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*What Roles Do Population and Migration Flows Play in the Spatial Diffusion of COVID-19 from Wuhan City to Provincial Regions in China?**

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Abstract

Population flow and migration flow are related but different. This research demonstrates the important roles of population and migration flows in the spatial diffusion of COVID-19 in mainland China using statistical analysis. Visitors are often considered responsible for the spread of COVID-19. Many migrants traveled back to their hometown from Wuhan city before 23 January 2020 for the spring holiday. They had stayed in Wuhan for a long time and had a higher risk to be infected than other short-term visitors. Thus previous migration flow is expected to have an indirect impact on the spatial diffusion of COVID-19 via population flow. It is found that the migration flows in 2005–2010 and 2010–2015 generally had larger correlation coefficients than real-time population flows based on big data on any day during 10–22 January 2020 with the number of COVID-19 cases. The average population flow in 8 days also had high correlation coefficients with the number of COVID-19 cases. The weighted average share of population

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flow and migration flow had the highest correlation coefficient with the number of COVID-19 cases on 26 January 2020. The COVID-19 risk for a migrant and a resident from an affected area could be 9 times that for a visitor.

The new coronavirus disease (COVID-19) pandemic has swept the world since late 2019, while the research continues on the origin of COVID-19 in the world.[1] There is a great concern about the growth and spread of COVID-19, which affects the public health and economy in the world enormously. After a significant outbreak in Wuhan, the subsequent transmission has much to do with the preparedness of public health system, and the government and public responses to such highly infectious diseases in various cities, regions and countries.[2] It is argued that infectious diseases are less of a "natural" disaster, but have emerged alongside social and spatial inequalities.[3]

The spatialities of health and infectious disease such as SARS in 2003 have received much attention in the literature.[4] Migration, urban population growth, urban population size, and high population density are considered major factors influencing the spread of disease.[5] In the past four decades, China has experienced large-scale rural to urban migration and urbanization.[6] It is argued that income growth, urbanization, and globalization are exacerbating emerging zoonotic risks especially in China, which has been affected by the Black Death, avian influenza and SARS previously.[7]

China has experienced the spatial diffusion of COVID-19 from Wuhan to the rest of China since December 2019. The first confirmed COVID-19 case outside Hubei Province was reported in Henan on 21 January 2020. A migrant developed the COVID-19 symptoms in Wuhan on 29 December 2019 and returned to his hometown, Zhoukou city (周口市), on 7 January 2020.[8] Dramatic lockdown measures were implemented in Wuhan and many places in China from 23 January 2020 so that new COVID-19 cases in China were reduced to very small numbers by early March 2020.

The COVID-19 pandemic case in China took place with the following special context: rapid urbanization associated with massive migration to cities, the timing of the Spring Festival just weeks after the pandemic outbreak, huge flows of migrants and visitors returning to hometowns during the pandemic outbreak, just before the Spring