Study on the COVID-19 infection status, prevention and control strategies among entry people in Shenzhen

Jing-Zhong Wang (wongjz@126.com)
Shenzhen Center for Disease Control and Prevention

Xuan Zou
Shenzhen Center for Disease Control and Prevention

Zi-Qian Xu
Shenzhen Center for Disease Control and Prevention

Hai-Rui Wang
Shenzhen Center for Disease Control and Prevention

Bi-Xin Wang
Shenzhen Center for Disease Control and Prevention

Jian-Fan He
Shenzhen Center for Disease Control and Prevention

Research

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Abstract

Background The COVID-19 confirmed cases overseas continue to rise for months, while people overseas prefer to return at present. It is risky to have a large number of infected imported cases which may cause COVID-19 spread to China and even lead to outbreak again. In order to prevent imported infection, Shenzhen implemented the losed-loop management strategy by taking nucleic acid testing (NAT) for severe acute respiratory syndromes coronavirus 2 (SARS-CoV-2) and medical observation for 14 days among individuals who have epidemic history (Hong Kong, Macao, Taiwan province and other countries) within 14 days. Our study described the status of COVID-19 infection among entry people in Shenzhen, and also evaluated the effect of closed-loop management strategy.

Methods A total of 86,844 people overseas entered Shenzhen from January 1 to April 18, 2020, and there were 39 imported cases. We made a descriptive study by analyzing the entry time, reported time, local confirmed cases in origin countries, and the number of entry people from abroad. The NAT were completed in Shenzhen center for disease control and prevention (CDC), ten district-level CDCs, as well as fever clinics.

Results The infection rate of entry people was 4.49‰ (95% CI: 3.26‰ – 6.05‰). Most of the entry people or imported cases have Chinese nationality. The number of entry people and imported cases in Nanshan and Futian districts were larger than others. 15.73% of the entry people came from the US, and 12.67% came from the UK. 14 imported cases (35.9%) came from the UK, 9 (23.08%) came from the US. The imported risks from the US and UK in Shenzhen were higher than other countries or regions. According to the 14-days' incubation period and the number of entry people, individuals from the US since Mar 9 were the high-risk population. Accordingly, entry people from the UK since Mar 13 were the high-risk population. It is important to evaluate the imported risk by analyzing local confirmed cases status in origin countries or regions and the number of entry people from these countries or regions to Shenzhen. The distribution of entry time and report time for imported cases in Shenzhen were similar. So it is important to prevent and control COVID-19 imported infection by taking NAT and medical observation at port.

Conclusions It is effective to implement closed-loop management strategy for individuals who have epidemic history (Hong Kong, Macao, Taiwan province and other countries) within 14 days. In order to control COVID-19 outbreak, we need the collaboration and cooperation at the global, national, and subnational levels to prevent, detect, and respond effectively.

Background

In December 2019, the coronavirus disease 2019 (COVID-19) caused by severe acute respiratory syndromes coronavirus 2 (SARS-CoV-2) emerged from Wuhan. China reported to World Health Organization (WHO) and issued to other countries immediately [1, 2]. COVID-19 is characterized by fever, cough, fatigue, shortness of breath, pneumonia, and other respiratory tract symptoms [3, 4]. Infection via

respiratory droplets or secretions from infected individuals are thought to be the predominant mode of human-to-human transmission [5–8]. The absence of fever in SARS-CoV-2 was more frequent than in SARS-CoV (1%) and Middle East Respiratory Syndrome coronavirus (MERS-CoV) infections (2%), so the afebrile patients may be missed, and it is common to have asymptomatic cases [9]. No specific antiviral therapies are available, and efforts to develop antivirals and a vaccine continue [10]. All these have brought difficulties to prevent and control COVID-19. The policies of “early detection, early report, early diagnosis, early quarantine and early treatment”, and “concentrate patients, concentrate experts, concentrate resources, concentrate treatment” are effective to prevent and control the spread of COVID-19 in China with the cooperation of government and society departments. After 76 days, China lifted lockdown on Wuhan and allowed people to leave the city on April 8, 2020. The number of severe cases is 0 from April 24, and the number of hospitalized cases is 0 from April 26. The number of new local cases has been 0 for two months in Shenzhen. The intervention of COVID-19 in Shenzhen and nationwide had a real effect.

But the confirmed cases overseas continued to rise. On 11th March 2020, WHO declared the outbreak of COVID-19 could be characterized as a pandemic [11]. As of April 18, 2020, there are more than 2.1 million confirmed cases of COVID-19, and more than 140,000 deaths reported worldwide [12]. People work or study overseas prefer to return at present. It is risky to have a large number of infected imported cases and cause COVID-19 spreading to China and outbreak again. The first imported case from abroad in China was reported in Shenzhen on 1st March 2020. As of April 25, the number of outbreak in clusters associated with imported cases from abroad is about 60 which affected more than 10 provinces, including Guangdong. There are more people-to-people exchanges, overseas students and transnational workers in Shenzhen. As economic activity continues to resume in the coming weeks, it is stressful to prevent and control the second wave of imported cases caused by COVID-19 global pandemic. The main purpose has turned to prevent imported cases from abroad and domestic relapse at present. It is effective to implement the strategy of taking SARS-CoV-2 nucleic acid testing (NAT) and medical observation for 14 days among entry people from abroad. We implemented the closed-loop management strategy for entry people from the port of China to the house of every one by health workers with the cooperation of customs, immigration, health bureau and other departments. As of April 19, there are more than 85 thousands entry people in Shenzhen. Our study described the status of COVID-19 infection among entry people in Shenzhen, and also evaluated the effect of closed-loop management strategy.

Methods

Case management

On March 1, 2020, Shenzhen Center for Disease Control and Prevention (CDC) reported the first imported case from United Kingdom. In order to control COVID-19 imported spread, we have implemented the strategy of taking NAT for SARS-CoV-2 and medical observation for 14 days among the individuals who have epidemic history (Hong Kong, Macao, Taiwan province and other countries) within 14 days. Everyone enters Shenzhen shall take the closed-loop management strategy from the port of China to the

house of every one by health workers with the cooperation of customs, immigration, health bureau and other departments. Shenzhen also implemented the trinity cooperation community mode based on the prevention and control mechanism union in every neighborhood committee. The trinity cooperation community control and prevention mode, including medical staff from community health service centers, community workers, and community police. They can provide the order maintenance, medical and life service for every person. They shall manage the individuals who are taking home quarantine by health surveillance. They also have been screening the entry people in Shenzhen from January 1, 2020 in every neighborhood committee.

Implemented three categories of classification management for individuals who have epidemic history (Hong Kong, Macao, Taiwan province and other countries) within 14 days according to the Prevention and Control Plan for Coronavirus Disease 2019 (the sixth Edition) (Fig. 1): 1. Confirmed cases, suspected cases, and the individuals who have fever and respiratory tract symptoms in quarantine at the port shall take medical treatment in the designate hospital (Such as the third people hospital of Shenzhen). 2. The close contact individuals shall take isolation in the designate medical observation places, they shall take medical treatment in the designate hospital if they are positive in the NAT or in the detection of serum specific antibody, and have symptoms like fever, cough and fatigue during the quarantine. 3. The special individuals who are younger than 14 years old or over the age of 70, pregnant woman, or not suitable for centralized observation with basal disease shall take the NAT for SARS-CoV-2 before taking home isolation for 14 days. The trinity cooperation community work group shall manager the individuals who are taking home quarantine by health surveillance. Other entry individuals shall take isolation in the centralized observation places. They shall take the NATs on the 1st and 14th day during the quarantine. The individuals can release from quarantine if they are negative in NAT at the end of medical observation. The suspected cases who are positive in the NAT or in the detection of serum specific antibody, and have symptoms like fever, cough and fatigue during the quarantine shall take medical treatment in the designate hospital. Close contacts were identified through contact tracing of a confirmed, suspected or asymptomatic case and were defined as those who did not take an effective protection and contact with an index case 2 days before symptom onset according to the Prevention and Control Plan for Coronavirus Disease 2019 (the sixth Edition).

Guangdong-Hong Kong-Macao Greater Bay Area (GBA) have implemented the mutual recognition measures for the medical quarantine observation results in GBA. The individuals are negative in NAT at the end of medical observation can receive the notification and release from quarantine. The notification issued by local primary medical and health institutions is mutual recognition in GBA. The trinity cooperation community work group in neighborhood committee shall manager the individuals who have completed the medical observation by providing health and consultation service, taking temperature surveillance, checking the self-health declaration, and taking the guidance for somebody have the symptoms of fever, cough, and fatigue to the designated hospital.

Date collection

This was a descriptive research, supported by Shenzhen government based on the policies. The government shared the data (from January 1 to April 18, 2020) with us, so our data was the secondary and public data, and can be referenced. The study was approved by the Ethics Committees of Shenzhen CDC, and the need for consent was waived by approving ethics committee. The individuals who have epidemic history (Hong Kong, Macao, Taiwan province and other countries) within 14 days shall take NAT for SARS-CoV-2 by Reverse Transcription-Polymerase Chain Reaction (RT-PCR) of nasal swabs at 52 fever clinics, ten district-level CDCs, and Shenzhen CDC.

Results

A total of 86,844 people overseas entered Shenzhen from January 1 to April 18, 2020, and 77.09% have Chinese nationality. The rest of 22.91% have foreign nationalities. The main age of the population was 32, and 52.6% were male. Figure 2 is the distribution of these people in Shenzhen by ARCGIS10.2, including Shenzhen special cooperation zone. There were 32052 entry people in Nanshan district, 27794 in Futian district, and 12215 in Luohu district. The risk of imported infection in Nanshan, Futian and Luohu districts were higher than others. Dapeng district and Shenshan special cooperation zone have the small number of entry people, so they were at low risk. The risk of imported infection in southwest was higher than northeast in Shenzhen.

We made a rank on the origin countries according to the number of entry people (Fig. 3). More people came from United States of America, Thailand and United Kingdom to Shenzhen. 15.73% of the population came from the US, 15.39% came from THA, and 12.67% came from the UK. We have made an analysis on the relationship between daily number of entry people in Shenzhen and the new local confirmed cases in the US, THA and UK. The new local confirmed cases data in Fig. 4–6 came from WHO Novel coronavirus (2019-NCoV) situation reports, and we analyzed the local data in the US, THA and UK from Mar 1 from Apr 18 due to the small number of entry people and new local confirmed cases in these countries before Mar 1.

Figure 4 indicates that the earliest date for individuals entering Shenzhen from United States was Jan 3 this year, and there were two main peaks among the number of entry people from the US, one peak concentrated on Mar 18, and another peak concentrated on Apr 14. The first confirmed case in the US reported on Jan 23 according to WHO Novel coronavirus (2019-NCoV) situation report 3 (accessed Jan 23, 2020). There were three main peaks among the new local confirmed cases in the US, first one concentrated on Mar 23(16354 confirmed new cases), second one concentrated on Apr 6(33510 confirmed new cases), and third one concentrated on Apr 11(35386 confirmed new cases). We ignored the peak on Apr 18 according to the incomplete data since Apr 18. The incubation of COVID-19 can range from 1 to 14 days according to the recommendation by WHO. The interval between the first peak of entry people from the US and the first peak of new local confirmed cases in the US was 5 days. More entry people came from the US around Mar 18, and the new local confirmed cases turned to the first main peak 5 days later on Mar 23. The internal between Mar 9 and Mar 23 was 14 days, and there were still two

peaks concentrated on Apr 6 and Apr 11. The entry people from the US since Mar 9 were the high-risk population of imported infection.

Figure 5 indicates that the earliest date for individuals entering Shenzhen from Thailand was Jan 3 this year. The entry people from THA mainly concentrated on the period between Mar 10 and Mar 28. The first confirmed case in THA reported on Jan 13 according to WHO Novel coronavirus (2019-NCoV) situation report 1 (accessed Jan 20, 2020). The new local confirmed cases in THA mainly concentrated on the period between Mar 20 and Apr 8. The interval between Mar 10 and Mar 20 was 10 days. Although the local confirmed cases in THA were less than the US and UK, it is still risky for the entry people from THA since Mar 10 to cause imported infection in Shenzhen.

As of April 18, 2020, there were 39 imported cases detected and reported. 82% of the imported cases have Chinese nationality. The rest of 18% have foreign nationalities. The main age of the population was 27, and 61.54% were male. The infection rate of individuals entering Shenzhen from January 1 to April 18, 2020 is 4.49‰ (95% confidence interval [CI], 3.26‰ to 6.05‰). Figure 7 is the distribution of 39 imported cases in Shenzhen by ARCGIS10.2, including Shenshan special cooperation zone. There were 21 imported cases in Nanshan district, 8 in Futian district, 4 in Luohu district, 4 in Baoan district, and 2 in Longhua district. There was no imported case in Guangming, Longgang, Yantian, Pingshan, Dapeng and Shenshan special cooperation zone. All the 39 imported cases took the centralized medical observation when they entered Shenzhen and received the medical treatment in the designated hospital when they were positive in the NATs. The number of imported cases in Nasnshan district was the highest in Shenzhen.

We have analyzed and made a rank on origin countries based on the number of imported cases (Fig. 8). There were 14 imported cases (35.9%) from the United Kingdom, 9 (23.08%) from United States of America, 4 (10.26%) from France, 3 (7.69%) from Philippines, 2 (5.13%) from Brazil, 2 (5.13%) from Spain, and each one of the following counties (Cambodia, Russia, Thailand, Netherland and Switzerland) is detected 1 imported case (2.56%). As of April 18, there were 39 imported cases from abroad in Shenzhen. The imported cases in Shenzhen mainly came from the UK and US. There was no confirmed new cases among the entry people in Shenzhen since Apr 19.

As of Apr 18, 2020, the total number of confirmed cases in Shenzhen was 461, including 309 imported cases from Hubei province, 38 imported cases from other provinces in China, 39 imported cases from abroad, and 75 local cases by multiple infection mode in Shenzhen (the local close contacts, the locals contacted with people in affected areas, and other exposure methods). Figure 9 indicates that the new confirmed cases in Shenzhen from Jan 19 to Apr 25, 2020. The blue one means the confirmed cases in Shenzhen, including imported cases from Hubei and other province in China, and the local confirmed cases in Shenzhen. The red one means the imported cases from abroad. The first confirmed case reported on Jan 19, and he came from Hubei. The new confirmed cases in Shenzhen mainly concentrated on the period between Jan 20 and Feb 15, there was no tailing after taking the prevention and control union mechanism. The first imported confirmed case from the UK reported on Mar 1. The imported cases

from abroad mainly concentrated on the period between Mar 14 and Apr 7, and the number of local confirmed cases in foreign countries continued to rise during this time. It was important to prevent and control imported infection in Shenzhen.

Figure 10 indicates that the entry and report time of imported cases from abroad. The blue one means the entry time of imported cases, and the red one means the reported time of imported cases. The entry and report time ranged from Feb 17 to Apr 13, and mainly concentrated on the period between Mar 10 and Mar 30, and the number of local confirmed new cases in foreign countries kept growing during this time. We found the difference between entry time and report time was small, the distribution of entry time and report time were similar. So it is important to prevent and control COVID-19 spread from abroad by taking NAT and medical observation at port. It is effective to implement the closed-loop management by NAT and medical observation for the individuals who have epidemic history (Hong Kong, Macao, Taiwan province and other countries) within 14 days to prevent and control COVID-19, because the number of imported confirmed new cases from abroad is 0 since Apr 19.

Discussion

The findings from our study indicated that there were 86,844 entry people from abroad to Shenzhen, and there were 39 imported cases among them as of April 18, 2020, so the infection rate of entry people is 4.49‰ (95% CI: 3.26‰ – 6.05‰). Most of entry people or imported cases have Chinese nationality. Most of entry people are male. The number of entry people and imported cases in Nanshan and Futian were larger than other districts. The risk of imported infection in Nanshan, Futian districts were higher than others, and the risk of imported infection in southwest was higher than northeast in Shenzhen. The prevention and control work in Nanshan and Futian were more important. We found that the risk of imported infection from the US and UK were higher that other countries and regions in Shenzhen. Although the number of entry people from THA was the same large, we excluded THA according to the small number of local confirmed cases in THA and no imported case from THA in Shenzhen. The first peak of local confirmed new cases in the US was on Mar 23(16354 confirmed new cases), and the number of local new confirmed cases kept growing from Mar 23 to Apr 18. According to the 14-days' incubation period and the number of entry people, individuals from the US since Mar 9 were the high-risk population. The first peak of local confirmed new cases in the UK was on Mar 28 (2885 confirmed new cases). And the number of local new cases continued to rise from Mar 28 to Apr 18. According to the 14-days' incubation period and the number of entry people, individuals from the UK since Mar 13 were the high-risk population. In the meanwhile, the entry and report time of imported cases in Shenzhen mainly concentrated on the period between Mar 10 and Mar 30. So it is important to evaluate the imported risks by analyzing local confirmed cases status in origin countries or regions and the number of entry people from these countries or regions to Shenzhen. The difference between entry time and report time was small, the distribution of entry time and report time were similar. So it is important to prevent and control COVID-19 spread from abroad by taking NAT and medical observation at port. Shenzhen have taken the closed-loop management by NAT and medical observation for the individuals who have epidemic history

(Hong Kong, Macao, Taiwan province and other countries) within 14 days. This management is effective for the number of imported confirmed new cases from abroad is 0 since Apr 19.

Shenzhen is a mega city, immigrant city, and port city with a population of more than 20 million and thus had a high proportion of imported cases from Hubei or other provinces in China [13, 14]. It is also one of the cities with the largest population flow and the highest population density in China, so it is stressful to prevent and control COVID-19 in Shenzhen. The “ACT” community control and prevention mode in Shenzhen is effective and highly recognized by WHO experts. A means the coordination by administration. C means the profession service by community health service center. T means cooperation by trinity community control and prevention mode, including medical staff from community health service centers, community workers, and community police. The development of COVID-19 in Shenzhen can be divided into three stages. First stage: The number of local confirmed cases were mainly imported cases from Hubei and other provinces since Jan 19. The confirmed cases mainly concentrated on the period between Jan 20 and Feb 15. There was no tailing since Feb 22. Second stage: There was no local confirmed new case since Feb 22. Third stage: The first imported case from the UK reported by Shenzhen CDC on Mar 1. The new confirmed cases in Shenzhen were mainly imported cases from abroad since Mar 1, and the number of imported confirmed new cases from abroad is 0 since Apr 19. The prevention and control work depends on the surveillance mechanism which was established with the lesson learned from the 2003 Severe Acute Respiratory Syndrome (SARS) outbreak [15, 16], the surveillance mechanism was established with the aim of allowing the identification of novel pathogens such as SARS-CoV-2 in a timely manner [17]. The prevention and control work also depends on the closed-loop management with the cooperation of customs, immigration, health bureau and other departments, the trinity cooperation community mode, timely and professional medical treatment, big data analysis like self-health declaration system and public sense of social responsibility and prevention and control awareness. This work has some limitations. Asymptomatic travelers will be missed by symptom-based surveillance, even if they are tested, some asymptomatic contacts might be missed because of the imperfect sensitivity of the RT-PCR test [18]. The epidemic logical investigations are dependent on individuals’ recall of places visited, people seen, and symptom onset, so the investigation might not have identified all individuals with potential exposure to SARS-CoV-2.

The recent COVID-19 outbreak has been deemed a global health emergency, internationally, the number of confirmed reports has continued to rise [19]. By April 18, 2020, there were more than 2.1 million confirmed cases of COVID-19, and more than 140,000 deaths reported worldwide [12]. Strict containment measures have been effectively implemented throughout China, particularly in infected regions, preventing uncontrolled spreading, and the reproduction number has been on a declining trend [20–22]. Every country is closely connected under the background of globalization. In the past 5 years, multisectoral coordination and collaboration for health security strengthening has improved substantially [10]. The COVID-19 outbreak requires a robust mechanism of collaboration and cooperation at the global, national, and subnational levels to prevent, detect, and respond effectively [10]. The finding of our study can provide important reference information and experience for imported infection surveillance and public health strategy.

List Of Abbreviations

Center for Disease Control and Prevention, (CDC).

Corona Virus Disease 2019, (COVID-19).

Guangdong-Hong Kong-Macao Greater Bay Area, (GBA)

Middle East Respiratory Syndrome coronavirus, (MERS-CoV).

Nucleic Acid Testing (NAT).

Reverse Transcription-Polymerase Chain Reaction (RT-PCR).

Severe Acute Respiratory Syndrome (SARS).

Severe Acute Respiratory Syndromes Coronavirus 2, (SARS-CoV-2).

Thailand, (THA).

United Kingdom, (UK)

United Stated of America, (USA or US)

World Health Organization (WHO).

Declarations

-Ethics approval and consent to participate

The study was approved by the Ethics Committee of Shenzhen Center for Disease Control and Prevention [2020, code (039A)]

-Consent for publication

Not applicable

-**Availability of data and materials**

The datasets used and analysed during the study are available from Shenzhen Municipal Health Commission.

-Competing interests

The authors declare that they have no competing interests

-Funding

No funding was obtained for this study.

-Authors' contributions

ZX participated in liaison and coordination with government and data collection. XZQ participated in data analysis and drafted the manuscript. WJZ and HJF conceived of the design and coordination of the study. WHR performed the statistical analysis. WBX guided the statistical analysis and revisions of the manuscript. All authors read and approved the final manuscript.

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-Author details

*Jing-Zhong Wang is the corresponding author (wongjz@126.com).

[1]Shenzhen Center for Disease Control and Prevention, Shenzhen, China

Xuan Zou and Zi-Qian Xu are co-first authors of the article, Xuan Zou and Zi-Qian Xu contribute equally to the article.

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Figures

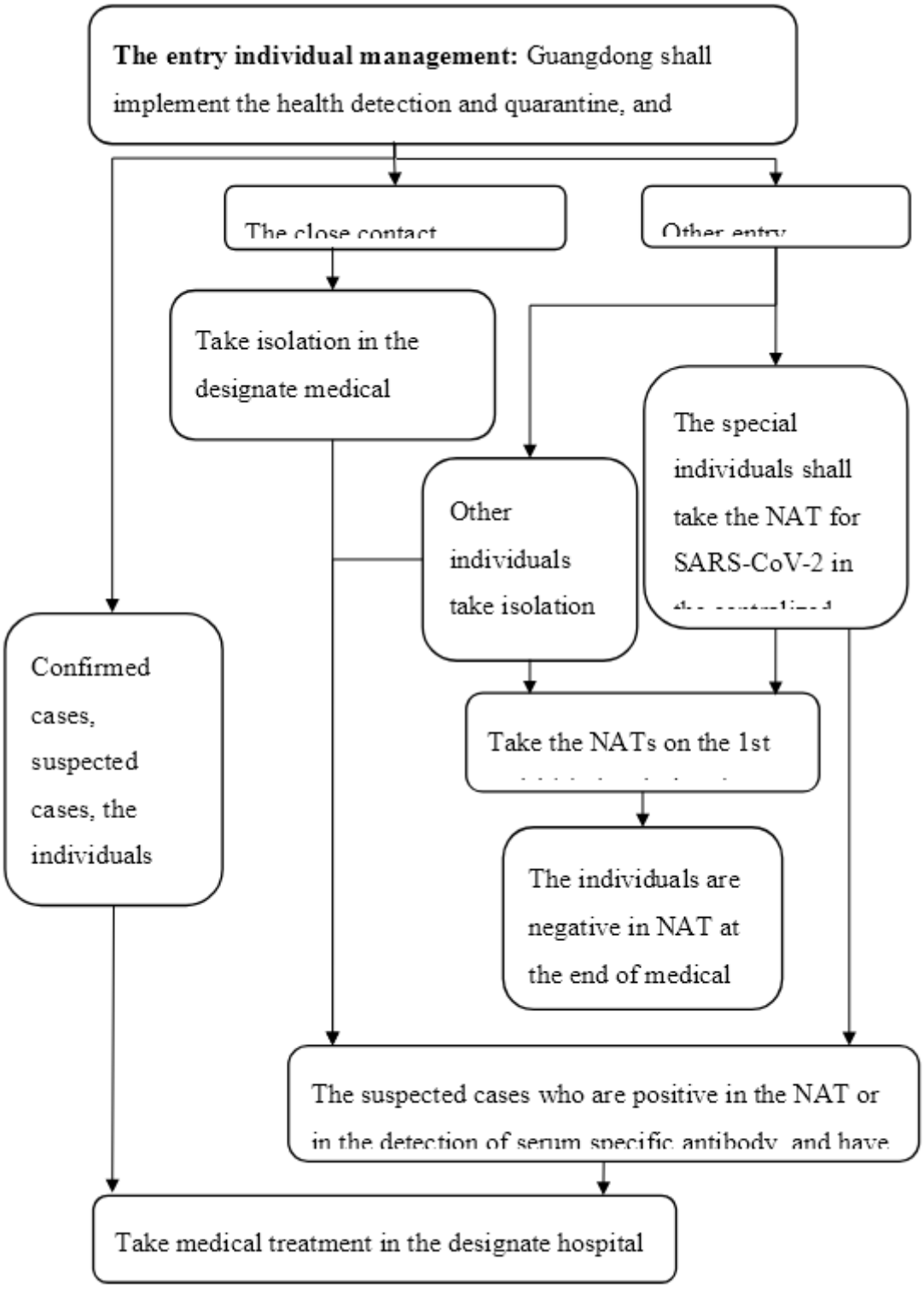

Figure 1

Flowchart of the entry people management in Shenzhen

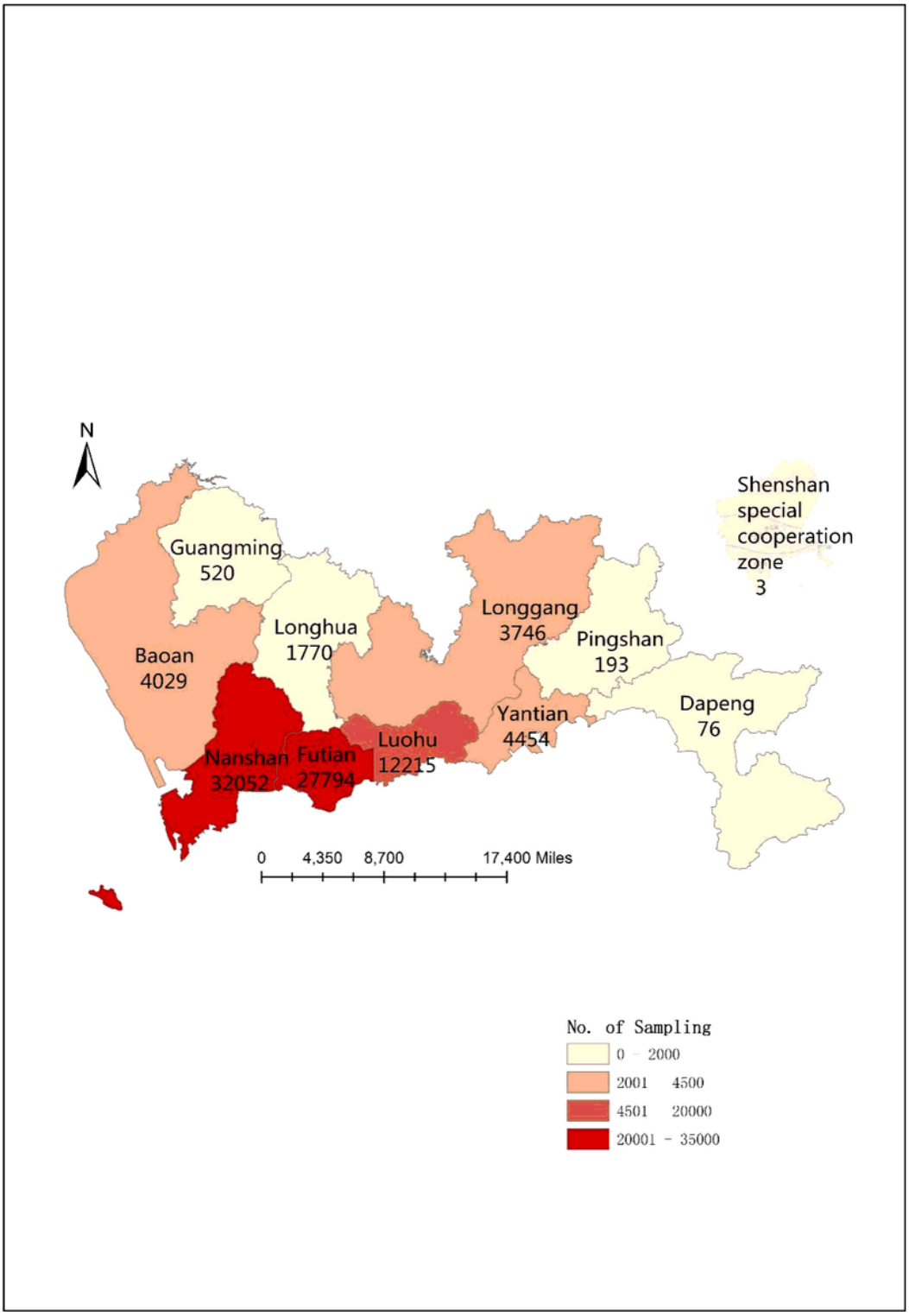

Figure 2

The distribution of all entry people in Shenzhen Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

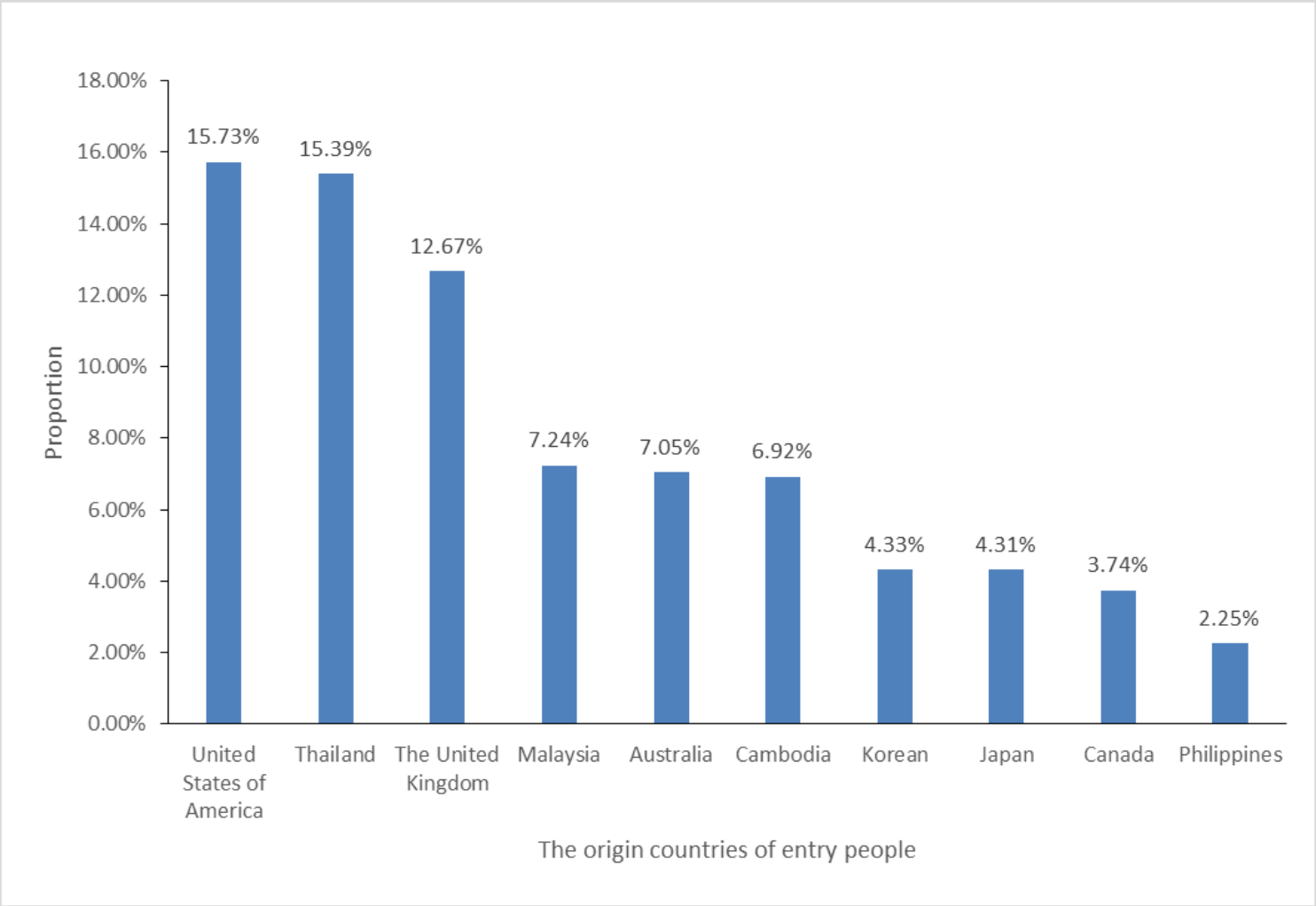

Figure 3

The top 10 countries of origin based on the number of entry people

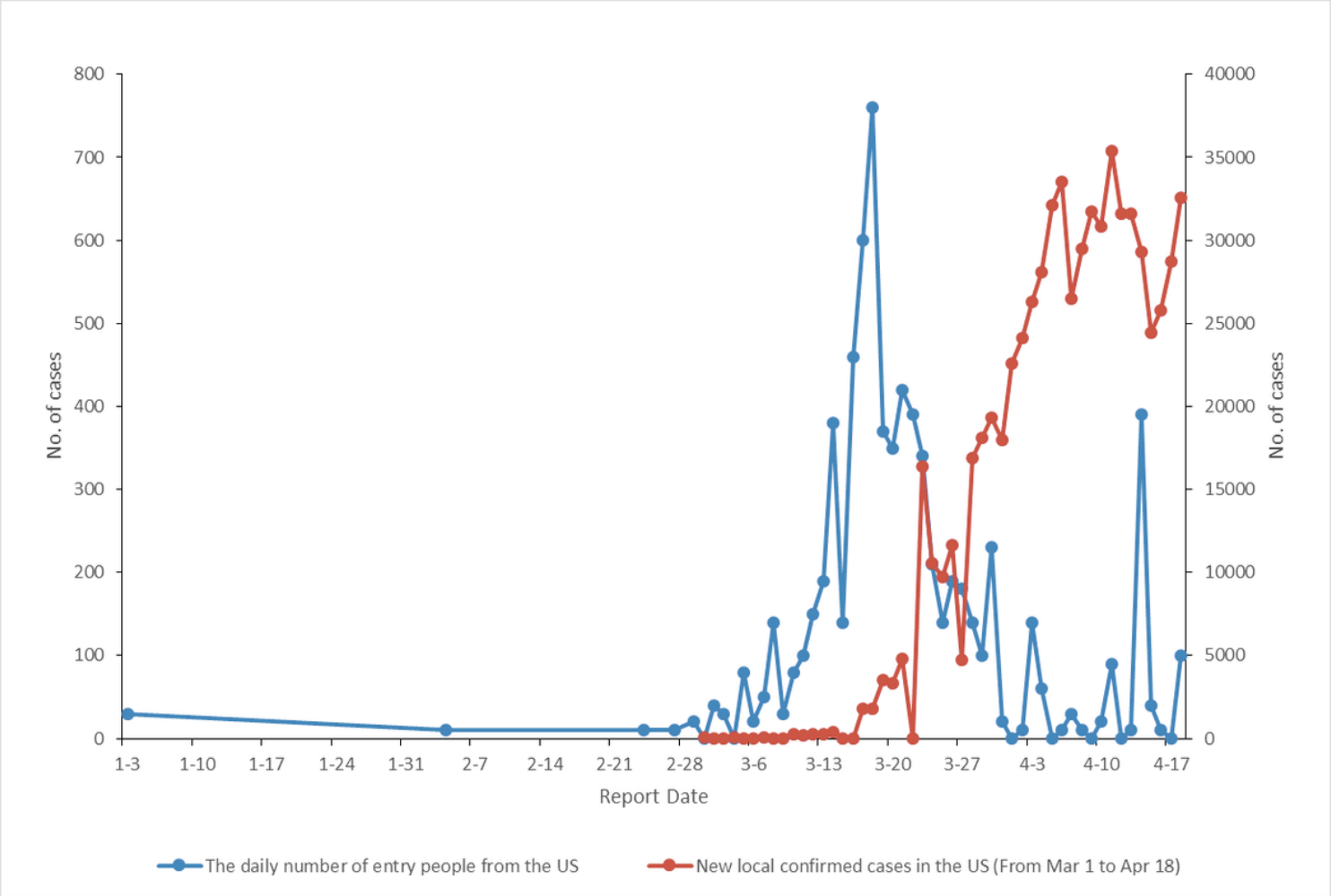

Figure 4

The daily number of entry people from the US (From Jan 3 to Apr 18) and new local confirmed cases in the US (From Mar 1 to Apr 18)

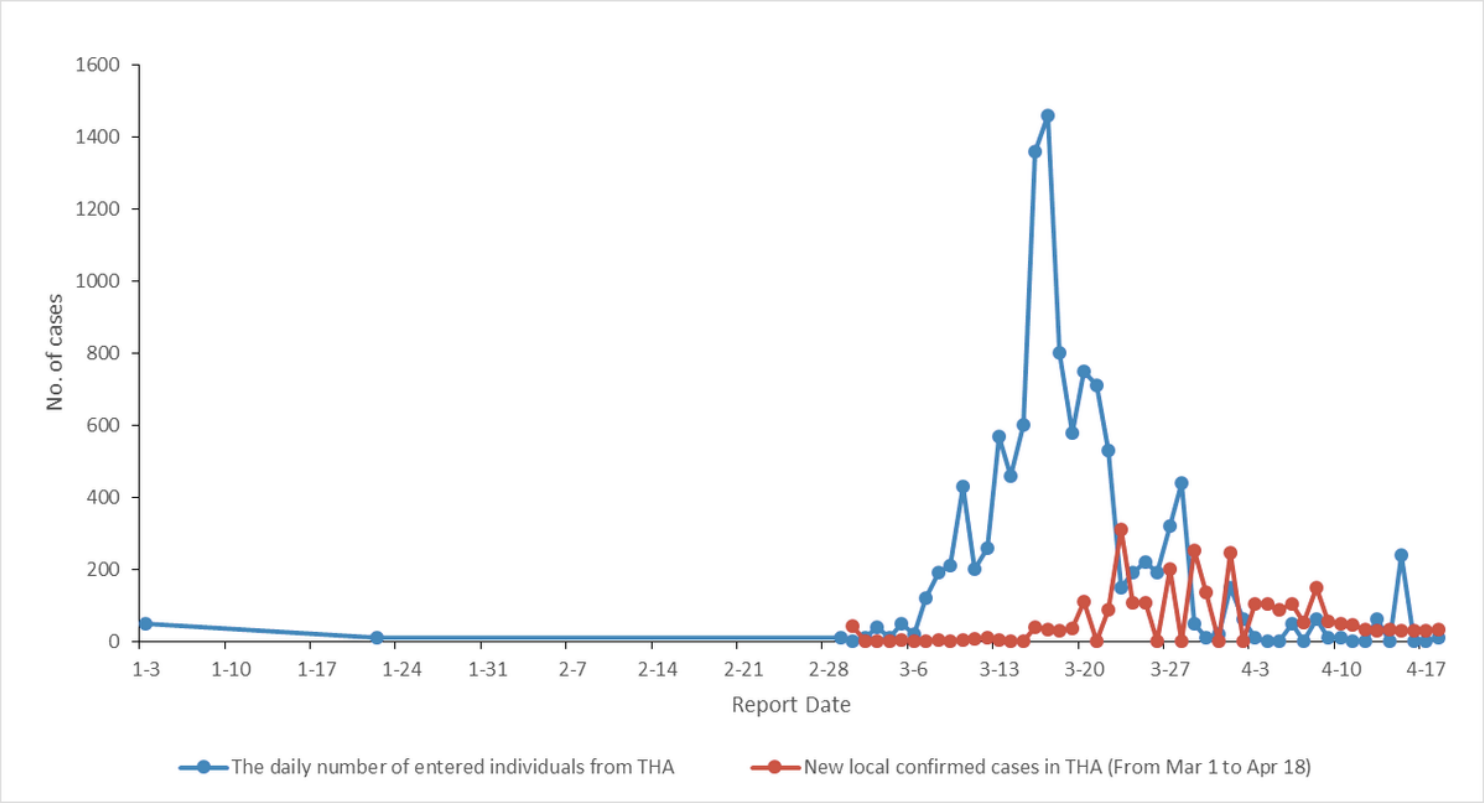

Figure 5

The daily number of entry people from THA (From Jan 3 to Apr 18) and new local confirmed cases in THA (From Mar 1 to Apr 18)

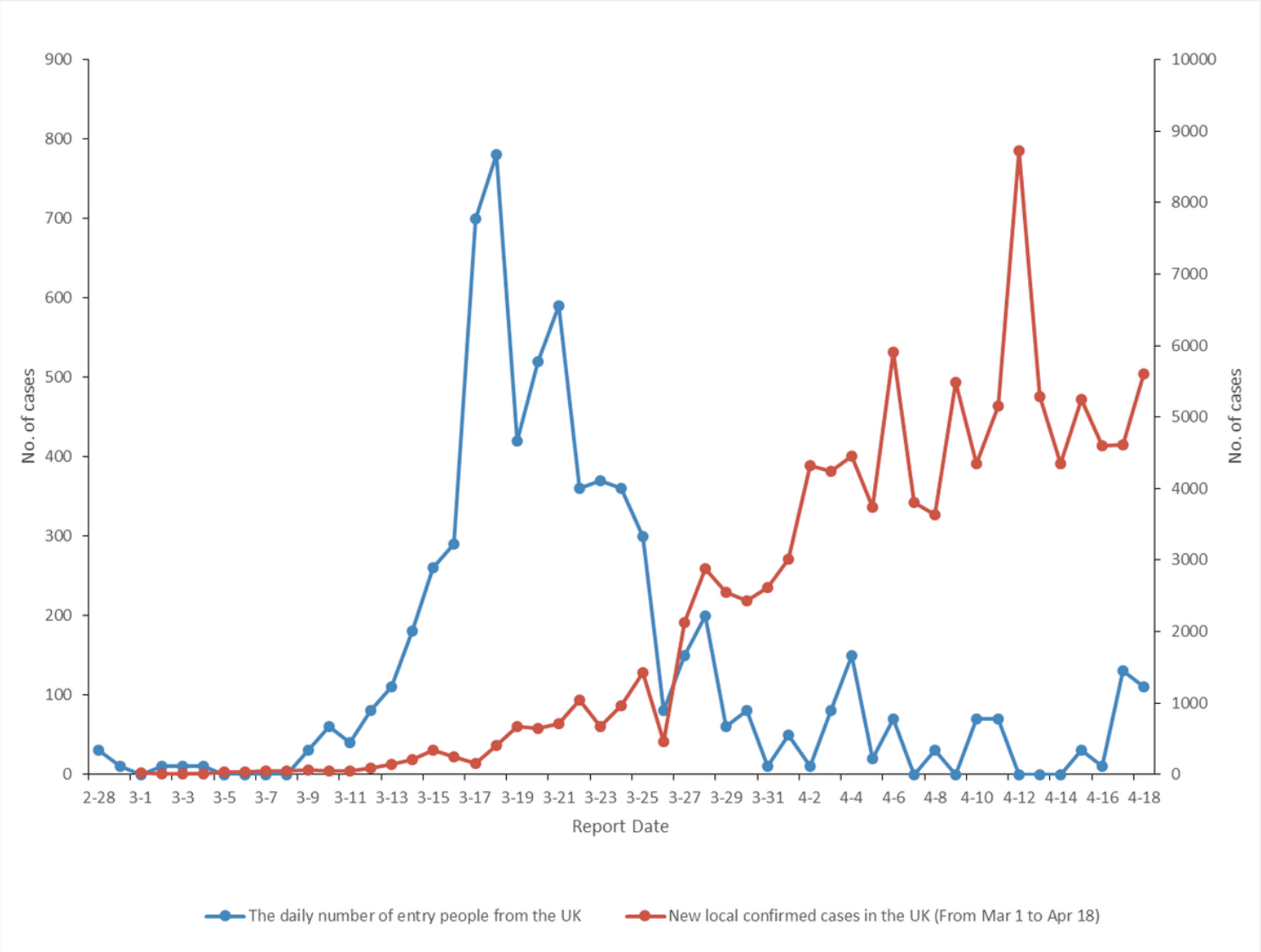

Figure 6

The daily number of entry people from the UK (From Feb 28 to Apr 18) and new local confirmed cases in the UK (From Mar 1 to Apr 18)

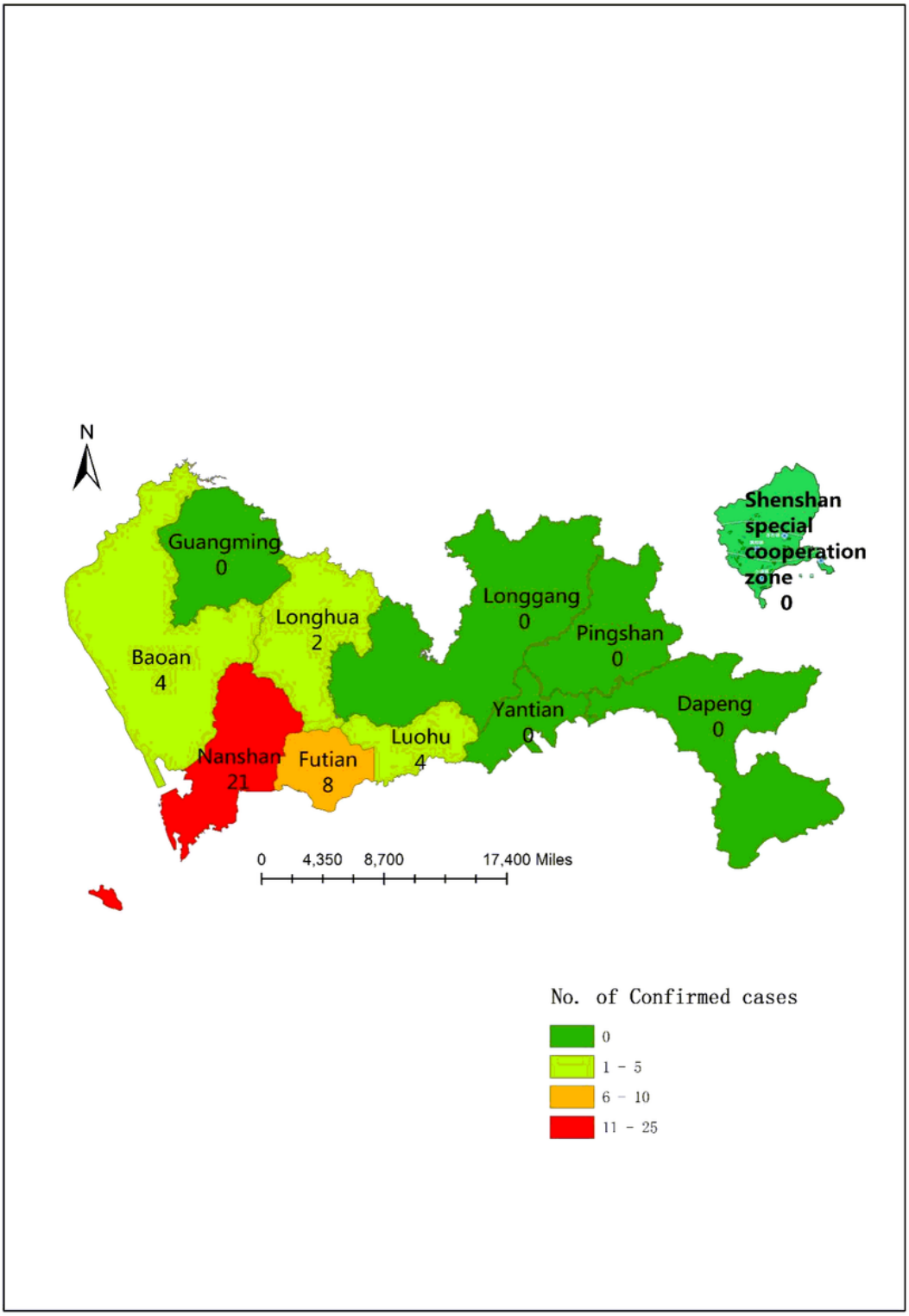

Figure 7

The distribution of imported cases in Shenzhen Note: The designations employed and the presentation of the material on this map do not imply the expression of any opinion whatsoever on the part of Research Square concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. This map has been provided by the authors.

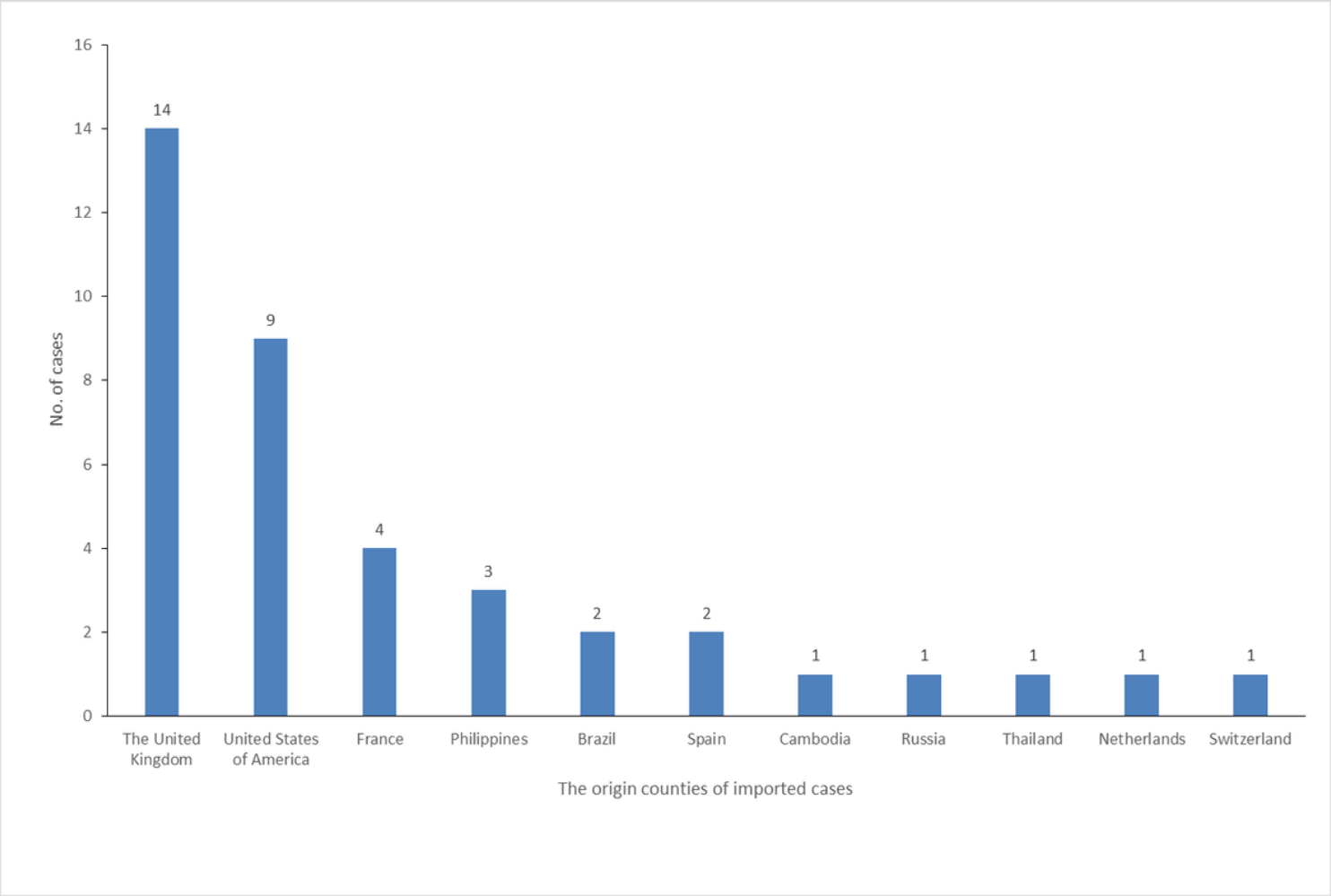

Figure 8

The origin counties of imported cases

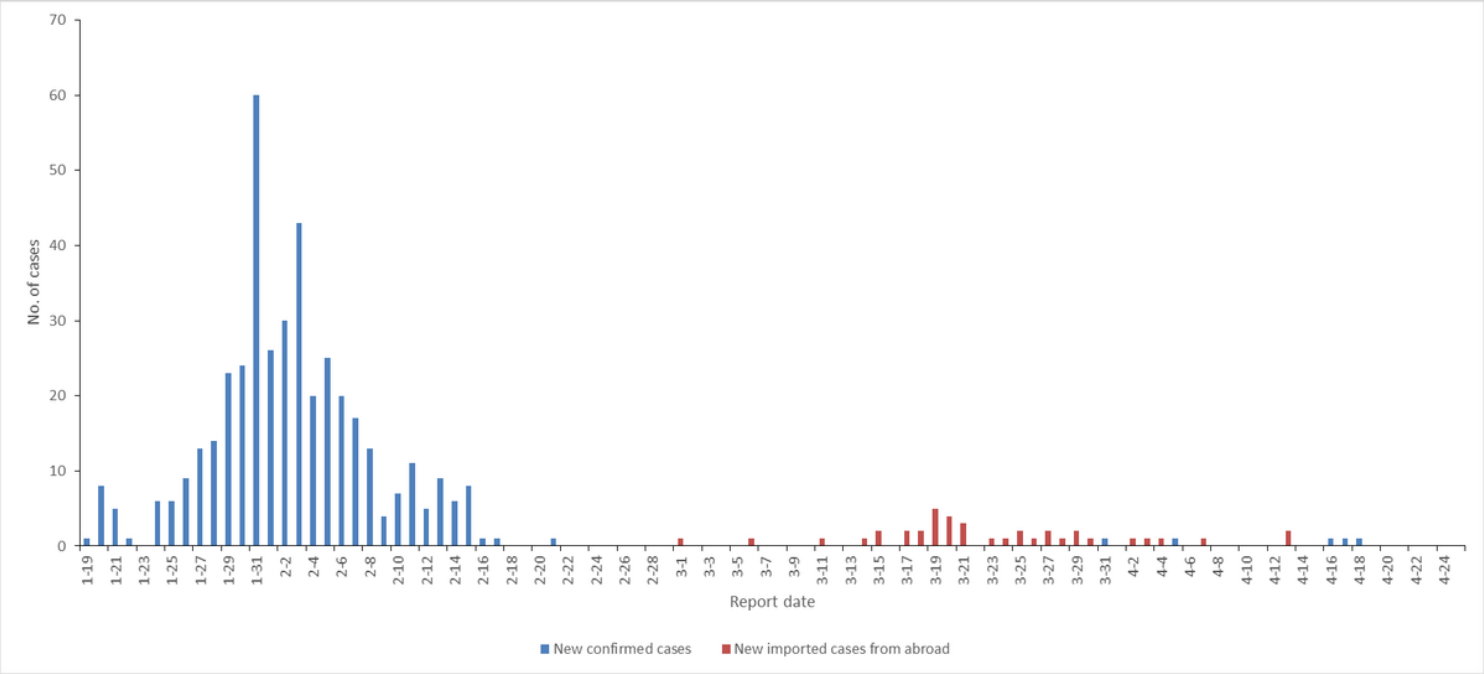

Figure 9

New confirmed cases in Shenzhen

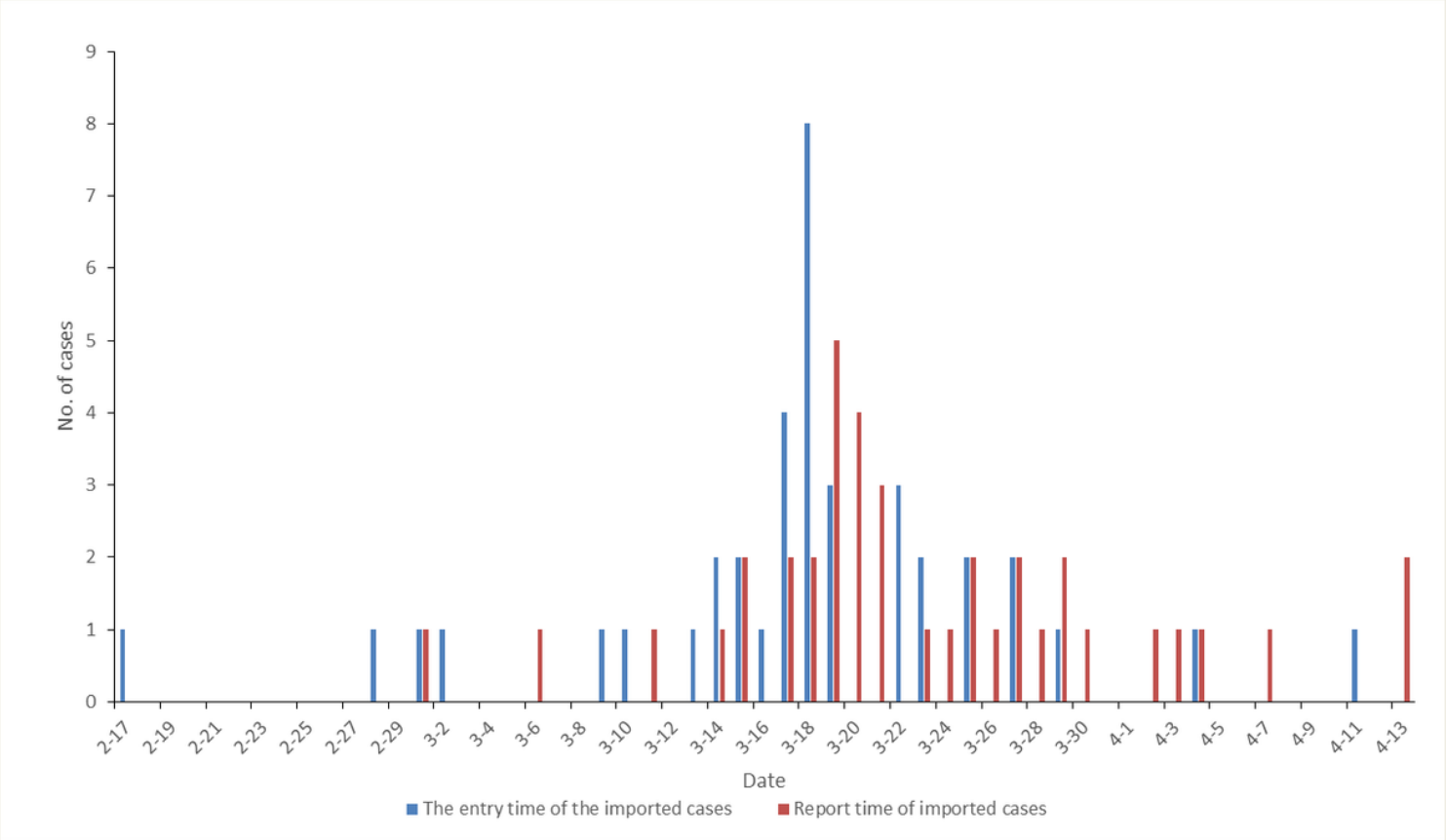

Figure 10

The entry and report time of imported cases from abroad in Shenzhen