Webinar Series on COVID-19 Impact Analysis
February 5, 2021

Spatiotemporal pattern of COVID-19 and government response in South Korea

Sun Kim
sunkim1@hsph.harvard.edu

HARVARD T.H. CHAN
SCHOOL OF PUBLIC HEALTH

International Journal of Infectious Diseases 98 (2020) 328–333

Contents lists available at ScienceDirect

International Journal of Infectious Diseases

journal homepage: www.elsevier.com/locate/ijid

Spatiotemporal pattern of COVID-19 and government response in South Korea (as of May 31, 2020)

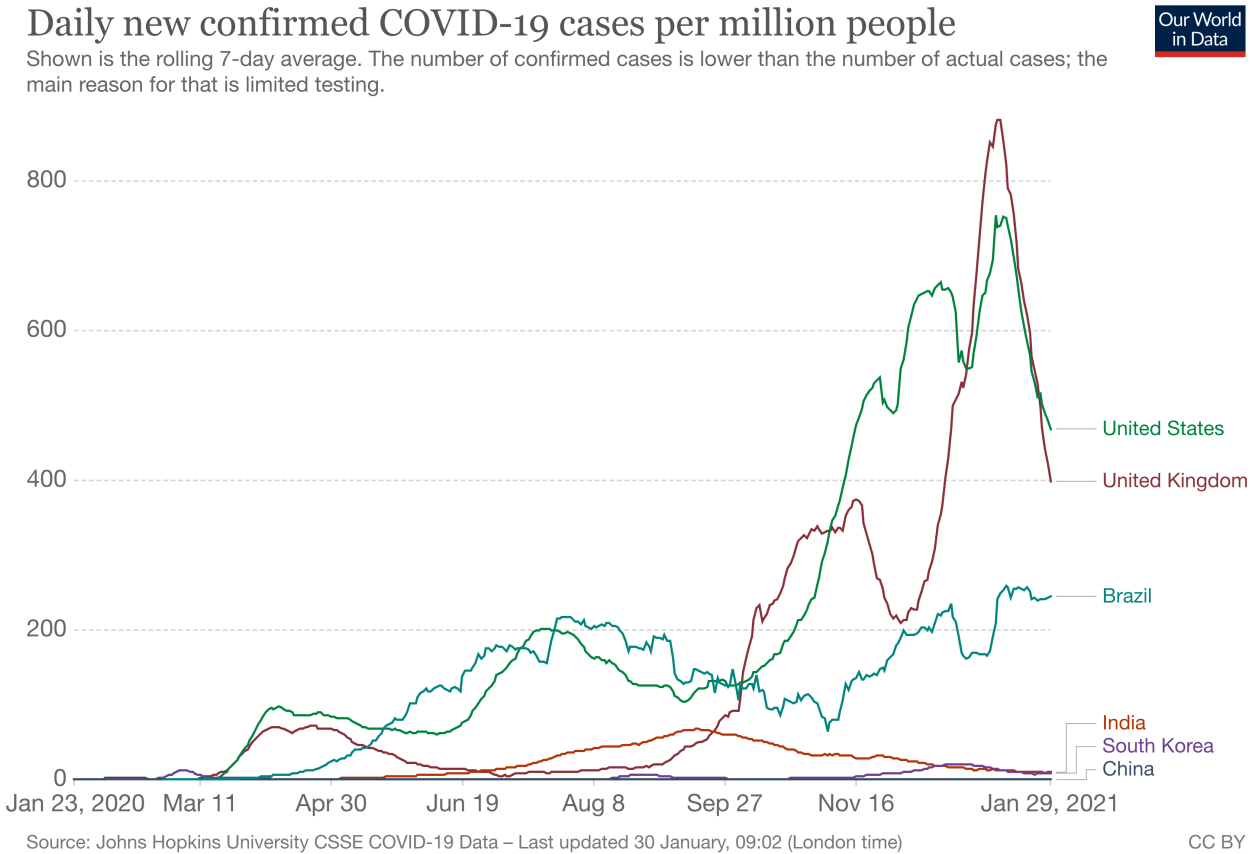
Sun Kim, Marcia C. Castro*

Harvard T.H. Chan School of Public Health, Department of Global Health and Population, 665 Huntington Avenue, Boston, MA 02115, USA

Outline

- Background
  - Context in South Korea
  - Motivation and objective of the study
- Data, methods and results
- What made South Korea’s response so successful?
- Remaining challenges
- Global implications

Background


Daily new confirmed COVID-19 cases per million people
Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.
Our World in Data
800
600
400
200
0
Jan 23, 2020
Mar 11
Apr 30
Jun 19
Aug 8
Sep 27
Nov 16
Jan 29, 2021
United States
United Kingdom
Brazil
India
South Korea
China
Source: Johns Hopkins University CSSE COVID-19 Data – Last updated 30 January, 09:02 (London time)
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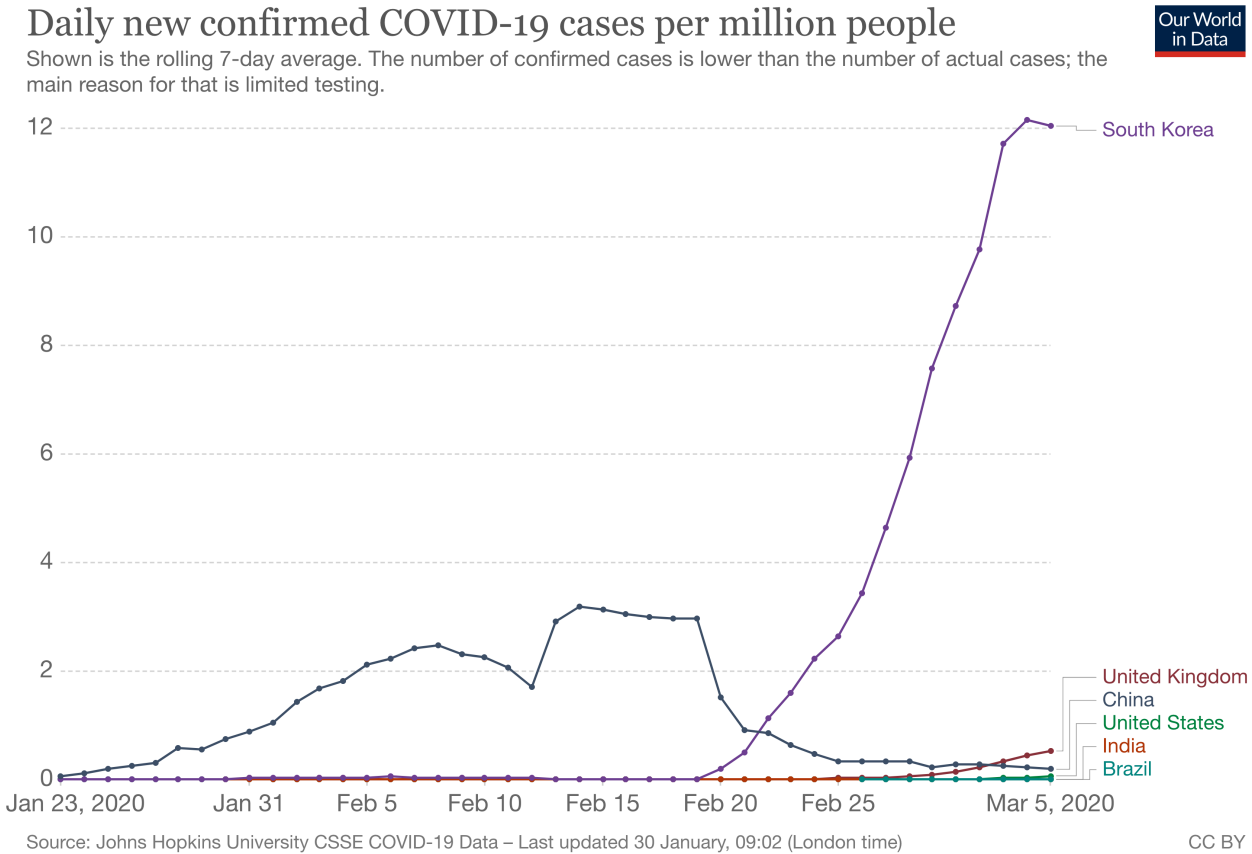
Background


Daily new confirmed COVID-19 cases per million people
Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.
Our World in Data
12
10
8
6
4
2
0
Jan 23, 2020
Jan 31
Feb 5
Feb 10
Feb 15
Feb 20
Feb 25
Mar 5, 2020
South Korea
United Kingdom
China
United States
India
Brazil
Source: Johns Hopkins University CSSE COVID-19 Data – Last updated 30 January, 09:02 (London time)
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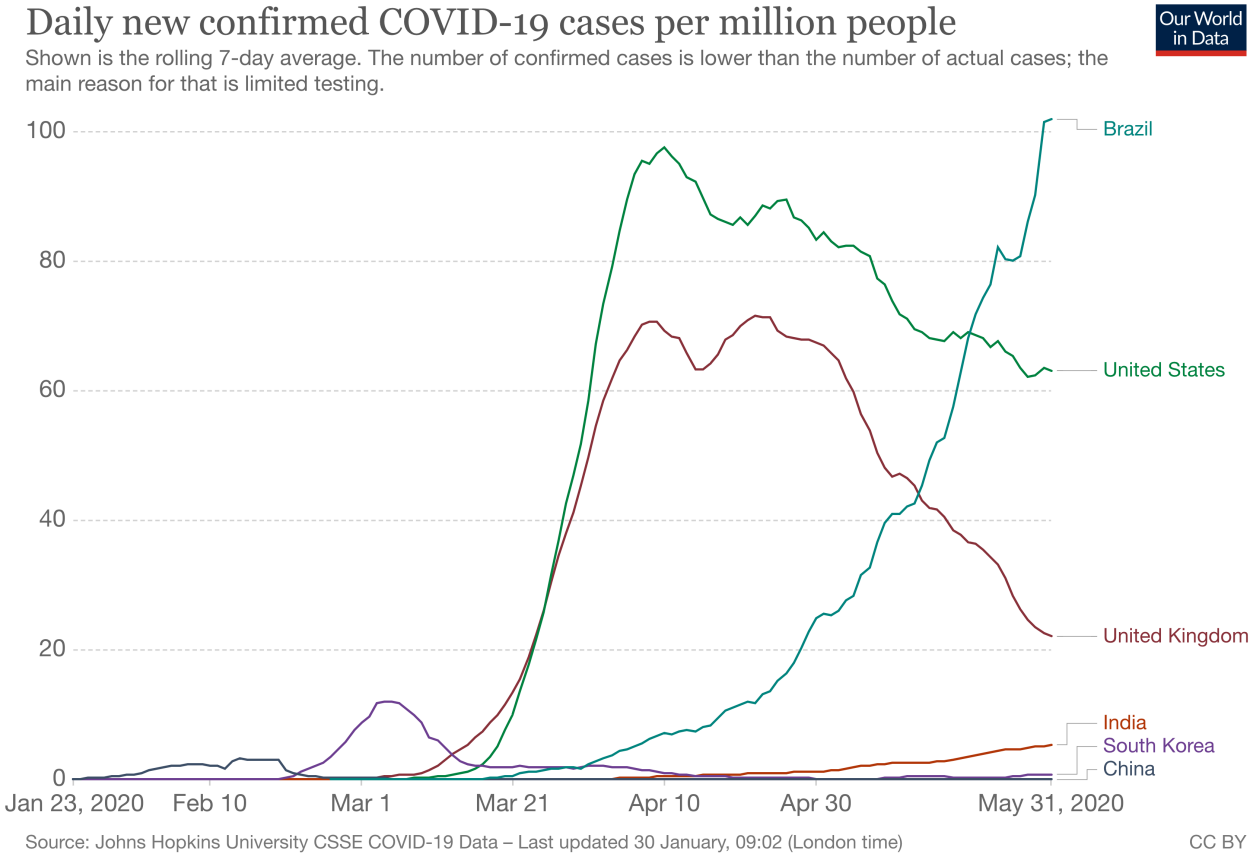
Background


Daily new confirmed COVID-19 cases per million people
Shown is the rolling 7-day average. The number of confirmed cases is lower than the number of actual cases; the main reason for that is limited testing.
Our World in Data
100
80
60
40
20
0
Jan 23, 2020
Feb 10
Mar 1
Mar 21
Apr 10
Apr 30
May 31, 2020
Brazil
United States
United Kingdom
India
South Korea
China
Source: Johns Hopkins University CSSE COVID-19 Data – Last updated 30 January, 09:02 (London time)
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Motivation of the study

- South Korea is one of the countries to **dramatically slow the spread of the disease without any lockdown or blanket entry bans** and has emerged as a model to emulate in fighting the pandemic.

- This retrospective spatiotemporal analysis of COVID-19 in South Korea was conducted in light of the country's response.

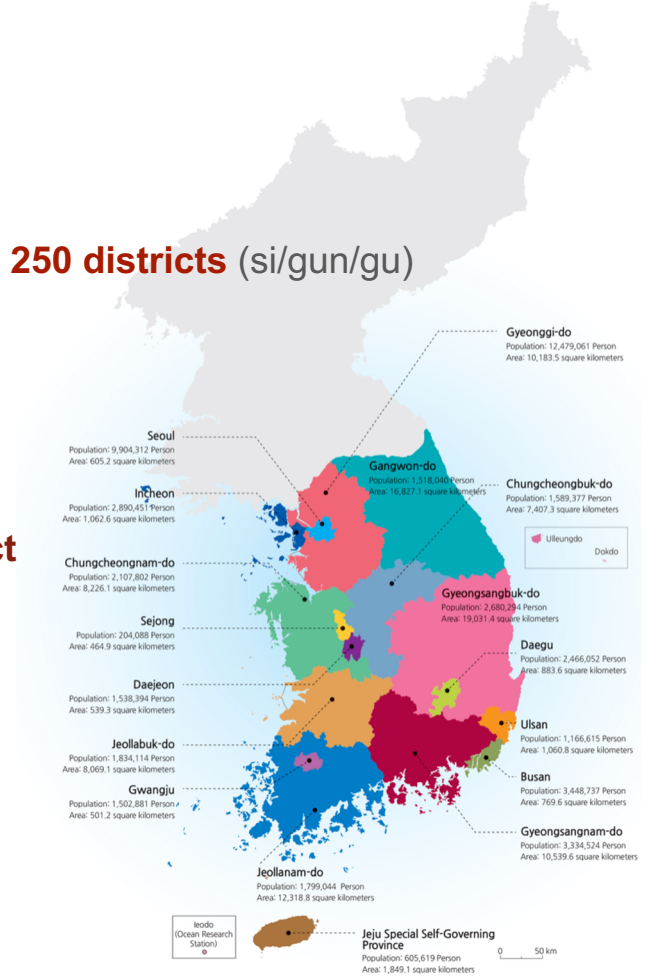
    - Rapid detection of **when** and **where** transmission occurs is crucial to reduce secondary infections, to avoid the surge of local outbreaks, and ultimately to control the epidemic.

Objective of the study

- Assess how COVID-19 clustered across districts in South Korea, and whether the pattern and duration of clusters changed and reduced over time following the country's response.

Study area, period and data

- Study area
  - 17 administrative divisions (provinces) - subcategorized into **250 districts** (si/gun/gu)
  - Shapefile from KOSTAT
- Period
  - **January 20, 2020 to May 31, 2020**
- Data
  - **Daily number of confirmed cases of COVID-19 by district**
    - Based on patients' residence
    - Collected from KCDC and each provincial website
  - Population 2020 by district from KOSTAT
  - Coordinates by district from KOSTAT



Methods

- **Spatial autocorrelation analysis**
  - **Global Moran's *I***
  - Assess whether cases are spatially correlated
  - Using cumulative cases per 100,000 by each district
  - Using open GeoDa software (v 1.14, Anselin)

- **Space-time cluster analysis**
  - **A retrospective space-time scan statistic method**
  - Identify where and when (and for how long) clusters occurred
  - Using date, daily number of cases and population in each district (discrete Poisson model)
  - Using SaTScan software (v 9.6, Kulldorff)

- **Mapping using ArcMap v 10.6.1** (ESRI, CA, USA)

Methods

- **Space-time cluster analysis using SaTScan software**
  - **SaTScan software (v 9.6, Kulldorff)** is a freely available software that uses the scan statistic to detect clusters
    - Identify clusters of high COVID-19 incidence rates considering space and time
  - Spatial window was set at maximum 5 % of the population at risk
  - Temporal window was set at maximum 25 % of the total duration (4 weeks)

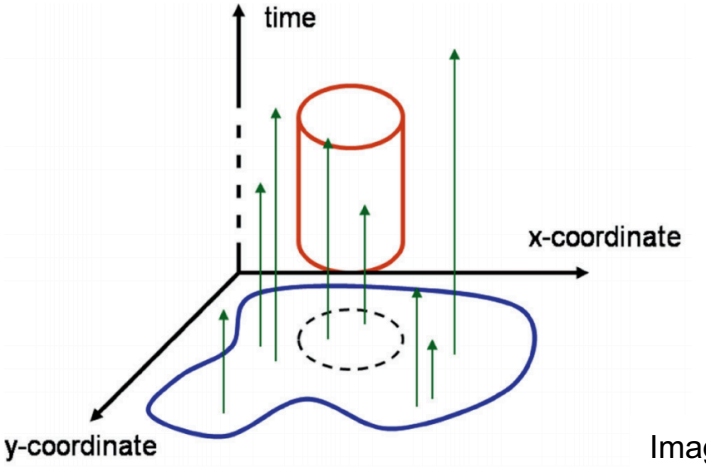
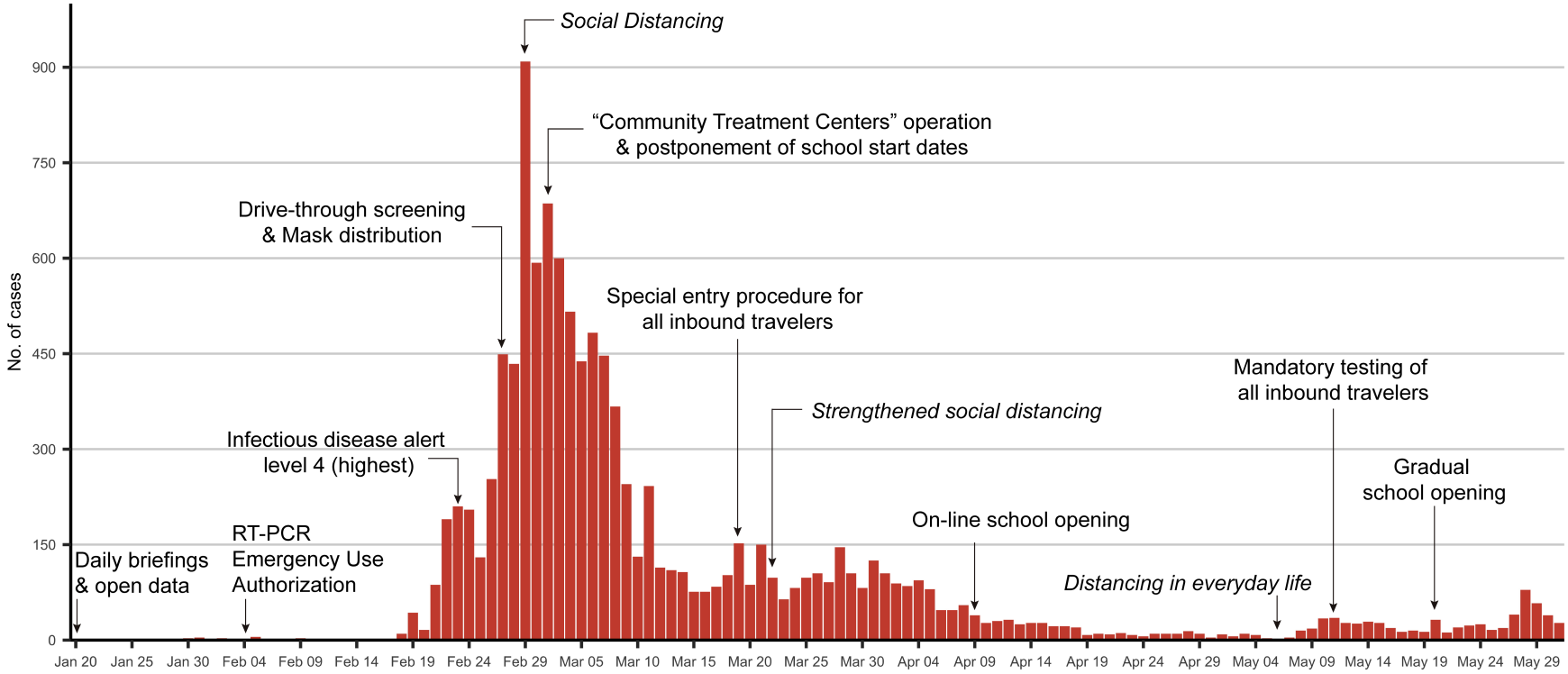


Image source: Costa and Kulldorff (2014)

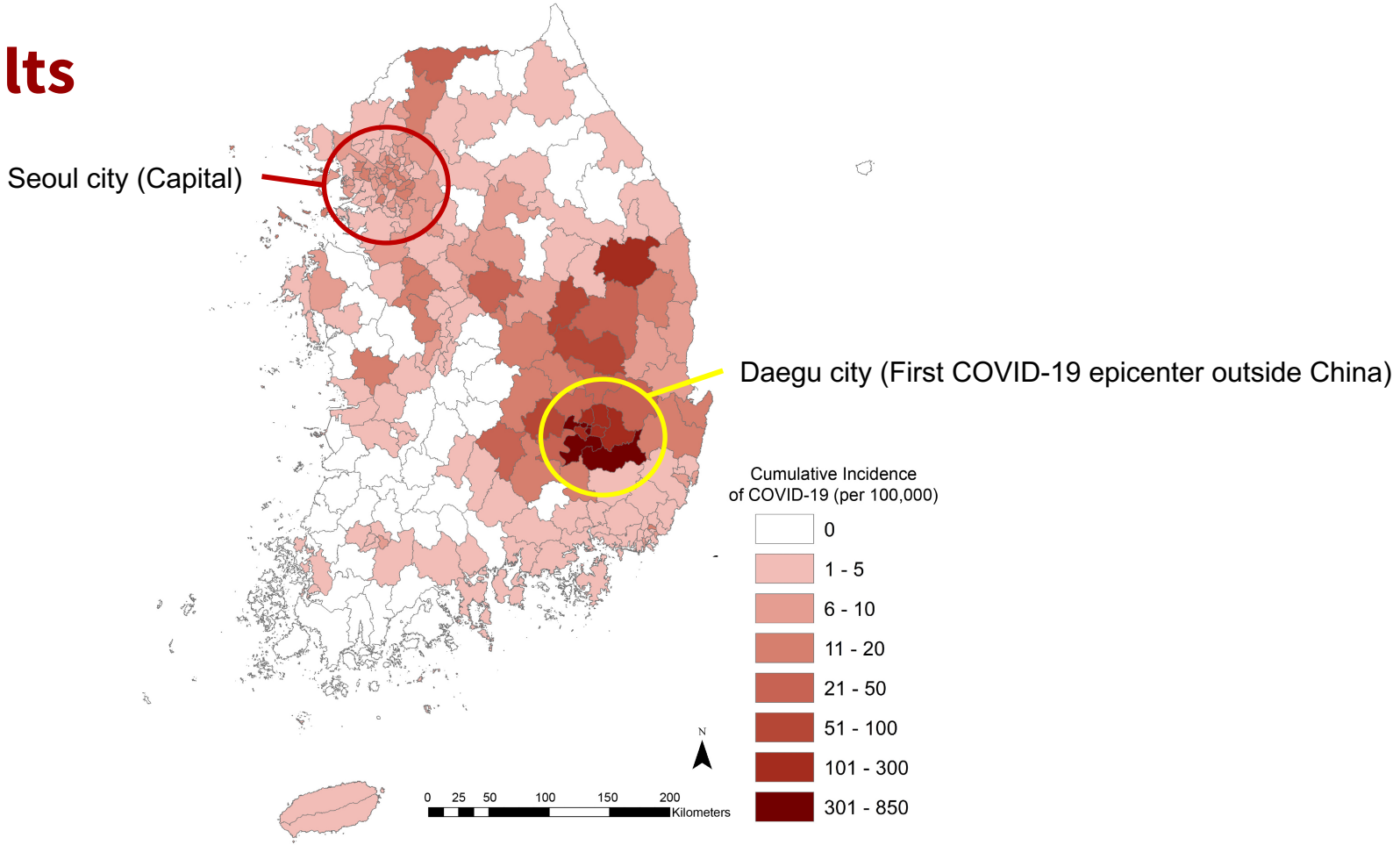
SaTScan™
Software for the spatial, temporal, and space-time scan statistics

Results



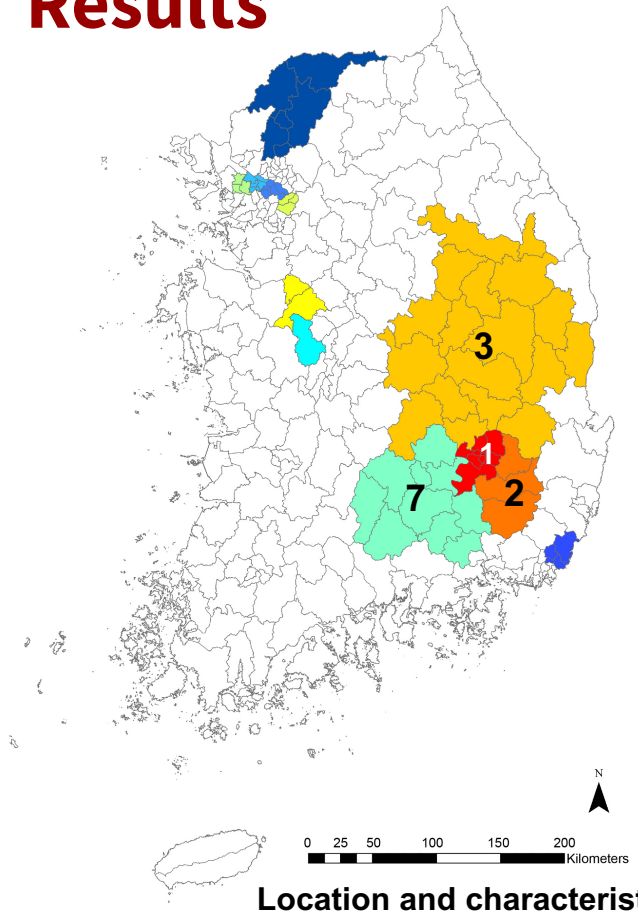
Epidemiological curve of COVID-19 cases, South Korea, January 20 to May 31, 2020

Results



Cumulative COVID-19 cases per 100 000 people by district, South Korea, January 20 to May 31, 2020

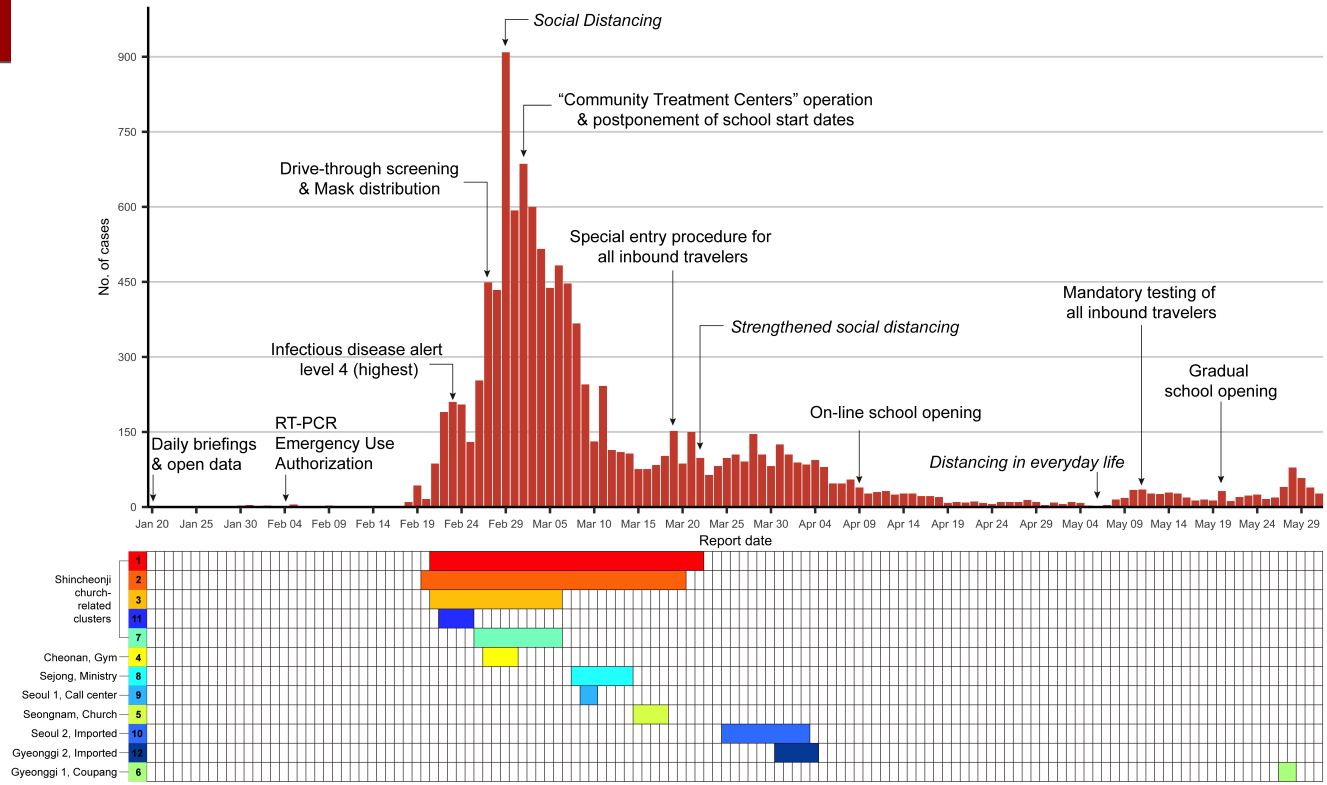
Results



No.	Location	Time frame	Population	Observed cases	Expected cases	Relative Risk	P-value
1	Daegu city	2/21-3/22	2,436,488	6,353	117.66	130.70	<0.001
2	Gyeongbuk 1	2/20-3/20	411,611	738	19.24	41.12	<0.001
3	Gyeongbuk 2	2/21-3/6	1,572,014	322	36.73	9.01	<0.001
4	Cheonan	2/27-3/1	652,845	62	4.07	15.32	<0.001
5	Seongnam	3/15-3/18	942,649	63	5.87	10.78	<0.001
6	Gyeonggi 1	5/27-5/28	1,642,141	59	5.12	11.59	<0.001
7	Gyeongnam	2/26-3/6	413,069	51	6.43	7.96	<0.001
8	Sejong	3/8-3/14	342,328	30	3.73	8.06	<0.001
9	Seoul 1	3/9-3/10	2,198,104	38	6.85	5.56	<0.001
10	Seoul 2	3/25-4/3	2,101,878	85	32.74	2.61	<0.001
11	Busan	2/22-2/25	1,081,140	32	6.74	4.76	<0.001
12	Gyeonggi 2	3/31-4/4	1,006,215	31	7.84	3.96	<0.001

Location and characteristics of spatiotemporal clusters of COVID-19 in South Korea

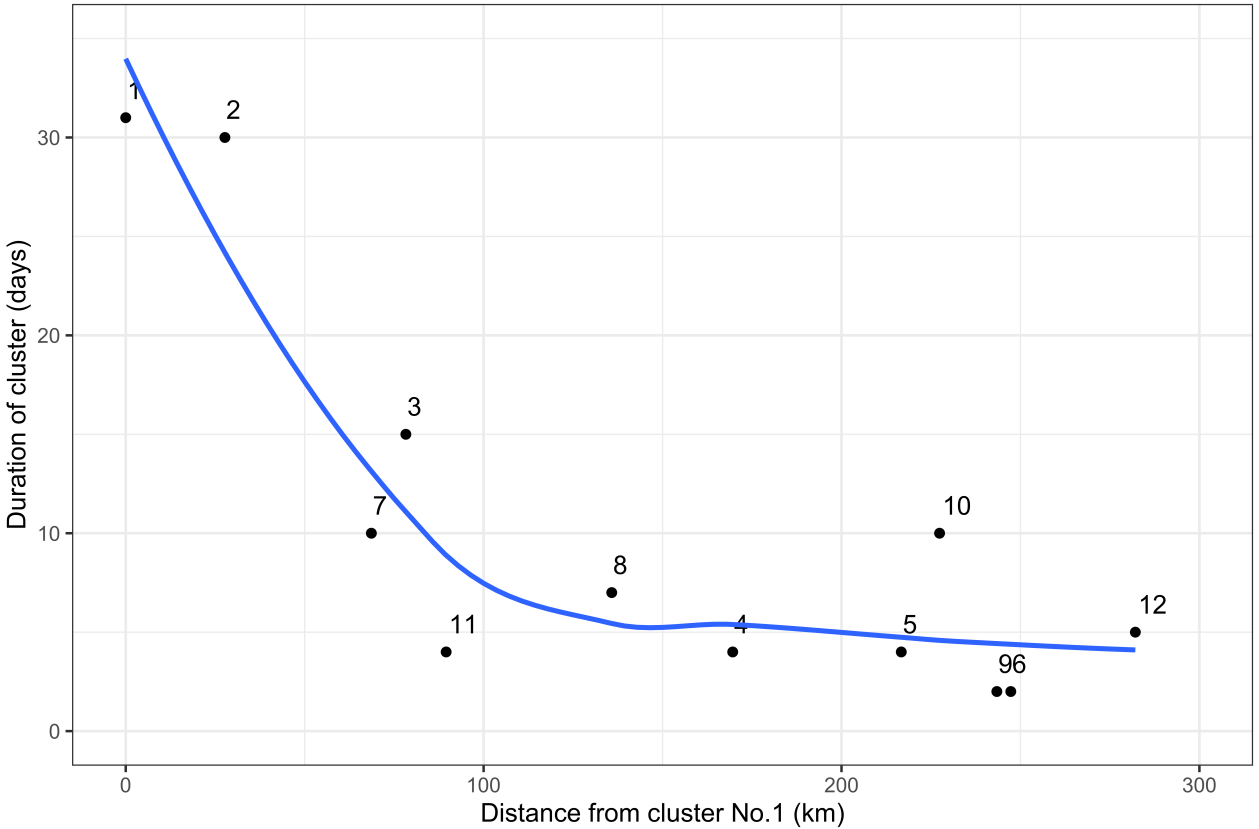
Results



3 T	Test	Pan-corona	RT PCR at designated clinics	Early detection - RT PCR testing at Drive-through & Walk-through screening stations
	Trace	Rigorous contact tracing - usage of credit card transaction history / mobile GPS data / CCTV footage under Infectious Disease Control and Prevention Act		
	Treat	Isolation / treatment at hospitals	Isolation / treatment at community treatment centers - exclusively for COVID-19 recovery	
Infection Prevention		Transparency - Daily press briefings, App & websites for tracking the spread of the virus, alerting potential risk areas, indicating available stock of masks		
		Promoting hand washing & wearing masks	Social distancing	Strengthened social distancing	Distancing in everyday life
		No policy for mask distribution	Mask distribution at pharmacies with two-per-person-per-week purchasing scheme	
Border Control		Keep borders open with special entry procedure (testing at the airport) and self-health check mobile app (monitor 14 days upon arrival)		
		Mandatory testing of travelers with symptoms	Mandatory testing of travelers from highly affected regions	Testing all travelers
		Mandatory quarantine (14 days) for inbound travelers from highly affected regions	Mandatory quarantine for all inbound travelers	

Kim and Castro (2020)

Results



Distance from the Daegu cluster (number 1) to each spatiotemporal cluster and the respective duration of the cluster

Kim and Castro (2020)

Conclusion

- This study provides an overview of the spatiotemporal patterns of COVID-19 in South Korea at the district level.
- COVID-19 cases in South Korea consisted of a small number of large clusters which were socially structured.
  - Highly localized clusters rather than widespread national transmission
  - Most of the likely clusters happened early, had longer duration, and were mainly concentrated in Daegu city and neighboring districts.
- The results indicate that **South Korea's containment strategy for COVID-19 was highly effective in both early detection and mitigation**, with recent clusters being small in size and duration.

What made South Korea's response so successful?

I. **Previous experience with infectious disease outbreaks (MERS)**
   - Governance reform based on the previous experience

II. **Technology and Innovation**
   - 3Ts (Testing, Tracing and Treatment)
   - Use of ICT (self-check mobile app, public safety alerts)

III. **Public health infrastructure**
   - National Health Insurance & digitalized healthcare system

IV. **Sticking to the principles**
   - Openness
   - Transparency
   - Civic Engagement

What made South Korea's response so successful?

I. Previous experience with infectious disease outbreaks (MERS)

- Governance reform based on the previous experience

Institutional and legal changes

- Enable health authorities to collect data needed for contact-tracing of infected individuals
- Authorize emergency use of testing kits and treatments

Risk communication

- Korea Centers for Disease Control and Prevention (KCDC) as the control tower of infectious disease control

Images via iStock and KCDC

What made South Korea's response so successful?

II. Technology and Innovation

- 3Ts (**T**esting, **T**racing and **T**reatment)

Open-air Walk-thru testing

Drive thru testing

Images from Yonhap news & Daily Medi

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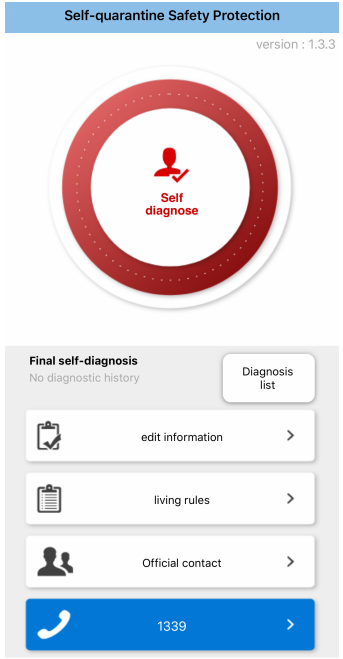

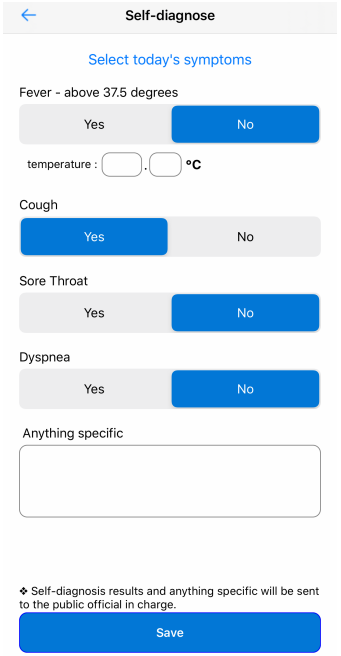

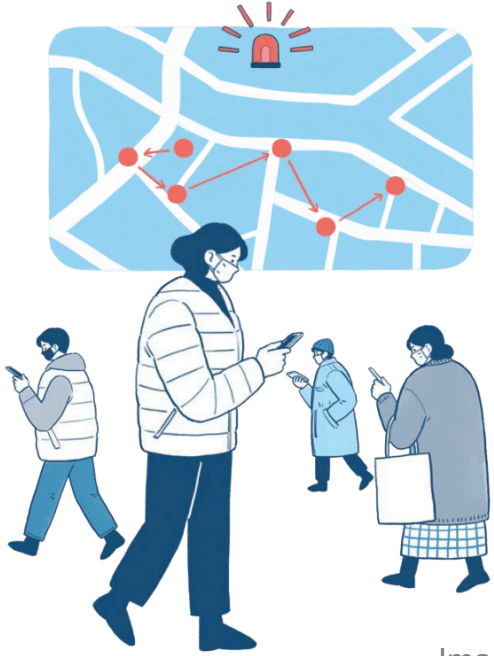

Images via MOFA Korea

What made South Korea's response so successful?

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IV. Sticking to the principles

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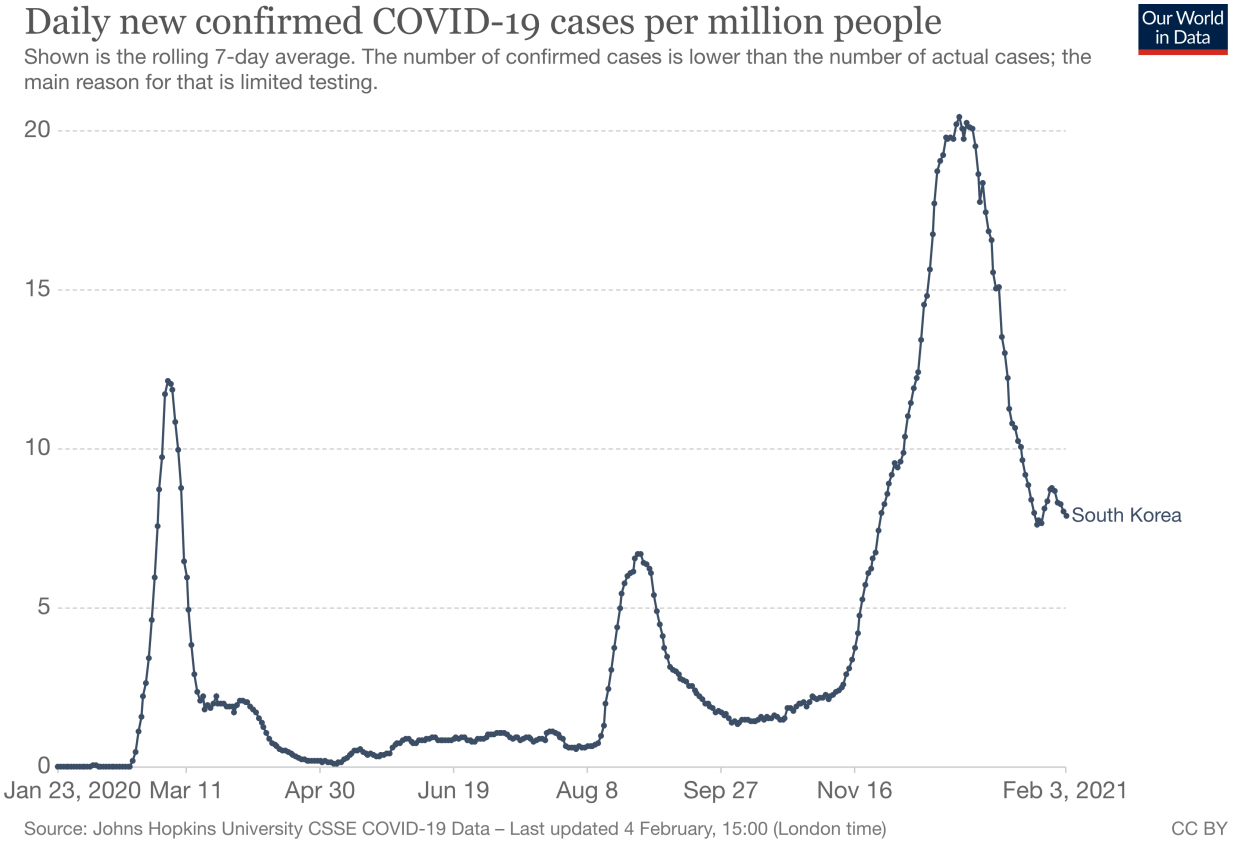
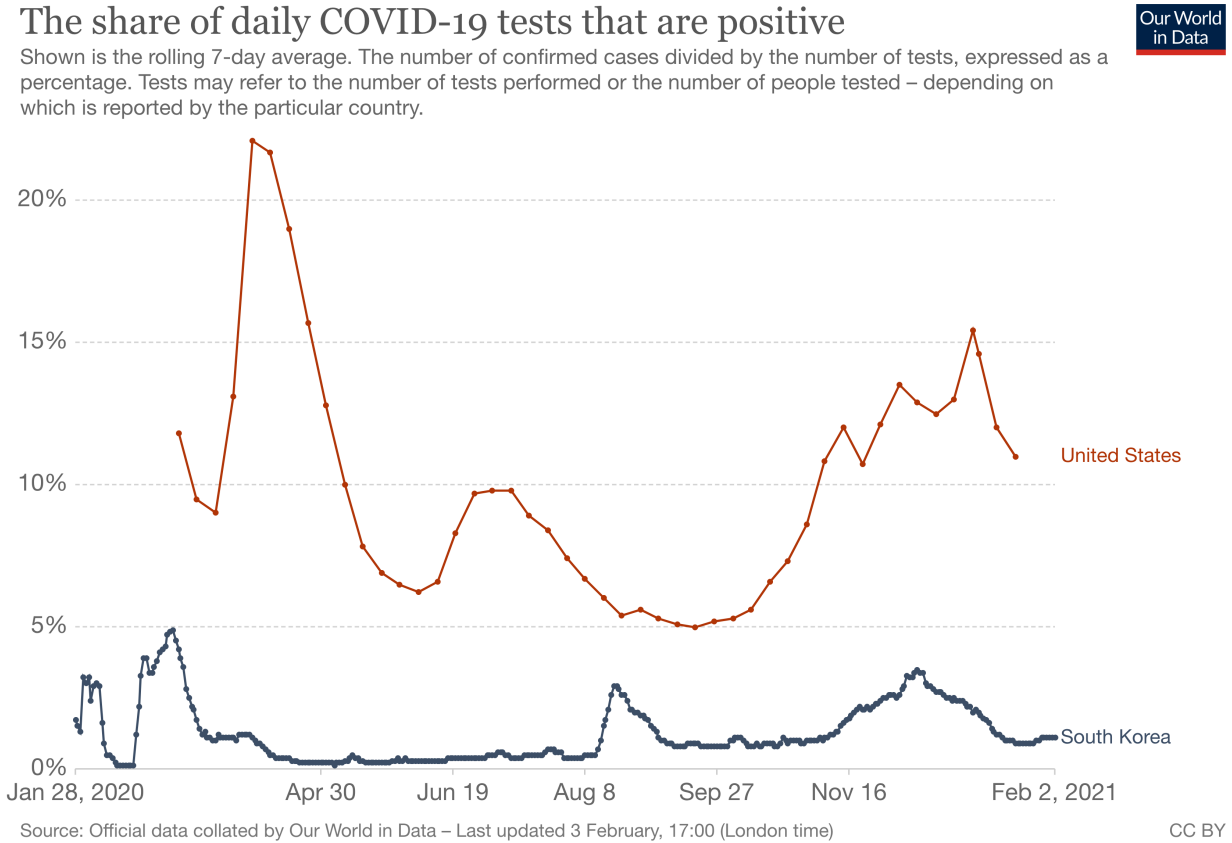
Remaining challenges



Remaining challenges



Global implications

- Openness and transparency
- Building public trust in the government
- International cooperation and solidarity

THANK YOU

sunkim1@hsph.harvard.edu

QUESTIONS