Supplementary Information

Methods

Adjustment of historical flight data

We generate the imputed daily air-travel volume for the epidemic period, taking into account yearly increases in flight numbers and the impact of travel bans, using two data sources: monthly air-travel volume data from BlueDot[18] from 1 December 2018 to 28 February 2019; and Cirium[20] data on daily landed flight departures from 1 December 2018 to 28 February 2019 and from 1 December 2019 to 28 February 2020.

First, we use Cirium[20] data on landed flight departures to estimate the expected change in air-travel volume from December 2019 to February 2020 relative to December 2018 to February 2019, γ_i, for each origin airport *i* as a result of yearly increase in air travel as well as travel bans implemented in late January 2020 as the following:

$$\gamma_i = \sum_{d=Dec2019}^{Feb2020} \sum_{j=1}^{N_D} f_{d,i} \; / \; \sum_{d=Dec2018}^{Feb2019} \sum_{j=1}^{N_D} f_{d,i} \;,$$

where the number of flight departures on day *d*, $f_{d,i}$, is summed from 1 December 2019 to 28 February 2020 and summed over all destination airports *j*. This value is divided by the number of landed flight departures from the same period last year, 1 December 2018 to 28 February 2019, summed over all destination airports *j*. We sum over all destination airports *j* instead of calculating this for each origin-destination connection due to sparse data limitations.

The total number of passengers traveling from origin *i* to destination *j* from 1 December 2018 to 28 February 2019, $V_{18-19,i,j}$, is then multiplied by the adjustment factor, γ_i, to yield an estimate of the total three-month flight volume for each origin-destination connection, with both increased annual travel and travel bans in late January taken into account, $V'_{19-20,i,j}$:

$$V'_{19-20,i,j} = \gamma_i * \; V_{18-19,i,j}$$

Note that, by using data on the number of landed direct flights to adjust air-travel volume, we make the assumption that the number of direct flight departures is proportional to the number of passengers from each origin-destination connection.

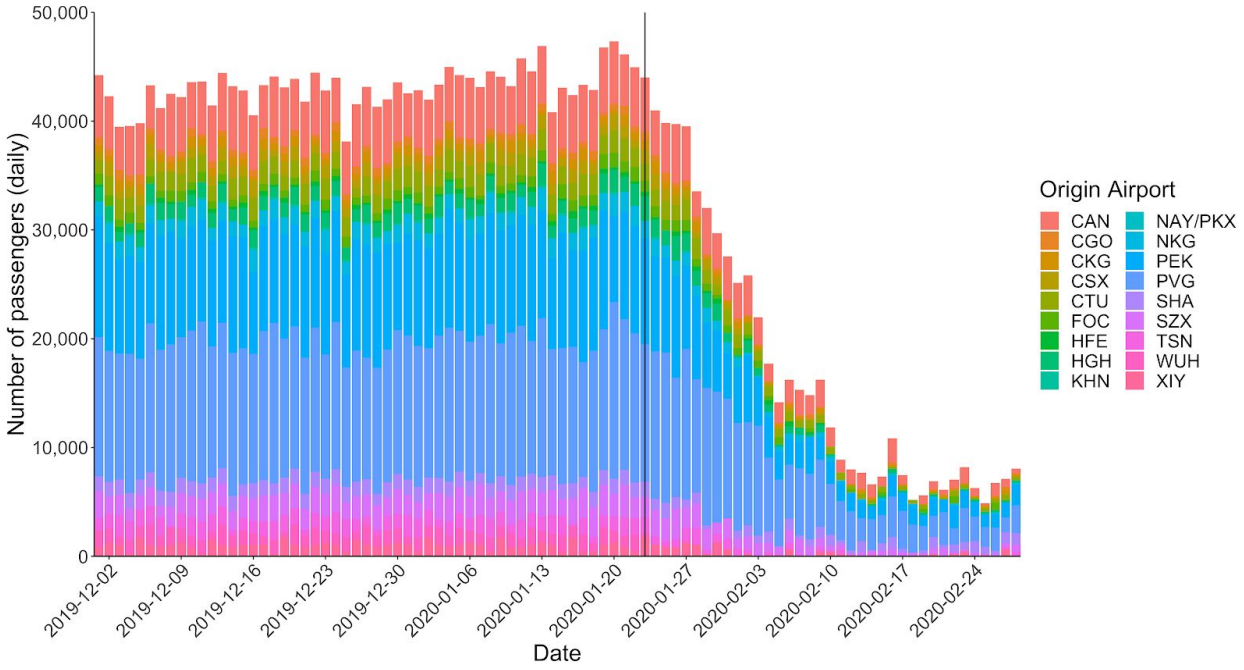
To estimate the daily distribution of passengers from December 2019 and February 2020, we distribute the adjusted total air-travel volume, $V'_{19-20,i,j}$, across the three-month period into daily air-travel volume for each day *d*, using the proportion of daily landed flight departures out of the total number of daily landed flights in the three month period.

$$v'_{d,i,j} = V'_{19-20,i,j}\left(\sum_{j=1}^{N_D} f_{d,i} \Big/ \sum_{d=Dec2019}^{Feb2020} \sum_{j=1}^{N_D} f_{d,i}\right) ,$$

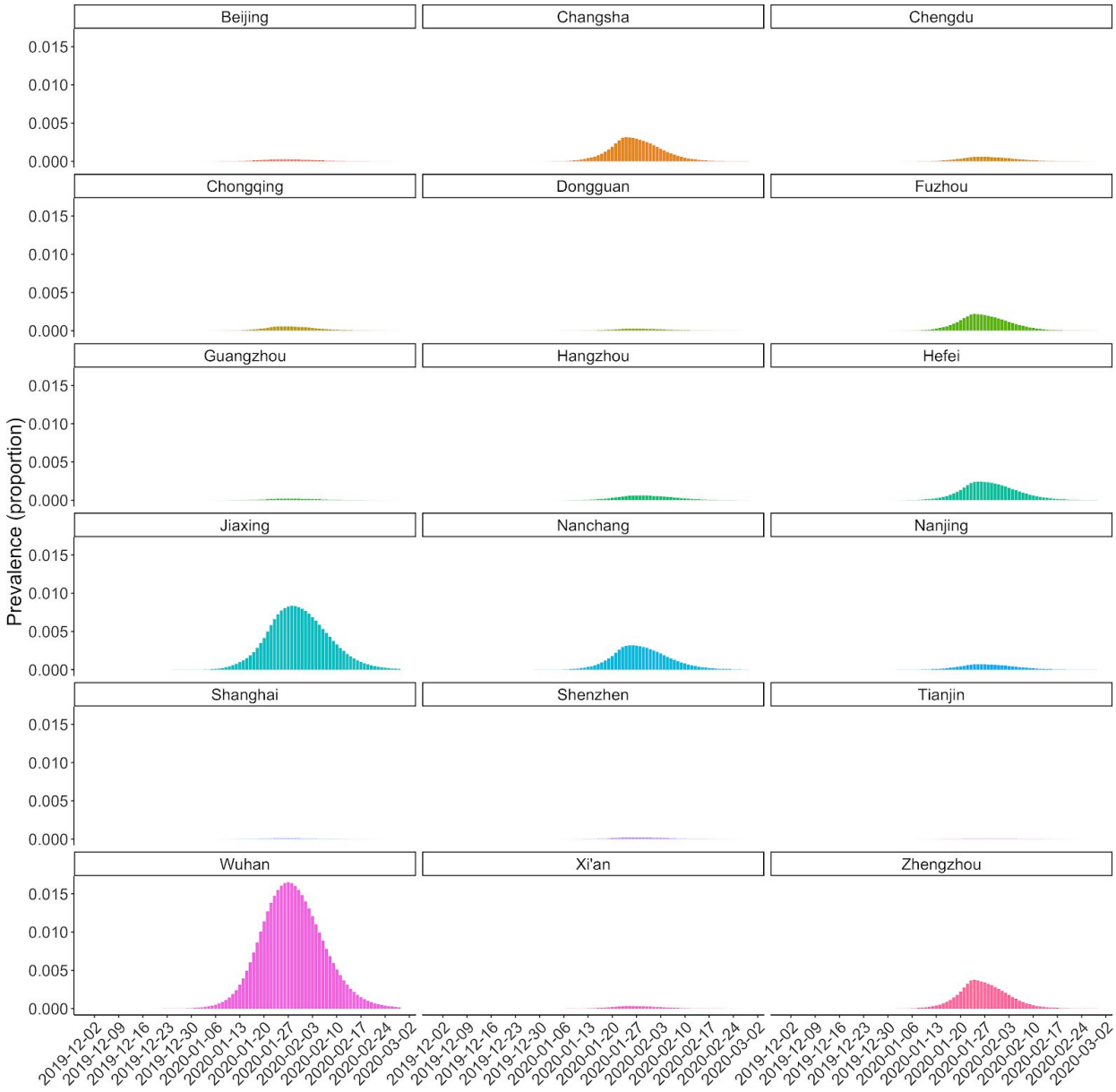
where $v'_{d,i,j}$ is the imputed air-travel volume from origin *i* to destination *j* on day *d*, and $f_{d,i}$ is the number of landed flight departures on day *d* from origin *i.* We calculate the proportion of daily flight departures for each origin *i* summed over all destinations *j* instead of calculating this for each origin-destination connection again due to sparse data limitations.

Since residents of the cities Shenzhen and Dongguan both use the Shenzhen Bao'an International Airport, we divide the air-travel volume equally between these two cities. Similarly, the air-travel volume for Hangzhou Xiaoshan International Airport airport is divided equally for the cities Jiaxing and Hangzhou. Importantly, Cirium data only documents the daily number of direct flights, but we use this data source 1) to estimate the expected flight volume reduction on all direct and indirect flights, and 2) to distribute a total three-month volume into daily volume. We therefore make the assumption that the number of direct flights is proportional to number of direct and indirect flights.

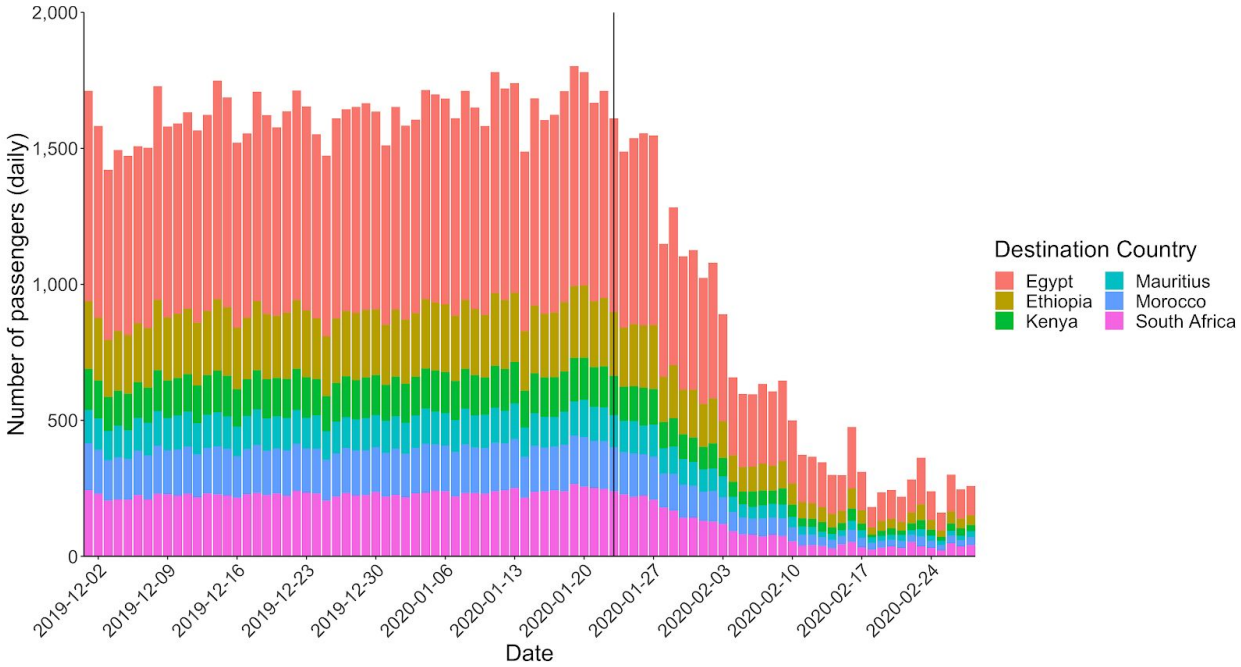
Results



Supplementary Figure 1. Estimated daily flight volume from 18 airports in 18 Chinese cities to 16 international destinations from 1 December 2019 to 28 February 2020



Supplementary Figure 2. Estimated daily prevalence of COVID-19 in 18 Chinese cities from 1 December 2019 to 28 February 2020



Supplementary Figure 3. Estimated daily flight volume from 18 airports in 18 Chinese cities to 6 African locations from 1 December 2019 to 28 February 2020

Destination Country	Lower Bound	Mean predicted number	Upper bound
Egypt	0	2.5	6
Ethiopia	0	0.8	3
Kenya	0	1.3	4
Mauritania	0	0.4	2
Morocco	0	1.0	3
South Africa	0	3.0	7

Supplementary Table 1: Predicted exported cases by destination country in Africa, with 95% CI (Lower Bound, Upper Bound)