The Effect of Travel Restrictions on the Domestic Spread of the Wuhan Coronavirus 2019-nCov

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THE OUTBREAK of the 2019-nCoV originated in the central China city of Wuhan. On Jan. 23, 2020, the Chinese government implemented travel restrictions on the epicenter of Wuhan and some other nearby cities in Hubei Province. By Jan. 24, a total of 15 cities with a combined population of 51.8 million were locked down [1]. The large scale quarantine is described as an "unprecedented response" by WHO officials [2]. As of Feb. 3, the virus has spread to 27 countries/regions with 17,391 confirmed cases and 362 dead. Some researches argue that the quarantine "had a negligible effect on the forward trajectories of the epidemic" [3]. Here we show that there was a substantial impact.

We collected the data of confirmed cased in 5 municipalities/cities (referred to as cities in the following) outside the quarantined province of Hubei: Beijing, Shanghai, Guangzhou, Shenzhen and Chongqing. We chose these cities because (1) they are some of the most populous cities in China, (2) they have high transportation rates from Wuhan, and (3) they are in four different cardinal directions from Wuhan so they have a widespread geographical representation. To compare, we also collected the data for the city of Wuhan, the province of Hubei, and China as a whole. Due to various limitations, the numbers reported may not be accurate. We will address the impact of inaccuracy on this analysis.

We plot the data in Fig. 1. The upper pane shows the daily new confirmed cases in these five cities from Jan. 21 to Feb. 3. The middle pane shows the ratio of new confirmed cases in each city to the new confirmed cases in Hubei. The lower pane shows the proportion of cumulative confirmed cases in the 5 cities to the cumulative confirmed cases in Hubei. The red dashed line on Jan. 22 indicates the onset of the travel restriction (plotted on Jan. 22 instead of 23 because the government issued the travel restriction on Jan. 23 at 2:00 in Wuhan, while all the case data are aggregated and reported by 24:00 every day; this decision does not change the conclusion). The pink band indicates a typical incubation period for the 2019-nCoV of 5 days [4], [5].

From the upper pane, we see the new cases are increasing for the 5 cities. Yet, the middle pane shows a decreasing proportion of new confirmed cases outside Hubei Province to that of inside Hubei Province. The decrease is particularly clear after Jan. 27, one typical incubation period after the lock-down. This means infected people traveling outbound from Hubei Province would generally have onset of symptoms before Jan. 27. Afterwards, the new confirmed cases in the 5 cities are mainly composed of local person-to-person transmission and travelers with extended incubation periods. The low relative number of new cases after Jan. 27 shows that the travel restriction successfully separated Hubei Province and the rest of China and prevented/delayed the outbreak in other cities. The bottom pane shows the proportion of cumulative confirmed cases, which is in agreement with this discussion.

There may be concern that problems with data accuracy can lead to incorrect conclusions. We note that due to the complex

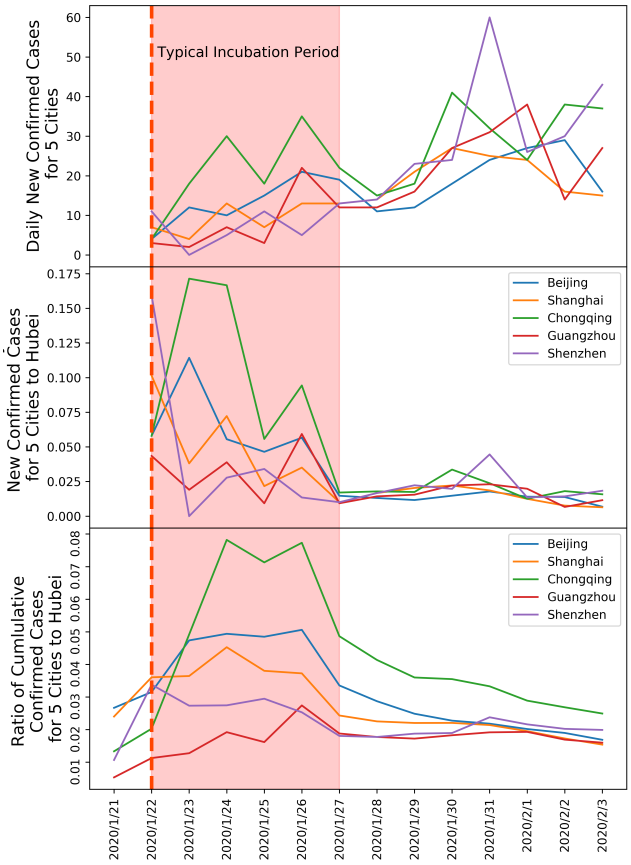

Fig. 1. Confirmed 2019-nCoV Cases in the cities of Beijing, Shanghai, Guangzhou, Shenzhen, and Chongqing (see text).

procedures required to confirm a novel virus infection, and the limitation of local medical resources in face of an outbreak, the data reported may not capture all the actual cases. However, we may expect that a potential underestimate should be more severe in the epicenter of Wuhan and Hubei Province than in cities elsewhere. First, the smaller count and scattered distribution is less demanding for local medical systems. Second, people outside Hubei Province are easier to identify because they have travelled to Hubei recently or have close contact with someone who has. For such errors, the actual ratios of cases outside Hubei Province to within Hubei should be even lower than what is plotted. This means the data accuracy does not undermine our conclusions.

The spreading of 2019-nCov is still rapid, both inside and outside China. But this should not be treated as counter evidence to the effectiveness of the large scale traffic restriction in Wuhan and Hubei Province. Without such drastic response, other parts of China would see a much more serious outbreak.

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