



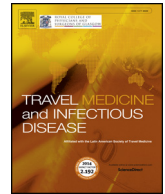
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Contents lists available at ScienceDirect

Travel Medicine and Infectious Disease

journal homepage: www.elsevier.com/locate/tmaid

Epidemiology of 2019 novel coronavirus in Jiangsu Province, China after wartime control measures: A population-level retrospective study

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ARTICLE INFO

Keywords:

COVID-19

Close contacts

Wartime control measures

Jiangsu

ABSTRACT

Background: A novel coronavirus emerged in China in December 2019, and human-to-human transmission was previously identified. This study aimed to compare the epidemiological characteristics in Jiangsu Province and assess whether so-called wartime control measures changed the trend of coronavirus disease 2019 (COVID-19) in the province.

Methods: Epidemiological data were obtained from the websites of China's Bureau of Health and the People's Government of Jiangsu Province and informal online sources from January 22 to February 20, 2020.

Results: The cumulative number of patients in Jiangsu Province (over 79 million people) was 613. The number of daily confirmed new cases reached the inflection point on January 31 with the maximum of 39 cases. The temporal number of patients peaked from January 29 to February 9. The proportion of confirmed cases who were residents or travelers to Hubei Province was 100.0%–58.8% before January 31 and then gradually declined. The proportion of close contacts increased gradually from January 27 to February 17. The geographical distribution of COVID-2019 cases showed that all 13 cities reported confirmed new cases after only five days of the first confirmed new case in Suzhou. The cases were concentrated in Nanjing, Suzhou, and Xuzhou with a high population density (over eight million people). The epidemiological features of COVID-2019 cases in Wuxi, Jiangsu showed that seven confirmed cases were tourists from others areas beyond Hubei Province. The longest incubation period of COVID-2019 was 19 days based on the onset of laboratory-confirmed cases.

Conclusion: The number of daily confirmed new cases in Jiangsu Province peaked around January 31 and then declined. This result emphasized that wartime control measures, such as putting cities on lockdown to limit population mobility in Jiangsu Province, resulted in dramatic reductions in COVID-19 cases.

1. Introduction

Pneumonia cases infected by unexplained new coronavirus were first reported in December 2019 from Wuhan, China [1,2]. The World Health Organization named this novel coronavirus disease as coronavirus disease 2019 (COVID-19) on February 11, 2020. COVID-19 is similar to severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome that can cause fever and serious respiratory symptoms, such as cough, wheezing, and dyspnea [3–5]. This novel coronavirus can quickly spread from person to person and can lead to widespread outbreaks when infected individuals travel to different areas or countries. With the celebration of Chinese New Year from

January 24 to January 25, 2020, more than five million people left Wuhan, and some of them were infected with the 2019 novel coronavirus (SARS-Cov-2), [6,7]. After a rapid increase in the number of new confirmed cases outside Hubei Province, all 31 provinces in mainland China (autonomous regions and municipalities directly under the central government) had reported COVID-19 cases. China was actively responding to the outbreak of the disease and implemented the national security strategy for COVID-19, which turned to so-called wartime control measures, and put cities in Hubei Province on lockdown on January 23, 2020 [8]. In other areas outside Hubei Province, the epidemiologic characteristics of COVID-19 were unclear as well as whether wartime control measures were able to control the disease.

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<https://doi.org/10.1016/j.tmaid.2020.101654>

Received 12 March 2020; Received in revised form 26 March 2020; Accepted 27 March 2020

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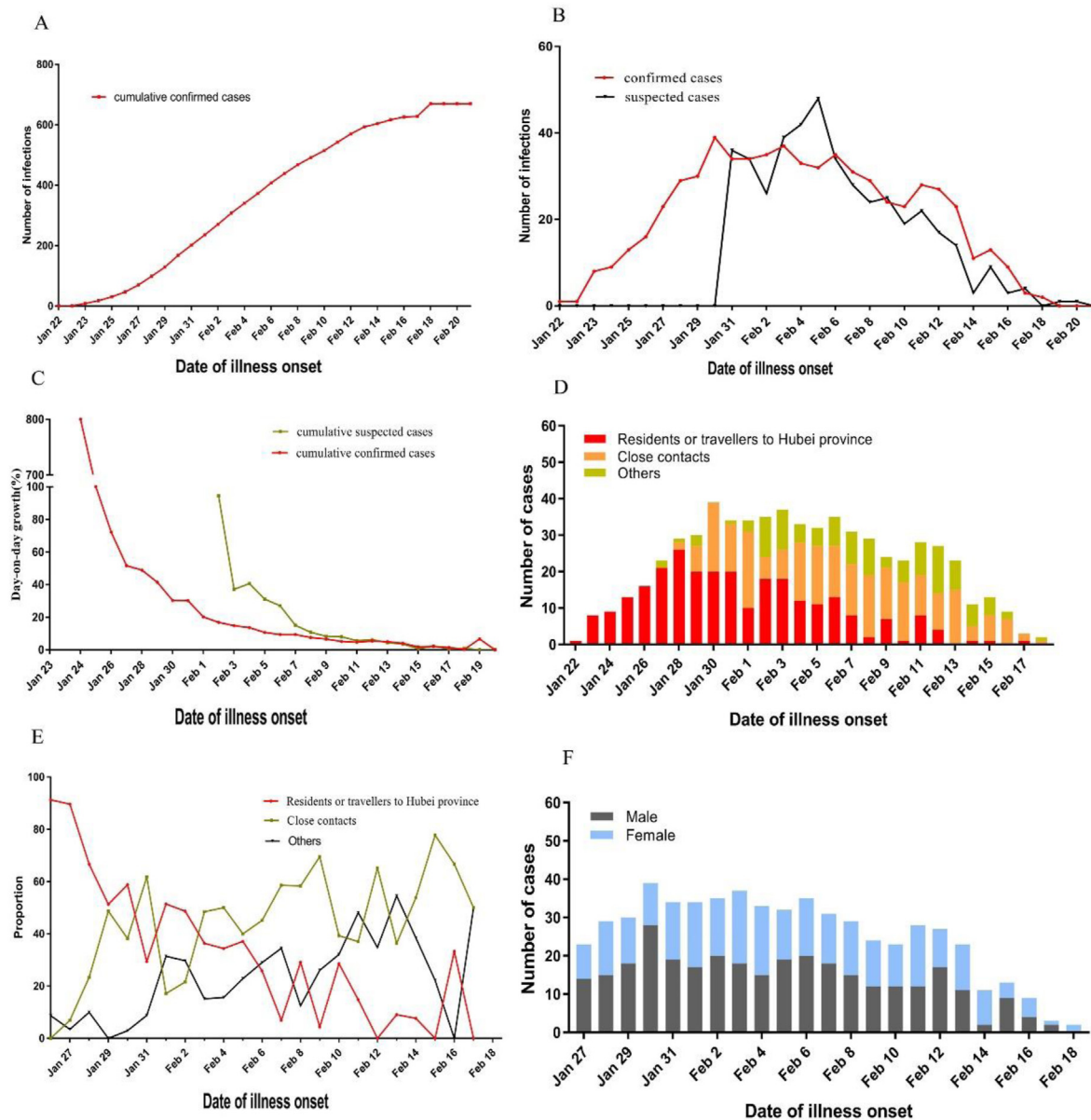


Fig. 1. Occurrence of COVID-19 cases over calendar time in Jiangsu Province. (A) Cumulative number of confirmed cases. (B) Number of new confirmed cases and new suspected cases. (C) Day-on-day growth rate of cumulative confirmed cases and cumulative suspected cases. (D) Number of COVID-19 cases who lived or traveled to Hubei Province or were close contacts or others. (E) Proportion of COVID-19 cases who lived or traveled to Hubei Province or were close contacts or others. (F) Number of COVID-19 cases who were male or female.

On January 22, 2020, the first confirmed case of COVID-19 was found in Jiangsu Province. On January 24, 2020, the People's Government of Jiangsu Province initiated wartime control measures for COVID-19. Jiangsu Province reported a total of 631 confirmed cases as of February 18, 2020, but no new cases were reported since then. Jiangsu Province, which is located at 116.60°–121.67° east longitude and 31.01°–34.89° north latitude on the central coast of China, has the nearest distance with 537.2 km from Hubei Province. This study aimed to estimate the effect of wartime control measures by analyzing the incidence trend and epidemic of COVID-19 after early imported cases in Jiangsu Province from Hubei Province. The findings of this study can serve as a standard reference for controlling COVID-19.

2. Methods

2.1. Wartime control measures

On January 24, Jiangsu province officially launched the so-called wartime control measures, known as the first-level response to major public health emergency. As follows:

1. Governments at all levels must report the epidemic of COVID-19 to the state council and take measures in epidemic prevention and control.
2. Collect, estimate, report and release emergency information every day.
3. Put cities with epidemic and cross-provincial epidemic areas on lockdown to limit population mobility.
4. Enforced measures
 - Restrict or stop crowd-gathering activities such as fairs, rallies,

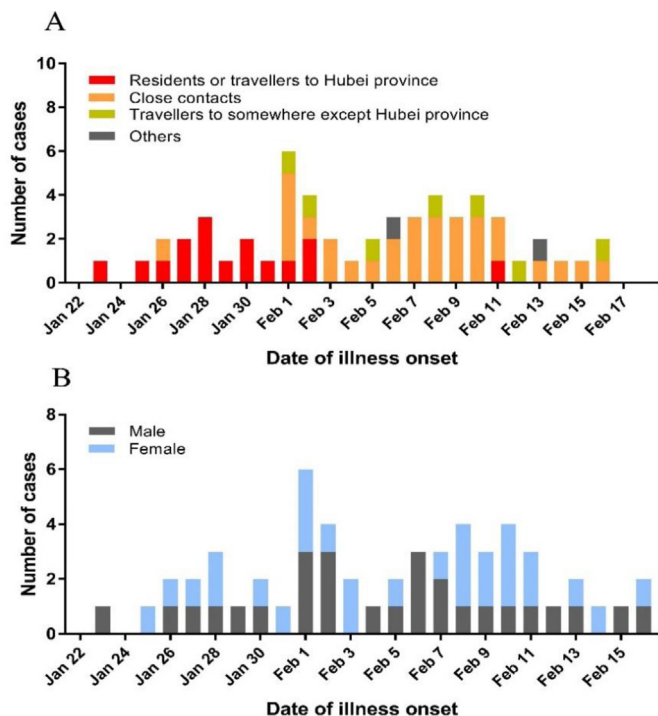


Fig. 2. Occurrence of COVID-19 cases over calendar time in Wuxi, Jiangsu Province. (A) Number of COVID-19 cases who lived or traveled to Hubei Province or were close contacts or others by date of illness onset. (B) Number of COVID-19 cases who were male or female by date of illness onset.

theater performances and so on. Stoppage, close down, and suspend classes. Closing or encasing public drinking water supplies, food and related articles contaminated by 2019 novel coronavirus. Temporary requisition of housing, vehicles and related facilities and equipment.

5. Migrant management

Strengthen prevention work, take measures for control COVID-19 such as on-site isolation, on-site observation and on-site treatment for confirmed COVID-19 cases and suspected COVID-19 cases, and take centralized or home-based medical observation for close contacts according to the condition.

6. Traffic health quarantine

Set up temporary traffic health quarantine station in traffic stations and ports of entry and exit to conduct quarantine inspection for travelers. All confirmed COVID-19 cases and suspected COVID-19 cases are temporarily isolated, detention for check-up and transferred to institutions designated by local health and family planning departments.

7. The residential districts, townships (towns), as well as the neighborhood committees and village committees shall help the administrative departments of public health, medical institutions and other departments collecting and reporting outbreak information, scattering and isolating people, implementing public health measures.

Since February 19, no new confirmed cases have been found in Jiangsu, province, China for 6 consecutive days. The People's Government of Jiangsu Province decided to adjust the emergency response level of epidemic prevention and control from so-called wartime control measures (the first-level response) to the second-level response since 24:00 on February 24.

2.2. Data collection

The time series of observations of COVID-19 cases from January 22 to February 18, 2020 was obtained from the websites of Bureau of Health and the People's Government of Jiangsu Province. The information included the number of confirmed cases, number of suspected cases, gender, and contact history.

2.3. Statistical analysis

The dates of illness onset and the geographical locations of COVID-19 cases were plotted. Close contacts were defined as people who did not take effective protection and have been within 1 m of a suspected case or laboratory-confirmed SARS-CoV-2 infection any time from two days before the onset of illness or an asymptotically infected person any time from two days before sample collection. Confirmed cases referred to laboratory-confirmed cases of SARS-CoV-2 infection. Statistical analyses were conducted with GraphPad Prism 8.0 and ArcGIS 13.0.

3. Results

3.1. The trend of COVID-19 cases

The cumulative number of confirmed cases gradually increased from one on January 22 to 631 on February 18 (Fig. 1A). No new confirmed cases were reported after February 18. Since the first confirmed case in Jiangsu Province on January 22, the number of cases had gradually increased to a maximum of 39 cases by January 30 and remained at a stable trend until February 8 (Fig. 1B). Since then, a downward trend was observed, and three, two, and zero cases were reported on February 17, 18, and 19, respectively. The number of suspected cases increased from 36 on January 31 to 45 on February 5 and then declined. A marked drop was observed in the day-on-day growth rate of the total confirmed cases and suspected cases (Fig. 1C).

3.2. Proportion of COVID-19 cases

In the first five days after the first confirmed case, all reported cases had lived or traveled to Hubei Province (Fig. 1D). The maximum number of confirmed cases who had lived or traveled to Hubei Province peaked and plateaued between January 27 and 31. The number of confirmed cases who were close contacts had a similar trend which peaked on February 1. The proportion of confirmed cases who were residents or travelers to Hubei Province was 100% in five days after the first confirmed case and then gradually declined. However, the proportion of confirmed cases who were close contacts increased gradually with peak at 77.8% in February 16 (Fig. 1E). As of February 18, the number of confirmed COVID-19 cases was 631 without deaths: 49 mild cases, 572 common cases, six severe cases, and four critical cases. Since then, no new case was reported. Moreover, COVID-19 cases were more common in men than in women (Fig. 1F).

To estimate the effect of wartime control measures for COVID-19, we analyzed the COVID-19 epidemic after the first confirmed case from Wuhan in Wuxi. From January 22 to 31, a total of 13 confirmed cases were found, 12 of which were residents or travelers to Hubei Province and one was close contacts (Fig. 2A). In February, a fast decline in the number of cases who were residents or travelers to Hubei Province was observed, and an increasing number of cases were close contacts. We also found that confirmed cases were travelers from Japan, Shanghai, Xinyang, Nanning, Huai'an, and Yunnan Province. Those from Hubei Province were excluded. Notably, one case was confirmed on February 12 who arrived at Wuxi from Wuhan on January 23. This result showed that COVID-19 had an incubation period of 19 days. As of February 16, the number of cumulative confirmed cases was 55 in Wuxi, China. Since then, no new case was reported. No difference was found between the

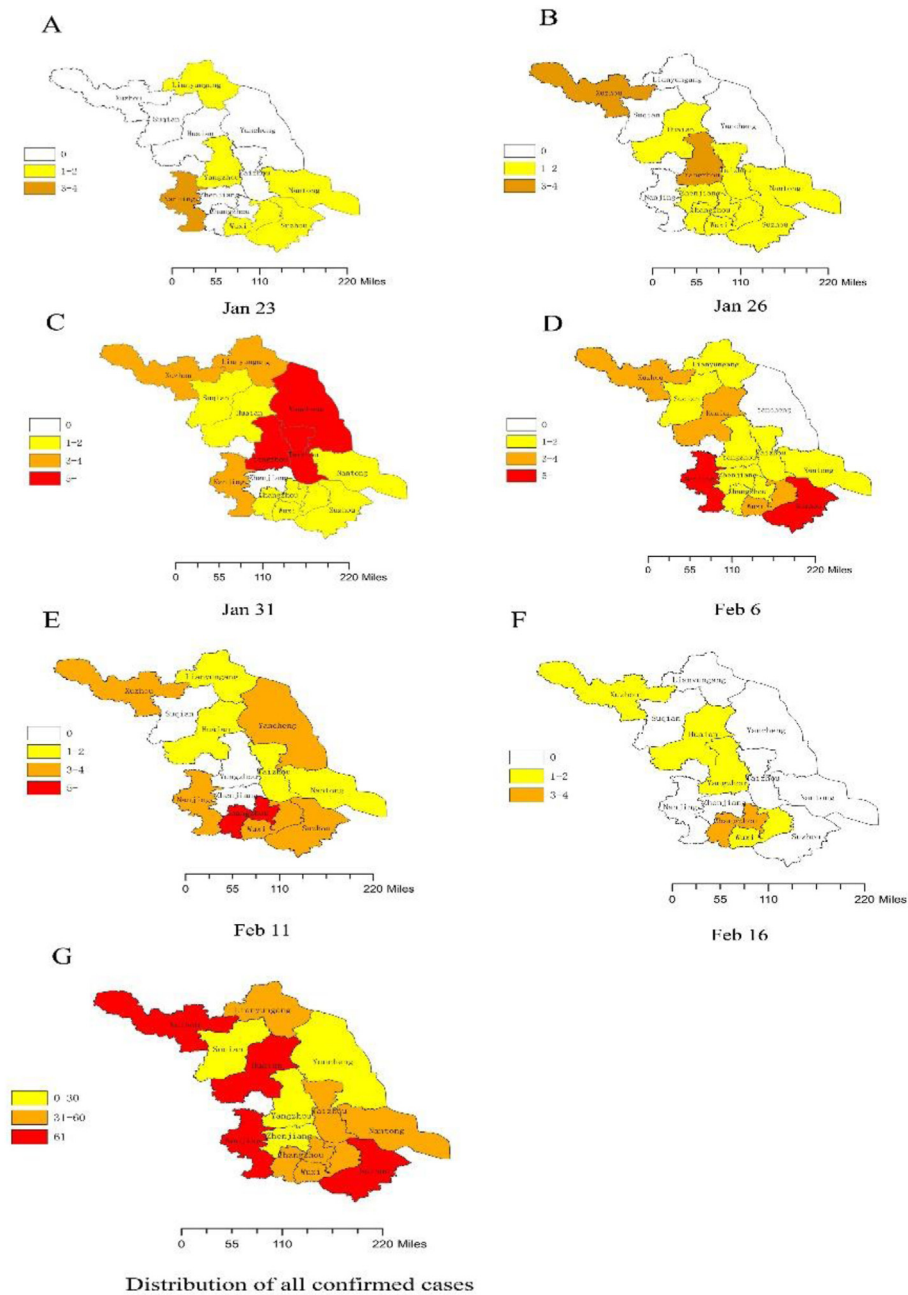


Fig. 3. Geographical distribution of confirmed COVID-19 cases over calendar time in Jiangsu Province. (A), (B), (C), (D), (E), and (F) refer to different days in February. (G) Geographical distribution of confirmed COVID-19 cases.

sexes (male, 27; female, 28) (Fig. 2B).

3.3. Geographical distribution of COVID-2019 cases

On January 22, the first COVID-2019 case was found in Suzhou. Since then, more cities reported new cases. New cases were reported in six cities on January 23 and in 12 cities on January 31 (Fig. 3A, B, C, D). In most cities, new cases were found every day, but the number of cases steadily declined. On February 6, nine cases were reported in five cities, and then gradually decreased. Similar trends were found in suspected cases, but the peak appeared on February 6 with 48 suspected cases. The day-on-day growth rate of cumulative confirmed cases and suspected cases showed a downward trend after January 25 and February 3, respectively. This finding presented the latest epidemiology of human infections with SARS-CoV-2 after wartime control measures in areas outside Hubei Province.

4. Discussion

On January 22, the first confirmed COVID-2019 case was reported in Jiangsu Province [9]. This case who returned to Suzhou from Wuhan on January 10 went to a fever clinic for medical treatment and was immediately transferred to designated medical institutions for isolation. The number of new confirmed cases had increased gradually, up to 39 cases on January 31, and then gradually decreased. Similar trends were found in suspected cases, but the peak appeared on February 6 with 48 suspected cases. The day-on-day growth rate of cumulative confirmed cases and suspected cases showed a downward trend after January 25 and February 3, respectively. This finding presented the latest epidemiology of human infections with SARS-CoV-2 after wartime control measures in areas outside Hubei Province.

In Jiangsu Province, of the 613 COVID-2019 cases, 42.6% ($n = 269$)

were residents or travelers to Hubei Province, whereas 38.0% were close contacts. Before January 31, the number of confirmed cases who were residents or travelers to Hubei Province was more than that of close contacts. Since then, new cases per day were primarily composed of close contacts. The remarkably increased number of close contacts with SARS-CoV-2 indicated that people were susceptible to SARS-CoV-2, and person-to-person transmission of the SARS-CoV-2 was important for coordinating current screening and containment strategies [10,11]. This result indicated that SARS-CoV-2 was transmitted in Jiangsu Province, and the second-generation transmitted cases appeared. The epidemiology of human infections with SARS-CoV-2 in Jiangsu was also found in other areas outside Hubei Province [12,13]. A few cases were confirmed whether residents or travelers to Hubei Province or close contacts. Finding out whether the cases were infected with SARS-CoV-2 in transportation facility or destination was difficult. Therefore, wartime control measures for COVID-2019, including limited population movements, were coercive but feasible [14]. One reported case on February 6 and another case on February 13 without exposure history to COVID-2019 in Wuxi was feared. This finding suggested that the SARS-CoV-2 might begin to spread in the community, and close communication with one another should be prohibited [15]. However, from February 19 to 27, no new cases were reported in Jiangsu Province. This result further indicated that wartime control measures, including limiting communication with one another implemented in Jiangsu Province, possibly prevented the spread of SARS-CoV-2.

Based on the spatial and temporal distribution of confirmed COVID-2019 cases in Jiangsu Province, all 13 cities confirmed that new imported cases were reported only four days after the first confirmed case. This result indicated that the people of Jiangsu and the people of Hubei had a frequent contact because of developed modern traffic, which brought certain difficulties in preventing and controlling COVID-19 [14,16,17]. People who arrived in Jiangsu before the implementation of wartime control measures were gradually diagnosed as suffering from COVID-2019 after the incubation period of COVID-2019. Therefore, a short peak of COVID-2019 appeared in each city. These cases were geographically concentrated in three large cities (Nanjing, Xuzhou, and Suzhou) with a high population density, which can accelerate the spread of SARS-CoV-2 among the people [7]. However, no new case was confirmed on February 19, indicating that the implementation of wartime control measures resulted in reductions in SARS-CoV-2 transmission.

Research suggests that the main route of human-to-human transmission of 2019-nCoV is probably through touch and respiratory droplets with an estimated reproductive number (R_0) of 2.2 (95% CI 1.4–3.9) [18]. Compared to MERS and SARS, SARS-Cov-2 has higher overall human-to-human transmission potential [19]. After the first confirmed case in Hubei province, soon the number of COVID-2019 cases exhibited signs of exponential increase with 78 824 confirmed cases, 2308 suspected cases and 2788 deaths so far [20]. It shows that the outbreak is still an epidemic threat in China. More seriously for China, each city facing a huge increase in people returning from trips after the Chinese Spring Festival vacation may result in recurrence of outbreak, despite wartime control measures have partly prevented the spread of SARS-CoV-2. Therefore, wartime control measures should continue in China. With the development of convenient transport facilities, the intercommunications among countries are more frequent. The epidemic of COVID-2019 has also spread to other countries from China. Billions of people in 23 other countries including the USA, South Korea, Germany, Australia, Japan, Malaysia, Thailand and Singapore have been hugely threatened with the spread of 2019-nCoV. In light of measures introduced by China, limiting travel and trade might be an advisable option.

Our analyses had several limitations. First, the data were from the website of Bureau of Health and Jiangsu Provincial People's Government, Jiangsu Province, China. Analyzing the transmission network of SARS-CoV-2 among the people was difficult because of the

lack of detailed case information. Second, based on the time of diagnosis instead of the time of onset, the time distribution of cases resulted in the effect of time lag on the epidemic of COVID-19 and error of the incubation calculation. This study showed that the number of new COVID-19 cases per day increased at first and then were gradually reduced to zero after the implementation of wartime control measures in Jiangsu Province. However, considerable attention should be paid to the peak of population mobility after the Spring Festival. Concrete information that can influence the epidemic of COVID-19, such as the source and destination of the floating population and the incidence of disease in each area, should be acquired.

The number of daily confirmed new cases peaked and then declined over calendar time in Jiangsu Province. After the implementation of wartime control measures, the proportion of confirmed cases who were residents or travelers to Hubei Province gradually declined, whereas that of confirmed cases who were close contacts increased gradually. Finally, no new case was reported. This result emphasized that wartime control measures could inhibit the epidemic of COVID-19.

Funding

This research was funded by The National Natural Science Foundation of China (81871681), The National First-class Discipline Programme of Food Science and Technology (JUFSTR20180101), and The Fundamental Research Funds for the Central Universities funded by the Ministry of Education of China (JUSRP51710A).

CRedit authorship contribution statement

Ke-wei Wang: Conceptualization, Writing - original draft. **Jie Gao:** Methodology. **Hua Wang:** Software. **Xiao-long Wu:** Formal analysis. **Qin-fang Yuan:** Data curation. **Fei-yu Guo:** Visualization. **Zhi-jie Zhang:** Supervision. **Yang Cheng:** Conceptualization, Writing - original draft.

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