Non-pharmaceutical interventions taken by China during the prevention and control of COVID-19

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Abstract. To study and analyze the effective non-pharmaceutical interventions taken by China during the avoidance and management of COVID-19, in order to provide suggestions for future response to major public health emergencies. Search for keywords such as 'COVID-19', 'SARS-CoV-2', 'non-pharmaceutical interventions', and 'control strategies' on PubMed, and establish domestic and foreign literature as well as dynamic epidemic reports and expert comments issued by official institutions and summary. During the epidemic, traditional infectious disease prevention measures were adopted, such as isolation, case testing, personal protection (wearing masks), and new measures, such as expanding social distance and restricting travel. Through the precise implementation of prevention and control measures, most Asian countries, mainly China, have effectively controlled the spread of the new coronavirus in the first half of 2020. Studies have shown that measures taken during the epidemic have reduced the spread of the new coronavirus and the incidence of other respiratory infectious illnesses. For the outbreak center of the epidemic, taking Wuhan as an example, targeted prevention and control measures such as closing schools, closing cities, and establishing sheltered hospitals have been adopted, and these measures have achieved remarkable results. Only by doing so can we minimize the virus spread and curb the spread of the epidemic.

Keywords: COVID-19, non-pharmaceutical interventions, control strategies.

1. Introduction

In December 2019, a brand new type of coronavirus, severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), emerged in Wuhan, Hubei. It caused a new type of coronavirus pneumonia called coronavirus disease 2019 (COVID-19). Subsequently, the novel coronavirus pneumonia outbreak broke out and expand globally. SARS-CoV-2 is very contagious. The basic reproduction number R0 published by the Chinese Center for Disease Control and Prevention on January 28, 2020, on-site traceability survey is between 2 and 3 [1]. This data was adopted by the World Health Organization (WHO). The Los Alamos National Laboratory in the United States believes that the infectivity of SARS-CoV-2 is higher than originally estimated, with R0 between 4.0 and 6.7 [2]. Based on data-driven analysis, teams such as China Ruijin Hospital estimated that the R0 of SARS-CoV-2 on the "Diamond Princess" cruise ship was 2.28 [3]. Although there are different research methods, both R0> 1 suggest that SARS- CoV- 2 is highly infectious. As of January 2021, the cumulative number of confirmed cases worldwide has exceeded 100 million, and the number of deaths has exceeded 2.1 million [4]. COVID-19 is highly contagious, the population is generally susceptible, and the transmission mode is easy to achieve [5]. In the absence of understanding, COVID-19 is a new infectious disease. At the beginning of the outbreak, there was a lack of awareness of the new coronavirus's infectiousness, pathogenicity, and virulence. Also, there was a lack of effective treatment drugs and vaccines that could be used for vaccination. The deterrence and regulator of the new crown virus pneumonia epidemic in 2020 would mainly adopt non-pharmaceutical intervention measures, including monitoring reports of patients and asymptomatic infections, patient isolation treatment, health follow-up, and monitoring after cure and discharge, close contact tracking, testing, and medical observation, high-risk Screening of key populations, disinfection of the epidemic source, personal protective measures such as suspension of work, suspension of business, suspension of classes, travel restrictions, etc. according to the development

trend of the epidemic [6]. This review systematically elaborates the published articles analyzing non-pharmaceutical intervention measures and aims to summarize effective prevention methods taken in the face of the epidemic. It is hoped that it can provide scientific evidence for future emergencies and be able to respond. It can be applied in a major epidemic similar to the COVID-19.

2. Social Distance

Social distance, also known as physical distance, is a set of non-pharmacological mediations or procedures to stop the spread of infectious diseases by preserving physical distance between people and decreasing the number of close contacts with each other. Such measures include closing schools, closing workplaces, canceling mass gatherings (such as sports events, concerts, and political gatherings), restricting travel (restricting face-to-face contact, leading business activities via telephone or the Internet, isolation (blocking highways and isolation of arriving train passengers).

2.1. Physical Distance

Physical distance refers to maintaining the space between oneself and people outside the family. This is attained by avoiding groups, large gatherings and keeping a distance of 2 meters from other people to lower the risk of direct transmission of new coronary pneumonia. Individual countries determine the size of the group or gathering according to their local conditions. These rules must be implemented consistently and without prejudice to maintain the public's trust and thus maintain compliance. A systematic review of physical distances in the workplace found that the policy has reduced the incidence of influenza among the general population by 23% [7]. The effective implementation of physical distance is very important to its effectiveness. For example, a simulation study reported that a single physical distance intervention is not very effective because once the distance is removed, the case is likely to make a comeback.

2.2. Lockdown

It is a community-wide containment strategy designed to minimize human interaction without basic medical care, security, and basic utilities. This severe non-pharmaceutical intervention will only become a means to stop or slow down community transmission. In the early stages of the epidemic, the Chinese government initiated an unprecedented stringent measure: Lockdown Wuhan and several other neighboring cities in Hubei Province to quickly curb the large-scale outflow of infected cases and restrict the flow to the epicenter [8]. To assess the impact of China's lockdown, a team of researchers compared the growth curve of cases and linked it to domestic air traffic. Their assessment is based on data from a public report about new coronary pneumonia. In the short period after the lockdown was implemented, the duration of new coronary pneumonia cases significantly doubled, from 2 days (95% confidence interval; 1.4-2.6) to 4 days (95% confidence interval: 3.5-4.3) [9].

A study concluded that epidemic prevention and control results in countries that did not implement lockdowns and social distancing were poor. At the same time, if countries that implemented lockdown measures later and countries that did not strictly restrict lockdowns, they would get poor results. The anti-epidemic effect is also poor. Perhaps, a complete lockdown across the country may be more beneficial. The lockdown brought mandatory physical distance, but at a huge economic cost.

3. School Closure

Closing schools is an important NPI because schools provide an ideal environment for the rapid spread of infection. Young children may not comply with the use of NPI. For example, it is very difficult to require children to maintain physical distance in classrooms and playgrounds. School closures reduce the possibility of transmission among students and between school staff and students. School closures also force parents and caregivers to stay at home, thereby reducing parents' work risks. In the first half of 2020, China has also taken measures to close schools, and schools and

universities have changed to online teaching methods. At the same time, most studies evaluate school closures as part of other interventions rather than as a single measure.

A systematic review of more than 100 studies in the UK found that the benefits of closing schools depend on the low transmission rate of the disease R0<2, and the incidence of children must be higher than that of adults [10]. Through the evidence provided by the most recent review, the reviewers found that school closures and social distancing to prevent the spread of disease among school-age children can only prevent 2% to 4% of deaths [11].

However, online education after closed schools will have an impact on the results of education, and at the same time, have varying degrees of adverse effects on the eyesight of students. In addition, health interventions provided by schools, such as school meals and school sports activities, will also be omitted. Care must be taken when reopening school because other children may be asymptomatic.

4. Airport Closure/Travel Restrictions

The convenience of worldwide travel is an important reason for spreading this disease globally, which has led to a pandemic. One author described the linear relationship between the number of cases and China's domestic air passenger traffic (R2-0.92; P<0.19) and international air travel (R2-0.98;) [12]. Based on the daily incidence data of new coronary pneumonia and the connectivity of the global airport network, some researchers found that the travel restrictions implemented by China avoided 70% of cases that were supposed to be exported. In the first 3 weeks of implementation, the rate of daily export cases decreased 81% [10]. However, the impact of these measures is limited to the early stages of the pandemic, and under-reporting is also a limitation of this study [13]. The travel restrictions imposed by Wuhan were implemented together with the blockade, which is estimated to slow the progress of the pandemic in other parts of China by 3-5 days [14]. Another report estimated that after introducing travel control measures in Wuhan, China, the daily median RO fell from 2.35 to 1.05 [15]. In addition, a form of voluntary travel restrictions provided to the public is to avoid unnecessary travel.

5. Isolation/Quarantine

Case isolation refers to the separation of people diagnosed with infectious diseases from those who are not. Isolation in the early stage of the epidemic can control the impact of personal activities on transmission [16]. The prerequisite for successful isolation is to conduct timely and timely treatment of each confirmed patient. Comprehensive contact tracking. Isolation can be done at home or in a designated place [17]. The New Coronavirus Epidemic Research Team of the London School of Tropical Medicine established a model showing that family quarantine delayed the epidemic's peak by 8 days (IQR: 5-11) and avoided 190,000 new infections during the entire epidemic (IQR: 185000-194000). Institution-based quarantine delayed the epidemic's peak by 18 days and reduced 18,900 new infections (IQR: 18700-19100). During the entire epidemic, a total of 546,000 cases (IQR: 540,000 to 550,000) were avoided. Compared with home isolation, the incidence rate was reduced by about 57% [18].

Quarantine is the activity of isolating and restricting contacts of possible cases. Medical observation is used to determine whether they are infected with the virus, thereby reducing their risk of infecting others. Specific measures include movement restrictions, ideally combined with medical observation [19].

The effectiveness of the measures depends on the sequence interval (the time interval between the appearance of clinical symptoms in the first-generation case and the time interval between the appearance of clinical symptoms in the second-generation case), the number of infections, and the feasibility of contact isolation [19].

According to a quick review by Cochrane [20], 10 simulated new coronary pneumonia studies conducted in China, the United Kingdom, South Korea, and the "Diamond Princess" cruise ship all

found that this measure successfully reduced the COVID-19 pandemic. The morbidity and mortality of the disease have reduced the number of patients by 44%-81% and the number of deaths by 31%-63% while reducing the cost of epidemic prevention.

Corey M Peak's [21] team established an epidemiological model analysis of public health intervention measures for the new coronavirus pneumonia epidemic in different situations. It concluded that the epidemic outbreak could be controlled in a short time when the contact isolation rate reaches 75%.

In isolation (case isolation) and quarantine (close contact management) in China, both suspected and confirmed cases are concentrated in specified hospitals with successful isolation and prevention requirements for isolation and treatment. The country has begun implementing grid-based and carpet-style management, focusing on tracking and urging personnel from areas where the epidemic occurred and home medical observation for 14 days.

However, isolation and quarantine also have some negative consequences, which must also be managed carefully. A survey conducted among people who had to be isolated found that the incidence of mental health diseases was high [22, 23]. In this regard, some scholars advocate that the time required to isolate individuals should not exceed the requirements as much as possible, and deliver obvious explanations for isolation and ensure that adequate supplies are provided [21].
personal protective

6. Hand Hygiene

It is essential to curb the new coronary pneumonia disease. This is because hand washing has been proven to reduce disease-causing hand-contaminating microorganisms by up to 90%, and respiratory diseases are generally reduced by one-fifth [24]. It is recommended to promote frequent, thorough, and strict handwashing with soap and tap water for at least 20 seconds at the community level. You can use alcohol-based hand sanitizer when there is no soap or obvious stains on your hands. The alcohol content of the hand sanitizer must be at least 60% [25]. Some domestic researchers have tested the wiping effect of various hand sanitizers. After deliberately contaminating the hands of one of the authors, they used a laboratory-grown low pathogenic avian influenza virus. They used towels soaked in water containing 1% soap powder, 0.05% sodium hypochlorite active chlorine, and 0.25% sodium hypochlorite active chlorine. Wipe your hands. Wiping hands with these solutions reduced virus contamination by 98%, 96%, and 99%, respectively [26].

7. Face Mask

The WHO issued a standard on applying masks in the context of the new crown pneumonia pandemic for public use and used in medical settings [27]. In a community environment, the first consideration should be to maintain physical distance. However, if you cannot maintain a physical distance of 1 to 2 meters from others, it is recommended to use any type of mask. Masks are a form of source control of infected persons. During the pandemic, the use of masks is a form of citizens taking responsibility for their health. (Use environment) It is recommended to use masks when the physical distance cannot be reached, such as in public transportation (buses, planes, or trains), and under specific working conditions where employees are in close contact with others [27].

The Modern Preventive Medicine in China [28] clearly pointed out that masks are an important line of defense to prevent respiratory infectious diseases and can reduce the risk of new coronavirus infections. The exposure risk of different populations to the new coronavirus environmental pollution can be divided into five levels: high, high, medium, low, and low risk. It is recommended to choose the appropriate type of mask according to the nature of the epidemic prevention work and the risk level. A study in Hong Kong, China [29] showed that wearing a mask significantly reduces the impacts. This measure can reduce the risk of new coronavirus infections in the population and, At the

same time, decrease the spread of other respiratory viruses. In the second round of high-incidence period of the epidemic, wearing masks is still an effective personal protection measure in public.

8. Testing and Contact Tracing

The use of large-scale testing to detect and isolate asymptomatic cases is a crucial strategy to curb the spread of the virus [30]. The prevention of the new coronavirus (COVID-19) is based on case testing and isolation. Commonly used case detection methods are mainly nucleic acid detection and antibody detection. Nucleic acid testing is currently the gold standard for discovering patients with new coronavirus pneumonia. Still, its accuracy is interfered with by various external factors, which may lead to a missed diagnosis of new coronary pneumonia [31]. The combination of nucleic acid testing and antibody testing can improve the positive detection of new coronary pneumonia. Out rate [32]. A research team conducted rapid detection of contacts of newly discovered cases in some communities in Arizona, USA. Observational studies found that the mortality rate in these communities was 1.1%, which is much lower than the mortality rate reported in other parts of Arizona [33]. Korean successful method of controlling the spread of the epidemic is to conveniently conduct tests at drive-through stations and then conduct intensive tracing of contacts of confirmed cases [34, 35]. This measure has effectively reduced the spread in the community [33] and is helpful for early detection, early diagnosis, and early treatment of confirmed cases to achieve early prevention. Since October, many countries have entered the second round of high-incidence period of the epidemic, and timely detection and isolation are still the main public health intervention measures. Increasing testing will increase the number of false negatives and false positives.

According to the definition of the WHO [36], contact tracing refers to monitoring and tracing close contacts of confirmed cases to prevent the further spread of the virus. The tracking methods adopted for this epidemic include digital tracking (based on mobile phone applications) and manual tracking (mainly telephone interviews). Digital tracking can more effectively control this epidemic [37]. After modeling and analysis, Bi [38] pointed out that the cases based on symptom monitoring and tracking were diagnosed on average 5.5 days (95%CI: 5.0~5.9) after the onset of the disease. In comparison, the cases found by contact monitoring were diagnosed on average 3.2 days (95%CI) after the onset of the disease. :2.7~3.8) The diagnosis is confirmed. Studies have shown that contact-based interventions are more effective than case-based measures. RachaelPung et al. [39]. Analyzed the epidemiological and clinical data of confirmed cases, and the results showed that this measure is essential to reduce the risk of widespread transmission in the community. An optimized contact tracking strategy (with a short delay and high coverage) can greatly reduce the number of infections [40]. Although digital applications are a faster and more reliable method of contact tracking, digital tracking is used to monitor Personal actions that have caused privacy issues, which need to be understood to be better implemented.

9. Conclusions

As the understanding of new coronary pneumonia continues to deepen, the world has basically reached a consensus on effective non-pharmaceutical interventions. However, non-pharmaceutical interventions based on restrictive measures are likely to cause panic among the people and have a certain impact on social and economic development, and sustainability is poor. Because these non-pharmaceutical interventions will be interfered by many factors, such as culture, religion, politics, and economics, etc., different countries or regions have great differences in implementing the same measure. This is also the main reason for the different prevention and control effects of different countries. On the surface of the current study, a single measure such as closed schools have little effect, and multiple public health intervention measures can be implemented simultaneously to contain the spread of the epidemic to the greatest extent. Studies have shown that the measures implemented during the epidemic reduced the spread of the new coronavirus and reduced the

incidence of other respiratory infectious illnesses. As for the outbreak center of the epidemic, taking Wuhan as an example, targeted prevention and control measures such as closed schools, closed cities, and the establishment of shelter hospitals have been adopted, and these measures have achieved remarkable results. During the second round of the high-incidence period of the epidemic, measures such as expanding social distancing and travel limits are flexibly adopted in accordance with the risk situation in local areas. This study has certain limitations. The summary of each measure is not comprehensive enough. Most of the existing research on individual measures are comprehensive measures in a certain period, and the best combination of measures cannot be obtained. Therefore, further research is needed for the analysis of single measures.

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