

Epidemiological Characteristics and Core Containment Measures of Imported COVID-19 Cases from Abroad in Early Phase in Guangdong, China

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Objective: This study aimed to analyze the distribution characteristics and influencing factors for the interval between entering mainland China and the diagnosis of imported COVID-19 cases in Guangdong province, in order to provide valuable experience for global pandemic in prevention and control.

Methods: We collected publicly reported data between March 1 and June 2, 2020. Univariate and multivariate regression analyses were performed to identify the significant associated factors with the interval between entering mainland China and diagnosis of imported COVID-19 cases.

Results: As of June 2, 2020, a total of 200 imported cases were reported in Guangdong province. The average interval time was 4.25 days with a median of 2 days, the interval time of 68% cases was between 1 and 3 days. The multivariate model results show that the three following factors were critical influencing factors: nationality was foreign nationality ($P = 0.037$), results of initial nucleic acid detection were negative ($P = 0.000$) and the interval between entering mainland China and the detection of positive results (T) exceeded two days ($P = 0.008$).

Conclusion: The results suggested that all travelers and returning resident should be taken strict sampling and testing, and isolation measures, improved the accuracy of the initial nucleic acid test results, and the detection efficiency and shortening the interval between entering mainland China and detection of positive results.

Keywords: COVID-19, imported cases, Guangdong province, containment measures

Introduction

The coronavirus disease 2019 (COVID-19) was first detected in late December 2019 in Wuhan, China. COVID-19 is different from the coronaviruses causing severe acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS) and it can be further spread rapidly through asymptotically infected persons.^{1,2} The World Health Organization (WHO) has declared the COVID-19 outbreak as a pandemic on March 11, 2020,³ which posed a severe challenge to the global public health and the world economy. As of June 7, 2020, there have been confirmed more than 6.8 million cases and nearly 399,000 deaths reported worldwide.⁴

In the early stage of the COVID-19 outbreak, the Chinese government took unprecedented nonpharmaceutical public health measures to contain the spread of COVID-19, which stabilizing the epidemic in China. While the epidemic has

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continued to spread globally, the complexity and high volume of international air travel has allowed the virus to spread rapidly. Continued, unwitting virus importation through air travelers could lead to large-scale community transmission without adequate control measures.⁵ Moreover, during the peak of the European pandemic in March–April 2020, the prevalence of SARS-CoV-2 positivity among air passengers was as high as 3–6%.⁶ Therefore, the imported cases will pose a huge challenge for China, and the imported cases epidemic prevention and control were particularly important for China. Besides, between March 1 and June 2, 2020, a total of 2415 new confirmed cases were reported in China, and the imported cases were 1762, accounting for 72.96%.⁷ This indicated that it is especially important to prevent and control imported cases from abroad.

Early detection, early reporting, and early isolation can effectively prevent and control the spread of imported cases in China. Also, studies showed that strictly strengthening the transmission mechanism of COVID-19 and the protection against the COVID-19 among returnees can prevent the occurrence of secondary transmission from travelers.^{8,9} And the time interval between entry and confirmation is an important basis for measuring the early and late detection of imported cases. Guangdong province is a coastal province in southern China, and adjacent to Hong Kong and Macao, with developed foreign trade and close foreign exchanges. So Guangdong province has a greater risk than other provinces or cities of China in the epidemic of imported COVID-19 cases. Our study aimed to analyze the distribution characteristics and influencing factors for the interval between entering mainland China and the diagnosis of imported COVID-19 cases from March 1 to June 2, 2020, and provide valuable experience for global pandemic prevention and control.

Materials and Methods

Variable Identification and Data Collection

All the data in this study were obtained from the official data released by the Guangdong Provincial Health Commission (<http://wsjkw.gd.gov.cn/>). Data were collected from March 1 through June 2, 2020. Next, we collected data on the webpage of the Guangdong Provincial Health Commission. The following variables were collected: age, gender, nationality, health status at the time of entry, occupation, results of initial nucleic acid detection, the method of case screening (active

inspection by customs and relevant departments, seek medical advice actively, and investigated as close contacts), the interval between entering mainland China and detection of positive results (T), time of entering mainland China, type of quarantine (designated quarantine point, quarantine in hospital, quarantine at home, and no quarantine), confirmation time.

The COVID-19 confirmed cases are defined according to the diagnostic criteria for the COVID-19 prevention and control protocol (trial version 7), which was published by the National Health Commission.¹⁰ Viral nucleic acid detection using real-time polymerase chain reaction (RT-PCR) assay, which has been developed and used for detection of SARS-CoV-2 rapidly.¹¹ The PCR technology faces the challenge of “false negative” results, but in the balance of sensitivity and specificity, compared to some rapid detection methods, the best balance is still RT-PCR detection technology. From the past major outbreaks, whether it is Ebola virus in West Africa, influenza A or Middle East Respiratory syndrome, RT-PCR is still the country’s first test method. And confirmation time is the interval between entering mainland China and the final clinical diagnosis.

Statistical Analysis

The data of imported COVID-19 cases were sorted out by Excel 2013 and set up a database. Enumeration data were expressed by frequency and percentage, while the measurement data were expressed by mean±standard deviation. Mann–Whitney *U*-test and Kruskal–Wallis *H*-test were used, respectively, to compare whether the difference was statistically significant in the time interval between two groups and multiple groups. A binary logistic regression model was used for multivariate analysis, the standard of confirmation time was whether it was exceeded 4 days, which was based on the average interval time between entering mainland China and diagnosis was 4.25 days. Two hundred cases were divided into two groups: the late detection group (denoted as 1) and the reference group (denoted as 0). Influencing factors with statistical significance in univariate analysis were included as independent variables in the logistic regression model for analysis, and variable screening was performed by the Forward LR method. All statistical analyses were done using the user-coded, syntax-based interface of SPSS Version 20.0. A *p*-value of 0.05 or less was considered statistically significant.

Results

A total of 200 imported COVID-19 cases from abroad were confirmed in Guangdong province between March 1 to June 20, 2020. The first imported COVID-19 case was confirmed in Shenzhen city, Guangdong province on March 1, 2020.¹² Figure 1 shows that there is a trend of new imported COVID-19 cases in Guangdong province. The imported COVID-19 cases were mainly concentrated between mid-late March and mid-early April. In May and June, the new imported COVID-19 cases were less than 2. Figure 2 shows that the interval between entering mainland China and diagnosis was skewed distribution, the average interval was 4.25 days, the median interval was 2 days, the maximum was 23 days and the minimum was 0 days. The interval focused on 1 day, 2 days, and 3 days with 17.5%, 37%, and 13.5%, respectively.

Table 1 shows that among the 200 imported cases, 126 were male (63%) with a median age of 31.57 years (range: 2 to 70 years). Most of the imported cases were Chinese overseas students (38%) and businessmen or workers (35%). Chinese nationality accounted for 81% of imported cases, the source of infection from the United Kingdom, the United States, the Philippines, and France represented 61.5% of the imported cases from overseas. Most of the imported cases were present asymptomatic (79.5%) before they arrived in Guangdong. In total, 78% of the imported cases entered mainland China at Guangzhou Baiyun International Airport and 14% of the imported cases entered Shenzhen Bay Port. Among the 200 imported cases, most of them were reported in Guangzhou and Shenzhen, which accounted for 67% and 19.5%, respectively.

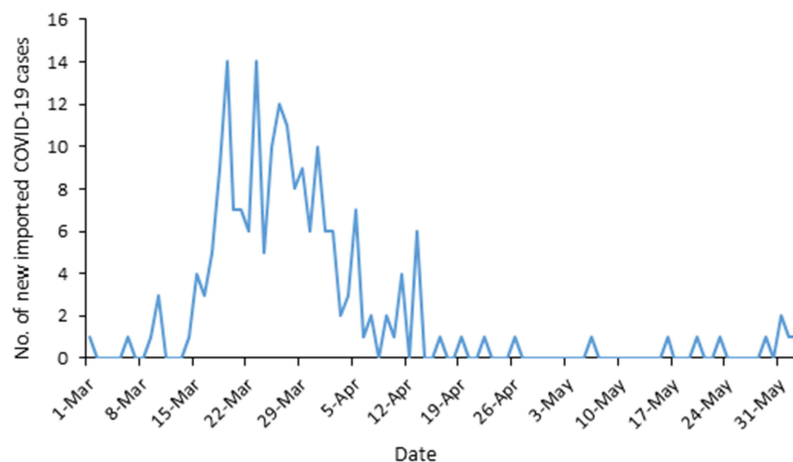


Figure 1 The prevalence of new imported COVID-19 cases in Guangdong province.

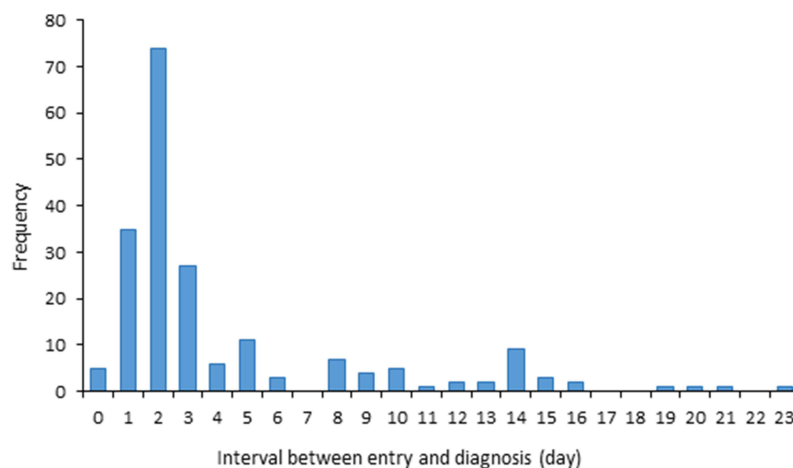


Figure 2 Frequency distribution of the interval between entering mainland China and diagnosis of imported COVID-19 cases in Guangdong province.

Table 1 Demographic Characteristics of the Imported COVID-19 Cases from Abroad in Guangdong Province, Confirmed Between March 1 and June 20, 2020

Characteristics	Cases (n = 200)
Male sex—no. (%)	126/200 (63%)
Median age (range)—years	31.57 (2–70)
Chinese nationality—no. (%)	162/200 (81%)
Health status at the time of entry: asymptomatic— no. (%)	159/200 (79.5%)
Occupation—no. (%)	
Chinese overseas students	76/200 (38%)
Businessmen or workers	70/200 (35%)
Living abroad	23/200 (11.5%)
Overseas travel	12/200 (6%)
Visiting friends or relatives	19/200 (9.5%)
Source of infection (by country)—no. (%)	
United Kingdom	57/200 (28.5%)
United States	35/200 (17.5%)
The Philippines	17/200 (8.5%)
France	14/200 (7%)
Others ^a	77/200 (38.5%)
The ports entering mainland China—no. (%)	
Guangzhou Baiyun International Airport	156/200 (78%)
Shenzhen Bay Port	28/200 (14%)
Others ^b	16/200 (8%)
Report city distributed—no. (%)	
Guangzhou	134/200 (67%)
Shenzhen	39/200 (19.5%)
Others ^c	27/200 (13.5%)

Notes: ^aOther sources of infection included the United Arab Emirates, Dubai, Ethiopia, Ireland, Angola, Australia, Pakistan, Brazil, Burkina Faso, Russia, The Democratic Republic of the Congo, Netherlands, Canada, Cambodia, Cote d'Ivoire, Madagascar, Malaysia, Bangladesh, the Niger, Nigeria, Switzerland, Thailand, Turkey, Spain, Chile, Singapore. ^bOther ports included Beijing Capital International Airport, Hong Kong-Macau Bridge Shuttle Bus, Shanghai Hongqiao Airport, Shanghai Pudong International Airport, Shenzhen Airport, Shenzhen Bay Port, Zhuhai Highway Port. ^cOther cities included Chaozhou, Foshan, Zhuhai, Dongguan, Jiangmen, Jieyang, Meizhou, Shantou, Zhanjiang, Zhaoqing, Zhongshan.

Table 2 shows the results of univariate analyses for factors associated with the interval between entering mainland China and the diagnosis of imported COVID-19 cases. The univariate analysis of confirmation time shows that the following factors were influenced the confirmation time: Nationality ($P = 0.000$), the type of quarantine ($P = 0.000$), health status at the time of entry ($P = 0.000$), results of initial nucleic acid detection ($P = 0.000$), the method of case screening ($P = 0.035$), the place of entering mainland China ($P = 0.001$) and the interval between entering mainland China and detection of positive results (T). However, the following factors were not relative to the confirmation time: gender ($P = 0.515$), age ($P = 0.079$) and personnel category ($P = 0.153$).

Table 3 shows the results of multivariate logistic regression analyses for factors associated with the interval

between entering mainland China and the diagnosis of imported COVID-19 cases. The independent variables with statistically significant differences (nationality, the type of quarantine, health status at the time of entry, results of initial nucleic acid detection, the place of entry mainland China, and interval between entering mainland China and detection of positive results) in the univariate analysis of Table 2 were included in the multivariate logistic regression model for analysis. Multivariate logistic regression analysis shows that a logistic regression model excluded three following factors: the type of quarantine, the health status at the time of entry, and the place of entering mainland China. The independent variables that finally entered the equation were nationality, the interval between entry to mainland China and detection of positive results (T), and results of

Table 2 Univariate Analyses for Factors Associated with Interval Between Entering Mainland China and Diagnosis of Imported COVID-19 Cases in Guangdong Province (Mean±SD)

Parameters	Cases (n=200)	The Average Interval Between Entering Mainland China and Diagnosis (T)	P values
Gender			
Male	126	4.09±4.533	P = 0.515*
Female	74	4.53±4.629	
Age			
≤20	43	4.47±4.426	P = 0.079 [#]
21<age≤35	90	3.17±3.209	
36<age≤50	45	5.96±6.116	
>50	22	4.77±4.937	
Nationality			
Chinese nationality	162	3.59±3.949	P = 0.000*
Foreign nationality	38	7.05±5.840	
The type of quarantine			
Designated quarantine point	142	4.35±4.531	P = 0.000 [#]
Quarantine in hospital	38	2.08±2.409	
Quarantine at home	10	4.70±4.785	
No quarantine	10	10.60±5.168	
Health status at the time of entry			
No symptoms as reported	159	4.77±4.809	P = 0.000*
Have symptoms as reported	41	2.24±2.644	
Occupation			
Chinese overseas students	76	3.30±3.422	P = 0.153 [#]
Businessmen or workers	70	4.76±4.942	
Living abroad	23	4.83±5.306	
Overseas travel	12	6.25±5.311	
Visiting friends or relatives	19	4.21±5.308	
Results of initial nucleic acid detection			
Positive	165	3.22±3.731	P = 0.000*
Negative	35	9.09±5.049	
The method of case screening			
Active inspection by customs and relevant departments	190	4.29±4.632	P = 0.035 [#]
Seek medical advice actively	6	4.83±3.061	
Investigated as close contacts	4	1.25±0.500	
The place of entry mainland China			
Inside the province	189	4.01±4.291	P = 0.001*
Outside the province	11	8.36±6.947	
Interval between entering mainland China and detection of positive results (T)			
T≤2 d	135	1.91±1.075	P = 0.000*
T>2 d	65	9.11±5.175	

Notes: *Mann–Whitney U-test; [#]Kruskal–Wallis H-test.

initial nucleic acid detection. Among them, the nationality was foreign ($P = 0.037$), the initial nucleic acid test result was negative ($P = 0.000$), the interval between entering

mainland China and detection of positive results ($T > 2d$) ($P = 0.008$) were risk factors for late detection of imported COVID-19 cases.

Table 3 Multivariate Logistic Regression Analyses for Factors Associated with Interval Between Entering Mainland China and Diagnosis of Imported COVID-19 Cases in Guangdong Province

Characteristic	B	S.E.	Wald χ^2	P value	OR (95% CI)
Constant	-7.236	2.320	9.729	0.002	0.001
Nationality					
Chinese nationality	Reference				
Foreign nationality	1.608	0.771	4.351	0.037	4.993 (1.102–22.624)
Interval between entry mainland China and detection of positive results (T)					
T ≤ 2 d	Reference				
T > 2 d	4.932	0.806	37.399	0.000	138.671 (28.543–673.714)
Results of initial nucleic acid detection					
Positive	Reference				
Negative	-2.007	0.753	7.100	0.008	0.134 (0.031–0.588)

Discussion

In the past several months when China was fighting against the COVID-19 pandemic, China adopted the most thorough, rigorous, and comprehensive prevention and control measures, unprecedentedly enforced quarantine and isolation, and mobilized medical resources across China. It has ensured that all those in need have been tested, quarantined, hospitalized, or treated. With these measures in place, China has prevented a wider spread and further development of the virus.¹³ On March 18, 2020, China's new local confirmed cases achieved first zero reporting, and China's epidemic prevention and control efforts have also shifted from local cases transmission to imported cases transmission.¹⁴ Therefore, it is crucial to control the epidemic of imported COVID-19 cases, and early detection, early reporting, and early isolation can contain the transmission of the epidemic in mainland China. Moreover, the experiences of Singapore, South Korea, and Taiwan and Hong Kong, China in early imported cases from abroad have shown that timely inbound temperature and symptom screening, isolation, close contact tracing, under strict enforcement of these measures and aggressive border control measures are effective in preventing COVID-19 community transmission.^{5,15,16}

The SARS-CoV-2 positive nucleic acid test is a crucial standard for the detection and confirmation of COVID-19

cases.¹⁰ Furthermore, a study showed that rapid and accurate testing of clinical samples dictates the effective response.¹⁷ Our study found that the interval between entering mainland China and detection of positive results (T) was an important influencing factor for the diagnosis of imported COVID-19 cases. The risk of late diagnosis in the T > 2 days group was significantly higher than that in the T ≤ 2 days group. The average interval time in the T > 2 days group was 9.11 days, which was much greater than 1.91 days in the T ≤ 2 days group. The interval between entering mainland China and detection of positive results (T) is close relative to the time of sample collection. Therefore, we should shorten the time of sample collection and improve the efficiency of testing, which can prevent the spread of the epidemic within China.

However, the COVID-19 has a longer incubation period and the median incubation period of COVID-19 was 3.0 days (range, 0 to 24.0 days), which lead to most COVID-19 patients had no obvious symptoms or mild symptoms in the early stage.¹⁸ Besides, the previous studies have shown that asymptomatic persons infected with the SARS-CoV-2 virus were infectious and might subsequently become symptomatic.^{19–21} Therefore, all travels or returning residents who entered Guangdong province through immigration checkpoints should be required real-time reverse transcription-polymerase chain reaction (rRT-PCR) test and subjected to a 14-day quarantine, similarly

to what Singapore did. If these travelers and residents do not present with symptoms and are tested negative for SARS-COV-2 after 14 days of isolation, they will be released from isolation.^{1,22} Our study also found that the results of initial nucleic acid detection were an important influencing factor for the interval between entering mainland China and diagnosis of imported cases. The risk of late diagnosis in the negative initial nucleic acid tests was significantly higher than positive, and the average interval between initial negative nucleic acid tests was 9.09 days, which was much greater than 3.22 days of positive tests. Thus, it is necessary to take samples for nucleic acid testing and screening in time. However, the late confirmed cases were due to the initial negative nucleic acid test, and some inbound travelers have been negative many times during the entry nucleic acid test. This means that those who were negative for the initial nucleic acid test must be rechecked multiple times, and imaging results of clinical symptoms can be combined to speed up the diagnosis during the screening and diagnosis process. However, to prevent community transmission caused by imported cases from outside China, all inbound persons, whether positive or negative nucleic acid test results, are subjected to a 14-day quarantine observation and multiple nucleic acid tests that on the first, seventh and 14th days are performed during the observation period.²³

Besides, nationality was a crucial factor for the interval between entering mainland China and diagnosis of imported cases. For the risk of late diagnosis of imported COVID-19 cases, foreign nationality is higher than Chinese nationality. The average interval time of foreign nationality between entering mainland China and diagnosis was 7.05 days, which is greater than 3.59 days of Chinese nationality. Thus, the local government required that all travelers and returning residents, whether Chinese or foreign nationality, should take strict sample collection, test nucleic acid, and quarantine for 14 days. Meanwhile, it is necessary to strictly prevent major entry-exit ports and strengthen the inspection of entry-exit personnel to control the spread of the imported cases. Implementing strict sampling inspection and isolation measures can speed up the imported COVID-19 cases confirmed.²⁴ Moreover, Guangdong Province has been strictly enforcing the “five lines of defense” policy of port quarantine, medical observation and isolation points, community screening, fever clinics, and hospital treatment for all inbound personnel, with a closed-loop management of the whole process.²³ Meanwhile, a study of imported cases from abroad in

Shanghai showed that the closed-loop management model of the joint prevention and control mechanism at the port was effective in detecting and managing imported cases from abroad.²⁵

There are limitations in the present study that epidemiological investigations have recall bias, especially the difficulty in judging the source of infection at the origin place, and clinical symptom indicators may be further improved. Nevertheless, our study analyzes the distribution characteristics and influencing factors for the interval between entering mainland China and the diagnosis of imported COVID-19 cases in Guangdong province, the findings could provide valuable experience for the global pandemic in preventing and controlling the imported COVID-19 cases.

Conclusion

The study found that the interval between entering mainland China and detection of positive results (T), the results of initial nucleic acid detection, and nationality were critical factors for the interval between entering mainland China and diagnosis of imported cases. So, the following policy measures were suggested to implement. First, strengthening the prevention and control of major entry-exit ports. All travelers and returning residents, whether Chinese or foreign nationality, should be taken strict sampling and testing, and isolation measures. All inbound personnel needs closed-loop management with nucleic acid testing and 14-day quarantine observation. During the quarantine observation period, nucleic acid tests will be carried out on the first, seventh, and 14th days. Second, improving the accuracy of the initial nucleic acid test results, which can avoid false-negative results lead to cannot confirm imported cases in time. The initial nucleic acid test must be retested several times and can be combined with clinical symptoms imaging findings during the screening and diagnosis process to speed up the diagnosis. Third, improving the detection efficiency and shortening the interval between entering mainland China and detection of positive results. So, Nucleic acid testing samples should be delivered early, frequently, and quickly.

Paper Context

The COVID-19 pandemic is continuing to spread worldwide. After the COVID-19 outbreak, China took unprecedented nonpharmaceutical public health measures to contain the spread of COVID-19. This study found that nationality was foreign nationality, results of initial nucleic acid detection were negative, and the interval between entering mainland China and detection of positive results

(T) exceeded two days influenced the interval between entering mainland China and diagnosis of imported COVID-19 cases in Guangdong province.

Ethics and Consent

This study did not involve ethical issues.

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Disclosure

The authors have no conflicts of interest to declare.

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