International Health 2021; **13**: 350–357
doi:10.1093/inthealth/ihaa079 Advance Access publication 14 October 2020

ORIGINAL ARTICLE

Wuhan's experience in curbing the spread of coronavirus disease (COVID-19)

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Received 27 July 2020; revised 15 September 2020; editorial decision 15 September 2020; accepted 22 September 2020

Background: Since December 2019, coronavirus disease (COVID-19) has affected over 50 000 people in Wuhan, China. However, the number of daily infection cases, hospitalization rate, lag time from onset to diagnosis date and their associations with measures introduced to slow down the spread of COVID-19 have not been fully explored.

Methods: This study recruited 6872 COVID-19 patients in the Wuchang district, Wuhan. All of the patients had an onset date from 21 December 2019 to 23 February 2020. The overall and weekly hospitalization rate and lag time from onset to diagnosis date were calculated. The number of daily infections was estimated by the back-projection method based on the number of daily onset cases. Their association with major government reactions and measures was analyzed narratively.

Results: The overall hospitalization rate was 45.9% (95% CI 44.7 to 47.1%) and the mean lag time from onset to diagnosis was 11.1±7.4 d. The estimated infection curve was constructed for the period from 14 December 2019 to 23 February 2020. Raising public awareness regarding self-protecting and social distancing, as well as the provision of timely testing and inpatient services, were coincident with the decline in the daily number of infections.

Conclusion: Early public awareness, early identification and early quarantine, supported by appropriate infrastructure, are important elements for containing the spread of COVID-19 in the community.

Keywords: back-projection, coronavirus disease, COVID-19, epidemic curve.

Introduction

In late December 2019, the coronavirus disease (COVID-19) started to spread in Wuhan, Hubei province, China.[1,2] Up to 13 September 2020, there were 90 685 COVID-19 cases (4741 deaths and 85 546 recoveries) in China, of which 50 344 cases (3869 deaths and 46 475 recoveries) came from Wuhan.[3] Wuhan was the first city in the world to experience the entire process of the COVID-19 pandemic, from the outbreak to successful control. Wuchang district is one of the central districts in Wuhan, consisting of 1.26 million residents, accounting for one tenth of Wuhan's population. The number of COVID-19 cases in the Wuchang district accounted for 15% of all the cases in Wuhan.[4] The government and public health system made different attempts to both slow the transmission of COVID-19 and to provide treatment to more patients. For example, the whole of Wuhan was lockdown on 23 January 2020.[1,2] Two new hospitals, Huoshenshan Hospital and Leishenshan Hospital, as well as 16 quarantine facilities called Fangcang hospitals were built, providing more than 20 000 beds.

Studying the trajectory of epidemic curves was one of the ways to explore the effectiveness of various preventive measures.[2,5–15] However, all of these epidemic curves were based on the daily number of onset, except for one which constructed the epidemic curve for the Japanese cruise outbreak based on the estimated daily number of infections.[16] Because there was a delay between infection and onset date, an epidemic curve based on the infection date would be more accurate for exploring the effectiveness of various measures. Hence, the current study used back-projection to estimate the daily number of infections and reconstructed the epidemic curve of COVID-19 in the Wuchang district.

While the characteristics of COVID-19 patients for all of China were presented in a previous study,[2] some of the useful parameters, such as the number of daily infections, hospitalization rate and time lag from onset to diagnosis date, were not fully explored. The current study analyzed the data of patients diagnosed with COVID-19 from late December 2019 to February 2020 in the Wuchang district. The objectives of the current study were to (1) estimate the daily number of infections, the proportion of patients hospitalized, the time lag from onset to diagnosis date; and (2) to narratively explore the trajectory of the number of infections in relation to government reactions and measures.

The COVID-19 pandemic is still seriously affecting the world and globally the daily number of new cases is greater than 100 000.[17] Those countries and regions that have successfully controlled the COVID-19 pandemic also face the risk of second (or even third) outbreaks. The experience of Wuhan provides details of effective ways with which to contain COVID-19.

Materials and methods

Data source

This study was a retrospective study using data extracted from China's Infectious Disease Information System (IDIS). After the first consultation, the doctor uploaded the patient's name, ID number and contact information to IDIS.[1] Hence, the system contained all the COVID-19 cases, of which the author had access to those cases in Wuchang district. Epidemiologists and public health workers contacted selected patients and asked them to complete an epidemiological questionnaire. Unique ID numbers ensured that there was no duplication of records. Prior to the start of telephone interviews, oral consent was asked for and secured from each patient. All data were handled as confidential to protect privacy.

The data inclusion criteria were (1) confirmed, asymptomatic or clinically diagnosed cases, (2) an onset date from 21 December 2019 to 23 February 2020 and (3) diagnosis in hospitals and community medical centers in Wuchang district, Wuhan. The four types of COVID-19 diagnosis adopted in China were confirmed, clinically diagnosed, asymptomatic and suspected cases.[1] Confirmed cases referred to those who had positive results in a viral nucleic acid test. Clinically diagnosed cases referred to those with COVID-19 radiographic image features and typical symptoms, but either waiting for or having received negative results in the viral nucleic acid tests. This classification was only adopted in the Hubei province. Asymptomatic cases were those with positive results in the viral nucleic acid test but no COVID-19 clinical symptoms. Suspected cases had very mild COVID-19 symptoms or had close contact with confirmed patients, but they had not received any tests or had negative results in viral nucleic acid tests.[18,19] Suspected cases were excluded from this study.

Variables

Sociodemographic and epidemiologic information was collected. The sociodemographic information included age, gender, address and occupation. The epidemiological information included onset date, diagnosis date, diagnosis type, severity of disease, contact history, group infection history and hospitalization. In this study, severity was classified as asymptomatic, mild, moderate, severe or critical. Asymptomatic cases had positive results in the viral nucleic acid test but no COVID-19 clinical symptoms.[19] According to the National Health Commission, mild cases referred to those without pneumonia or with mild pneumonia symptoms and no pneumonia imaging signs; moderate cases were those with pneumonia symptoms such as fever and cough and signs of pneumonia imaging; severe cases referred to those with dyspnea, a respiratory frequency of $\geq$30/min, rest blood oxygen saturation of $\leq$93%, PaO_2/FiO_2 ratio <300 or lung infiltrates $>50\%$ within 24 to 48 h; and critical cases were those who exhibited respiratory failure, septic shock and/or multiple organ dysfunction/failure.[20] People who had close contact with diagnosed or suspected patients were regarded as having a contact history. Having a group infection at home, socially or in the workplace was regarded as having a group infection contact history. In the current study, hospitalization referred to patients admitted to formal hospitals, including the Leishenshan and Huoshenshan hospitals. People admitted to Fangcang hospitals while waiting for formal hospital beds were not included in the hospitalization rate calculation because admission information for Fangcang hospitals was not extracted. The diagnosis date was regarded as the onset date of an asymptomatic patient.[1]

Data analysis

The patients' characteristics were summarized by descriptive analysis. The hospitalization rate was defined by the number of hospitalized cases divided by the number of diagnosed cases. The weekly hospitalization rate used the number of newly diagnosed cases in a week as the denominator and the cumulative hospitalization rate used the cumulative number of diagnosed cases up to that week as the denominator. The time lag (in days) between the date of onset and the date of diagnosis was calculated and the weekly mean time lag of the onset cases in each week was estimated.

The daily number of infections was estimated by the back-projection method, which was originally developed for the HIV epidemic[21,22] and was later applied to the Severe Acute Respiratory Syndrome (SARS) epidemic.[23] In brief, the number of daily onset cases were used as the input for the back-projection. It was assumed that there was no infection 10 d prior to the first reported date of onset. The daily mean number of onset cases was expressed as the sum of the daily mean number of infections on different days multiplied by the probability function of the incubation period with the corresponding incubation period. A Weibull distribution with a mean of 6.4 d (SD 2.3 d) was used to model the incubation period of COVID-19.[24] An iterative algorithm called 'Estimate-Maximize-Smooth' was used to estimate the daily number of infections. Based on the initial values (the exact value did not affect the estimate), an expected log-likelihood function was computed, which was then maximized. Smoothing was performed for the numbers of infections on adjacent days. The new estimates of daily infections were then used in the expectation and maximization steps until the changes in the new estimates were negligible. Details of the back-projection method are reported elsewhere.[21,22] Python was used for running the algorithm. An epidemic curve was constructed by plotting the estimated daily number of infections against time.

Major government reactions, measures and major events were marked against the sequence of time. The information was referenced from the official websites of government departments such as the Chinese Center for Disease Control and Prevention (http://www.chinacdc.cn/), the National Health Commission (http://www.nhc.gov.cn/), the Health Commission of Hubei (http://wjw.hubei.gov.cn/), Wuhan Municipal Health Commission (http://wjw.wh.gov.cn/) and mainstream media such as *People's Daily* (http://paper.people.com.cn/).

Results

A total of 6872 COVID-19 patients were included in the analysis (Table 1). Their ages ranged from 2 d to 100 y. The mean age was 54.4±15.6 y; nearly half of the patients (47.6%) were aged 51–70 y. Slightly over half were female (52.8%). The majority of patients lived in Wuchang (68.0%) and the nearby Hongshan district (20.8%). Only 6.8% of the patients worked in health facilities.

Over 85% of the patients were confirmed cases (i.e. had received positive results in the viral nucleic acid test). Asymptomatic, mild, moderate, severe and critical cases contributed to 0.9%, 39.9%, 42.8%, 15.4% and 1.5% of all cases, respectively. More than three-quarters of patients claimed they had no contact history (75.1%) or group infection history (77.6%). Figure 1 shows the estimated number of daily infections and observed daily onset cases, along with government reactions, measures and major events.

The weekly mean lag time from the date of onset to diagnosis for 6847 patients (25 asymptomatic patients were excluded) breakdown by severity and onset date is presented in Table 2. During the study period, the lag time between onset to diagnosis ranged from 0 to 58 d (mean ± SD: 11.1±7.4 d). The mean lag time of mild, moderate, severe and critical patients was 10.0±6.6, 11.5±7.7, 13.0±8.1 and 11.7±8.7 d, respectively. Severe cases had the longest delay from onset to diagnosis, while mild cases had the shortest delay. Before the availability of COVID-19 testing kits on 13 January 2020, the overall weekly mean lag time from onset to diagnosis ranged from 50 to 19.7 d. From 18 January 2020, the weekly overall mean lag time from onset to diagnosis showed a decreasing trend from 14.3 to 2.0 d. The shortened time lag was coincident with the downphase of the epidemic.

During the study period, the overall hospitalization rate was 45.9% (95% CI 44.7 to 47.1%) (Table 3). The hospitalization rates of asymptomatic, mild, moderate, severe and critical patients were 52.0% (95% CI 32.4 to 71.6%), 39.6% (95% CI 37.8 to 41.4%), 40.9% (95% CI 39.1 to 42.7%), 74.3% (95% CI 71.7 to 76.9%) and 62.7% (95% CI 53.4 to 72.1%), respectively. Severe cases had the highest hospitalization rates. The weekly hospitalization rates of all severity levels generally showed a decreasing trend from 18 January to 14 February 2020, which subsequently became an increasing trend over the next fortnight. The cumulative overall hospitalization rate showed a similar trend, dropping from 64.9% (95% CI 57.2 to 72.6%) to 43.1% (95% CI 41.8 to 44.4%) during 18 January to 14 February, then increasing to 45.9% (95% CI 44.7 to 47.1%) in the 10th week. The cumulative hospitalization rates of severe and critical patients were >60% for most weeks, whereas the rates of other severity levels and the overall sample were frequently <50%.

Table 1. Characteristics of 6872 diagnosed cases

Variables	Count (%)
Age (y), mean (SD)	54.4 (15.6)
0–20	70 (1.0)
21–30	460 (6.7)
31–40	932 (13.6)
41–50	1143 (16.6)
51–60	1594 (23.2)
61–70	1676 (24.4)
71–80	728 (10.6)
81–100	269 (3.9)
Gender	
Male	3241 (47.2)
Female	3631 (52.8)
Occupation	
Working in a health facility	470 (6.8)
Not working in a health facility	6402 (93.2)
Location	
Wuchang district	4675 (68.0)
Hongshan district	1426 (20.8)
Jianghan district	229 (3.3)
Qingshan district	120 (1.7)
Other districts in Wuhan	383 (5.6)
Outside Wuhan	39 (0.6)
Diagnosis type	
Clinically diagnosed cases	1020 (14.8)
Confirmed cases	5852 (85.2)
Severity	
Asymptomatic	25 (0.4)
Mild	2742 (39.9)
Moderate	2944 (42.8)
Severe	1059 (15.4)
Critical	102 (1.5)
Contact history	
Yes	1712 (24.9)
No	5160 (75.1)
Group infection contact history	
Yes	561 (8.2)
No	5331 (77.6)
Not clear	980 (14.3)

The trajectory of the number of daily infections was examined. From December 2019 to early January 2020, cases were sparse and most patients had close contact with the Huanan seafood

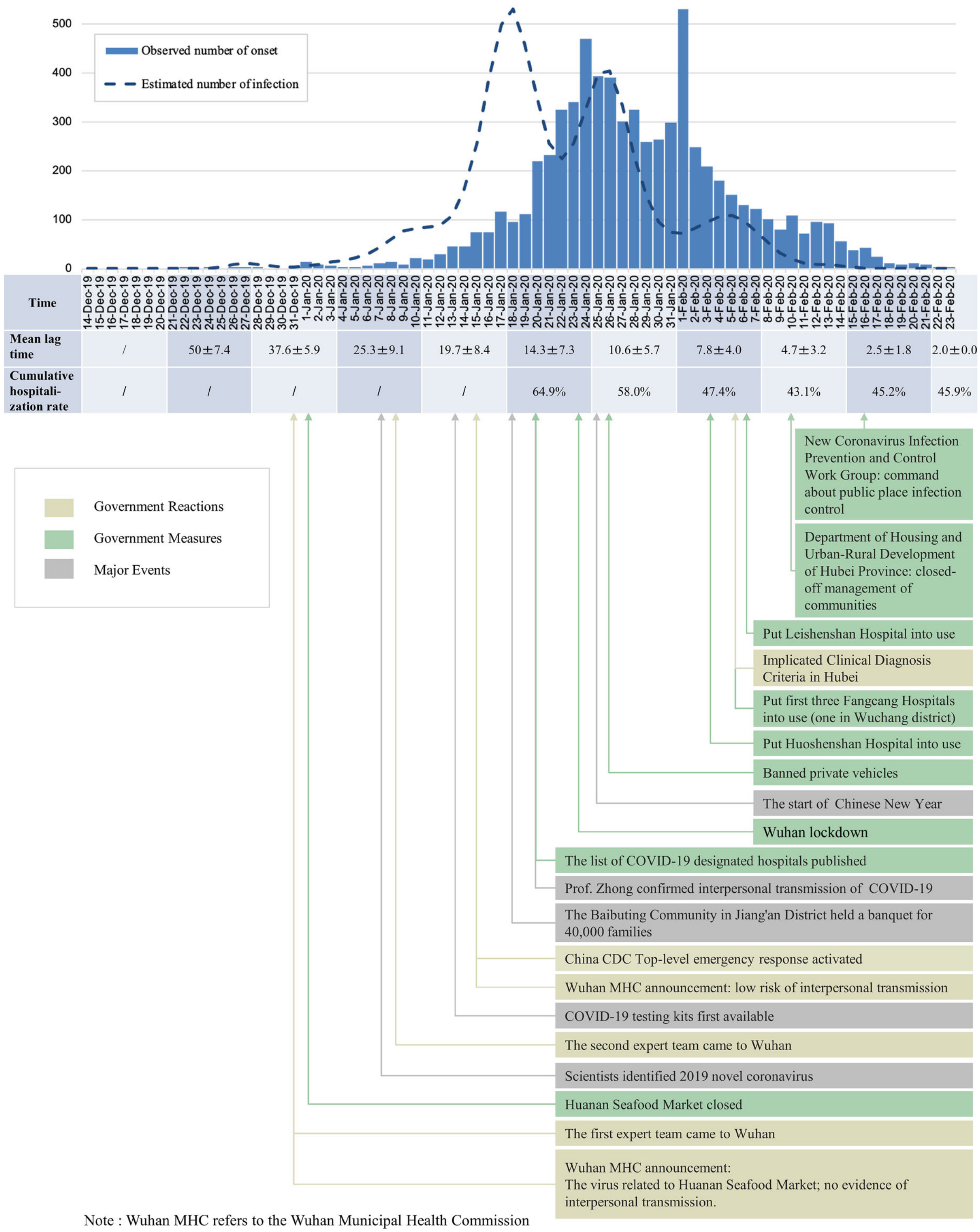

Figure 1. Epidemic curves of the estimated number of infections and observed number of new cases, along with the weekly mean lag time between the date of date and diagnosis, cumulative hospitalization rate and government reactions, measures and major events in the Wuchang district, Wuhan from 14 December 2019 to 23 February 2020.

Table 2. Weekly mean lag time from onset to diagnosis# (in days) of 6847 patients (25 asymptomatic patients excluded) breakdown by severity and date of onset

		Mild			Moderate			Severe			Critical			Overall		
Week	Onset date (by week)	n	mean	SD	n	mean	SD	n	mean	SD	n	mean	SD	n	mean	SD
1	21/12/2019–27/12/2019	3	46.3	7.2	2	55.5	2.5	0	NA	NA	0	NA	NA	5	50.0	7.4
2	28/12/2019–3/1/2020	11	36.73	4.6	12	35.9	5.2	10	37.3	8.2	1	39.0	NA	34	36.7	5.9
3	4/1/2020–10/1/2020	9	31.2	4.6	30	26.8	9.4	26	21.5	8.5	3	24. 7	10.6	68	25.3	9.1
4	11/1/2020–17/1/2020	66	22.8	7.1	186	18.8	9.0	133	19.4	7.4	20	17.6	9.4	405	19.7	8.4
5	18/1/2020–24/1/2020	523	15.1	5.7	847	13.8	8.2	389	14.8	7.0	37	11.3	7.5	1796	14.3	7.3
6	25/1/2020–31/1/2020	995	10.0	5.0	944	11.5	6.0	268	10.3	6.5	24	8.4	4.9	2231	10.6	5.7
7	1/2/2020–7/2/2020	793	7.2	3.6	611	8.5	3.9	151	8.7	5.3	13	7.5	5.1	1568	7.8	4.0
8	8/2/2020–14/2/2020	280	4.2	2.8	255	4.9	3.4	62	6.4	3.4	3	5.3	5.0	600	4.7	3.2
9	15/2/2020–21/2/2020	60	2.6	1.6	56	2.3	1.8	20	2.9	2.3	1	0	NA	137	2.5	1.8
10	22/2/2020–23/2/2020	2	2.0	0	1	2.0	0.0	0	NA	NA	0	NA	NA	3	2.0	0.0
	Whole period	2742	10.0	6.6	2944	11.5	7.7	1059	13.0	8.1	102	11.7	8.7	6847	11.1	7.4

Diagnosed date refers to the date of confirmation with viral nucleic acid test or clinically diagnosed with radiographic image tests.
NA: not applicable.

market.[1,2] The Wuhan Municipal Health Commission (MHC) made optimistic judgments about the contagiousness of COVID-19. On 31 December 2019, Wuhan MHC published a notice claiming that there was no evidence of interpersonal transmission of COVID-19. Huanan seafood market closed on 1 January 2020. On 5 January, Wuhan MHC announced that COVID-19 had a low risk of interpersonal transmission. Consequently, public gatherings continued as usual. For example, on 18 January, Baibuting Community held a family banquet attended by 40 000 families. Furthermore, people followed the tradition of returning home before Chinese New Year. Wuhan was one of the China's transport hubs, and large crowds gathered at bus terminals, high-speed rail stations, railway stations, airports. The first wave of infections that peaked on 18 January was possibly related to ongoing social contact and the heavy traffic prior to the Chinese New Year.

When the number of new onset cases increased rapidly, Wuhan MHC announced a list of designated hospitals which were only accessible by patients with COVID-19 symptoms (from 20 January). This measure separated patients suspected to have COVID-19 from other patients. On the same day, an expert confirmed interpersonal transmission of COVID-19 in the media and recommended minimal gatherings, mask-wearing and good hand hygiene. The number of estimated daily infection cases declined from its peak during 18–22 January 2020.

The decline in the infection curve from its first peak terminated on 23 January. On that date, at 2 am, the government announced that all of Wuhan would be lockdown from 10 am on 23 January. All public events were canceled. Intercity and intracity public transportation restrictions were implemented. Only private vehicles and taxis could be used for intracity transportation. However, grocery stores and supermarkets were open for business as usual. Instead of promoting social distancing, the sudden lockdown of the city caused panic buying with the public rushing to shops and supermarkets to purchase food and other necessities. Meanwhile, traditional family gatherings took place on Chinese New Year's Eve (24 January) and New Year's Day (25 January). It was conjectured that the second wave of infection that peaked on 25 and 26 January 2020 was related to panic buying and the Chinese New Year social gatherings. To enforce social distancing, at midnight on 26 January, the government announced further traffic restrictions banning the use of private vehicles. The number of daily infections declined from its second peak on 26 January 2020.

Huoshenshan Hospital (which opened on 3 February) and Leishenshan Hospital (which opened on 6 February) were built to admit and treat confirmed and clinically diagnosed cases from all of Wuhan. On the evening of 5 February, the first of the three Fangcang hospitals (with 700 beds) started admitting suspected and confirmed cases in the Wuchang district. The number of daily infections declined from its third peak on 5 February, possibly indicating that the new hospitals and quarantine facilities were contributing to slowing down the spread of the virus. Nevertheless, the reason(s) for the local maxima of daily infections on 5 February 2020 remained uncertain.

With the closed-off management of communities started on 10 February and the Public Infection Control Command released on 16 February, the number of daily infections continued to decline and stayed at a low level.

Discussion

This is the first study to construct the epidemic curve based on the number of daily infections in the Wuchang district, Wuhan, China and to estimate epidemiological characteristics such as the hospitalization rate and the lag time from onset to diagnosis. Our study revealed that the daily number of infections and the government's reactions, measures and major events were related. Other countries might benefit from Wuhan's experiences by raising public awareness, implementing community

Table 3. The weekly and cumulative hospitalization rate of 6872 patients breakdown by severity and diagnosis date

Week	Diagnosed date# (by week)	Asymptomatic n	Asymptomatic Weekly %	Asymptomatic Cumulative %	Mild n	Mild Weekly %	Mild Cumulative %	Moderate n	Moderate Weekly %	Moderate Cumulative %	Severe n	Severe Weekly %	Severe Cumulative %	Critical n	Critical Weekly %	Critical Cumulative %	Overall n	Overall Weekly %	Overall Cumulative %
5	18/1/2020–24/1/2020	0	NA	NA	0	NA	NA	99	60.6%	60.6%	42	76.2%	76.2%	7	57.1%	57.1%	148	64.9%	64.9%
6	25/1/2020–31/1/2020	0	NA	NA	186	43.0%	43.0%	403	58.3%	58.8%	116	74.1%	74.7%	29	51.7%	52.8%	734	56.7%	58.0%
7	1/2/2020–7/2/2020	5	0.0%	0.0%	971	37.1%	38.0%	642	30.8%	43.1%	440	71.8%	72.6%	29	72.4%	61.5%	2087	42.9%	47.4%
8	8/2/2020–14/2/2020	2	50.0%	14.3%	1213	35.9%	37.0%	1272	34.7%	38.7%	226	69.0%	71.6%	27	66.7%	63.0%	2740	38.4%	43.1%
9	15/2/2020–21/2/2020	8	62.5%	40.0%	344	54.7%	39.2%	467	47.1%	40.0%	197	83.2%	73.8%	10	60.0%	62.7%	1026	56.8%	45.2%
10	22/2/2020–25/2/2020	10	70.0%	52.0%	28	78.6%	39.6%	61	82.0%	40.9%	38	86.8%	74.3%	0	NA	62.7%	137	81.8%	45.9%
Whole period	25	52.0%	NA	2742	39.6%	NA	2944	40.9%	NA	1059	74.3%	NA	102	62.7%	NA	6872	45.9%	NA	

Diagnosed date refers to the date of confirmation with viral nucleic acid test or clinically diagnosed with radiographic image tests.
NA: not applicable.

containment and providing infrastructure support to enhance the effectiveness of timely quarantine measures.

Not being aware of the possibility of interpersonal transmission and continuing social contact were probably the triggers for the COVID-19 outbreak in Wuhan. Before 20 January 2020, people were not aware of the necessity of self-protection because they were told that COVID-19 only had limited interpersonal transmission. The estimated COVID-19 basic reproduction number ranged from 1.4 to 6.49, which indicated that without preventive measures the epidemic could spread quickly.[25–28] Furthermore, the typical symptoms of COVID-19 were a dry cough, fatigue and fever, which were similar to flu or a common cold.[5,18,20] Approximately 1% of patients were asymptomatic.[2,29] Those who were infected might ignore symptoms.

The rapidly increasing number of infections prior to the first peak on 18 January indicated that a lack of knowledge and increased social contact contributed to the COVID-19 outbreak. Patients received outpatient treatment and conducted quarantine at home before being diagnosed. Family members, neighbors and people in contact with patients in public places could easily be infected. Furthermore, severe and critical patients had a longer mean lag time than mild and moderate patients. It was possible that the prolonged delay led to a higher severity level. Meanwhile, the pandemic broke out before Chinese New Year, which is a traditional time for family gatherings. People traveled home to meet family members and friends, which might have sped up the spread of COVID-19.

The number of infections declined from 18 to 22 January, which was possibly associated with the public receiving appropriate health education. After the confirmation that COVID-19 can spread by interpersonal transmission, members of the public started wearing masks and paying attention to hand hygiene. Around 20 January 2020, hospitals began giving patients detailed instructions on self-protection and conducting home quarantine through booklets, online links and 24-h online consultations. The temporary decline in the number of daily infections indicated that giving instructions on self-protection and home quarantine might have a positive effect on slowing the transmission. Although the public received appropriate health education, the risk of intrafamily infection could not be neglected, especially as not every family had access to protective supplies such as standard surgical or respirator masks. In our study, 25% of patients reported their contact history. Also, 8.2% of patients reported group infection, mostly intrafamily group infection, which might be attributed to the lack of epidemiology surveys at the beginning of the pandemic.

The second infection peak revealed that transportation restrictions alone could not suppress the transmission of COVID-19. The city lockdown announced on 23 January included intercity and two stages of intracity transportation restrictions. Although the city lockdown was reported as effective in reducing the transmission of COVID-19 in Chongqing,[15] our study did not demonstrate the desired effects immediately after the city lockdown in Wuhan. This could be attributed to the panic buying and stocking up of daily necessities by Wuhan residents, whereas in Chongqing the supply of daily necessities was regulated by government officials and consequently the city lockdown did not trigger panic buying. Before 26 January, people could drive private vehicles or take taxis and supermarkets continued business as usual, which presented an opportunity for continuing social contact. As masks and disinfection products sold out, when people crowded together in supermarkets, a certain proportion of them might not be wearing masks. Some people still gathered with family members or friends regardless of the pandemic during the Chinese New Year's Eve (Jan 24) and the first day of the Chinese New Year (Jan 25). Starting on 26 January, the second stage of intracity traffic restriction forbade any car owners without special permission from driving their cars; however, walking in public was not restricted. Although most people were forced into self-isolating at home, this did not rule out that a minority of people still went out. It was also possible that people were infected when they were shopping.

The peak in daily onset cases on 1 February 2020 might have resulted from new infections during the Chinese New Year or during panic buying following the city lockdown as the mean incubation time increased from 5.2 to 6.4 d.[14,24] Although clinical diagnosis was added as a special diagnosis criteria for the Hubei province on 5 February, this was unlikely to give rise to the peak in new cases[18] because there was no peak in the daily number of diagnoses in the week following the revised definition.

During the study period, the hospitalization rate remained at a low level. Although Huoshenshan Hospital opened on 3 February 2020 and Leishenshan Hospital opened on 6 February 2020, the weekly hospitalization rate dropped to 42.9% from 1 to 14 February. Moreover, from 1 February, cumulative hospitalization rates were less than 50%. This lack of increase in the hospitalization rate can be attributed to three factors. First, from 1 to 14 February, more than 2000 patients were diagnosed each week and the new hospitals could not accommodate all of these new emerging cases. Second, the Wuchang district was the district with the highest number of diagnosed patients in Wuhan.[4] Two new hospitals were open to Wuhan, which might not have significantly increased the hospitalization rate in the Wuchang district. Third, the Leishenshang and Huoshenshang Hospitals accepted patients who were transferred from other overloaded hospitals and those patients were already accounted for in the cumulated hospitalized rate. We observed that hospitalization rate of critical patients was lower than the severe patients. This usual observation may be because some critical cases died before completing hospitalization procedures. However, as our database did not include mortality information, more detailed patient records would be needed to fully understand the situation.

Quarantine facilities such as the Fangcang hospitals probably played an important role in slowing the pandemic as the estimated infection curve declined after they opened on the evening of 5 February. The Fangcang hospitals admitted suspected cases who were waiting for diagnosis, ae well as confirmed and clinical diagnosed cases who were waiting for admission to formal hospitals. Although most of the mild and moderate cases were reported as non-hospitalized, they were able to stay in Fangcang hospitals rather than having to quarantine at home. As we did not extract information about admission to Fangcang hospitals, we are unable to evaluate how the admission rate to Fangcang hospitals influenced the hospitalization rate and the spread of the disease.

The community containment measures started on 10 February. Under the closed-off community management, all facilities in the communities were closed; only one entrance and exit was kept in each community; the body temperature of every person entering or exiting was taken; and non-residents and vehicles were restricted from entering the community. Social workers and volunteers from the community took responsibility for buying food, medicines and other necessities. A week later, under Public Infection Control Command, public entertainment facilities were closed; places such as hotels and supermarkets were instructed to conduct disinfection procedures; and people without masks were forbidden from entering any public facility. With the implementation of community containment, the number of daily new cases underwent a further decline then remained at a low level.

Our study corroborates the literature that raising public awareness of self-protection and social distancing, strict community containment and early quarantine helps to effectively control COVID-19 transmission.[5,7,8,12–14,30,31] Fast diagnoses and an increase in the hospitalization rate may also play a role in pandemic control. However, as we did not have access to detailed data about mortality and prognosis of COVID-19, we were unable to explore how these are associated with preventive measures or policies, as well as the timeliness of diagnosis and hospitalization. This should be explored in future research.

Owing to self-reporting, there might be recall bias in the recording of onset dates. However, after COVID-19 was added into IDIS, patients' data were collected 24 h after the first consultation, which should have reduced recall bias. The estimation of the number of daily infections was affected by assumptions made regarding the incubation period. Nonetheless, we used the best available information to date.[24] Using the diagnosis date as a proxy for the onset date of an asymptomatic patient may also have introduced bias. Nevertheless, as asymptomatic cases only contributed 0.4% of all the studied cases, the bias would be minimal. There were other factors that might contribute to the control of COVID-19, such as nucleic acid detection capability. Due to the unavailability of data, we were unable to study their impact. Our study was a narrative approach where significance testing on effectiveness could not be performed.

Conclusion

In the Wuchang district from 21 December 2019 to 23 February 2020, the weekly hospitalization rate of COVID-19 patients over time was rising in general, while the mean lag time from onset to diagnosis decreased. It was important to give the public information related to the epidemic, in particular detailed instructions for home quarantine and self-protection. Together with community containment and the quarantine of patients along with sufficient hospitalization, COVID-19 was brought under control.

Authors' contributions: All the authors contributed to the study design, study implementation, analysis and interpretation of data, writing the paper then reviewing and approving the final version. YD also contributed to data acquisition.

Funding: None.

Competing interests: All the authors declare no competing interests.

Ethical approval: Ethics approval (ID: [2020] IEC [A002]) was obtained from the Institutional Review Board of Liyuan Hospital, Tongji Medical College, Huazhong University of Science and Technology.

Data availability: The data underlying this article were accessed from China's Infectious Disease Information System. The corresponding author has no right to share the data.

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