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Characteristics of COVID-19 near China’s epidemic center

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BACKGROUND

The first novel coronavirus pneumonia (COVID-19) case was identified in Wuhan, Hubei Province, China, on December 12, 2019, after which the disease gradually spread. The emergence of the COVID-19 epidemic coincided with the traditional Chinese Spring Festival when most migrant workers return to their hometowns to celebrate. COVID-19’s novel infection presented few obvious upper respiratory symptoms (such as nasal discharge, sneezing, or sore throat), indicating the virus mainly was infecting the lower respiratory tract, and most patients’ first symptom was fever. The mode of transmission might have been by droplets, close contact, aerosol, mother–infant, or fecal–mouth transfer. During the incubation period, patients could transmit the virus to other humans. As of February 22, 2020, 29 countries had reported confirmed cases of COVID-19, of which China reported 76,936 confirmed cases, 22,888 recovery cases, and 2,442 deaths. According to the research reports, COVID-19 is highly infectious, and the large-scale population migration associated with the Spring Festival exacerbated the spread of the disease to outlying areas.

METHODS

Data
China’s data on COVID-19 are gathered based on its classification as a Class B infectious disease. Class B infectious diseases are considered mandatory notifiable diseases: all new cases must immediately be reported using the National Infectious Diseases Monitoring Information System Database. To prevent rapid spread of the disease, the municipal health departments publicized information about the confirmed cases on the governments’ websites, including personal information, personnel exposure, and the disease trajectory. We downloaded the case information from the target cities’ health information and control measures.
2020, 416 cases of effective data were collected in the two cities\textsuperscript{16,17}: their residential areas.

### Conceptualization

The sources of infection were: (1) firsthand or secondhand contact with Hubei ("Hubei exposure"), (2) "confirmed case contact," (3) "non-Hubei returnee exposure," and (4) "others." "Hubei exposure" comprised confirmed cases of individuals who had recently left Hubei Province or had not recently left Hubei but had been in contact with asymptomatic individuals who had been in Hubei Province. "Confirmed case contact" refers to infected individuals who had not left their residential areas and they had been in close contact with individuals who were confirmed cases. "Non-Hubei returnee exposure" refers to individuals who had recently returned to Xinyang or Fuyang from non-Hubei provinces. In this study, a “returnee” was an individual who had returned to Xinyang or Fuyang from some other location, and “non-returnee” referred to an individual who had not left Xinyang or Fuyang.

### Statistical analysis

The age, gender, trajectory, and rates of infection distributions of the 416 confirmed cases in Xinyang and Fuyang were analyzed. The distribution of confirmed cases in households was analyzed to describe the extent of COVID-19 clustered within household units. Using the data on timing of disease onset and final diagnosis, the COVID-19 development over time was investigated. Regarding the disease trajectory (confirmed cases), four temporal stages were identified: (1) arrival → disease onset, (2) disease onset → first medical visit, (3) first medical visit → final diagnosis, and (4) final diagnosis → recovery. The mean periods of each stage were described and analyzed. IBM SPSS 22.0 was used for data analysis.

### RESULTS

#### Epidemiological situation

As of February 22, 2020, 429 cases had been confirmed in Xinyang and Fuyang. In Xinyang, 184 of the 274 cases were in recovery (67.15%), and two had died (0.73% fatality rate); in Fuyang, 99 of the 155 cases were in recovery (63.87%), and no deaths were reported. Thus, on that date, there were 88 and 56 ongoing cases in Xinyang and Fuyang, respectively. However, 13 cases were not included due to incomplete information.

#### Gender and age distributions

Among the confirmed cases with complete effective data ($N = 416$), 236 were male (56.73%) and 180 were female (43.27%). The proportional age distribution was 0-18 years old (5.05%), 19-59 years old (78.84%), and 60 years or older (16.11%). The proportion of confirmed cases aged 19-59 years in the returnee group was higher than among the nonreturnees, and the proportions of confirmed cases aged 0-18 and aged 60 or older among the nonreturnees were higher than among the returnees. Table 1 presents the distributions regarding age, gender, source of infection, and within-household transmission and Figure 1 illustrates the disease trajectory between onset and final diagnosis from January 11, 2020, through February 22, 2020, and the disease trajectory from January 23, 2020, through February 22, 2020, by source of infection.

#### Time distribution

Figure 1A illustrates that the first day of disease onset in the two cities was January 11, 2020, after which the number of confirmed cases gradually increased. The disease onset peak was January 25 through January 30 and then the number of newly confirmed cases gradually decreased. The first final diagnosis was on January 23, 2020, the numbers of final diagnoses gradually increased, they peaked January 31 through February 5, and they gradually decreased from that date. The peak of the final diagnoses was about 6 days after the peak of disease onset.

### Table 1

Distribution of confirmed cases by age, gender, source of infection, and extent of household infection ($N = 416$)

| Variable                  | All confirmed cases | Returnees | Nonreturnees |
|---------------------------|---------------------|-----------|--------------|
|                           | N       | Percentage | n       | Percentage | n       | Percentage |
| **Age**                   |         |           |         |           |         |           |
| 0-18                      | 21      | 5.05      | 7       | 3.54      | 14      | 6.42       |
| 19-59                     | 328     | 78.84     | 173     | 87.37     | 155     | 71.10      |
| 60 or older               | 67      | 16.11     | 18      | 9.10      | 49      | 22.48      |
| **Gender**                |         |           |         |           |         |           |
| Male                      | 236     | 56.73     | 123     | 62.12     | 113     | 51.83      |
| Female                    | 180     | 43.27     | 75      | 37.88     | 105     | 48.17      |
| **Source of infection**   |         |           |         |           |         |           |
| Hubei exposure            | 213     | 51.20     | 113     | 51.83     | 63      | 29.87      |
| Confirmed case contact    | 109     | 25.96     | 56      | 26.07     | 53      | 25.65      |
| Non-Hubei returnee        | 32      | 7.69      | 11      | 5.36      | 21      | 10.47      |
| Other                     | 63      | 15.14     | 36      | 16.81     | 27      | 13.50      |
| **Household clusters**    |         |           |         |           |         |           |
| Number of cases per household | 33 | 64.71 | 13 | 25.49 | 6 | 11.80 |
Infection sources and extent of household infection

Hubei exposure was the source of 213 (51.20%) confirmed cases, 108 (25.96%) cases were confirmed case contacts, non-Hubei returnee exposure accounted for 32 (7.69%) cases, and there were 63 (15.14%) cases due to other sources. Figure 1B shows that the main source of infection before February 7 was Hubei exposure, and, after February 7, the main source of infection was confirmed case contact.

Regarding within-household infection, 51 households (with 130 confirmed cases) experienced within-household transmission based on multiple infected household members (Table 1). Of them, 33 households had two, 13 households had three, two households had four, one household had five, and two households had six infected household members (64.71%, 25.49%, 3.92%, 1.96%, and 3.92% of the households with more than one infected household member, respectively). The mean number of people infected in the households with more than one infected member was 2.55.

The period between the date of return and the date of recovery

Table 2 shows that the mean period between the date of return to Xinyang or Fuyang and date of disease onset was 6.69 days (among the 198 confirmed cases categorized as “returnees”). The mean period between date of disease onset and date of first visit for all cases was 4.44 days, between date of first visit and date of final diagnosis was 3.18 days, and between date of final diagnosis and date of recovery was 13.42 days. The mean number of days between date of disease onset and date of first visit was slightly longer for the 218 nonreturnees than the 198 returnees. The period between date of first visit and date of final diagnosis was slightly longer for nonreturnees than returnees, and the period between date of final diagnosis and date of recovery was slightly longer for returnees than nonreturnees.

DISCUSSION

Among the returnees, the proportion of confirmed cases aged 19-59 years was 87.37%, whereas the proportion of those aged 60 years or older and 0-18 years was just 12.64%. In comparison to the returnees, the proportion of nonreturnees aged 19-59 years was 16.28% higher and the proportion of those aged 60 or older was 13.38% lower. The returnees’ male to female sex ratio was 1.64:1, and the male to female sex ratio among nonreturnees was 1.08:1. These results might reflect the fact that migrant workers are most likely to be males aged 19-59 years, which means that there were relatively higher proportional representations of females and older people among the nonreturnees. Moreover, this finding indicates that people of all ages are susceptible to COVID-19.

The numbers of final diagnoses of confirmed cases peaked within 14 days of onset and then gradually decreased until February 22 when just one case was diagnosed. This finding demonstrates that the spread of the virus had effectively been controlled through various measures, such as isolating exposed people, reducing public gatherings, increasing screenings for fever, and widespread public dissemination of prevention and control information.

This study’s analysis revealed that the main source of confirmed cases was Hubei exposure or confirmed case contact. During the first half of the outbreak period, Hubei exposure was the likeliest source and, during the second half of the outbreak period, confirmed case contact was the likeliest source of infection. Previous studies have found that close contact with infected individuals tended to carry a high risk of infection.18,19 The present study found that, of the confirmed cases whose source of infection was “confirmed case contact,” 72.22% were via household contact with one or more confirmed cases.

Of the 130 confirmed cases clustered in households, the most frequent extent of household infection was two (64.71%) or three
(25.49%) confirmed cases per household, and the mean was 2.55 confirmed cases per household. According to the statistical yearbook data of Xinyang and Fuyang, as of 2018, the average number of people in each household unit was 3.48. A previous study estimated that one confirmed case could infect an average of 2.2 people, and the World Health Organization estimated a range of 1.4-2.5 people, whereas the current study found the number of infected household clusters in the study area had a slightly higher risk.

Among the confirmed cases with an infection source of “other,” a crowded public place was the main source of infection. These results imply that the prevention and control measures on public gatherings markedly slowed the COVID-19 rate of infection outside households. On January 21, 2020, Wuhan City in Hubei Province began to take measures to reduce the number of people gathered. On March 19, 2020, the number of new cases in Wuhan was zero for the first time. Studies have shown that the number of infected cases was significantly reduced by controlling the city’s traffic, closing entertainment venues, and banning public gathering. Implementing these measures can limit the progression of the epidemic. By further controlling within-household contact with infected people and the size of public gatherings, incidences might be further decreased.

The key to controlling infectious diseases is early detection, reporting, isolation, and treatment. We found that the mean period from date of return to the study area and date of disease onset was 6.69 days (range –3 to 33). Twenty confirmed cases among the returnees (10.1%) had symptoms before they arrived in Xinyang or Fuyang, suggesting that one of the first steps to take should be to assertively control of workers’ mobility and decreasing close within-household contact.

The mean period from date of disease onset to first medical visit was about 4.44 days (range: –3 to 21). Two cases did not have symptoms at the time of first medical treatment (screening). Li et al. found that the mean interval between date of disease onset and date of first visit was 5.8 days (cases with onset before January 1, 2020) or 4.6 days (onset from January 1 through January 11). We found a markedly reduced rate of infection would further be reduced.

The key to controlling infectious diseases is early detection, reporting, isolation, and treatment. We found that the mean period from date of return to the study area and date of disease onset was 6.69 days (range –3 to 33). Twenty confirmed cases among the returnees (10.1%) had symptoms before they arrived in Xinyang or Fuyang, suggesting that one of the first steps to take should be to assertively control of workers’ abilities to return home which, in the early stage, might slow the rate of infection.

The mean period from date of disease onset to first medical visit was about 4.44 days (range: –3 to 21). Two cases did not have symptoms at the time of first medical treatment (screening). Li et al. found that the mean interval between date of disease onset and date of first visit was 5.8 days (cases with onset before January 1, 2020) or 4.6 days (onset from January 1 through January 11). We found a slightly shorter period, implying that public awareness of COVID-19 and medical treatment had gradually improved and people were increasingly likely to seek treatment. Moreover, the mean period between date of disease onset and date of first visit among nonreturnees was slightly longer than among returnees, indicating that quarantine and isolation measures were slightly stronger for returnees than nonreturnees. We found that the mean period between date of first visit and date of final diagnosis was 3.18 days, suggesting that the efficiency of early detection measures needed improvement. In addition, the mean period between date of final diagnosis and date of recovery was about 13.42 days (range: 5-25). The mean hospital stay was 10 days in a previous study, but it was slightly longer in our study.

**CONCLUSIONS**

Effective responses to COVID-19 for prevention and control required implementation of governmental measures, which apparently controlled the rate of infection in Xinyang and Fuyang, which are cities with significant flows of migrant workers to and from Hubei Province. The key to controlling the rate of infection via returnees is to act as quickly as possible, focus on isolating and controlling returnees’ mobility, and decreasing close within-household contact between infected and noninfected household members. If these measures were implemented as a preemptive first step, the rate of infection would further be reduced.

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**Table 2**

Distributions of numbers of days from date of return to the study area to date of recovery among returnees and nonreturnees

| Variable | All confirmed cases | Returnees | Nonreturnees |
|----------|---------------------|-----------|--------------|
| Date of return–date of onset | Mean | Max | Min | Mean | Max | Min | Mean | Max | Min |
| Date of onset–date of first visit | 4.44 | 21 | –3 | 6.69 | 33 | –7 | 4.04 | 13 | –3 |
| Date of first visit–date of final diagnosis | 3.18 | 19 | 0 | 3.55 | 19 | 0 | 3.02 | 18 | 1 |
| Date of final diagnosis–date of recovery | 13.42 | 25 | 5 | 13.64 | 25 | 5 | 13.15 | 25 | 7 |

1 Numbers less than zero mean that some confirmed cases had symptoms indicating disease onset before they returned to the study area.

2 The negative number indicates that some cases did not present symptoms at the time of first medical visit.

3 Numbers less than zero mean that some confirmed cases had symptoms indicating disease onset before they returned home.

4 The negative number indicates that some cases did not present symptoms at the time of first medical treatment.
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