infectious diseases shall include plague and cholera.*
>
> *B Class infectious diseases shall include viral hepatitis, bacillary and amebic dysentery, typhoid and paratyphoid, AIDS, gonorrhea, syphilis, poliomyelitis, measles, pertussis, diphtheria, epidemic cerebrospinal meningitis, scarlet fever, epidemic hemorrhagic fever, rabies, leptospirosis, brucellosis, anthrax, epidemic*

and endemic typhus, epidemic encephalitis B, kala-azar, malaria, and dengue fever.

C Class infectious diseases shall include pulmonary tuberculosis, schistosomiasis, filariasis, echinococcosis, leprosy, influenza, epidemic parotitis, rubella, tetanus neonatorum, acute hemorrhagic conjunctivitis and infectious diarrhea other than cholera, dysentery, typhoid and paratyphoid." [14]

In addition, the law also stipulates that the health administration department under the State Council may decide to increase, decrease or adjust the types of infectious diseases in B Class and C Class and announce them in accordance with the outbreak and prevalence of infectious diseases and the degree of danger. In the case of an outbreak of an infectious disease of unknown cause that requires the adoption of preventive and control measures for A Class infectious diseases referred to in this Law, the health administration department under the State Council shall promptly report to the State Council for approval before announcing and implementing the measures [14].

On 10 February 2020, the Supreme People's Court, the Supreme People's Procuratorate, the Ministry of Public Security, and the Ministry of Justice of China jointly formulated the Opinions on Punishing Illegal Crimes that Obstruct the Prevention and Control of COVID-19 Infected Pneumonia pandemic in accordance with the Law. It clearly states that the crime of resisting pandemic prevention and control measures is severely punished according to law. After listing the acts of spreading infectious diseases to which the crime of endangering public security by dangerous means applies, it stipulates that for other people who refuse to implement the preventive and control measures proposed by the health prevention and pandemic control agencies in accordance with the Law on the Prevention and Control of Infectious Diseases, causing the spread of COVID-19 or having a serious risk of spreading it, they shall be convicted and punished for the crime of obstructing the prevention and control of infectious diseases in accordance with the provisions of Article 330 of the Criminal Law.

Thus, COVID-19 pneumonia has been incorporated into Chinese law as a B Class infectious disease for which A Class infectious disease prevention and control measures have been adopted. Chinese citizens who violate the preventive and control measures proposed by the health and pandemic prevention agencies in accordance with the law, including mass nucleic acid testing, will face penalties.

3.2 Reality Requires

The COVID-19 pandemic has greatly impacted the normal functioning of our economy and society, negatively affecting the health, psychology, and lives of our citizens. In terms of physical health, the symptoms and severity of COVID-19 infection vary from person to person, with asymptomatic infections of the disease existing and those with symptoms predominating in mild cases (approximately 81%) [15]. Most of these patients have symptoms similar to influenza infection, such as fever and cough. Some patients also experience shortness of breath, muscle pain, headache, sore throat, nasal congestion, chest pain, and diarrhea [16]. There are also some patients whose sense of smell and taste may be affected or even lost [17]. In addition, there is evidence that some patients who recover from COVID-19 pneumonia continue to suffer from long-term complications

and sequelae in multiple organs and systems, typically lasting more than 12 weeks [18]. These studies suggest that once patients have contracted COVID-19 pneumonia, their health is likely to be compromised for an extended period.

In terms of the mental health dimension, many residents experienced psychological problems after the pandemic. Faced with a public health emergency, many people experienced some symptoms of anxiety [19]. Some scholars have pointed out that this is because when a pandemic occurs, individuals whose lives or property are at risk are prone to negative emotions such as stress, anxiety, and insecurity [20]. The prolonged isolation caused by a pandemic can lead to emotional symptoms such as fear, frustration, and boredom about contracting the virus, and people also have to deal with real-life stresses such as inadequate supplies, insufficient information, financial pressures, and stigmatized discrimination during isolation, and the effects of these psychological stresses on citizens can be pervasive and longer-term [21]. In turn, these real-life stresses and negative emotions can reduce the quality of life of residents, which in turn disrupts normal social interactions and lifestyles. Fortunately, studies have shown that raising awareness of COVID-19 pneumonia is beneficial in improving quality of life [22]. The normalization of nucleic acid testing is beneficial for improving the transparency of information on COVID-19, making the public feel in control of their disease and having a beneficial effect on the quality of life. Therefore, the development of regular nucleic acid testing is a practical need to protect public health and relieve psychological stress in the current environment.

3.3 Mass Foundation

Citizens obey law-based authority. The inclusion of COVID-19 pneumonia in the Law of the People's Republic of China on the Prevention and Treatment of Infectious Diseases is of great significance for the common participation of citizens in the prevention and control of the COVID-19 pandemic. The Law of the People's Republic of China on the Prevention and Treatment of Infectious Diseases is the core law enacted to prevent, control, and eliminate the occurrence and prevalence of infectious diseases and to safeguard human health and public health [23]. Because of this, this law plays a pivotal role not only in the field of infectious disease prevention and control but also in the development of health and health care as a whole.

Max Weber has mentioned in his book Economy and Society that legal authority is founded on the acceptance of the validity of interdependent ideas, and that any given legal norm can be established by agreement or imposition, on the grounds of expediency or value-rationality, or both, usually requiring the obedience of persons in the area covered by the territory [24]. The Chinese government has incorporated the prevention and control of COVID-19 into the law, from the perspective of expediency, in response to a sudden pandemic, and from the perspective of value-rationality, to protect the Chinese economy, social order, and the health of its citizens affected by COVID-19. For these reasons, it is the responsibility of Chinese citizens to comply with the authority of the law and to unite against the adverse effects of COVID-19 pneumonia in all areas. It can therefore be argued that the successful implementation of regular nucleic acid testing is the inevitable result of the people's compliance with a law-based authority.

In addition to legal constraints, large-scale nucleic acid testing cannot be carried out in an orderly manner without the active cooperation of citizens. Wang (2021) claims that universal nucleic acid testing is a social effort that requires a high participation rate, which requires good health literacy and awareness of prevention and control among the population [25]. In discussing the reasons for the successful prevention and control of the pandemic in China, Gao(2022) also mentioned that the scientific literacy and healthy lifestyle of citizens, as well as mutual trust, self-discipline, tolerance, and understanding, supported the scientific response to pandemic [26]. According to the former study, it showed that in the face of a pandemic, the population's expectation of a healthy life and normal social life is very urgent, and the need and expectation for social order restoration is higher than that for economic order restoration [27]. The normalization of nucleic acid testing can help to identify people infected with COVID-19 pneumonia throughout society and achieve precise prevention and control. Therefore, the public is actively cooperating with large-scale nucleic acid testing, expecting that they can jointly contribute to the restoration of social order.

Besides, the normalization of nucleic acid testing as a free medical security service provided by the government to the public has provided social security and security for the residents, enhancing the sense of fairness and dignity of their rights [27]. In addition, as an unexpected public health event, the COVID-19 pandemic triggered public panic, anxiety, depression, and other psychological crises [28]. Conducting regular nucleic acid testing is conducive to the timely screening of potential risks through regular testing, promoting timely disclosure of pandemic information by the government to all residents, enhancing citizens' trust in the government, and reducing the public's psychological crisis.

3.4 Technology Support

The improvement in technology and efficiency of nucleic acid testing has provided technical support for the implementation of normalized nucleic acid testing in China. At the beginning of the COVID-19 pandemic outbreak, the nucleic acid testing method used in some regions of China was single-collection or single-test. This testing method is accurate but inevitably inefficient. Since the incubation period of COVID-19 pneumonia is generally two weeks, time and efficiency need to be grasped to complete centralized nucleic acid testing for the whole population in one transmission cycle. Based on this situation, Wuhan was the first city to apply the "mixed sampling" method to large-scale nucleic acid testing.

Mixed sampling refers to placing samples from 5 to 20 individuals in a single collection tube at the time of collection for subsequent testing. This sampling method is scientifically validated, both in terms of its collection tube size and material as well as its viral preservation fluid composition and content, and is precisely designed to meet the requirements of large-scale screening, which can significantly improve screening efficiency [29]. The generalizability of this method within China was later validated. This is because shortly after the completion of the universal centralized nucleic acid testing in Wuhan, there were multiple confirmed cases in Beijing and Urumqi. At that time, large-scale nucleic acid testing was urgently needed to map the pandemic situation in the whole city. It was due to Wuhan's rich experience in nucleic acid testing that these

areas were able to complete large-scale nucleic acid testing. Nowadays, to meet the need for regular nucleic acid testing, this mixed collection method has gradually replaced single collection and is used in more areas of China.

3.5 Significance of Nucleic Acid Normalization

The normalization of nucleic acid testing is conducive to achieving precise prevention and control and creating a healthy and safe living environment for people. Through large-scale nucleic acid testing, we can maximize the number of asymptomatic infected people, grasp the development pattern of pandemic transmission, and consolidate the pandemic prevention and control results that have been achieved so far [25]. Wuhan, where COVID-19 was first detected, was unblocked after the universal nucleic acid testing, and the pandemic of novel coronary pneumonia in Wuhan continued to improve after the unblocking, with the detection rate of asymptomatic infections at a very low level. This result indicates that COVID-19 pandemic prevention and control measures in Wuhan have been effective, and also shows that large-scale nucleic acid testing is one of the effective measures to test the effectiveness of pandemic prevention and control in a city.

Besides, the normalization of nucleic acid testing is an important driving force to promote the resumption of production and economic development in the city. The COVID-19 pandemic has brought a huge impact on the nation's economy and further affected the normal order of people's lives. Carrying out centralized nucleic acid testing and screening, will help speed up the restoration of normal economic and social order, overcome the adverse effects brought by the COVID-19 pandemic, and minimize the damage of the pandemic to the economy and society.

4 Future Suggestions

It is necessary to improve the technology and efficiency of nucleic acid testing. Timely identification of infected individuals is the purpose of regular nucleic acid testing. Most residents now need to travel with a negative nucleic acid result certificate within 48 h. However, current nucleic acid testing methods take several hours to get the test results, which still creates a hindrance for people to travel. Therefore, it is important for citizens to shorten the time to get the results of nucleic acid tests while ensuring the accuracy of the results. The techniques that have been used for the clinical detection of COVID-19 include real-time fluorescent quantitative PCR, ring-mediated isothermal amplification, CRISPR and gene sequencing, and electrochemical methods based on viral nucleic acid detection, and enzyme-linked immunosorbent assay, immunocolloidal gold, chemiluminescence, and fluorescent immunoassay based on viral antibody detection [30]. According to the clinical results, all these detection methods have their advantages and disadvantages. Based on the above reasons, the integrated use of various technical means and innovative nucleic acid detection techniques and methods to improve the speed and quality of detection is beneficial to improve the efficiency of nucleic acid detection and further facilitate the daily life of residents.

The government and related departments need to convey the right message to the community promptly. As mentioned earlier, as an unexpected public event, the COVID-19 pandemic caused public panic, anxiety, depression, and other psychological crises. A previous study by Tang and Kong (2020) showed that reliable information released by the government at the beginning of the pandemic was an effective way to counteract the public's psychological crisis, and the public's trust in the government helped to reduce their psychological crisis [28]. Liu et al. (2021) also claimed that COVID-19 cognition would alleviate depression and thus improve quality of life [22]. Consequently, the government and relevant departments should promptly release the latest pandemic information to the public, including prevention and control details, interpretation of prevention and control policies, and protection knowledge. In this way, the transparency of COVID-19 information can be improved so that the public can feel that the pandemic is controllable. This is helpful to reduce the psychological stress of residents and improve their quality of life.

5 Conclusion

The successful implementation of the current normalization of nucleic acid testing in China cannot be separated from China's policy base, practical needs, public base, and technical support. The normalization of nucleic acid testing is important for achieving precise prevention and control, creating a safe and healthy environment, and consolidating the achievements of pandemic prevention. In the future, the government and related departments need to release the latest pandemic information to citizens on time to reduce their psychological pressure. The pandemic prevention workers can further improve the technology and efficiency of nucleic acid testing from the needs of the residents to promote the restoration of normal life order of the residents.

However, the limitation of this study is that the analysis of the reasons is not comprehensive. The large-scale implementation of routine nucleic acid testing is not limited to the four reasons mentioned in this study. Because of the complexity of China's national situation, a policy is often implemented for a combination of reasons. For example, the financial base of the Chinese government and the current level of information technology in China is also favorable conditions for the normalization of nucleic acid testing. Therefore, future researchers can further analyze the favorable factors that promote the normalization of nucleic acid testing, taking into account the situation and anti-pandemic experience of different regions in China and provide scientific reference and basis for other regions and countries.

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