# Real-time nowcast and forecast on the extent of the Wuhan CoV outbreak, domestic and international spread

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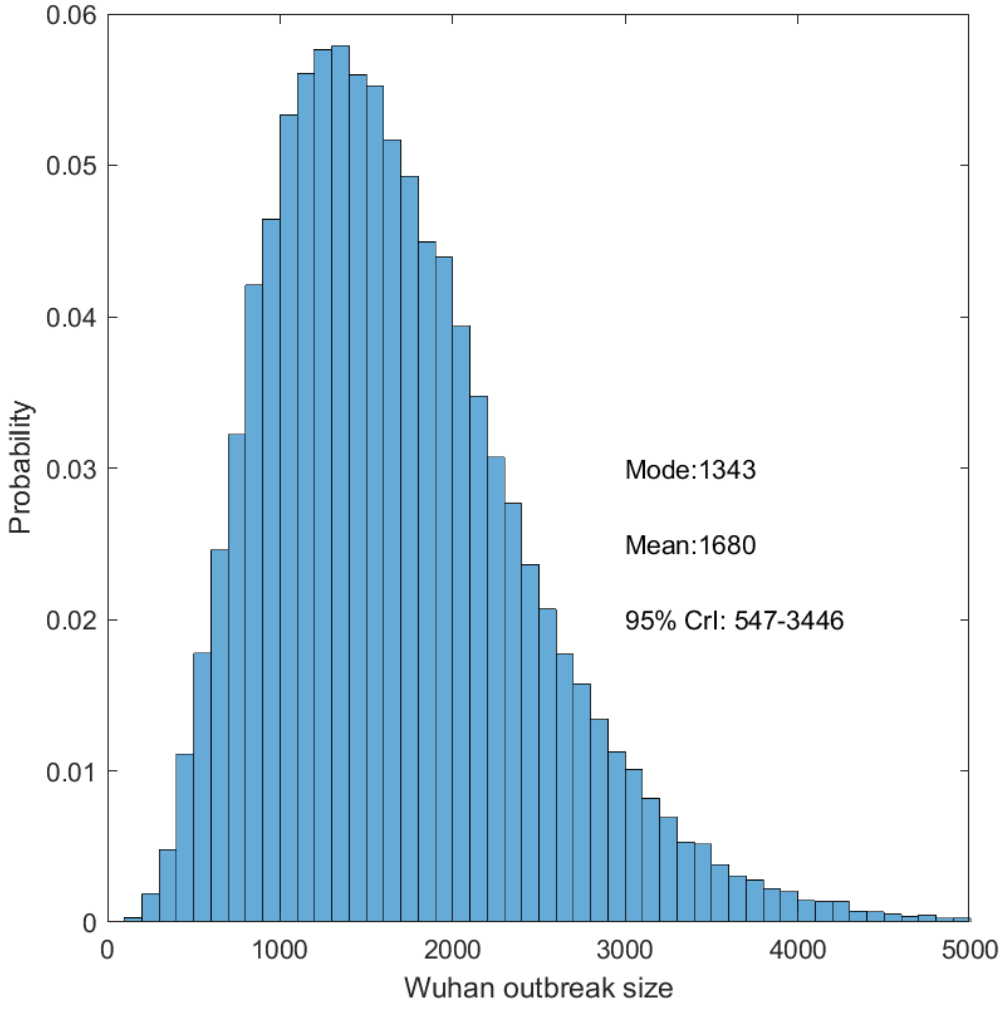
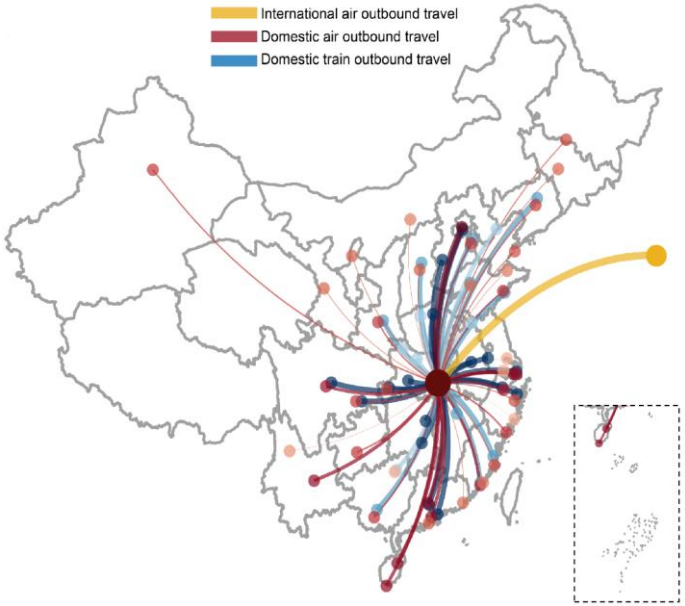
# Nowcasting/backcasting

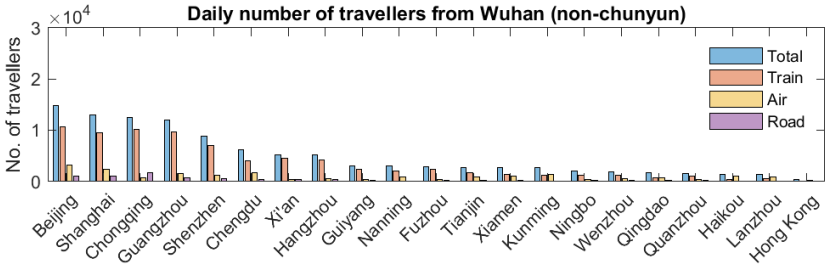
**Estimating the number of cases in Wuhan from international case exportation (2 in Thailand, 1 in Japan and 1 in South Korea)**

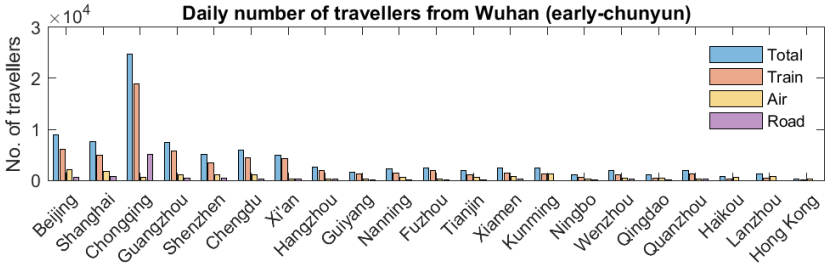
**1 Jan – 17 Jan (the most recent onset date of international case exports)**

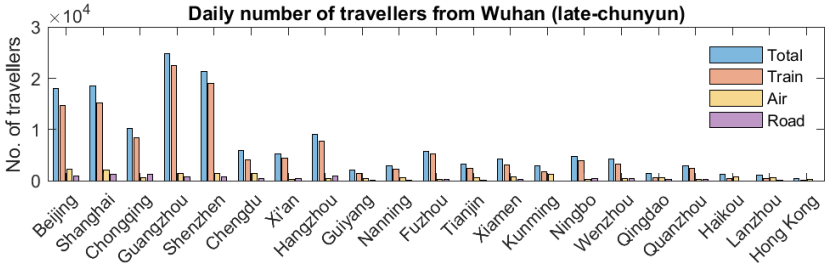


# Wuhan is Central China's transportation hub



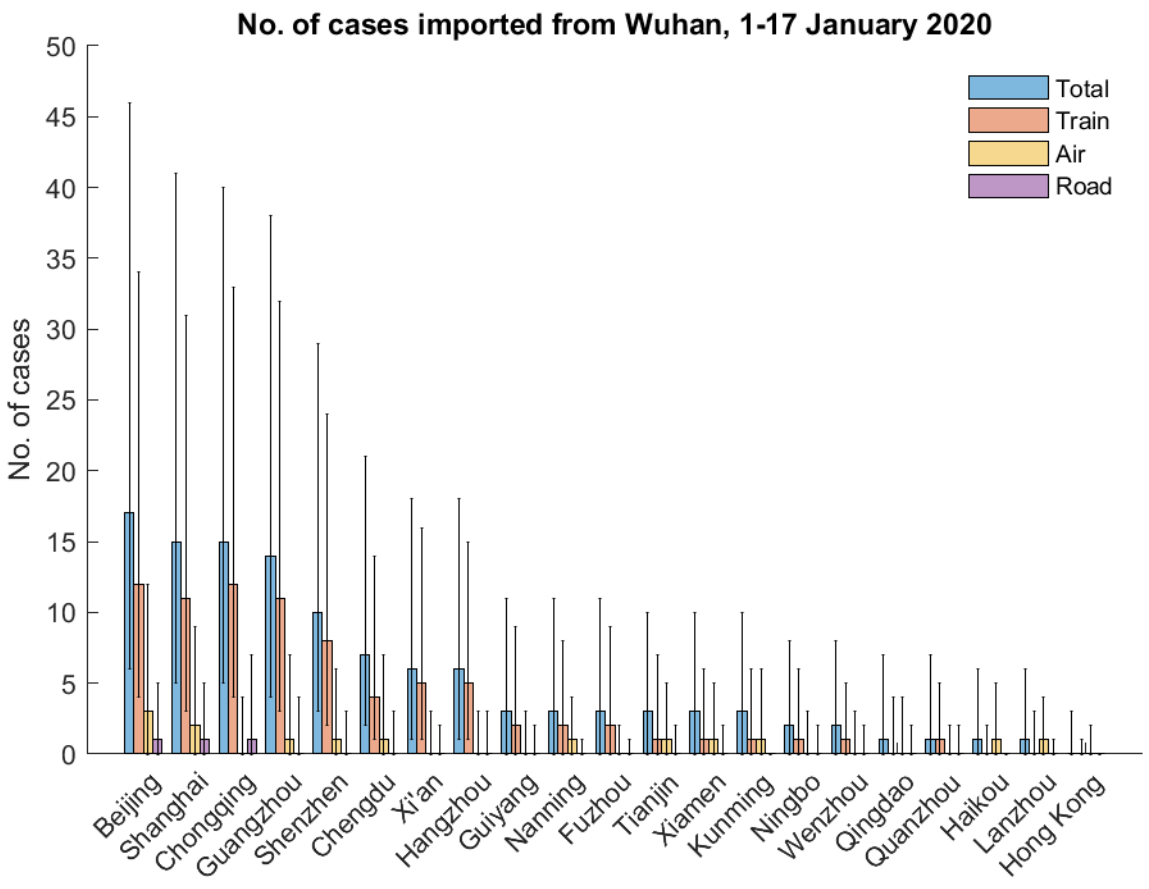



# Estimation of domestic exports by train, air and road

## 1 Jan – 17 Jan

**Using posterior modes as point estimates**

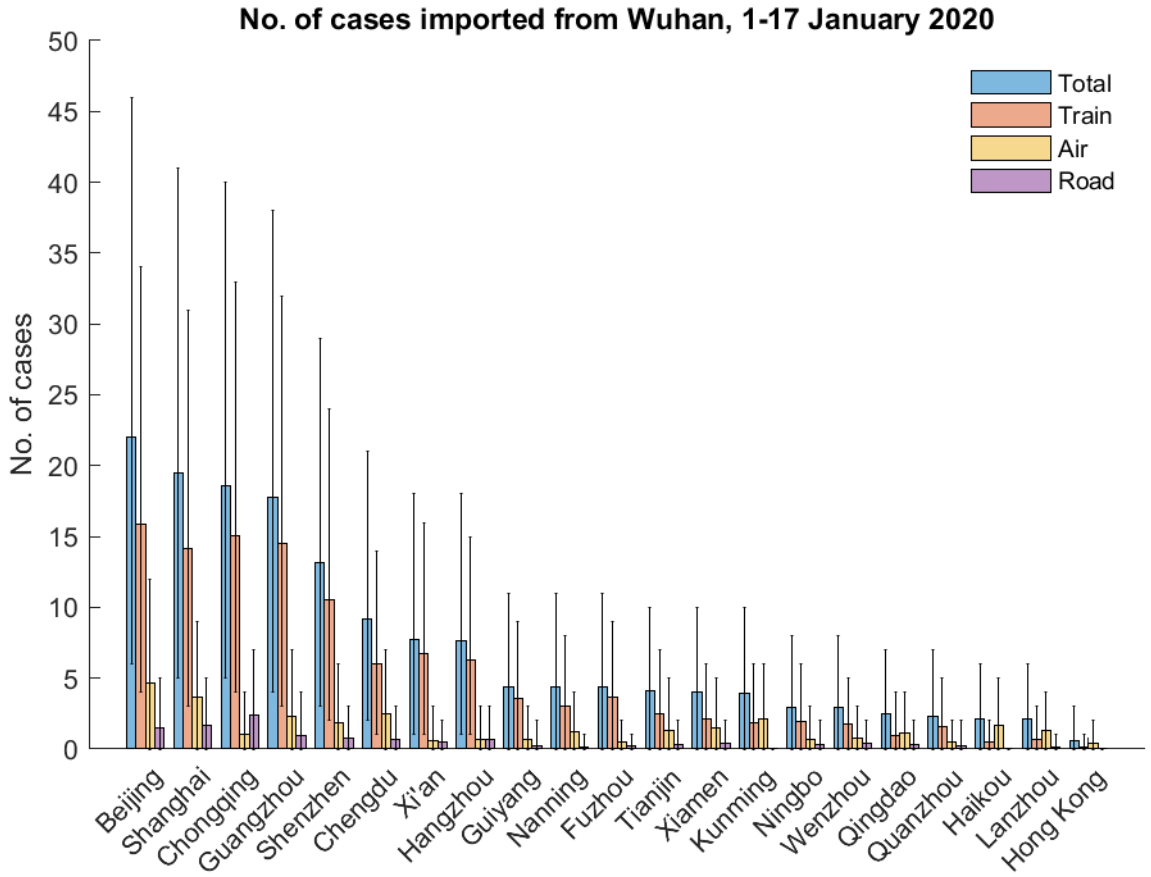



| | Total |
|---|---|
| Beijing | 17 (6-46) |
| Shanghai | 15 (5-41) |
| Chongqing | 15 (5-40) |
| Guangzhou | 14 (4-38) |
| Shenzhen | 10 (3-29) |
| Chengdu | 7 (2-21) |
| Xi'an | 6 (1-18) |
| Hangzhou | 6 (1-18) |
| Guiyang | 3 (0-11) |
| Nanning | 3 (0-11) |
| Fuzhou | 3 (0-11) |
| Tianjin | 3 (0-10) |
| Xiamen | 3 (0-10) |
| Kunming | 3 (0-10) |
| Ningbo | 2 (0-8) |
| Wenzhou | 2 (0-8) |
| Qingdao | 1 (0-7) |
| Quanzhou | 1 (0-7) |
| Haikou | 1 (0-6) |
| Lanzhou | 1 (0-6) |
| Hong Kong | 0 (0-3) |

# Estimation of domestic exports by train, air and road

## 1 Jan – 17 Jan

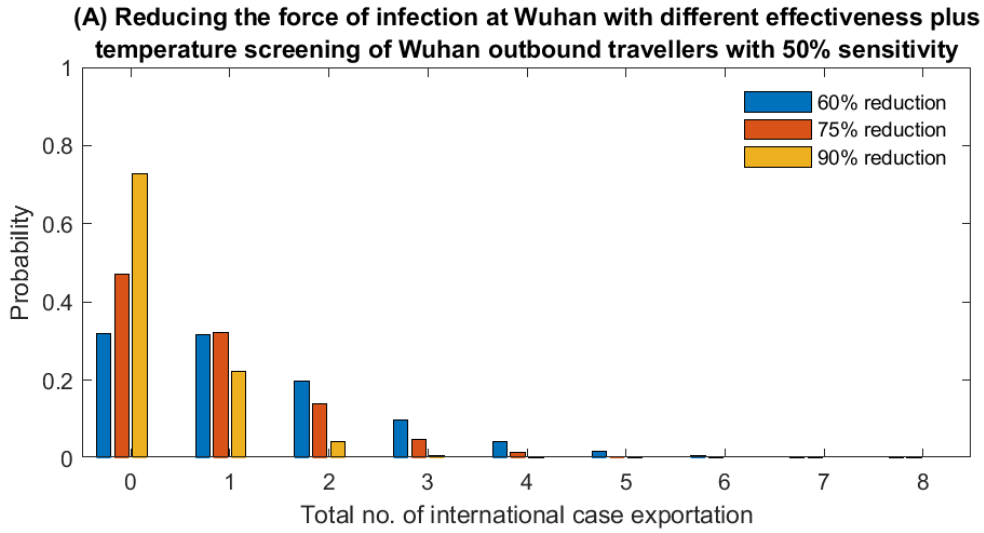
**Using posterior means as point estimates**

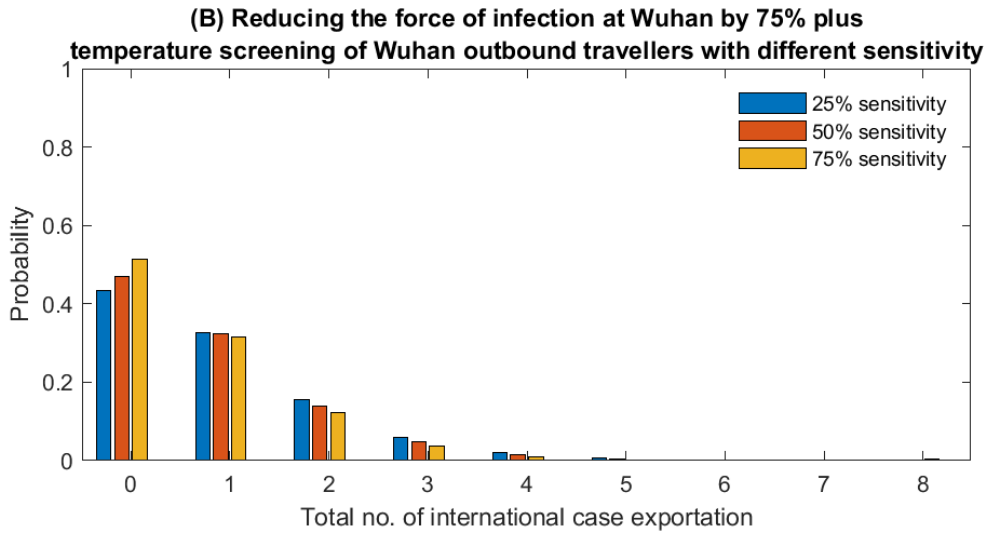



| | Total (Mean) |
|---|---|
| Beijing | 21.98 (6-46) |
| Shanghai | 19.48 (5-41) |
| Chongqing | 18.55 (5-40) |
| Guangzhou | 17.80 (4-38) |
| Shenzhen | 13.15 (3-29) |
| Chengdu | 9.14 (2-21) |
| Xi'an | 7.76 (1-18) |
| Hangzhou | 7.65 (1-18) |
| Guiyang | 4.41 (0-11) |
| Nanning | 4.40 (0-11) |
| Fuzhou | 4.37 (0-11) |
| Tianjin | 4.08 (0-10) |
| Xiamen | 4.07 (0-10) |
| Kunming | 3.97 (0-10) |
| Ningbo | 2.92 (0-8) |
| Wenzhou | 2.91 (0-8) |
| Qingdao | 2.46 (0-7) |
| Quanzhou | 2.34 (0-7) |
| Haikou | 2.16 (0-6) |
| Lanzhou | 2.13 (0-6) |
| Hong Kong | 0.55 (0-3) |

# Forecasting

# Forecasting international exports during the weeks before and after the first day of Spring Festival




**Exit screening** in Tianhe Airport and major train stations started on 15 Jan in Wuhan

Different international ports have also recently started or enhanced pre-existing **entry screening**

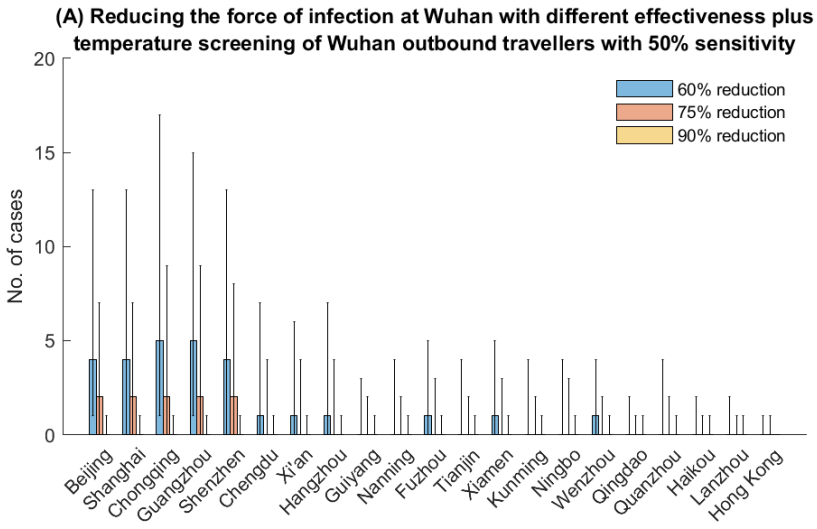
| Reduction in FOI | Screening sensitivity | No. of export (Mode) | No. of export (Mean) |
|---|---|---|---|
| 60% | 50% | 1 (0-4) | 1.29 (0-4) |
| 75% | 50% | 0 (0-3) | 0.81 (0-3) |
| 90% | 50% | 0 (0-2) | 0.32 (0-2) |
| 75% | 25% | 0 (0-3) | 0.91 (0-3) |
| 75% | 50% | 0 (0-3) | 0.81 (0-3) |
| 75% | 75% | 0 (0-3) | 0.71 (0-3) |

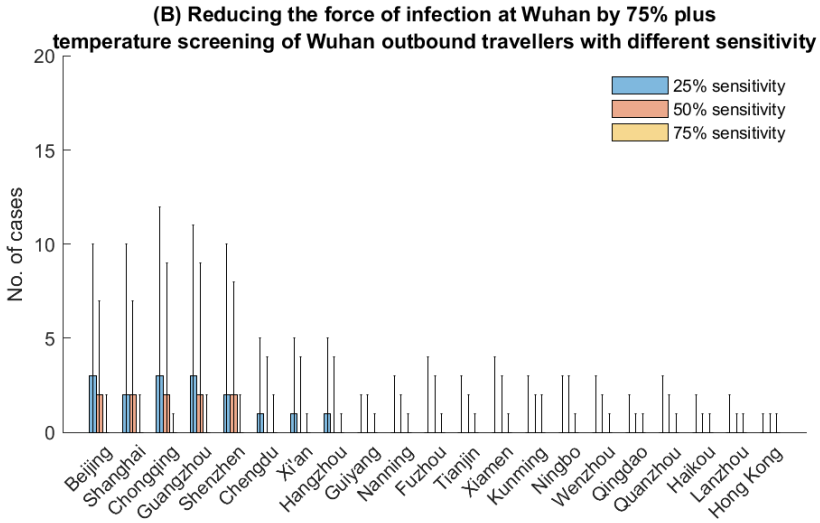
# International outbound air travel from Wuhan

| City | Monthly no. of air passengers in CNY 2019 |
|---|---|
| Bangkok | 16202 |
| Hong Kong* | 7531 |
| Seoul | 5982 |
| Singapore | 5661 |
| Tokyo | 5269 |
| Taipei | 5261 |
| Kota Kinabalu | 4531 |
| Phuket | 4411 |
| Macau | 3731 |
| Ho Chi Minh City | 3256 |
| Kaohsiung | 2718 |
| Osaka | 2636 |
| Sydney | 2504 |
| Denpasar-Bali | 2432 |
| Phnom Penh | 2000 |
| London | 1924 |
| Kuala Lumpur | 1902 |
| Melbourne | 1898 |
| Chiang Mai | 1816 |
| Dubai | 1799 |

*Due to the ongoing social unrest since June 2019, we parameterized the models with actual air passenger volume based on local estimates

# Forecasting domestic exports during the weeks before and after the first day of Spring Festival




**Reduction in FOI = 75%**
**Screening sensitivity = 50%**

| City | No. of export (Mode) | No. of export (Mean) |
|---|---|---|
| Beijing | 2 (0-7) | 2.56 (0-7) |
| Shanghai | 2 (0-7) | 2.47 (0-7) |
| Chongqing | 2 (0-9) | 3.35 (0-9) |
| Guangzhou | 2 (0-9) | 3.47 (0-9) |
| Shenzhen | 2 (0-8) | 2.78 (0-8) |
| Chengdu | 0 (0-4) | 1.04 (0-4) |
| Xi'an | 0 (0-4) | 1.07 (0-4) |
| Hangzhou | 0 (0-4) | 1.19 (0-4) |
| Guiyang | 0 (0-2) | 0.33 (0-2) |
| Nanning | 0 (0-2) | 0.46 (0-2) |
| Fuzhou | 0 (0-3) | 0.89 (0-3) |
| Tianjin | 0 (0-2) | 0.44 (0-2) |
| Xiamen | 0 (0-3) | 0.57 (0-3) |
| Kunming | 0 (0-2) | 0.36 (0-2) |
| Ningbo | 0 (0-3) | 0.57 (0-3) |
| Wenzhou | 0 (0-2) | 0.55 (0-2) |
| Qingdao | 0 (0-1) | 0.14 (0-1) |
| Quanzhou | 0 (0-2) | 0.47 (0-2) |
| Haikou | 0 (0-1) | 0.08 (0-1) |
| Lanzhou | 0 (0-1) | 0.11 (0-1) |
| Hong Kong | 0 (0-1) | 0.03 (0-1) |

# In case of superspreading events (SSEs)

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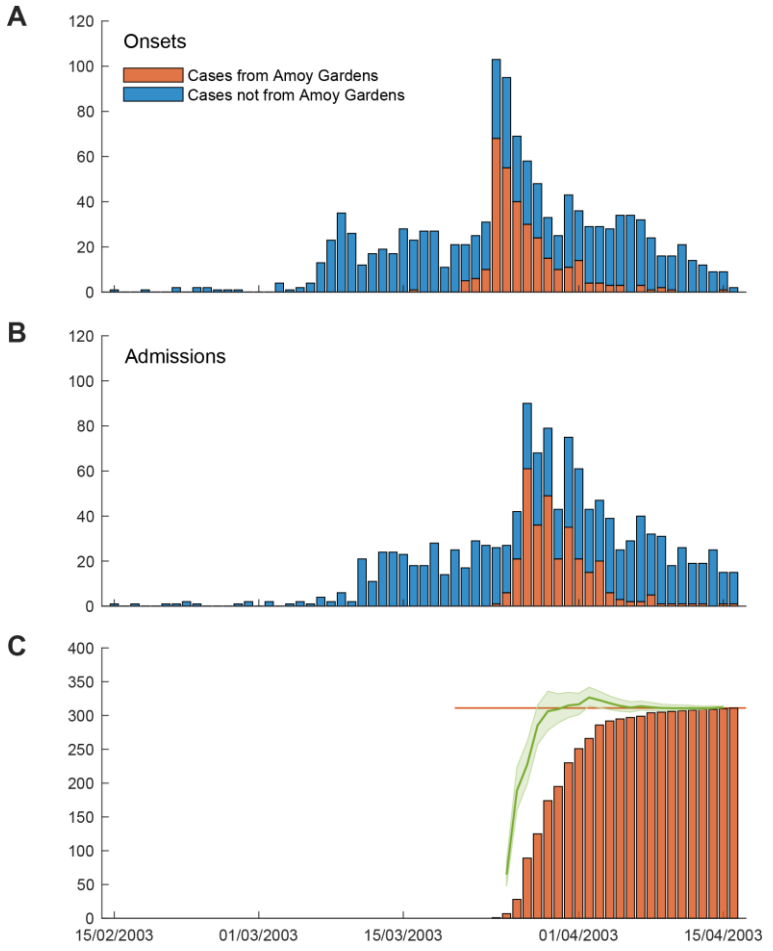
## Final size estimation for superspreading clusters

Dataset
[Download data sample]
Explanation
Column 1) Patient reference number
Column 2) Date of symptom onset
Column 3) Date of hospital admission
Column 4) Superspreading cluster index

Choose File | No file chosen

| | |
|---|---|
| Date of exposure (mm/dd/yyyy) [Date of exposure for data sample is 12/07/2019] | 12/07/2019 |
| Guess of cases that will be shown afterwards (integer) | 100 |
| Guess of mean incubation period (days) | 7 |
| Guess of standard deviation of the incubation periods (days) | 2 |
| Guess of mean delay from symptom onset to hospital admission (days) | 5 |
| Guess of standard deviation of the delay from symptom onset to hospital admission (days) | 2 |
| Mean incubation period from previous outbreaks (days) | 4.4 |
| Standard deviation of incubation period from previous outbreaks (days) | 4.2 |
| Mean delay from symptom onset to hospital admission from previous outbreaks (days) | 4.9 |
| Standard deviation of the delay from symptom onset to hospital admission from previous outbreaks (days) | 6.6 |

## Case study of SARS SSE in HK



# Critical issue of case definitions

## National CDC:

**Suspected**

- Fever (≥38)
- Radiographic findings of pneumonia or acute respiratory distress syndrome
- Reduced or normal white blood cells; reduced lymphocytes subsets counts
- No improvement or deteriorate after 3-5 days of antibiotics treatment

**Probable**

- Suspected + Epidemiologic link/history

**Confirmed**

- 1st case in the province: Probable + City and provincial and national CDC's RT-PCR
- 2nd case or after: Probable + City and provincial CDC's RT-PCR

## Estimation by ICL/HKU:

Symptomatic cases who could be detected by temperature screening at international borders and/or with disease severity of a level requiring hospitalization plus travel history to Wuhan.

## Assumptions of modelling studies

- Case definitions
- Assumptions about force of infection (dependent on effectiveness of control measures so far implemented)
- Assumption of sensitivity of exit and entry screening in detecting symptomatic cases with fever
- Assumption that Wuhan remains the only epidemic centre
- Assumption of no superspreading events in Wuhan or elsewhere with confirmed cases
- Assumption of robust surveillance and high degree of alertness to detect potential cases everywhere