

Effective Infection Control Accelerated SARS-CoV-2 Suppression in China

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The novel coronavirus pneumonia disease (COVID-2019), which began in December 2019, was a severe respiratory infectious disease caused by a new coronavirus (SARS-CoV-2) infection in Wuhan, Hubei province^{1,2}. The disease is highly infectious, and infectious in asymptomatic incubation period. The total number of new confirmed cases has dropped more than 30 consecutive days, and the number of new deaths has remained at a low level (Figure 1).” This shows that the national epidemic development has been effectively controlled and continues improving (Figure 1), especially in areas outside Hubei.

Such periodical results were achieved by the joint efforts of the whole society, including not only the hard work and dedication of the front-line medical workers but also the active cooperation of the general public. Although the strict epidemic prevention and control measurements have brought remarkable control results, the economic productions of the whole society have been greatly affected. In the present

study, the basic infection number of the coronavirus R_0 (basic replication number of the infection, Table 1) before and after prevention and control measurements was simulated and to elaborate the measurements of the Chinese government on epidemic prevention and control, providing a guidance for the people worldwide³.

On December 31, 2019, the experts of the National Health Commission (NHC) arrived in Wuhan. On January 3, 2020, China reported the epidemic situation to the World Health Organization (WHO), United States and surrounding countries. On January 8, NHC confirmed the new coronavirus as the source of the epidemic situation. On January 17, NHC suggested to be aware of the risk of human to human transmission and asymptomatic infection. The novel coronavirus pneumonia was included in the legal infection source on January 20 (R_0 , 2.93; Table 1). At same time, Nanshan Zhong, academician, confirmed human to human transmission of the novel coronavirus pneumonia. Then the novel coronavirus pneumonia was listed in the class B infectious diseases according to the Law of the People's Republic of China on the Prevention and Treatment of Infectious Diseases, and adopted the prevention and control measurements based on class A infectious diseases. The comprehensive prevention and control measurements of novel coronavirus pneumonia include three aspects, including the management of infectious source, the transmission route cut off and protection of susceptible population. On January 23, 2020 (R_0 , 2.52; Table 1), Wuhan was isolated.

The Standing Committee of the Political Bureau of the Communist Party of China (CPC) Central Committee held a meeting on the prevention and control of the pneumonia epidemic caused by the novel coronavirus on January 25 (R_0 , 2.44; Table 1). The meeting set up a CPC Central Committee leading group to conduct the battle. Till February 29, 2020, the CPC Central Committee leading group has held twelve conferences; remarkable achievements have been obtained.

With the conference measures, China has made great efforts to fight against the epidemic so as to protect Chinese people and the people around the world. The summary is as follows:

1. Epidemic surveillance and isolation of infectious sources. For example, strengthen case discovery and case report. Early detection, early report, early diagnosis, early isolation and early treatment. Hotels, venues, schools and other places were expropriated to carry out centralized treatment and isolation. The “leishenshan” and

“huoshenshan” hospitals were built within 10 days, and the shelter hospitals were built as well. The suspected cases were confirmed or excluded within 48 hours. Close contacts were sampled for testing and medical observation.

2. Prevention and control of aggregate epidemic, migrant workers, medical workers and community. Postpone and reduce meetings and mass gatherings, close public places where people gathering. The school carries out online teaching. Epidemic prevention and control also was adopted to monitor transportation after Spring Festival and resumption of work at different time. Medical staff should be trained to handle prevention and control measurements. People returned from Wuhan must carry out home-based medical observation for 14 days. Continue to implement the detection and treatment of the first cases in communities, workplaces and other units to prevent the outbreak from rebounding after returning to work.

3. Strengthen the effective treatment of patients. It includes rapid development of effective treatment and prevention methods. Novel coronavirus pneumonia diagnosis and treatment plan (trial version sixth) was issued by NHC, which recommend the clinical application of Chloroquine Phosphate and Arbidol. The plan also provides the treatment of integrated traditional Chinese and Western medicine. Measures have been made and taken to help enterprises, for example, the measures used to strengthen emergency supplies for medical supplies and daily necessities including the development of simple detection reagents, drugs and vaccines; the measures used to support production enterprises that urgently need medical materials such as medical protective clothing and masks; the measures used to help enterprises quickly reach production capacity, expand production capacity and increase production in various ways.

4. Strengthen international cooperation. Strengthen cooperation among countries around the world, and invite experts with experience in emerging infectious diseases to China to participate in prevention and control.

These strict segregation measures, including long-term control of cities, are unlikely to be accepted in many countries. However, the current SARS-CoV-2 outbreak is moving rapidly. As of March 1, 2020, there are more than 7,000 cases in 60 other countries. The new coronavirus may soon become a pandemic, so the world should consider these effective measures.

References

1. N Z, D Z, W W, et al. A Novel Coronavirus from Patients with Pneumonia in China, 2019. *The New England journal of medicine* 2020.
2. C H, Y W, X L, et al. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet (London, England)* 2020.
3. Koff RS. *Infectious diseases of humans: Dynamics and control*. By R.M. Anderson and R.M. May, 757 pp. Oxford: Oxford University Press, 1991. \$95.00. *Hepatology* 2005;15:169-.

Conflicts of interest

The authors declare that there are no conflicts of interest.

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Figure legends

Figure 1. Declination trend of SARS-CoV-2 after the implementation of the prevention and control measures. A. Development of SARS-CoV-2 incidence in China (yellow, confirmed cases; orange, susceptible cases; purple, dead cases; green, recovered cases). B. The dynamic of infectious populations. The blue line is the fitted curve of SARS-CoV-2 confirmed cases. The gray area is the 95% confidence interval. C. The basic reproductive numbers R_0 values of SARS-CoV-2 from Jan 18 to Feb 23, 2020. D. Prediction of R_0 values under constant infection prevention and control. The epidemic will enter the turning point ($R_0 < 1$) around March 5, 2020. The light gray area is 95% confidence interval, the dark gray is 80% confidence interval.

Table 1. R_0 values from January 18 to February 19, 2020.

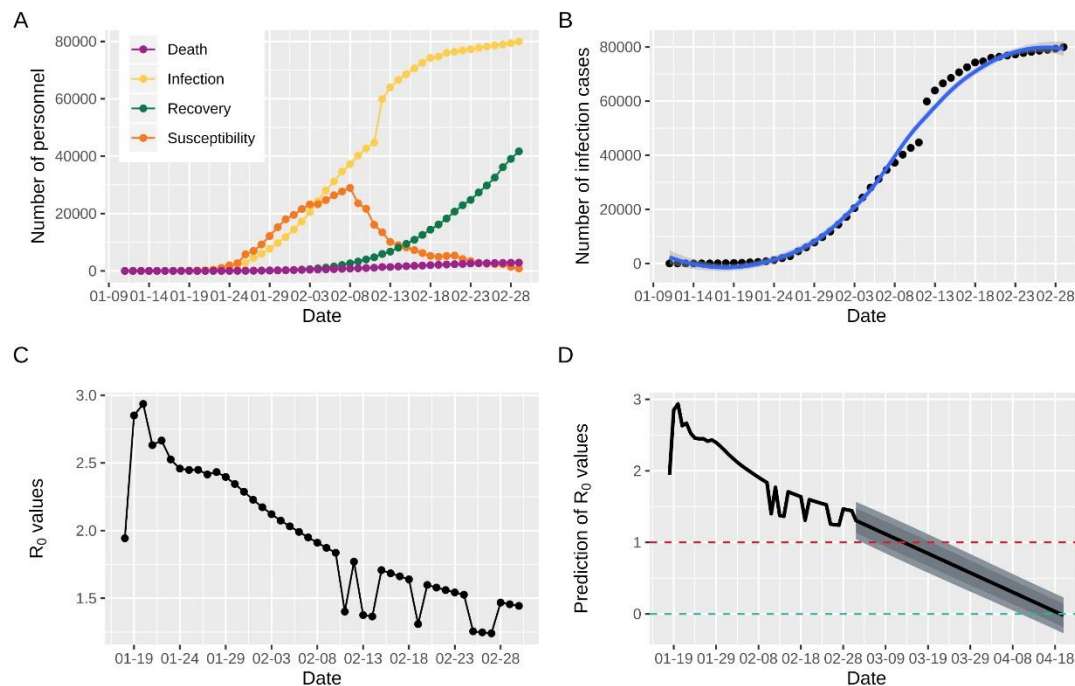


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Table 1. R_0 values from January 18 to February 29, 2020.

date	Jan 18	Jan 19	Jan 20	Jan 21	Jan 22	Jan 23	Jan 24	Jan 25	Jan 26	Jan 27
R_0	1.94	2.85	2.93	2.63	2.66	2.52	2.45	2.44	2.44	2.41
date	Jan 28	Jan 29	Jan 30	Jan 31	Feb 1	Feb 2	Feb 3	Feb 4	Feb 5	Feb 6
R_0	2.43	2.39	2.34	2.28	2.22	2.17	2.12	2.07	2.03	1.99
date	Feb 7	Feb 8	Feb 9	Feb 10	Feb 11	Feb 12	Feb 13	Feb 14	Feb 15	Feb 16
R_0	1.94	1.91	1.87	1.83	1.40	1.76	1.37	1.36	1.70	1.68
date	Feb 17	Feb 18	Feb 19	Feb 20	Feb 21	Feb 22	Feb 23	Feb 24	Feb 25	Feb 26
R_0	1.66	1.63	1.30	1.59	1.57	1.56	1.54	1.53	1.26	1.25
date	Feb 27	Feb 28	Feb 29							
R_0	1.47	1.46	1.44							