SARS-CoV-2 Transmission and Epidemic Characteristics in Jining City, China

Jianwei Zhou,1 Yu Li,2 Cui Kong,3 Jiang Yu,1 Yizhao Li,4 Qinghua Zhang,5 Yao Liang6
1Medical Laboratory, Affiliated Hospital of Jining Medical University, Jining City, Shandong Province, China, 2Medical College, Jining Medical University, Jining City, Shandong Province, China, 3Nursing Department, Affiliated Hospital of Jining Medical University, Jining City, Shandong Province, China, 4Rehabilitation Department, Fangan Rehabilitation Hospital of Jinan City, Jinan, China, 5Neurology Department, Shandong Provincial Hospital Affiliated to Shandong First Medical University, Jinan, China, 6Health School of Jining City, Jining City, Shandong Province, China

Abstract

Background: Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) that causes severe acute respiratory syndrome has spread to hundreds of countries and infected millions of people, causing more than a hundred thousand deaths. This study aimed to describe the epidemic characteristics of SARS-CoV-2 and its transmission in a city in China.

Methods: This was a descriptive study on retrospective data collected from January to February 2020 from reports issued by the authority of Jining City, China, including data on travel history, transmission, gender, and age of infected persons.

Results: During the period January and February 2020, 52 cases were confirmed to be SARS-CoV-2 infections with more than half were males (n=32, 61.5%) and in the age grup of 31–50 years old (53.8%). The modes of transmission were mostly primary infections (n=23) and a history of travel to and from outside of Shandong Province (n=14). Interestingly, the infection was the 4th transmission and most primary infectious persons did not transmit the virus to others.

Conclusions: The key characters of infected people in Jining City in early epidemic time with the exception of exogenous inputs are male gender, city dweller, and middle-aged people of 31–50 years old. There is a restricted transmission in Jining City of China at the early phrase of the SARS-CoV-2 epidemic, indicating that the strategy for the fight against SARS-CoV-2 is effective to some extent and worth to be learned by the members of the global village. This strategy includes actions such as home isolation, collective centralized quarantine, social distancing, and face mask use.

Keywords: Jining City, epidemic characteristics, SARS-CoV-2, transmission

Introduction

Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2) has spread in hundreds of countries and made millions of people infected with more than two hundred thousand death. In this pandemic, lots of cities in the world have been invaded by the virus; and among them, there are some cities of China at the primary stage of the epidemic. Wuhan is the epidemic epicentral in China and many other cities of and out of Hubei Province are involved, such as Huanggang, Shanghai, Hangzhou, and so on. The epidemic and clinical characteristics of SARS-CoV-2 infection in first-tier cities have been described in some reports. However, relatively few reports about virus transmission in small cities.

As one of sixteen prefecture-level cities of Shandong province, Jining City belongs to a third-tier city in China. However, it is famous in the world for the Confucius' hometown—Qufu which is a county that belong to Jining. In this pandemic of SARS-CoV-2, Jining cannot escape by sheer luck. In this article, we retrospectively collected and analyzed the
Figure 1 Geographical Position of Jining City in China

Note: (a) Jining City is located in the east of China, southwest of Shandong Province, or northeast of Wuhan City, the area where SARS-CoV-2 first found. (b) The geographical distribution of cases with SARS-CoV-2 infection in Jining City (n22), Qufu City (n14), and Yanzhou District (n8)
epidemic data related to SARS-CoV-2, further presented the transmission panorama and demographic characteristics of the city and elucidated information or ideas for future research in the aspects of prevention, control, and epidemic analysis.

Methods

The design of the study was a descriptive study, and the data source was the reports issued by the authority of Jining City, including the traveling history, the transmission, the gender, and age of the infected persons. Furthermore, reports of Jining Municipal Health Committee, Rencheng District Health Committee of Jining City, and other local authority’s media, as well as the detailed information related to the cases infected with SARS-CoV-2 was collected, organized, and analyzed.

Data were collected from January 24 to February 16, 2020. All data of individuals with SARS-CoV-2 infection issued by the authority of Jining City were taken as the study subjects. With the data, the traveling history, the transmission, the gender, and age of the infected persons were analyzed. Age was further categorized from infant to the elderly with 10 years of interval and presented in a histogram. The residence of the cases was also categorized and presented whether cases from countryside, town, or county. The study was approved by the Ethics Committee of the Hospital Affiliated to Jining Medical University.

Results

There were 52 cases with SARS-CoV-2 infection reported in Jining City. Out of total of 11 counties or districts, no cases were found in three counties i.e. Weishan, Liangshan, and Yutai County as shown in Figure 1. There were

Figure 2 Traveling Experience Out of Shandong Province among Cases with SARS-CoV-2 Infection

Note: WH, Wuhan; ZZ, Zhengzhou; BJ, Beijing; CQ, Chongqing; CS, Changsha; JX, Jiangxi and a city in Hubei Province except for Wuhan
different numbers of infectious cases in the remaining 8 administrative regions. The most prevalent cases were from the urban district i.e. Jining City (22), Qufu City (14), and Yanzhou District (8). Furthermore, cases in Sishui, Wenshang, and Jiaxiang County were only 2 in each region, and only 1 case was founded in Jinxing and Zoucheng County; and no case in Liangshan, Weishan, and Yutai County.

Furthermore, the travel history of the cases was explored. The confirmed dates for 52 cases with SARS-CoV-2 infection were ranged from January 24 to February 16, 2020. There were 14 cases that had been travelled outside Shandong Province, of whom 7 cases had entered Wuhan; 2 cases had traveled to Zhengzhou; and 5 cases had a travel experience in one of the following cities: Beijing, Chongqing, Changsha, Jiangxi, and a city of Hubei Province except for Wuhan (Figure 2).

In total there were 52 cases of whom 32 were male (61.5%), and 37 (71.2%) individuals infected with SARS-CoV-2 came from the city, including Jining City and its affiliated counties and districts. Interestingly, 5 (9.6%) came from town and 10 (19.2%) came from the countryside. Most of the infected cases (n=38, 73.1%) had no traveling history to other provinces as shown in Figure 3.

Among the infected cases, the eldest age was 91 years old, and the youngest age was only 4 years old. The most common cases were from age category 31-40 years (n=14) and 41-50 years (n=14) and the total proportion was 53.8%. Furthermore, the age category >50 years old was the second most prevalent age group with 30.7% of the total case (Figure 3).

In the present study, we analyzed the infection source, confirmed date, and the relationship between the infected persons. A graphical figure of the transmission of SARS-CoV-2 in Jining City was presented in Figure 4. There were 23 cases in the first transmission of SARS-CoV-2 infection. The number for the second, third, and fourth transmission was 21, 2, and 4 cases, respectively.

### Discussion

The pandemic of SARS-CoV-2 has been a severe threatening to human health worldwide. In China, the novel coronavirus spread in many cities at the beginning of 2020. Except for Dongying City, the cases of SARS-CoV-2 emerged in the other fifteen cities of Shandong Province. This study puts the eyes on one of the prefecture-level cities—Jining City which is famous for Qufu city where is the hometown of Confucius, a well-known thinker, and educator.

As the results showed, there were 52 cases of SARS-CoV-2 infection in nine counties or districts of Jining City. The urban district of Jining City, Qufu City, and Yanzhou District...
were the top three regions with a higher number of infected cases. The reason for this status is that Jining, Qufu, and Yanzhou is the prefecture-level, the traveling, and the railway transport city, respectively, and the number of infection cases is associated with the degree of population mobility. In the gender analysis of 52 cases, the percentage of the female and male was 38.5% and 61.5%, respectively. This was similar to Chans' report in which the female and male ratios were 32% and 68%. In Ryu's investigation, more than two-third (10 in 15) of individuals infected with SARS-CoV-2
were male. In Huang’s study, the percent of the male was high to 73.2%, while the rate in Wang’s paper was only 54.3%. Although there are differences in the ratios of the male in different reports, it is obvious that the case number of the male was more than that of the female.

In the infected population, the age almost covered every phase: from elder men to little children, and the average age was 45.3 years. This was very near to Fang’s report, in which the average age of the patients with SARS-CoV-2 infection was 45.1 years. It is also consistent with the mean age of 47.0 years in Guan’s study. Certainly, there are inconsistent references about the average age of the infected person, for example, 37 years for Yang’s study on Nanjing. As the epicenter of this epidemic, the mean age was reported as 55.5 and 56.0 years in two reports focused on Wuhan, and it was obvious that the data were higher than in others cities. Whether the average age of the people infected with SARS-CoV-2 in non-epicenter usually is younger than that of the epicenter area needs further observation.

To analyze the cases with different age groups, we found that the percentage of age group 31–50 years was 53.8%, which was significantly higher than other reports. However, the percentage of this age group is more than one-third and higher than those of other age groups in those studies. The ratio for the age more than 71 years was 11.5%, similar to another report. In the range of age younger than 10 years, only 5.8% cases with SARS-CoV-2 infection in this study, a little bit higher than reported in other references. These findings probably indicate that the youngster is not easy to be infected with SARS-CoV-2, and the reason possibly is that this population consists of the students of primary and middle school. They usually live in a relatively small space and have very little social activities, and hence, they have a very low chance to be infected with SARS-CoV-2.

Of 52 cases, 71.2% came from the city which including Jining City and the affiliated counties and districts of the city; while less than 30% of the persons with SARS-CoV-2 infection came from towns and countryside. This finding is consistent with Chen’s and Lin’s reports. This point is determined by the relatively greater popular mobility of city dwellers. According to such a character, it is suggested that the city is of the primary importance for controlling the transmission of SARS-CoV-2.

According to the epidemic investigation reported by the local health authority, graphics has been drawn out to describe the transmission of SARS-CoV-2 in this study. There were 23 index persons who were taken as the initial transmission source. These index cases were responsible for the local epidemic of SARS-CoV-2 to some extent. Among them, 14 cases had clear travel histories out of Shandong Provinces, indicating that the inputting cases were the main infectious source for a city of non-epicenter such as Jining City. In all of the spread brought by 23 index infectors, there was only one time for the four generations of transmission, two generations of transmission happened five times, and most of the primary infectious person did not transmit the virus to others. The reality strongly proved that the preventing strategies against SARS-CoV-2 infection were very effective, such as home isolation, collective centralization quarantine, keeping social distance, wearing a face mask. Besides, from Figure 4 we could found that the transmission usually happened between the relatives of a family, so the family cluster was the main element for virus spreading in Jining City. Therefore, the prevention and control of SARS-CoV-2 transmission between the family members or relatives are rather important during the SARS-CoV-2 epidemic.

There are two limitations in the study at least, which is the lack of clinical information of all the cases and the other is that the infectious resource for the index persons remains unknown. However, these limitations do not affect the analysis of the epidemic characteristic of SARS-CoV-2 in Jining City.

To conclude, there is a restricted transmission in Jining City of China at the early phase of the SARS-CoV-2 epidemic. The key characters of the infected people in this epidemic are, besides exogenous input, mainly male, city dweller, and middle-aged people of 31–50 years old. According to the panorama and epidemic characteristic of SARS-CoV-2 in Jining City, China, it is suggested that the strategy for the fight against SARS-CoV-2 is effective to some extent and worthy to learn by the members of the global village, such as home isolation, collective centralization quarantine, keeping social distance, and wearing a face mask.

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