COVID19 Pandemic Preparedness and Response in Countries with Insufficient Medical Resources

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국립암센터 국제암대학원대학교
대한예방의학회, 한국역학회 코로나19 대책위원회

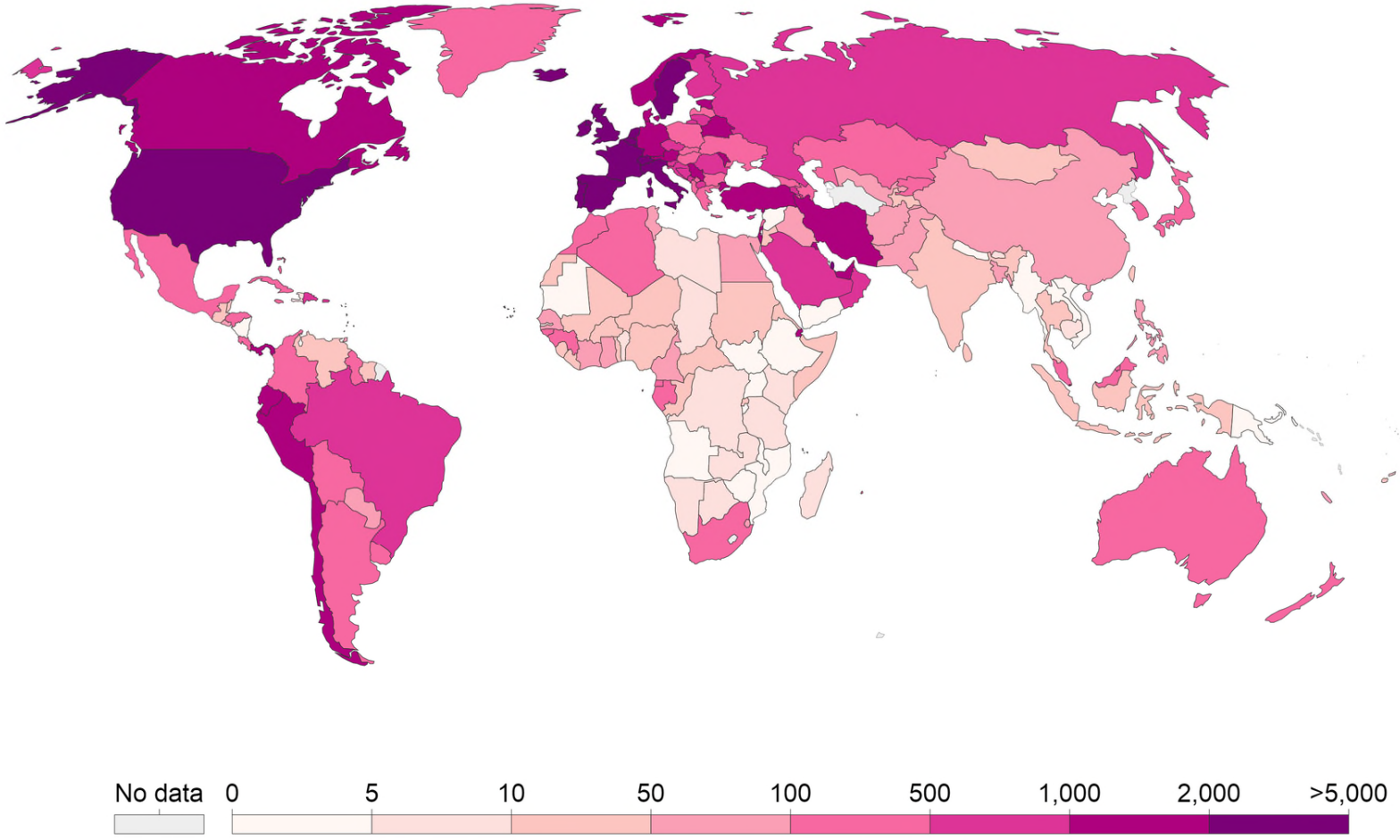
2020/01/01 – 05/09

COVID-19 Pandemic

Total confirmed COVID-19 cases per million people, May 5, 2020

The number of confirmed cases is lower than the number of total cases. The main reason for this is limited testing.

Our World in Data

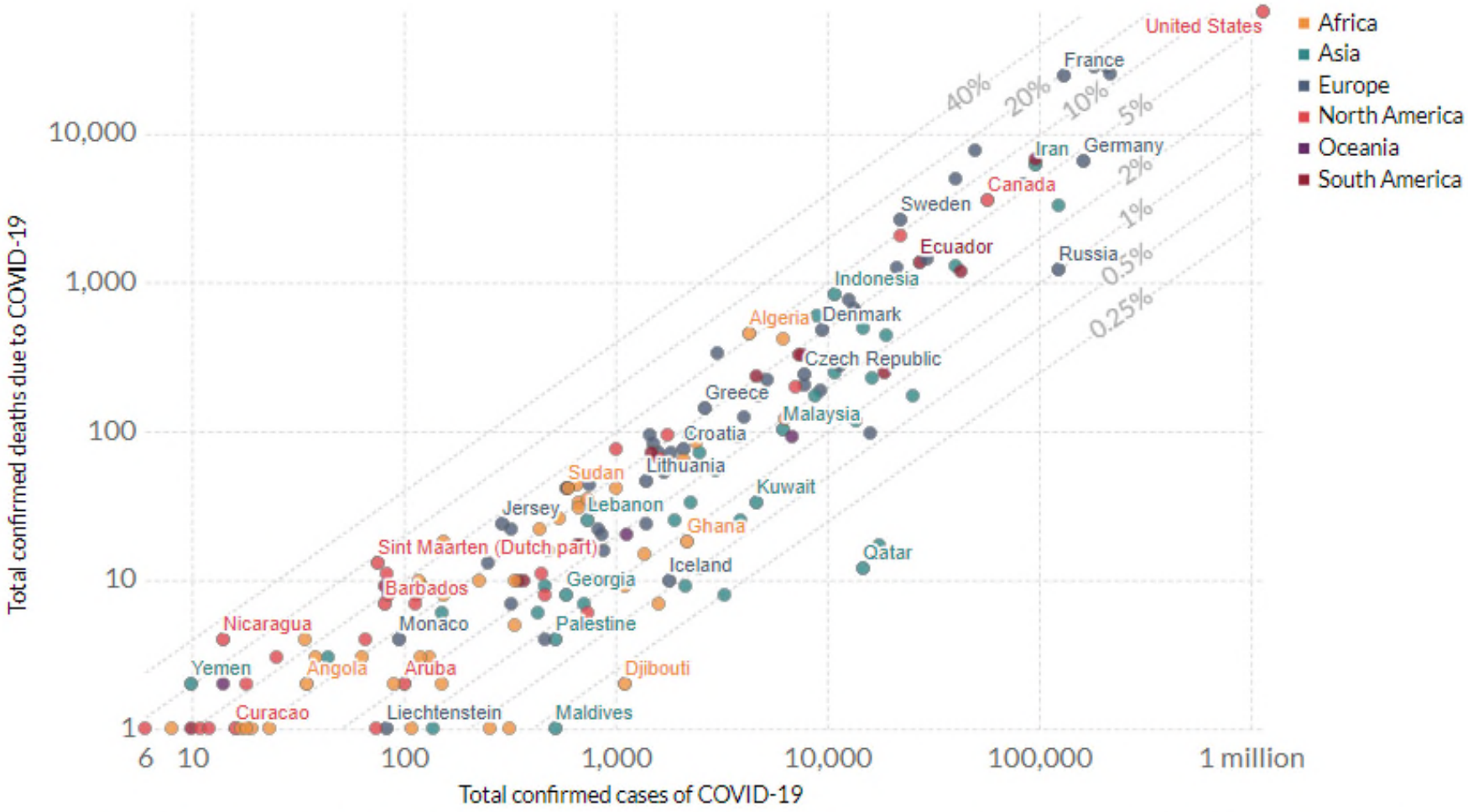


Source: European CDC – Situation Update Worldwide – Last updated 5th May, 11:30 (London time)

Total confirmed COVID-19 deaths vs. cases, May 3, 2020

Our World in Data

The number of confirmed cases is lower than the number of total cases. The main reason for this is limited testing. The grey lines show the corresponding case fatality rates, CFR (the ratio between confirmed deaths and confirmed cases).



Source: European CDC – Situation Update Worldwide – Last updated 3rd May, 11:45 (London time)

Epidemic Curve

2020/01/01 – 05/09 https://covid19.who.int/

Globally, as of **12:49pm CEST, 9 May 2020**, there have been **3,855,812 confirmed cases** of COVID-19, including **265,862 deaths,** reported to WHO.

Confirmed Cases Over Time

3,855,812

confirmed cases

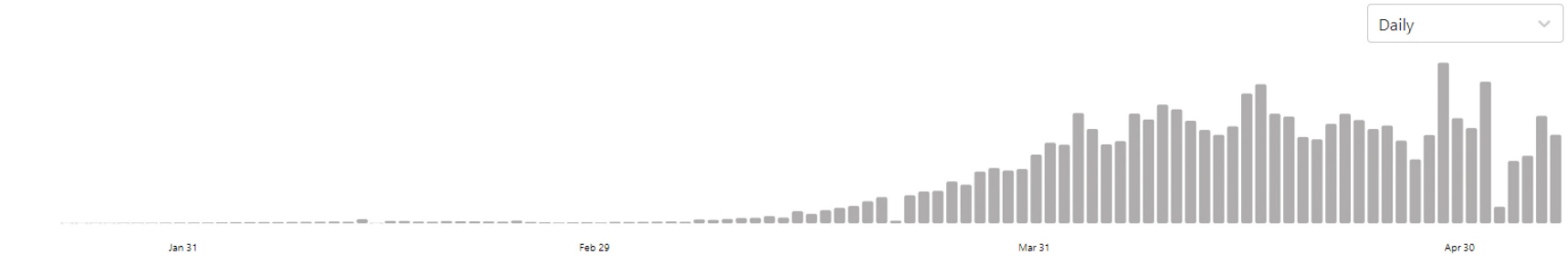
Source: World Health Organization

Deaths Over Time

265,862

deaths

Source: World Health Organization



2020/01/01 – 05/09

Epidemiologic Characteristics

2019-nCoV

2019–2020 novel coronavirus outbreak

Wuhan, China

Date 12 December 2019 – present

Location Origin: Wuhan, Hubei, China

Casualties

Cases

Country	Confirmed Cases	Deaths	Ref
China	218	3	[1]
Japan	1	0	[1]
Thailand	2	0	[1]
South Korea	1	0	[1]
Total	222	3	

As of 20 January 2020

Cases as of 26 January 2020:

Country or region	Confirmed cases	Deaths	Ref.
China (mainland)	2,748	80	[2][3][4][5]
Hong Kong	8	0	[6]
Thailand	8	0	[7]
Macau	6	0	[8][9][10]
United States	5	0	[11][12][13]
Australia	4	0	[14]
Japan	4	0	[15][16]
Malaysia	4	0	[17]
Singapore	4	0	[18]
Taiwan	4	0	[19]
France	3	0	[20][21]
South Korea	4	0	[22][23]
Vietnam	2	0	[24]
Nepal	1	0	[25][26]
Total	**2,805**	**80**	

KST 2020. 01. 31. 09:30 기준

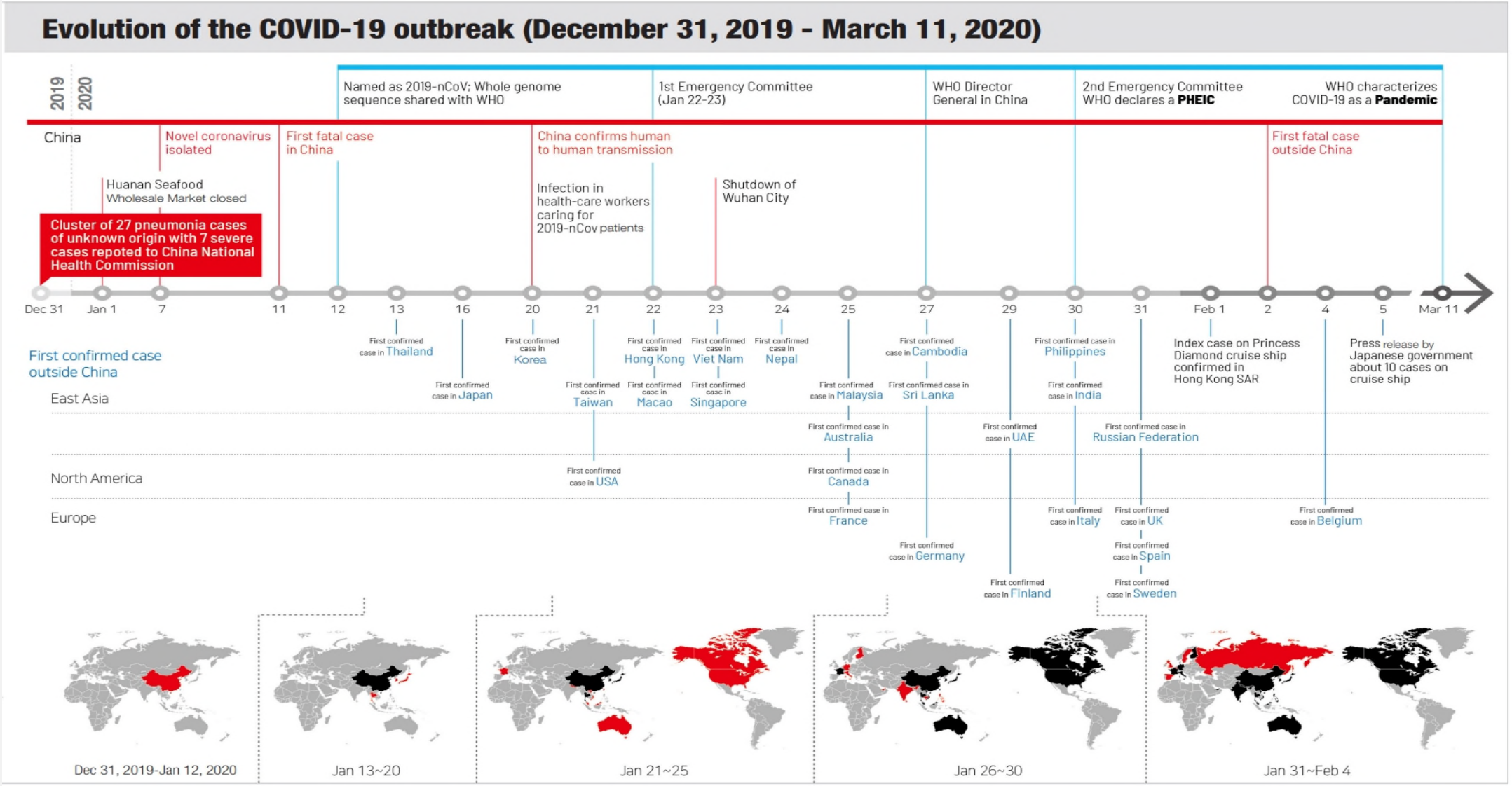
각국의 감염자 현황

※ 감염은 사망과 완치가 포함된 수치임.

국가	감염	사망	완치
중국[24]	9,692명	213명	171명
태국	14명	0명	5명
일본	14명	0명	1명
싱가포르	13명	0명	0명
홍콩[A]	12명	0명	0명
대만	9명	0명	0명
호주	9명	0명	2명
말레이시아	8명	0명	0명
마카오[A]	7명	0명	0명
대한민국	7명	0명	0명
미국	6명	0명	0명
프랑스	6명	0명	0명
베트남	5명	0명	1명
독일	4명	0명	0명
아랍에미리트	4명	0명	0명
캐나다	3명	0명	0명
이탈리아	2명	0명	0명
네팔	1명	0명	1명
캄보디아	1명	0명	0명
스리랑카	1명	0명	0명
핀란드	1명	0명	0명
인도	1명	0명	0명
필리핀	1명	0명	0명
총 계	**9,821명**	**213명**	**181명**

Outbreak Timeline

DOI: https://doi.org/10.4178/epih.e202001



Early 28 cases In Korea

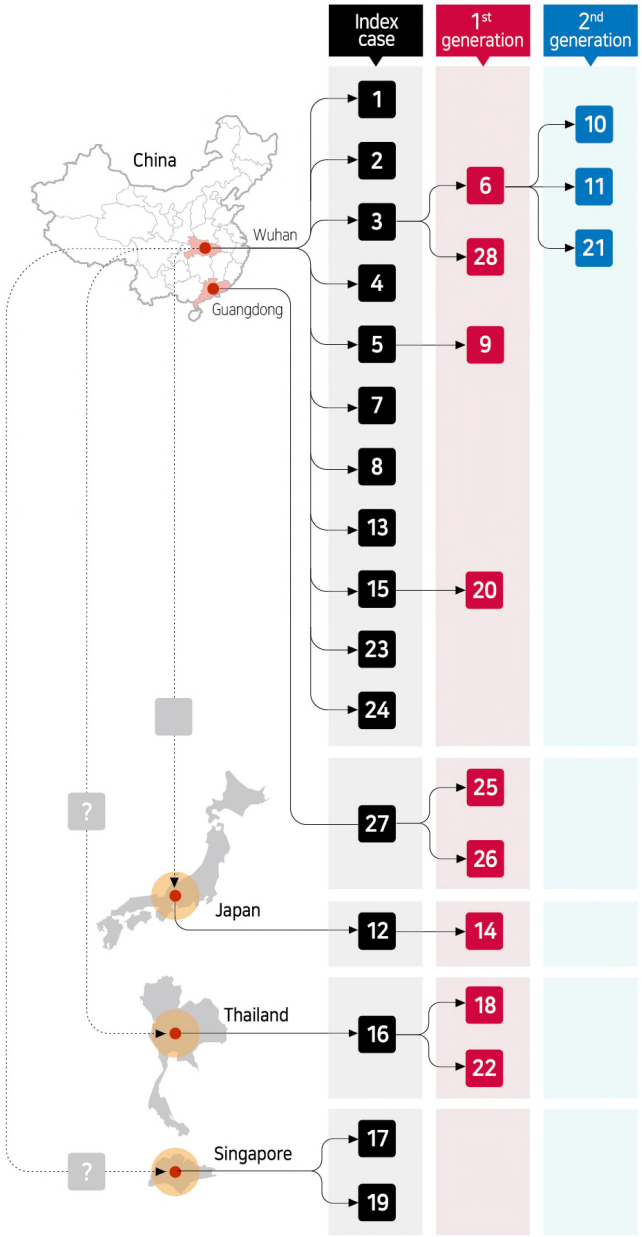


Table 1.

Summary of epidemiologic characteristics of 2019 novel coronavirus disease using early 28 cases in Korea

Characteristics	n (%)
Male	15 (53.6)
Age (yr)	
20-29	6 (21.4)
30-39	6 (21.4)
40-49	6 (21.4)
50-59	8 (28.6)
60-69	1 (3.6)
70-79	1 (3.6)
Nationality	
Korean living in Korea	22 (78.6)
Chinese living in Korea	3 (10.7)
Chinese travelers from Wuhan, China	3 (10.7)
Source of infection	
Index case (n=16)	
Wuhan, China	11 (68.8)
Guangdong, China	1 (6.3)
Singapore	2 (12.5)
Japan	1 (6.3)
Thailand	1 (6.3)
1st generation (n=9)	
#16	2 (22.2)
#3	2 (22.2)
#5	2 (22.2)
#15	1 (11.1)
#12	1 (11.1)
#15	1 (11.1)
2nd generation (n=3)	
#6	3 (100)
Period category (d)	**Average (range)/median**
Incubation period[1]	3.9 (0-15)/3.0
Serial interval	6.6 (3-15)/4.0
Symptom-onset to diagnosis[1]	5.2 (0-16)/4.0
Symptom-onset to quarantine or isolation[1]	4.3 (0-15)/3.0
Diagnosis to discharge[2]	13.0 (7-17)/12.5
Reproduction number	**Estimate (Poisson 95% CI)/[binominal 95% CI]**
Total	0.48 (0.25, 0.84)/[0.28, 0.69]
1st generation (n=9)	0.56 (0.26, 1.07)/[0.30, 0.80]
2nd generation (n=3)	0.33 (0.07, 0.97)/[0.07, 0.70]

CI; confidence interval.

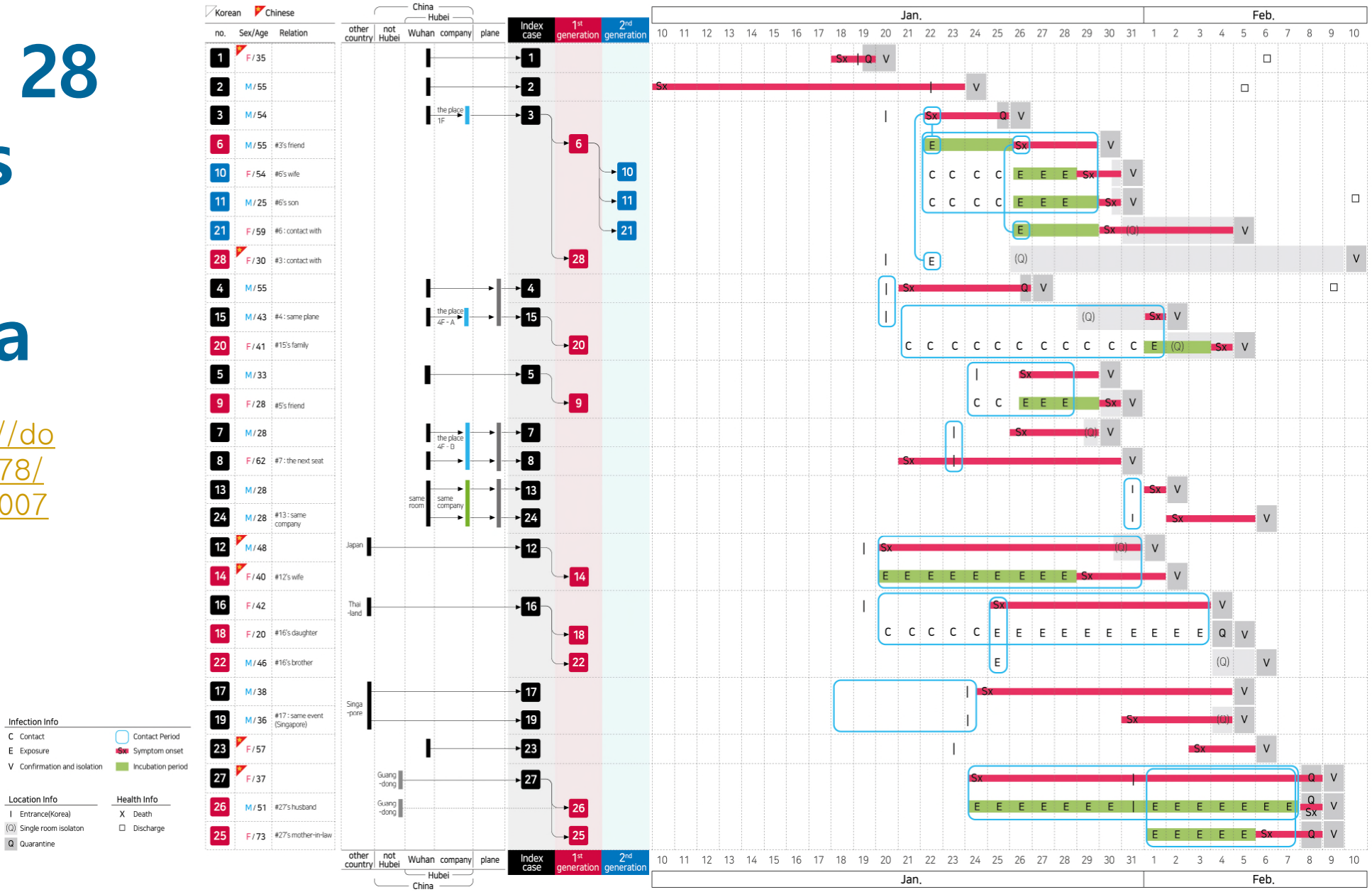
[1] Three asymptomatic cases were excluded.

[2] First 8 discharge cases were included.

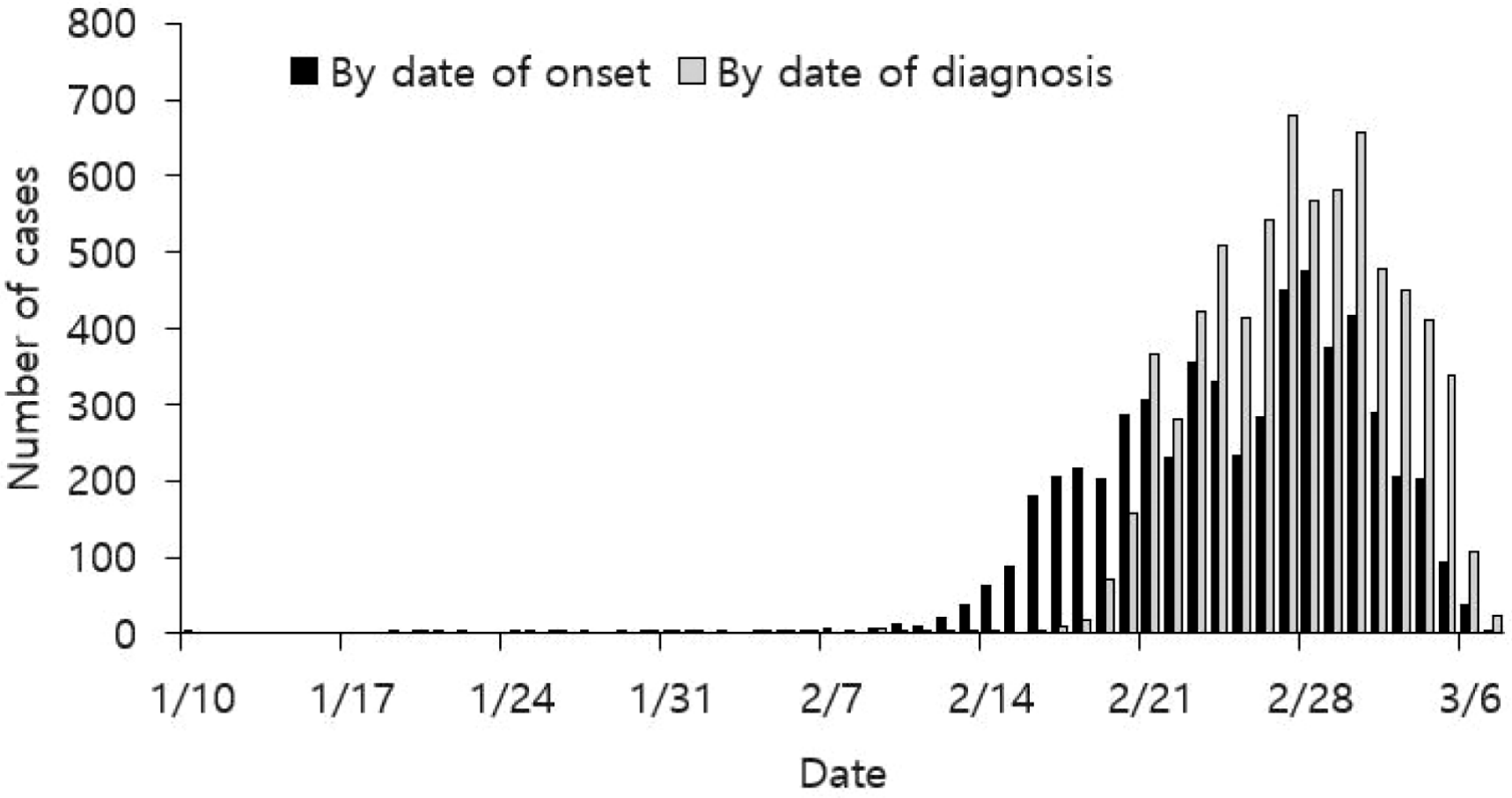
DOI: https://doi.org/10.4178/epih.e2020007

Early 28 cases In Korea

DOI: https://doi.org/10.4178/epih.e2020007



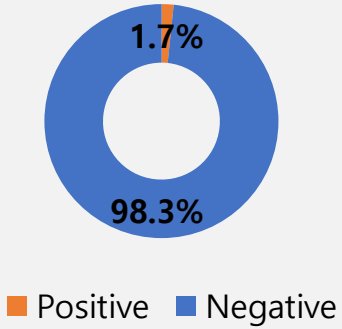
Sx. onset vs. confirm, South Korea



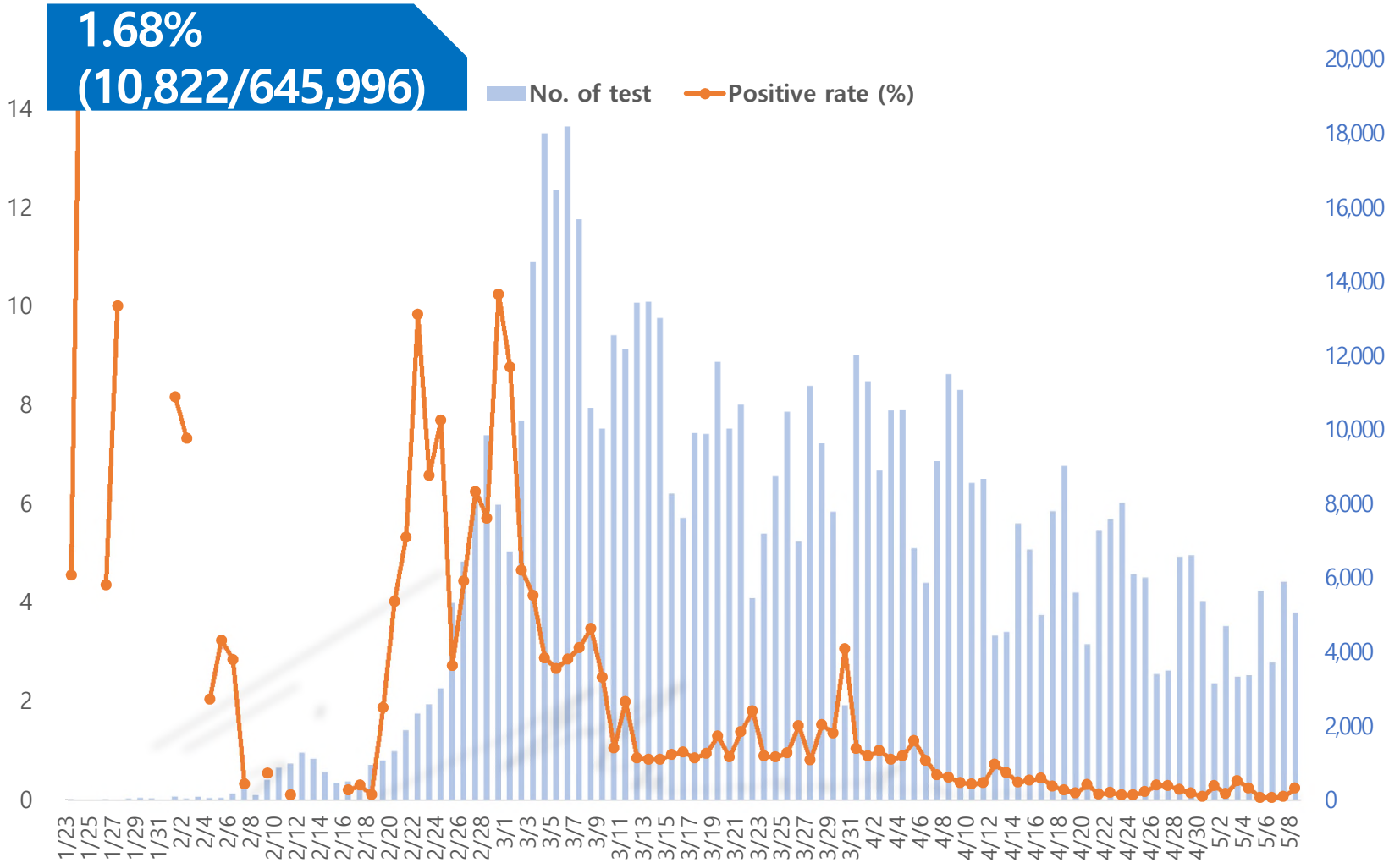
DOI: https://doi.org/10.24171/j.phrp.2020.11.2.05

COVID-19 PCR test

Total rt-PCR test
(as of May 8)



No. of tests per day, positive rate(%)



발병일	모름	0일	1일	2일	3일	4일	5일	6일	7일	8일	9일	10일	11일	12일	13일	14일	15일 이상
모름	115	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2020-01-10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-
2020-01-19	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2020-01-20	-	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-
2020-01-21	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-
2020-01-22	-	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-	1
2020-01-23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2020-01-24																	
2020-01-25																	
2020-01-26	-	-	-	-	-	1	-	-	-	-	1	-	-	-	-	-	-
2020-01-27																	
2020-01-28	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2020-01-29	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2020-01-30	-	1	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-
2020-01-31	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1
2020-02-01	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	1
2020-02-02	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
2020-02-03	-	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	3
2020-02-04	-	1	-	1	-	-	1	-	-	-	-	-	-	-	-	-	2
2020-02-05	-	2	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2020-02-06	-	1	-	1	1	-	-	-	-	-	-	-	-	-	1	-	3
2020-02-07	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	2	-
2020-02-08	-	-	-	-	-	-	-	-	-	-	-	-	-	1	2	1	-
2020-02-09	-	2	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-
2020-02-10	-	2	-	-	-	-	-	-	-	-	2	-	1	3	1	1	-
2020-02-11	-	1	-	-	-	-	-	-	-	1	1	-	1	-	-	-	-
2020-02-12	-	2	-	-	-	-	-	-	4	1	3	3	1	-	-	-	-
2020-02-13	-	2	-	-	-	-	2	4	4	2	2	4	1	-	-	-	-
2020-02-14	-	-	-	-	1	1	3	5	9	3	-	1	1	-	-	-	-
2020-02-15	-	-	-	-	4	5	10	8	9	8	1	-	-	-	-	-	-
2020-02-16	-	5	1	2	7	6	20	8	7	4	2	-	-	-	-	-	-
2020-02-17	-	5	3	11	17	20	14	12	2	1	-	-	-	-	-	-	-
2020-02-18	-	6	11	18	28	23	14	5	2	-	-	-	-	-	-	-	-
2020-02-19	-	11	21	20	20	16	4	6	-	-	-	-	-	-	-	-	-
2020-02-20	-	64	42	16	17	7	4	-	-	-	-	-	-	-	-	-	-
2020-02-21	-	151	23	16	5	4	-	-	-	-	-	-	-	-	-	-	-
2020-02-22	-	43	17	9	8	1	-	-	-	-	-	-	-	-	-	-	-
2020-02-23	-	99	14	4	1	-	-	-	-	-	-	-	-	-	-	-	-
2020-02-24	-	57	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-

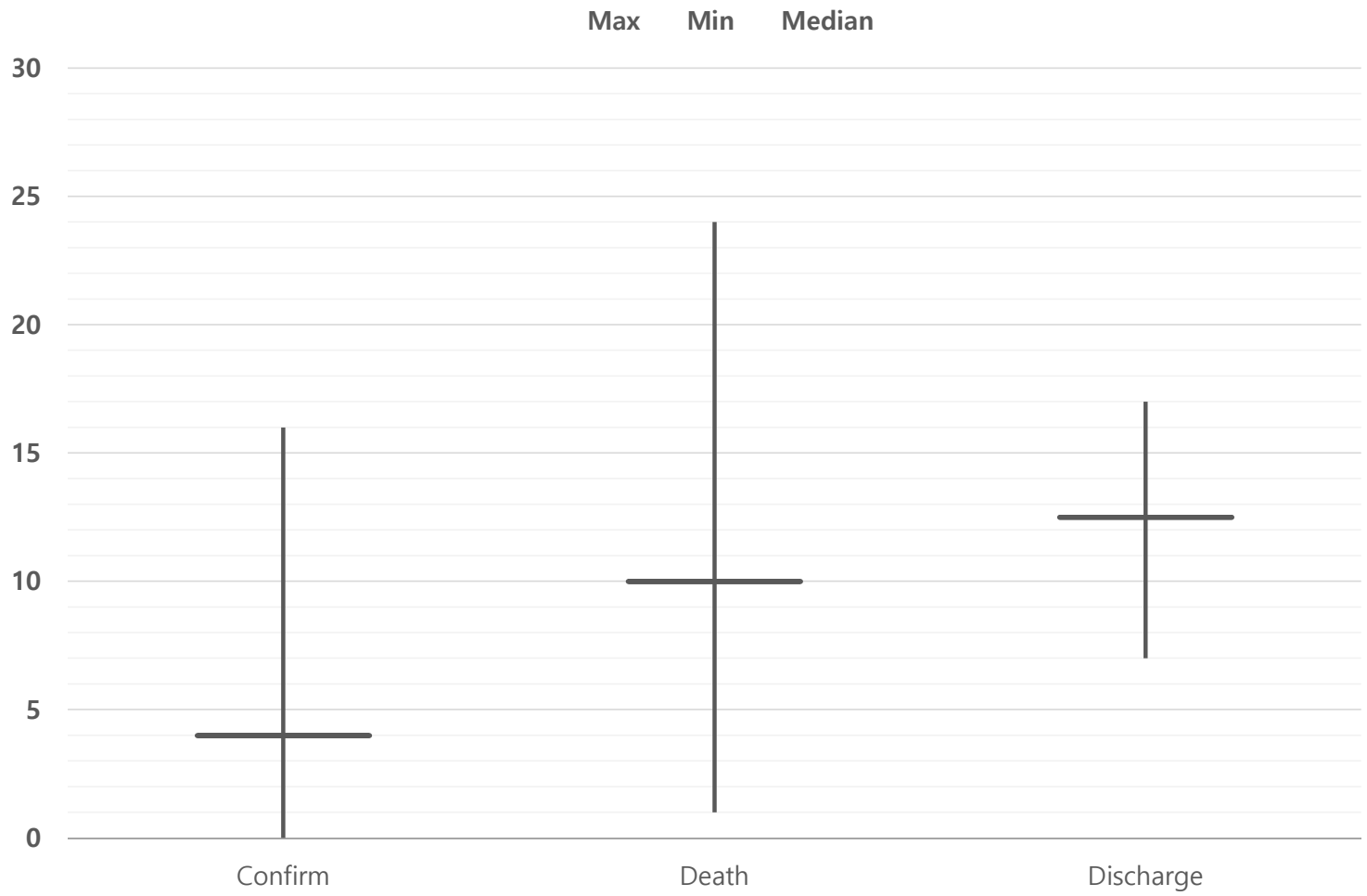
Duration

Sx. onset

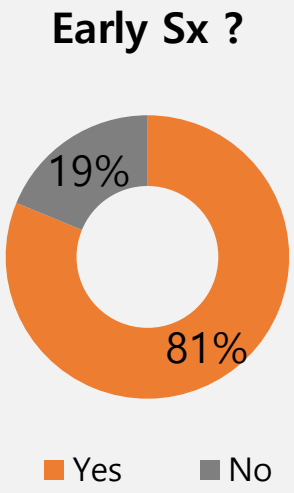
~ confirm: 4 d (0-16)

~ death: 10 d (1-24)

~ discharge: 12.5 d (7-17)



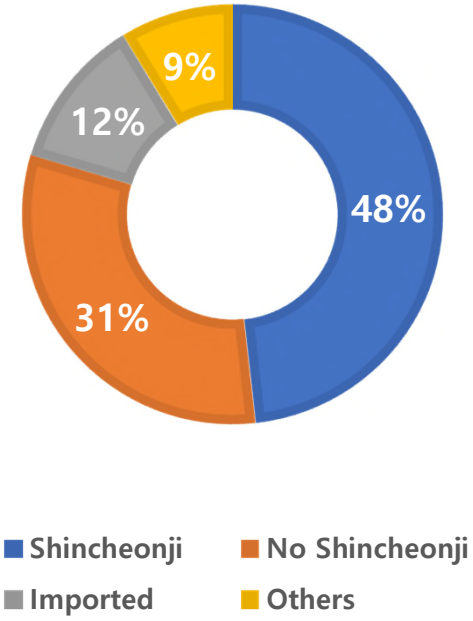
COVID-19 Cases



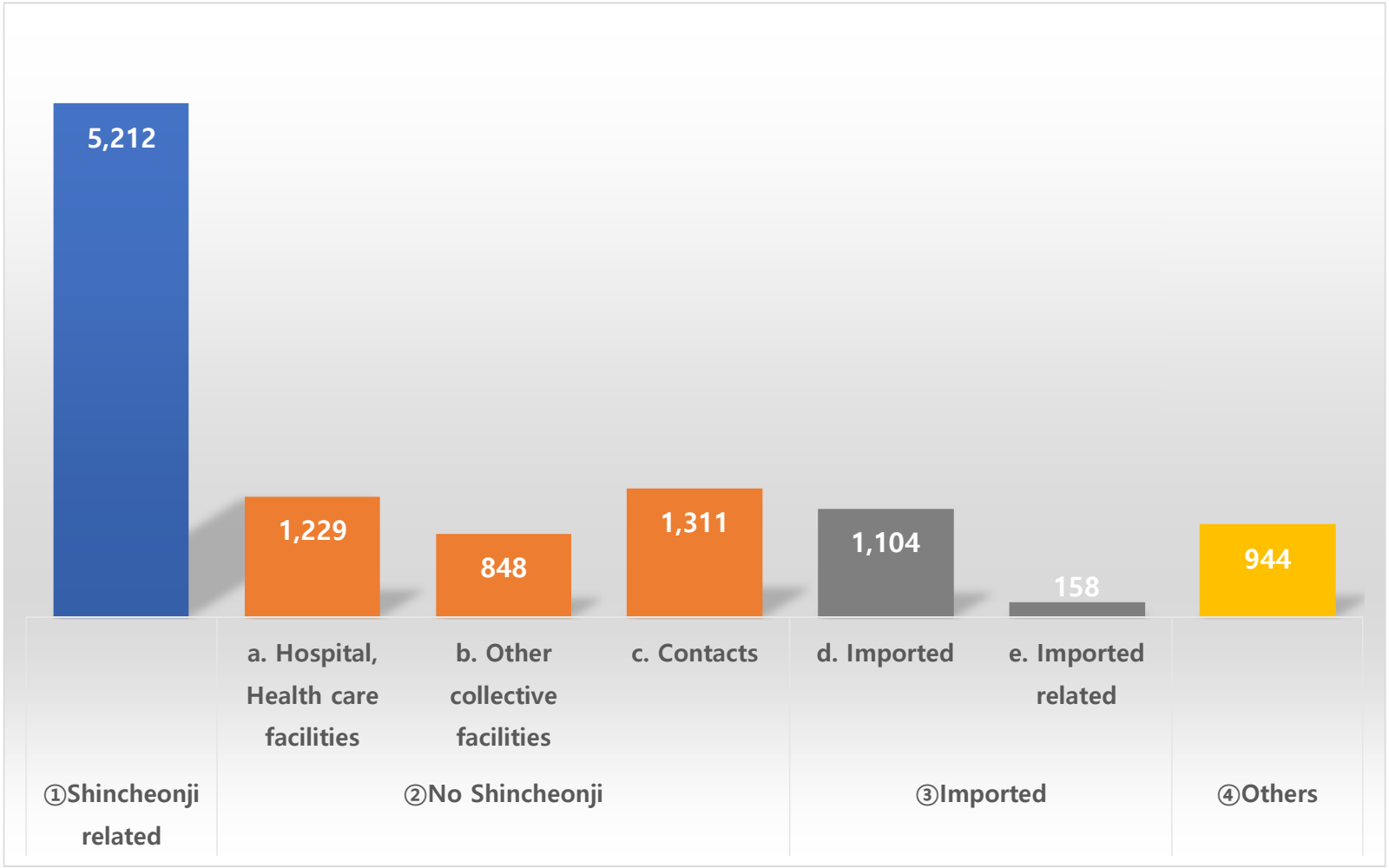
Early symptoms

Main Sx	Yes (%)		No (%)	
Fever	1,679	(19.1)	7,096	(80.9)
Cough	2,202	(25.1)	6,573	(74.9)
Sputum	1,107	(12.6)	7,668	(87.4)
Sore throat	1,187	(13.5)	7,588	(86.5)
Shortness of breath	176	(2.0)	8,599	(98.0)
Myalgia	1,185	(13.5)	7,590	(86.5)
Chills	1,185	(13.5)	7,590	(86.5)

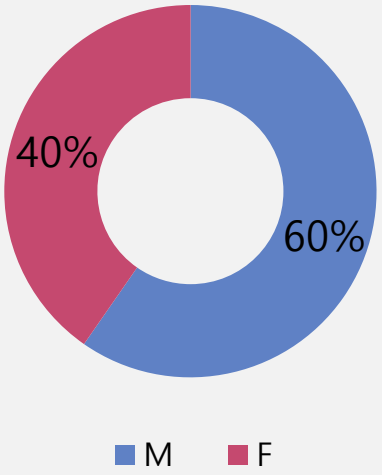
COVID-19 Cases



Outbreak Clusters



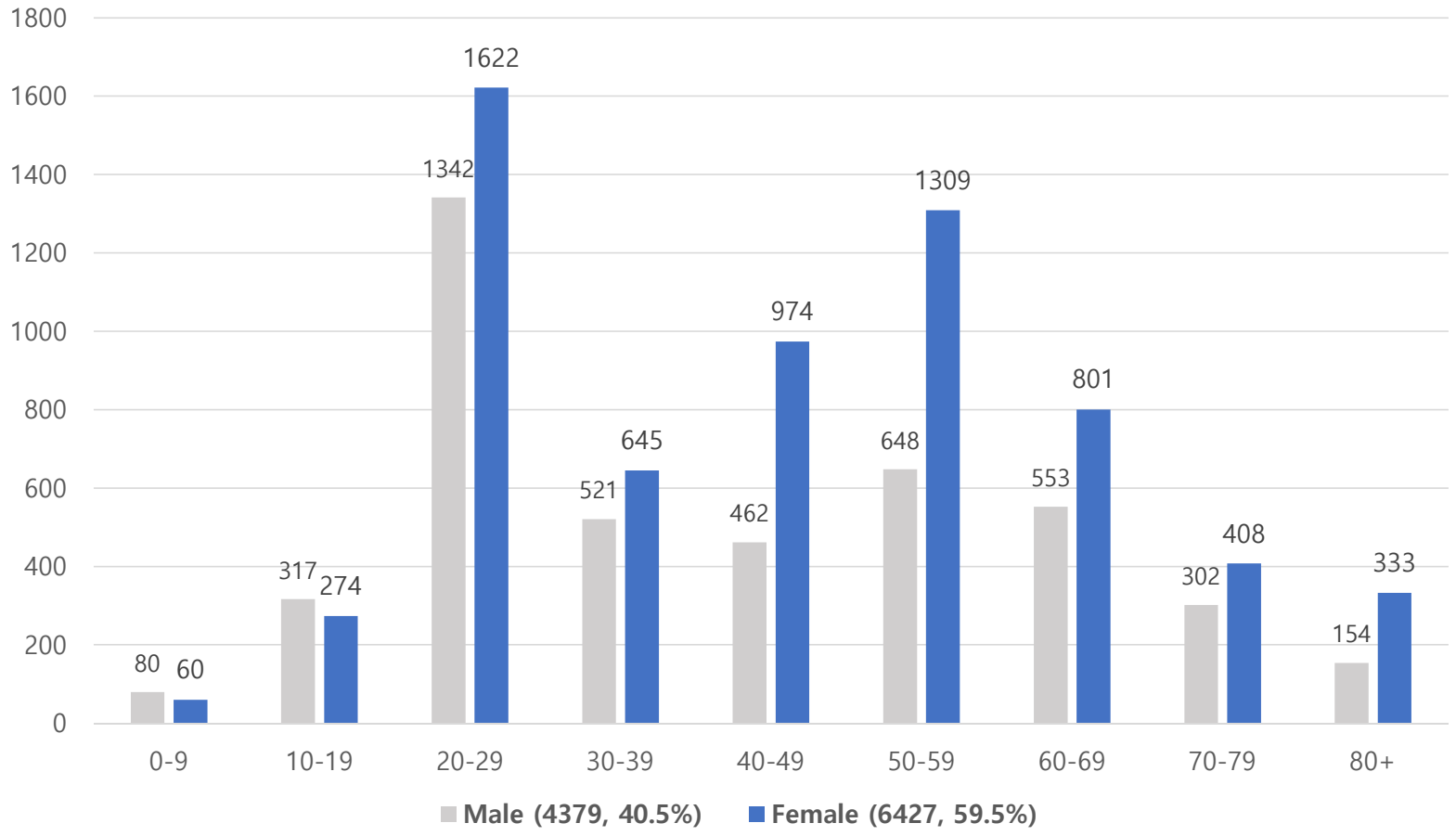
COVID-19 Cases



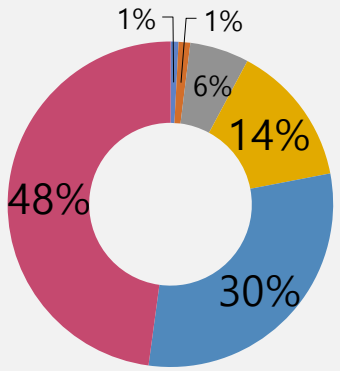
Median age 44

Range (0-104)

Sex, age



Case fatality rate (CFR)



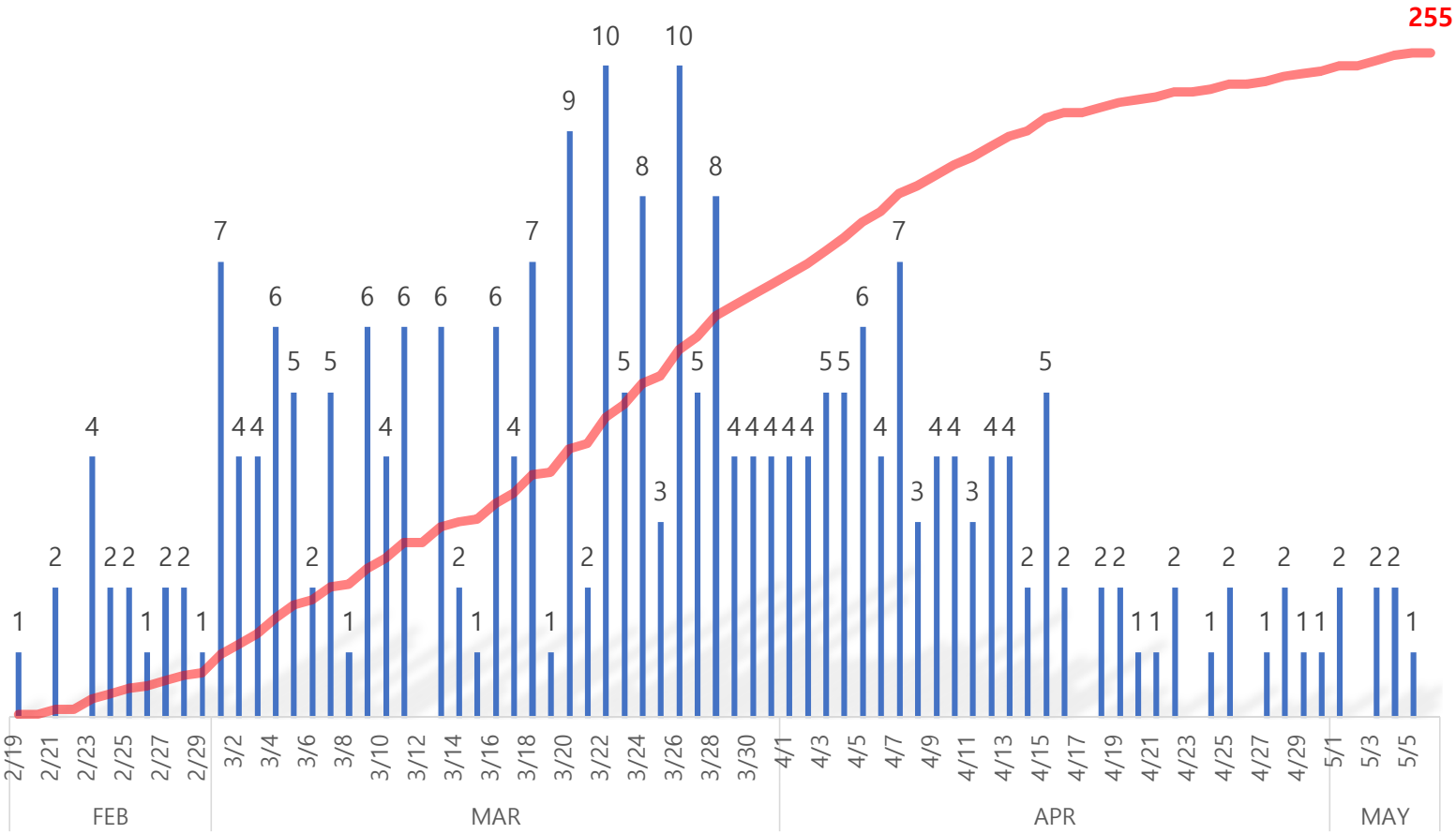
30-39 40-49
50-59 60-69
70-79 80+

Median age 79

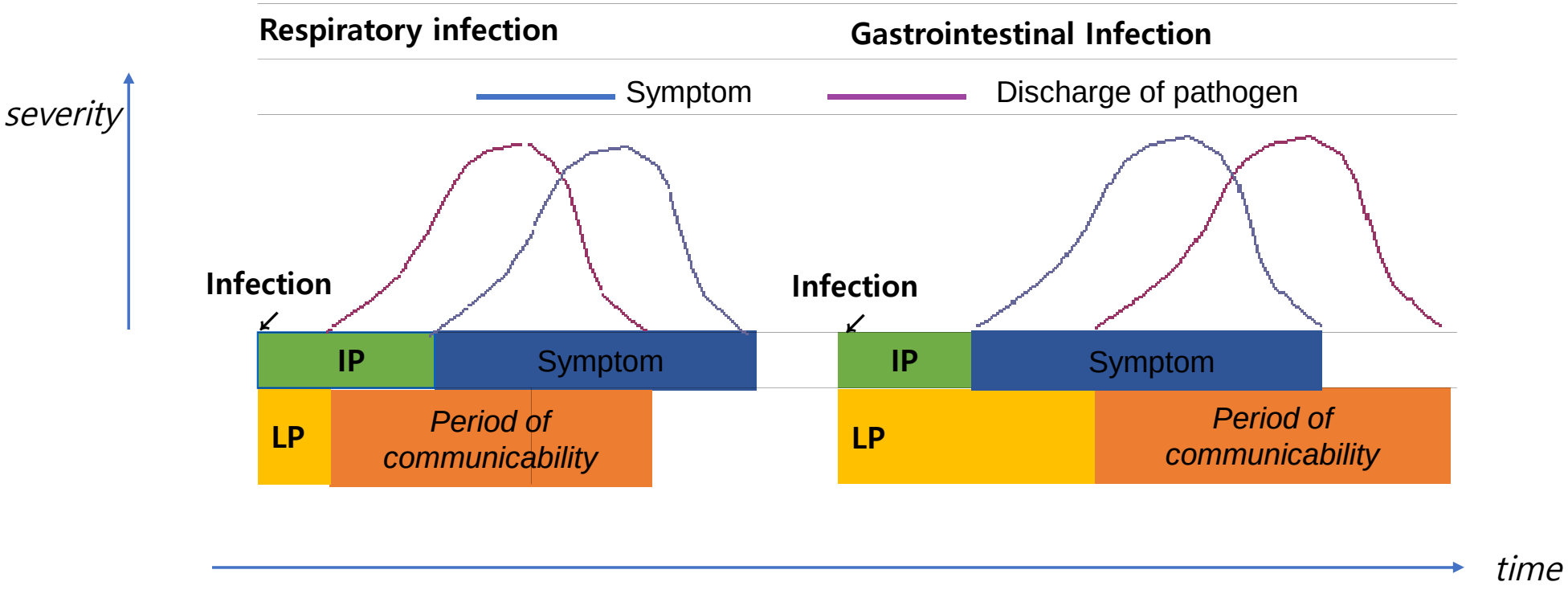
Range (35-98)

No. of death by date

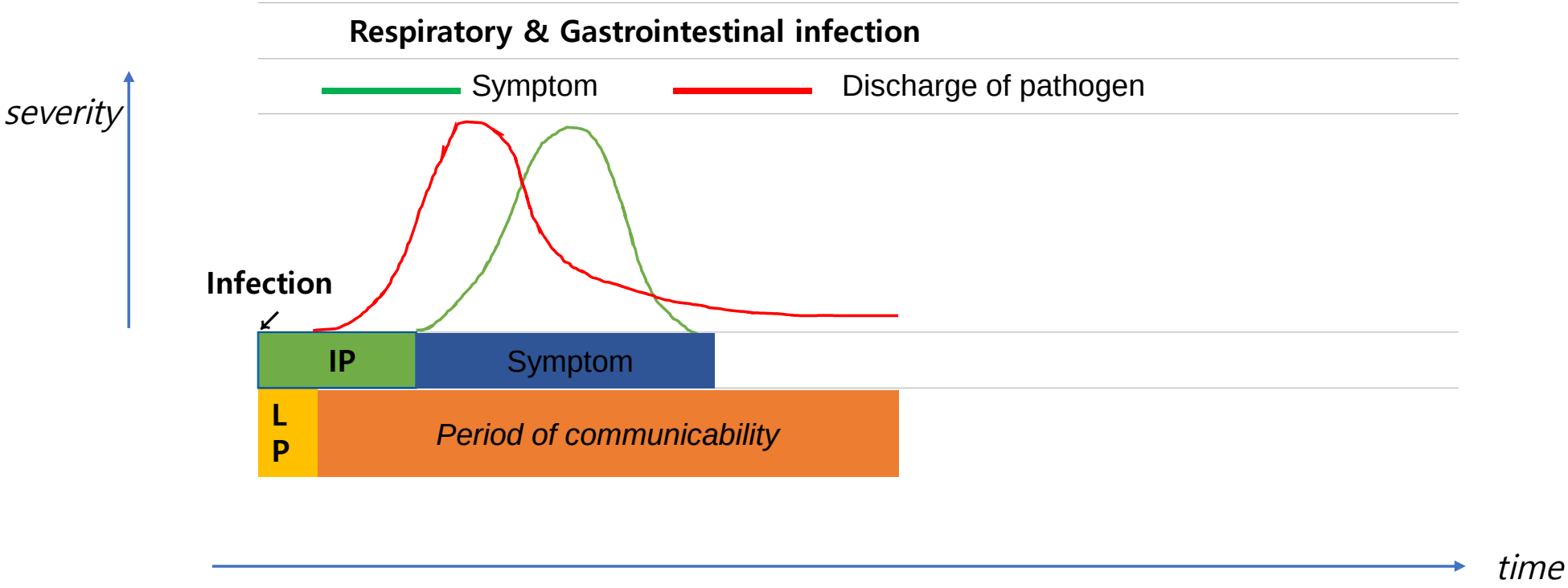
2.36% (255/10,806)



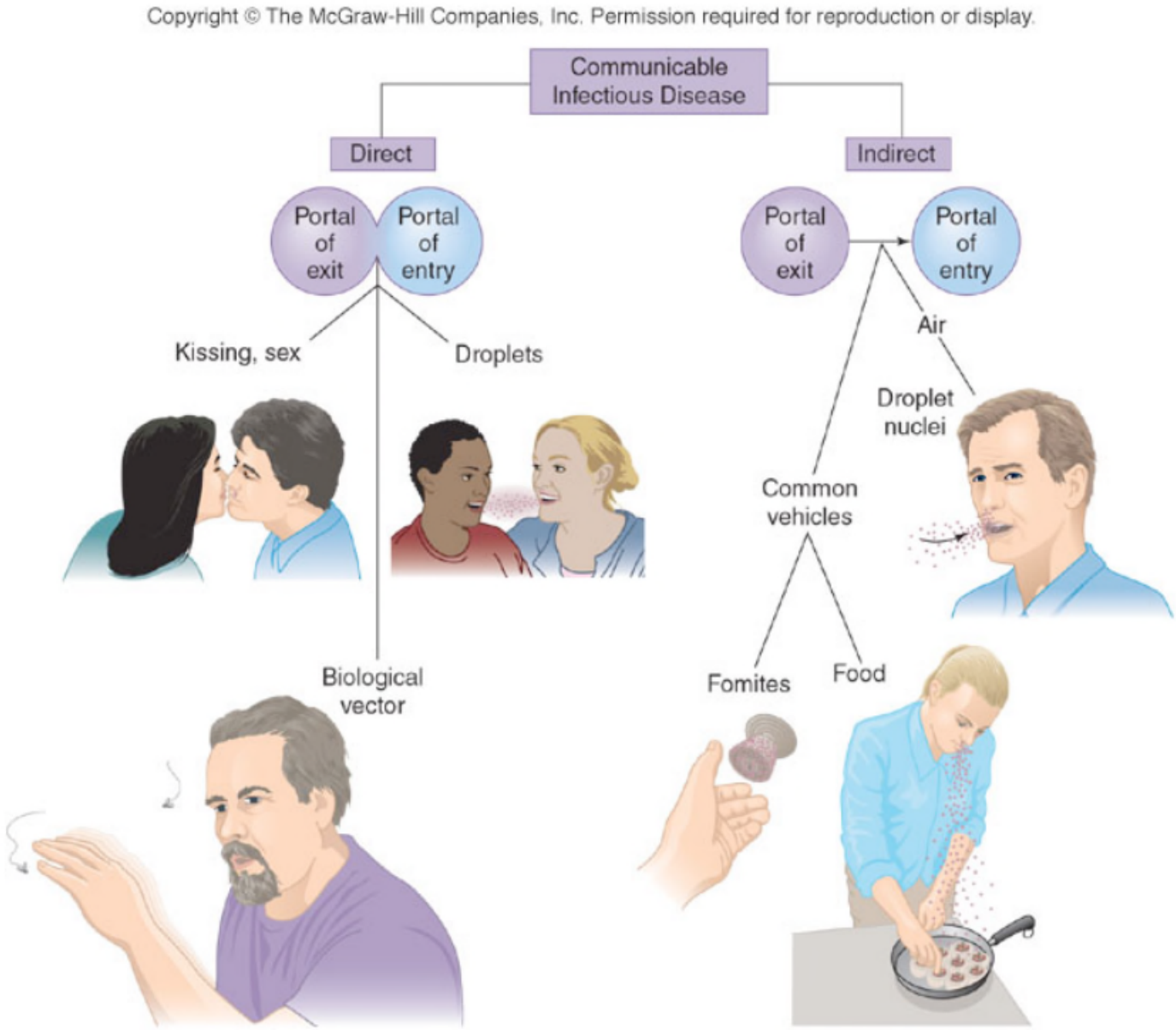
Incubation period vs. Latent period



COVID-19 Incubation period vs. Latent period



Mode of Transmission



Mode of Transmission

Droplet dispersal following a violent sneeze

Indicators for interaction between pathogen and host

N: Total Susceptibles	Infection				
	Inapparent (A)	Clinical			
		Mild(B)	Moderate(C)	Severe (D)	Fatal(E)

(1) **Infectivity = (A+B+C+D+E) /N × 100**

- Ability of a microorganism to invade and replicate in a host tissue, whether the microbe is pathogenic or not.
- ID50(Infection Dose) : the amount of pathogenic microorganisms that will cause infection in 50 per cent of the test subjects.
- proportion of infected cases among susceptibles. (Secondary attack rate can be used)

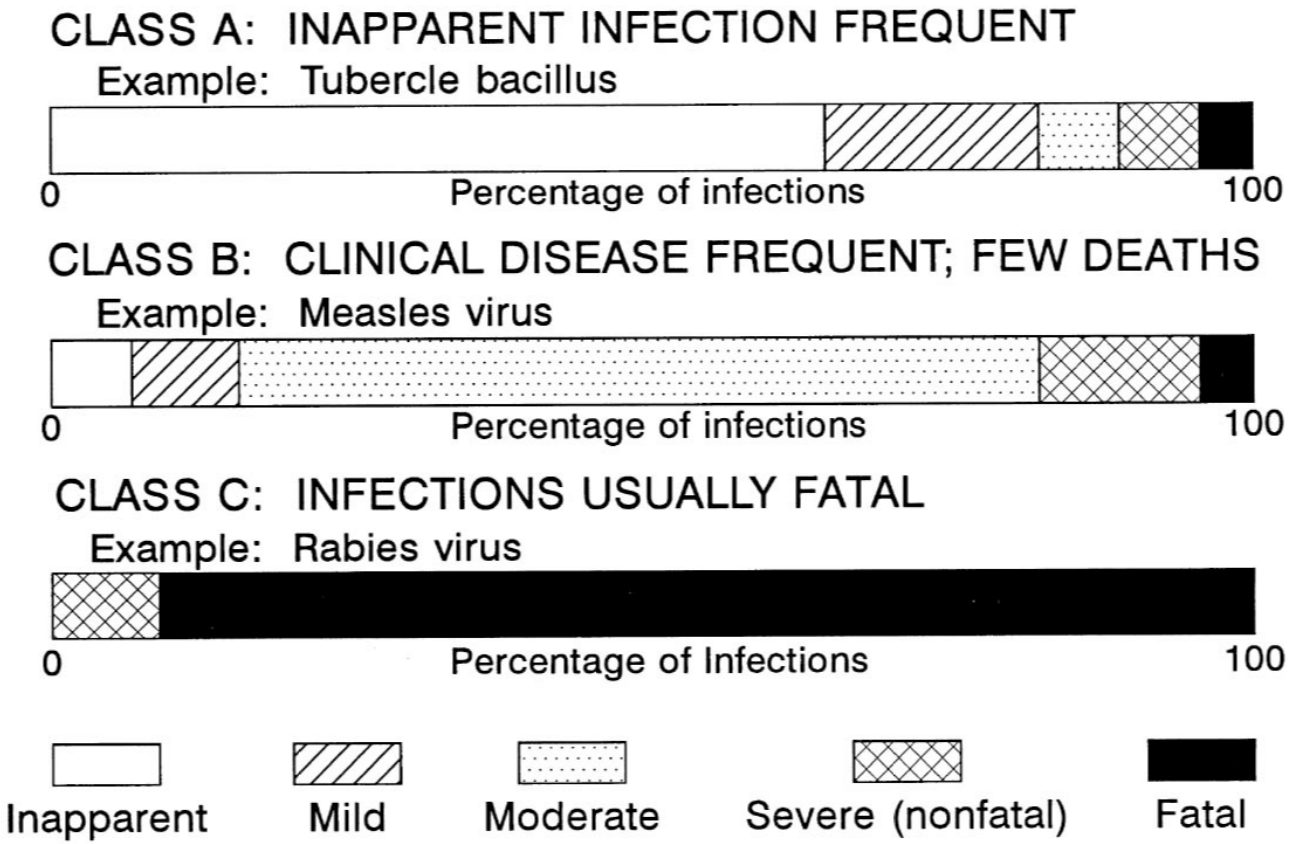
(2) **Pathogenicity = (B+C+D+E) /(A+B+C+D+E) × 100**

- capacity of a microorganism to cause disease.
- proportion of symptomatic cases among infected population.

(3) **Virulence rate, fatality = E /(B+C+D+E) × 100**

- proportion of fatal cases among symptomatic cases.(case-fatality ratio can be used)

Distribution of clinical severity for three classes of infections



COVID-19 Clinical severity

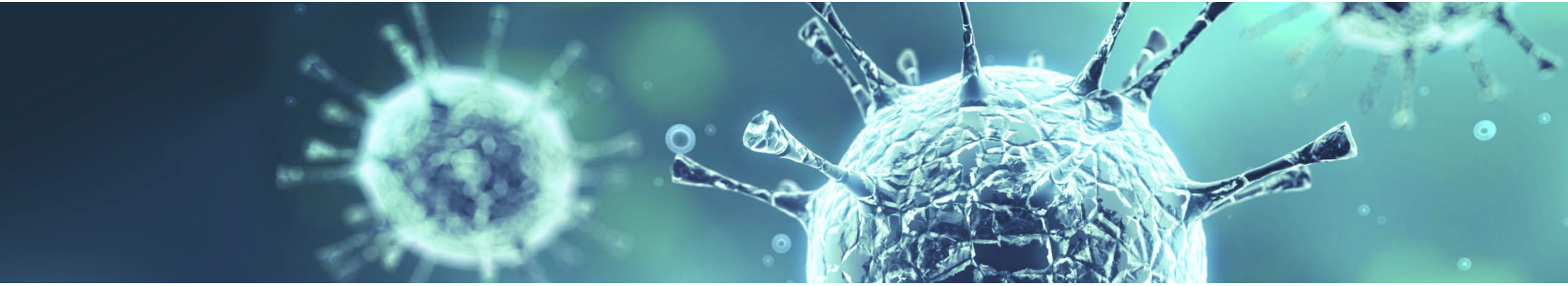
Clinical Diseases Frequent (mostly Mild), Few Deaths (High in old ages)

Inapparent	Mild	Moderate	Severe	Fatal
5-15	75-85	5-15	1-5	2-10

- ✓ Inapparent or Mild: Isolation in treatment center until 3 wks or 2wks after no symptoms
- ✓ Moderate: Treatment with Oxygen therapy in clinic
- ✓ Severe: Treatment with mechanical ventilation(70%) or ECMO(30%) in ICU of hospital

- Moderate criteria: respiratory rate 30+/min, lung infiltration 50%+, <90% oxygen saturation, high risk group, or special situation
- High risk group: 65+years, underlying disease(diabetes, chronic kidney disease, chronic liver disease, chronic lung disease, chronic cardiovascular disease, cancer treatment patient, patient taking immunosuppressants, etc.),
- Special situation: pregnant women, dialysis patients, transplant patients, highly obese patients

COVID-19 Preparedness and Response



Infectious disease control principle

1. Management of pathogen and reservoir
2. Blocking the infection transmission process
3. Management of host

Infectious Disease Control

Management of pathogen and reservoir

- The most obvious way to manage infectious diseases is to remove pathogens, or reservoir, which are necessary for the survival and proliferation of pathogens.
- If an animal is a reservoir, for example, a chicken or duck is a reservoir, or a pig is a reservoir, such as the Nipa virus, it is effective to kill.
- If a person is a reservoir, use a method to reduce the number of reservoir in the general population by promptly discovering patients or carriers and providing appropriate treatment or isolation.

Infectious Disease Control

Blocking the infection transmission process

1. **Quarantine and Isolation**
   - Quarantine (contacts or risk group): From time an infection is suspected to maximum incubation period
   - Isolation (infectious subject): Until transmission is eliminated (until microbes are not discharged).
2. **Sanitary management**
   - Environmental hygiene
   - Food hygiene
   - Personal hygiene

Infectious Disease

Driving Factors of Infectious Disease (ID)

Major:

- Nutritional status, personal hygiene, public sanitation, overall health, social status

Minor:

- Vaccines, health care

Bidirectional causality

- ↑ Poverty → ↑ Prevalence of ID (major and minor reasons above)
- ↑ Prevalence of ID → ↑ Poverty (barriers to physical/mental development ↑ loss of later productivity, mass deaths ↑ loss of parents/teachers/infrastructure)

Infectious Disease

3 Roles of Public Health in Dealing with ID

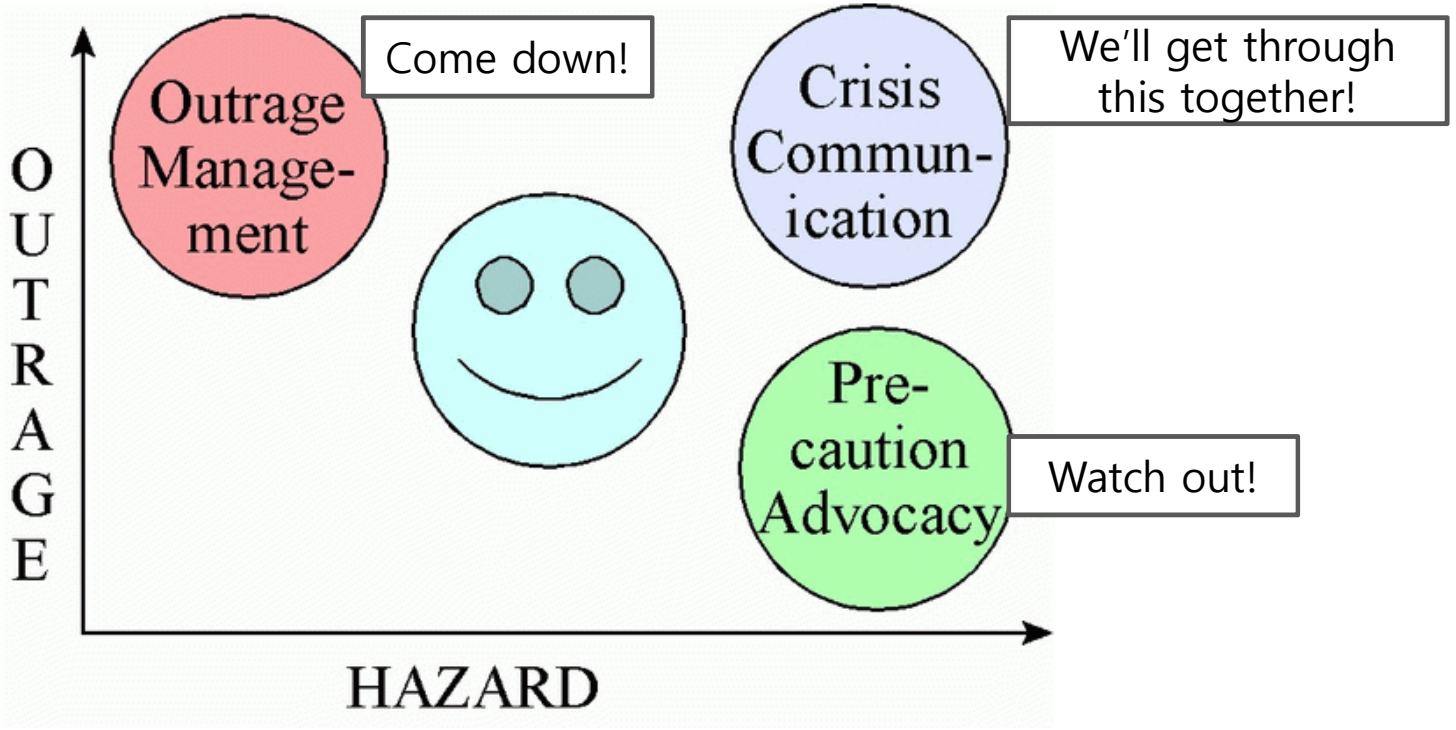
1. **Improving resistance of host**
   - hygiene, nutrition, postexposure prophylaxis , chemoprophylaxis
2. **Improving environmental safety**
   - air quality control, water and food safety, control of vectors and animal reservoirs
3. **Improving public health systems**
   - contact tracing, education, containment, and herd immunity

COVID-19 Preparedness

1. **Improving public health systems:** Health education, clean water, food, basic immunization and healthcare facilities
2. **Universal health coverage :** Anyone can easily and cheaply receive public health system benefits
3. **Law on Communicable Disease Prevention and Control :** surveillance system, center for disease control and prevention, guidelines and training system, etc.
4. **Human resource** – Healthcare workers and Epidemic Intelligence Service Officers
5. **Measures to prevent hospital infections**
6. **Intersectoral coordination/collaboration**: public and private, health officials and experts, and public participation
7. **Risk communication**

Risk Communication

Risk = Hazard + Outrage



https://www.psandman.com/index-intro.htm

Risk Communication

- Need communication experts
- Key message: National infection prevention is completed through the participation of the public
- For medical personnel and you “thanks to” campaign
- Communication considering the vulnerable: interpreter for deaf, picture message, multilingual access, consultation telephone, etc.

Infodemics

Hundreds die in Iran over false belief drinking methanol cures coronavirus

Posted 28 Apr 2020

"We have to both cure the people with alcohol poisoning and also fight the coronavirus."

"This misconception has caused even children to drink alcohol ... which can lead to death and blindness."

abc.net.au/news/2020-04-28/hundreds-dead-in-iran-after-drinking-methanol-to-cure-virus/12192582

Infodemics

River of Grace Community Church sprays saltwater into worshippers' mouths

River of Grace Community Church in Seongnam, Gyeonggi Province, is alleged to have sprayed saltwater into the mouths of people attending church services on March 1 and 8, which may have contributed to the cluster infection of at least 46 people with the novel coronavirus.

http://www.koreaherald.com/view.php?ud=20200316000895

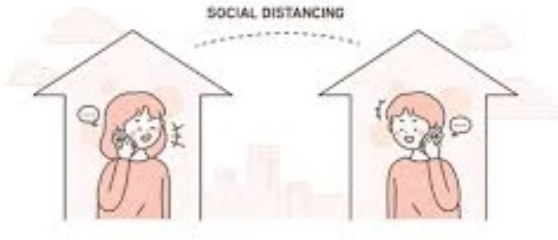
COVID-19 Responses to reduce incidence

- Containment phase: WHO scenario 2. Countries with 1 or more cases, imported or locally detected (Sporadic cases)
  - Personal protection
    - Individual: hand sanitization, cough etiquette, face mask
    - Healthcare personal, symptomatic person: face mask (N95)
  - Environment protection
    - Enhanced disinfection
    - Restriction or Prohibition of use of common items
    - Proper ventilation (preferably natural ventilation)
  - Social protection(Social distancing)
    - Quarantine of contacts(self-isolation), Isolation of patient in hospital
    - Close childcare facilities and schools can be considered when the burden of health care is high
    - Workplace: strengthen personal and environmental hygiene management
    - Group events: cancellations of large-scales or events expected to flow from hazardous areas
    - Traffic movement control: can be considered at an early stage of serious disease with high fatality

COVID-19 Responses to reduce incidence

- Mitigation phase : WHO scenario 3. Countries experiencing cases clusters in time, geographic location and/or common exposure (Clusters of cases); 4. Countries experiencing larger outbreaks of local transmission (Community transmission)
  - Personal protection
  - Environment protection
  - Social protection(Social distancing)
    - **Quarantine of contacts(self-isolation), Isolation of mild patient in treatment center, Isolation of moderate to sever patient in hospital**
    - **Close childcare facilities and schools**
    - **Workplace: c**hange of working hours, Temporary telecommuting, reducing the degree of concentration among employees, reducing face-to-face reporting through video conferencing, minimizing customer face-to-face response, using personal protective equipment during working hours, supporting self-isolation in case of symptomatic case occur, and strengthening environmental hygiene management at the company level
    - **Group events: large events canceled, postpones, and scaled down**
    - Traffic movement control: can be considered at an early stage of serious disease with high fatality

Stop COVID-19 Campaign

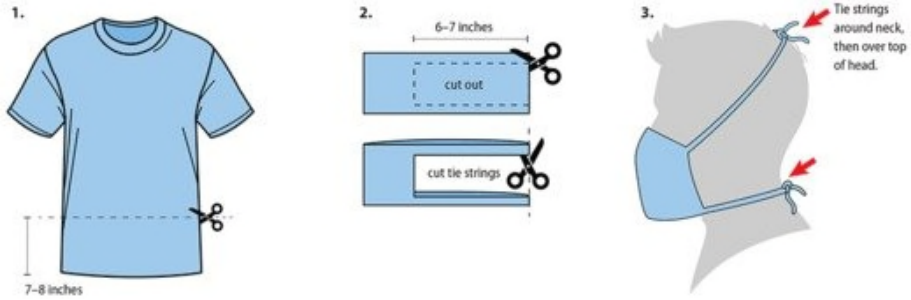


Quick Cut T-shirt Face Covering (no sew method)

Materials

- T-shirt
- Scissors

Tutorial



Personal Protection Face Mask

1918 Flu Pandemic in US

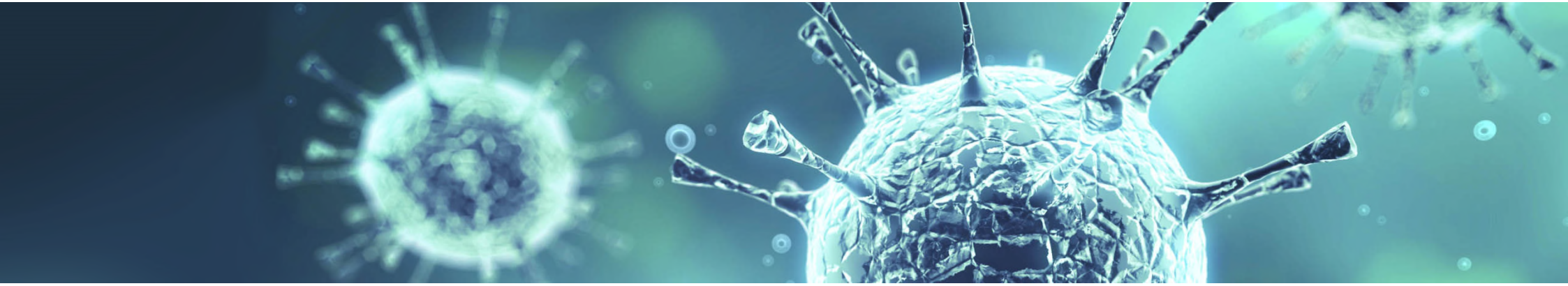
Personal Protection Face Mask

1918 Flu Pandemic in US

마스크를 사기위해 약국앞에 줄을 선 사람들

(1918년 미국)

Using Reproductive No. to reduce cases

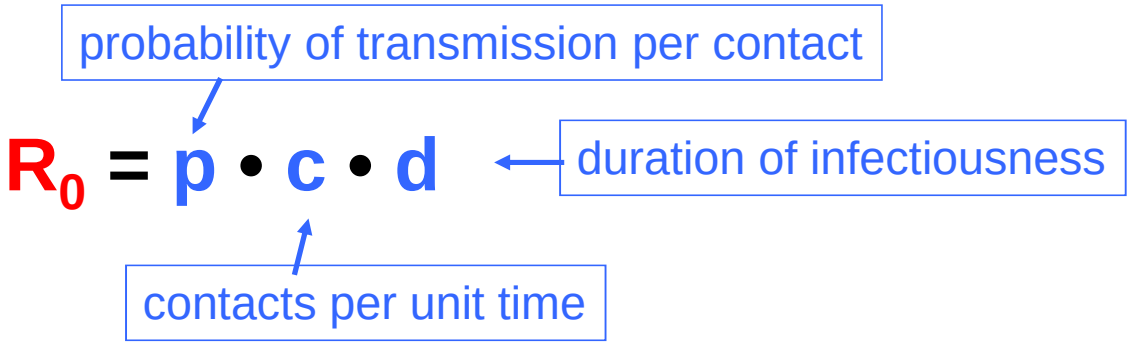


Reproductive rate, R

- Also called “reproductive number”
- Average number of new infections caused by 1 infected individual
- In an entirely susceptible population
  - **Basic reproductive rate, R_0**
- In a population where <100% are susceptible
  - **Effective reproductive rate, R** = proportion susceptible x R_0

Determinants of R_0

For a pathogen with direct person-to-person transmission



$R_0 > 1$ Infection spreads (epidemic)

$R_0 = 1$ Infection remains constant (endemic)

$R_0 < 1$ Infection dies out

What determines R_0 ?

p, transmission probability per exposure – depends on the infection

- ❖ HIV, p(hand shake)=0, p(transfusion)=1, p(sex)=0.001
- ❖ interventions often aim at reducing *p*
  - ❖ use gloves, screene blood, condoms
- ❖COVID-19: Use mask, goggles, or gloves, cough etiquette and physical distancing

c, number of contacts per time unit – relevant contact depends on infection

- ❖ same room, within sneezing distance, skin contact,
- ❖ interventions often aim at reducing *c*
  - ❖ Isolation, sexual abstinence
- ❖COVID-19: Social distancing

d, duration of infectious period

- ❖ may be reduced by medical interventions (TB, but not salmonella)
- ❖COVID-19: Active testing and isolation

Why develop a mathematical model?

- To understand the system of transmission of infections in a population
- To help interpret observed epidemiological trends
- To identify key determinants of epidemics
- To guide the collection of data
- To forecast the future direction of an epidemic
- To evaluate the potential impact of an intervention

Types of transmission models

- Deterministic/compartmental
  - SIR model example
  - Categorize individuals into broad subgroups or "compartments"
  - Describe transitions between compartments by applying average transition rates
  - Aim to describe what happens "on average" in a population
  - Results imply epidemic will always take same course
- Probabilistic/stochastic (Monte Carlo, Markov Chain)
  - Incorporates role of chance and variation in parameters
  - Provides range of possible outcomes
  - Particularly relevant for small populations and early in epidemic
- Main challenge for both types of models? Good data for transmission parameters!

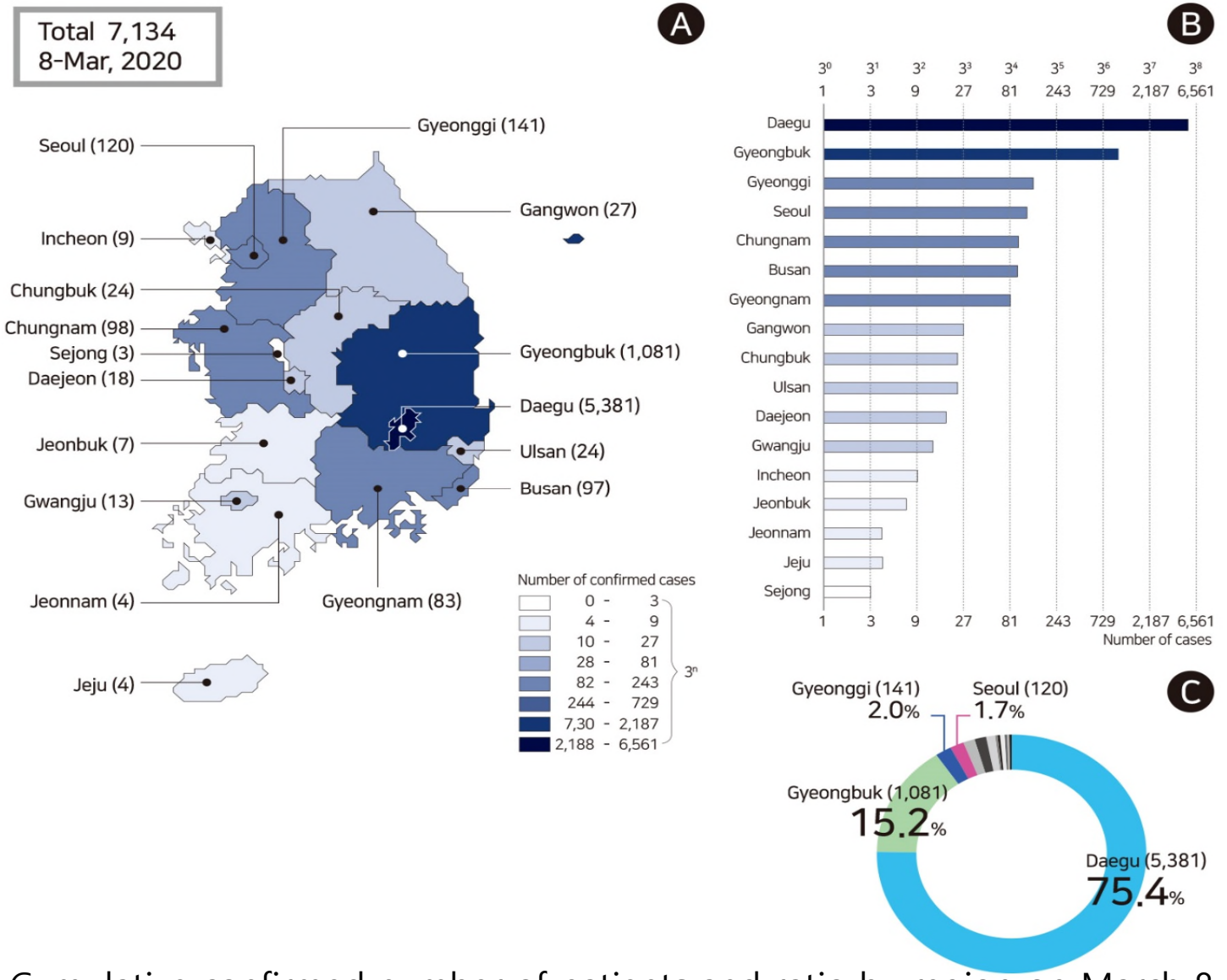
Deterministic SEIHR model for novel coronavirus disease (COVID-19). Susceptible (S), Exposed (E), Symptomatic Infectious (I), Hospitalized (H), and Recovered or Death (R).

Equation 1. Differential equation for population changes over time in deterministic SEIHR model for novel coronavirus disease (COVID-19)

$$\frac{dS}{dt} = -\beta \frac{I}{N} S,$$
$$\frac{dE}{dt} = \beta \frac{I}{N} S - \kappa E,$$
$$\frac{dI}{dt} = \kappa E - \alpha I,$$
$$\frac{dH}{dt} = \alpha I - \gamma H$$
$$\frac{dR}{dt} = \gamma H,$$
$$N = S + E + I + H + R.$$

DOI: https://doi.org/10.4178/epih.e2020011

Cumulative Number of COVID 19 (Korea)



Cumulative confirmed number of patients and ratio by region on March 8.
Gyeongbuk is North Gyeongsang Province

Parameters of the novel coronavirus disease (COVID-19) transmission model in South Korea

Symbol	Description	Value	Reference
β	Transmission rate	0.1389	data fitted
κ	Progression rate	1/4	[4]
α	Isolation rate	1/4	[4]
γ	Removal rate for isolated individuals	1/14	[4]

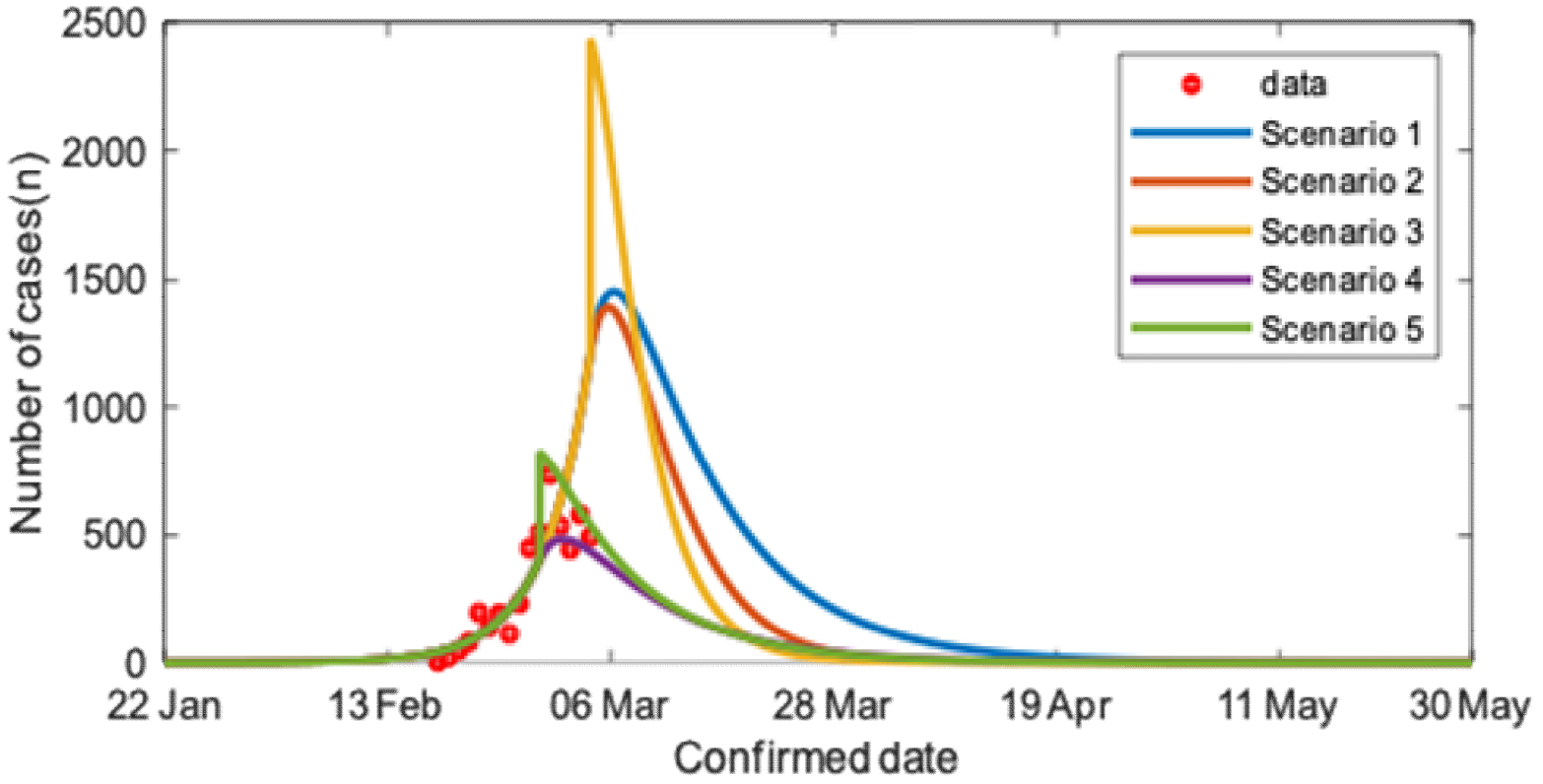
* The transmission rate has been estimated from the early stage COVID-19 epidemic model in South Korea from the Results section.

Estimated changes in the peak and size of novel coronavirus disease (COVID-19) epidemic according to the effect of preventive measures using mathematical modeling in Daegu and North Gyeongsang Province, 2020

Scenario	Preventive Measures			Peak Day	Confirmed case at peak day (n)	Less than 10 confirmed case per day (date)	Less than 1 confirmed case per day (date)	Total confirmed case (n)*
	Effect start date	Transmission duration ($1/\alpha$)	Transmission rate (β) reduction					
Base	None	4 days	0	April 5	22,389	June 14	June 28	4,992,000
1	March 5	4 days	90%	March 7	1,454	April 27	May 20	26,634
2	March 5	4 days	99%	March 6	1,390	April 5	April 16	19,426
3	March 5	2 days	99%	March 5	2,425	March 30	April 08	19,403
4	February 29	4 days	90%	March 2	485	April 12	May 04	8,894
5	February 29	2 days	75%	February 29	819	April 10	May 01	10,249

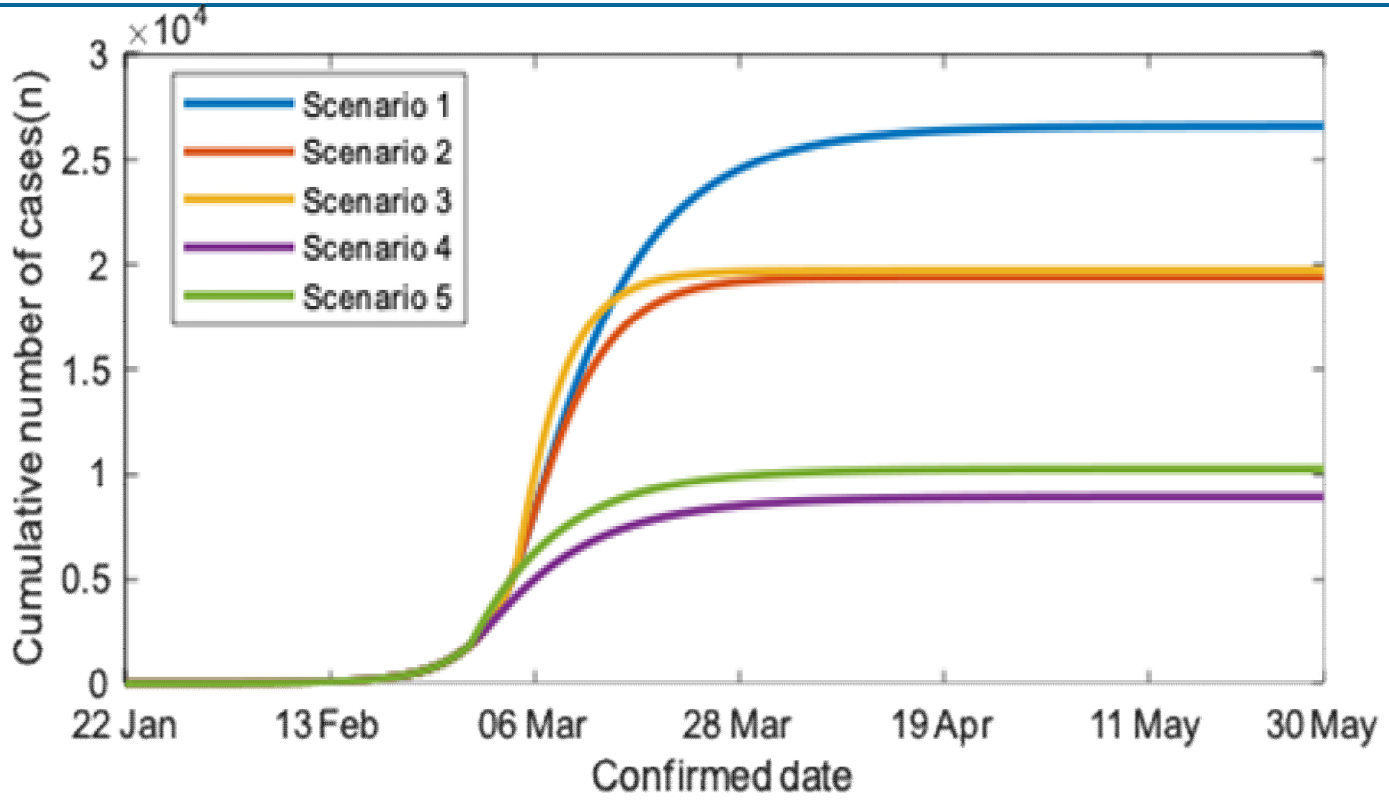
* Cumulative number of confirmed patients to less than one confirmed case per day

Estimated Number of COVID 19 (Daegu&, North Gyeongsang Province, Korea)



Estimated daily number of confirmed patients by scenario in Daegu and North Gyeongsang Province. See the table 2 for scenarios. Number of cases (red dots) and model fitting curves (colored lines)

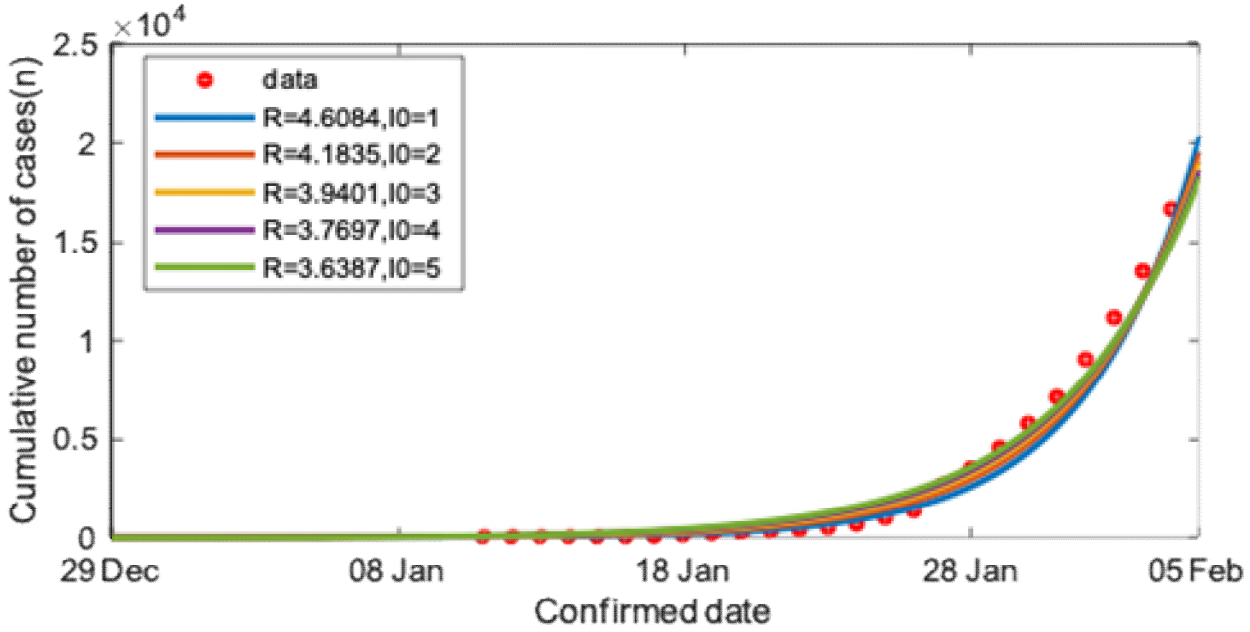
Estimated Number of COVID 19 (Daegu&, North Gyeongsang Province, Korea)



Estimated number of cumulative confirmed patients by scenario in Daegu and North Gyeongsang Province. See the table 2 for scenarios.

Reproductive Number of COVID 19 (Hubei, China)

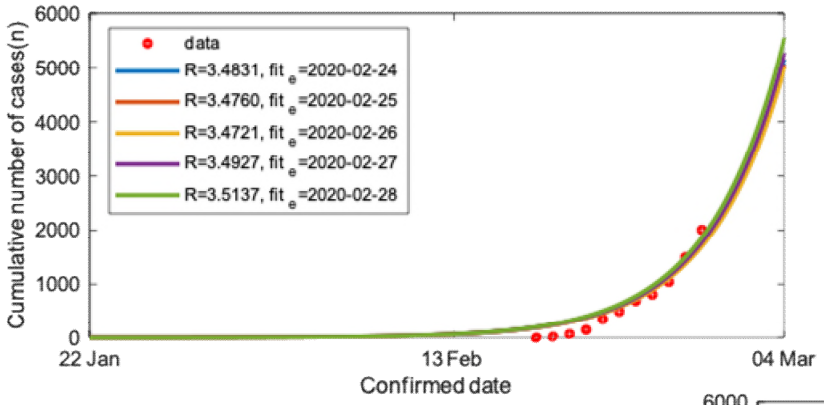
R = 3.6~4.6

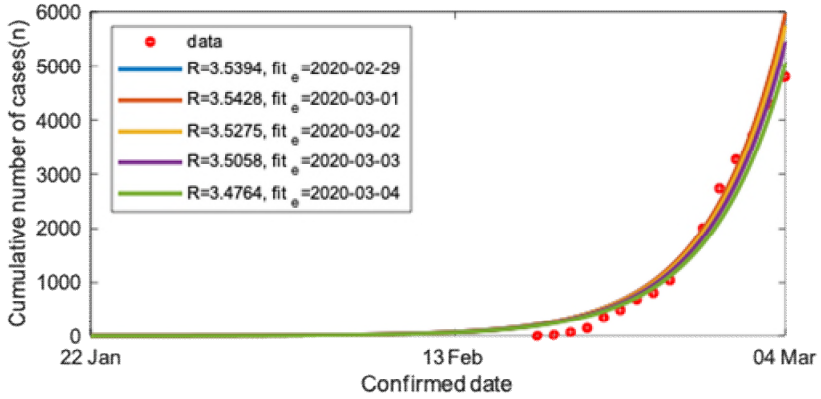


Estimated reproductive number by daily cumulative reported patients with COVID-19 in Hubei Province, China. The number of infected patients on December 29, 2019 was assumed as 1 to 5. Cumulative number of cases (red dots) and model fitting curves (colored lines)

Reproductive Number of COVID 19 (Daegu&, North Gyeongsang Province, Korea)

R ~ 3.5

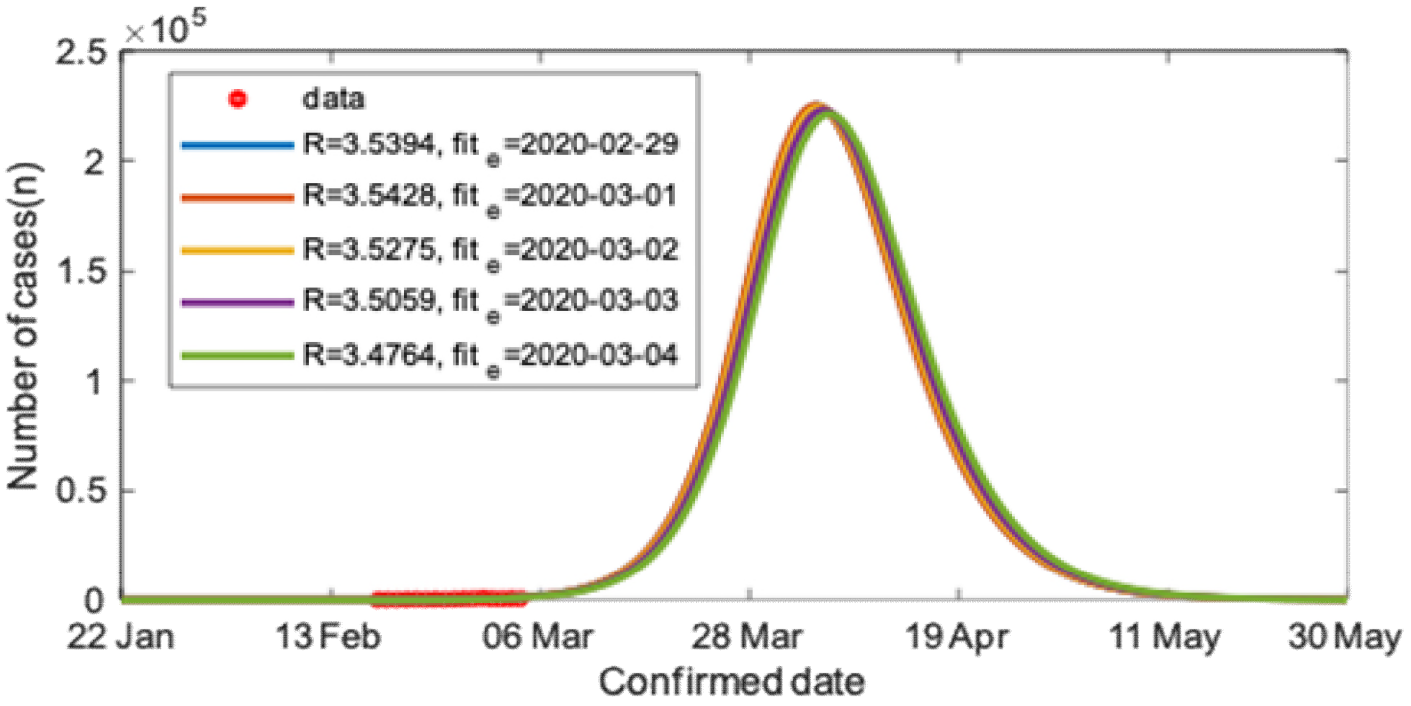




Estimated reproductive number by daily cumulative confirmed patients in Daegu and North Gyeongsang Province from February 18 to March 4. The first patient was assumed to have been infected on January 22. The fit_e refers to the last date of the model fitting. Cumulative number of cases (red dots) and model fitting curves (colored lines)

Reproductive Number of COVID 19 (Daegu&, North Gyeongsang Province, Korea)

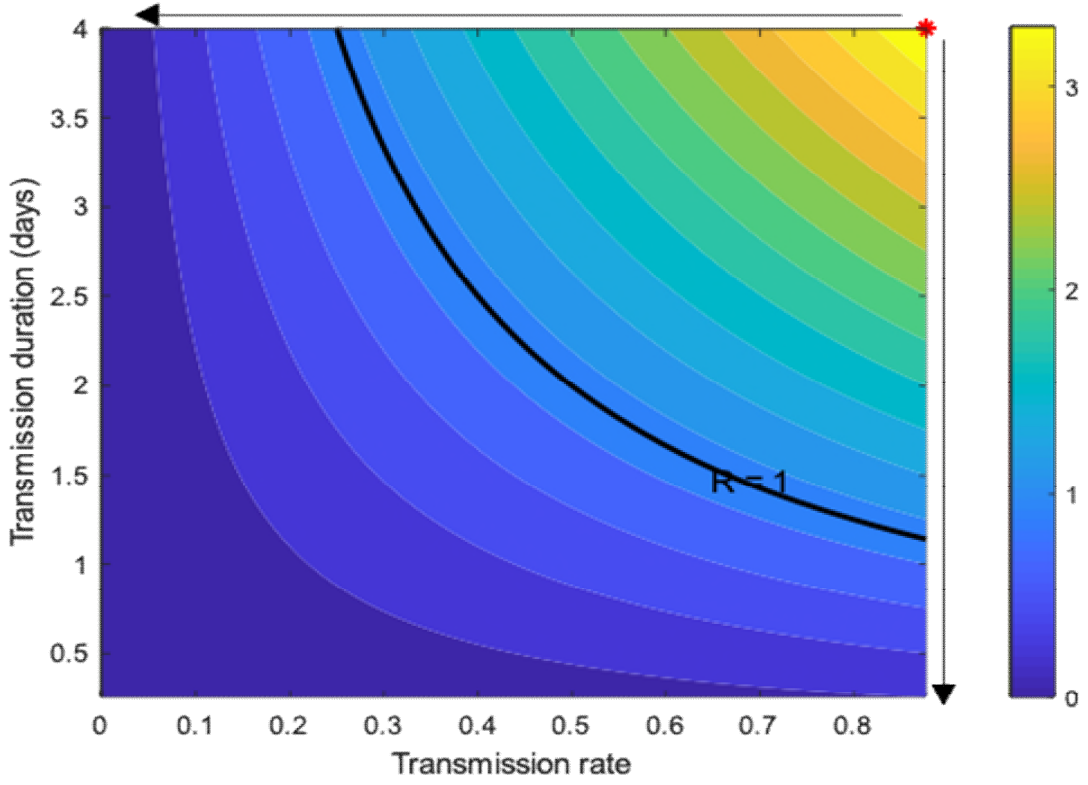
R ~ 3.5



Estimated reproductive number (R) and daily number of confirmed patients in Daegu and North Gyeongsang Province at base scenario which means no preventive measures. R varies with fitting period. Number of cases (red dots) and model fitting curves (colored lines)

Reproductive Number of COVID 19 (Korea)

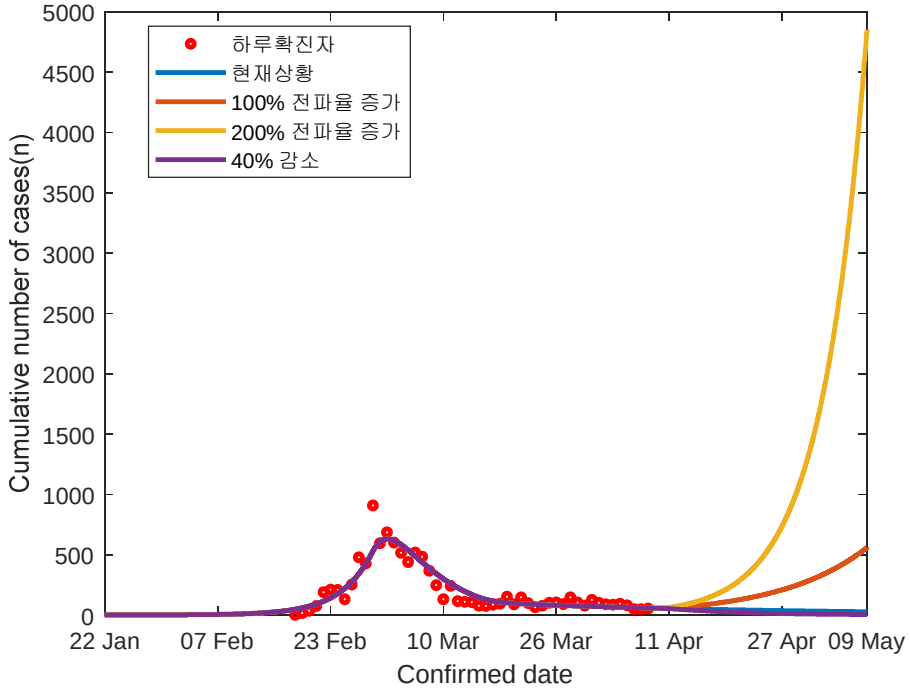
R ~ 3.5



A contour map of the reproductive number (R) as transmission rate and transmission duration changes. R=3.5 (red spot) and R=1 (black line).

COVID-19 Simulation1: ↓ Social distancing, ↑ transmission rate

Method: If early stage of COVID-19(2/18-2/28) transmission rate=β ,
Scenario 1. Keep the current situation: β *0.25 (75% decrease in the transmission rate compared to the early stage)
Scenario 2. ↑ 25% : β *0.5 (50% decrease in the transmission rate compared to the early stage , 100% increase over current
Scenario 3. ↑ 50% : β *0.75 (25% decrease in the transmission rate compared to the early stage , 200% increase over current)
Scenario 4. ↓ 90%: β *0.1 (with additional effort, 90% decrease in the transmission rate compared to the early stage , 40% decrease to current .)

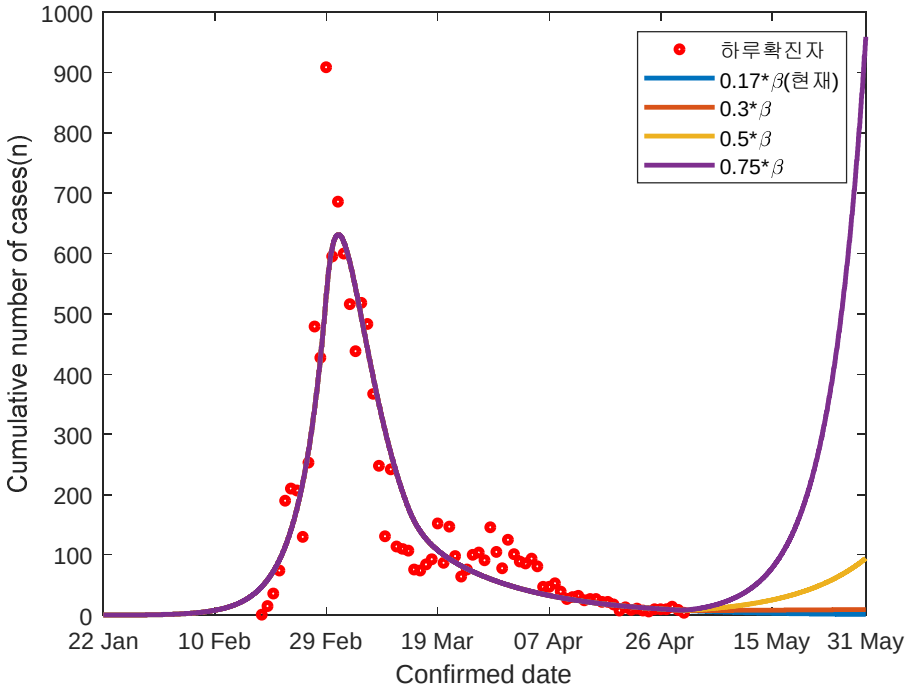


* Early stage of COVID-19(2/18-2/28) **R=3.5309**

Scenario	Transmission rate (β)	R	After 2wks, daily no. of cases (Cumulative no) (2020-04-23)	After 1-month, daily no. of cases (Cumulative no) (2020-05-09)
1	present	0.8103	40 (11091)	27 (11565)
2	↑ 100%	1.7654	150 (11743)	559 (16883)
3	↑ 200%	2.6481	396 (12866)	4854 (43569)
4	↓ 40%	0.3531	17 (10906)	3 (10989)

COVID-19 Simulation2: ↓ Social distancing, ↑ transmission rate

Method: If early stage of COVID-19(2/18-2/28) transmission rate=β ,
Scenario 1. Keep this current situation, β *0.17 (84% decrease in the transmission rate compared to the early stage)
Scenario 2. ↑ **14**% : β *0.3 (70% decrease in the transmission rate compared to the early stage)
Scenario 3. ↑ **34**% : β *0.5 (50% decrease in the transmission rate compared to the early stage)
Scenario 4. ↑ **59**%: β *0.75 (25% decrease in the transmission rate compared to the early stage)



* **E**arly stage of COVID-19(2/18-2/28) **R=3.5309**

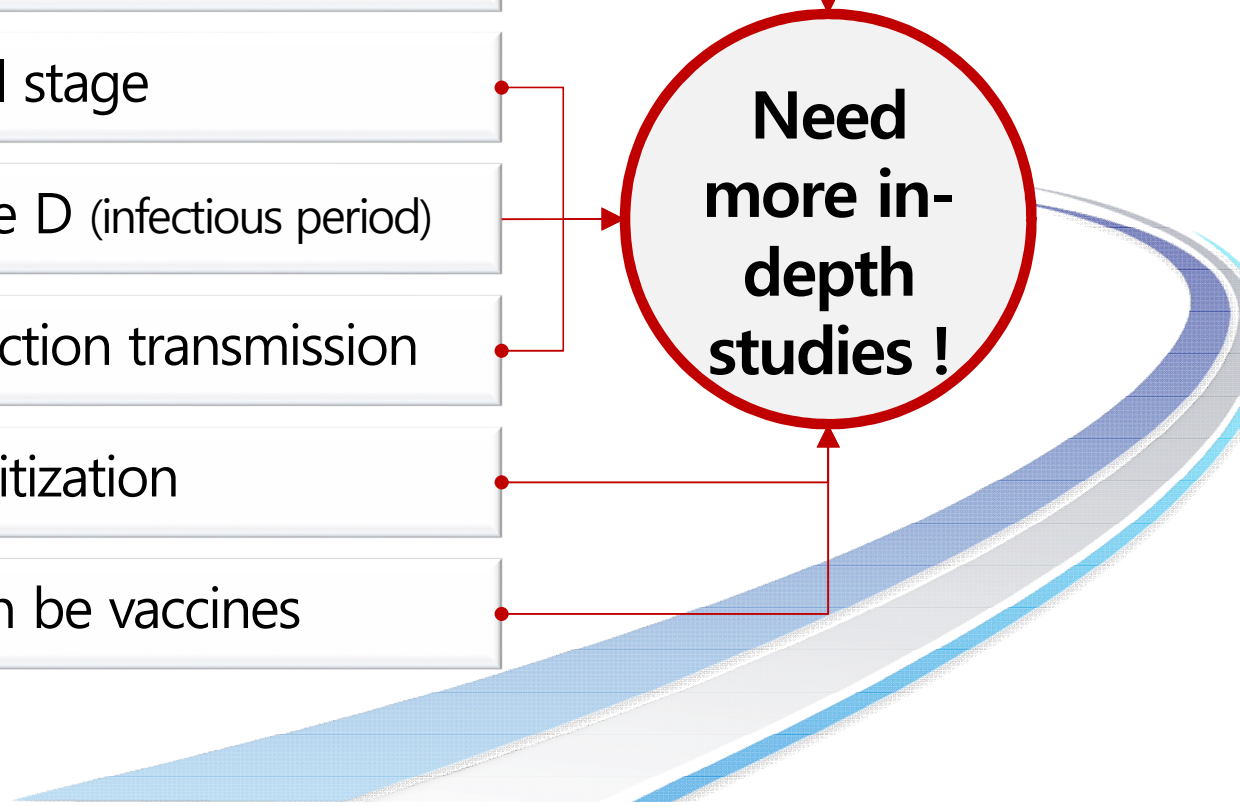
Scenario	Transmission rate (β)	R	After 2wks, daily no. of cases (Cumulative no) (2020-05-14)	After 1-month, daily no. of cases (Cumulative no) (2020-05-31)
1	β *0.17	0.58	3 (10809)	1 (10845)
2	β *0.3	1.06	7 (10835)	8 (10968)
3	β *0.5	1.77	18 (10890)	71 (11566)
4	β *0.75	2.65	43 (11003)	621 (14985)

2020/01/20 – 05/09

Summary

Summary

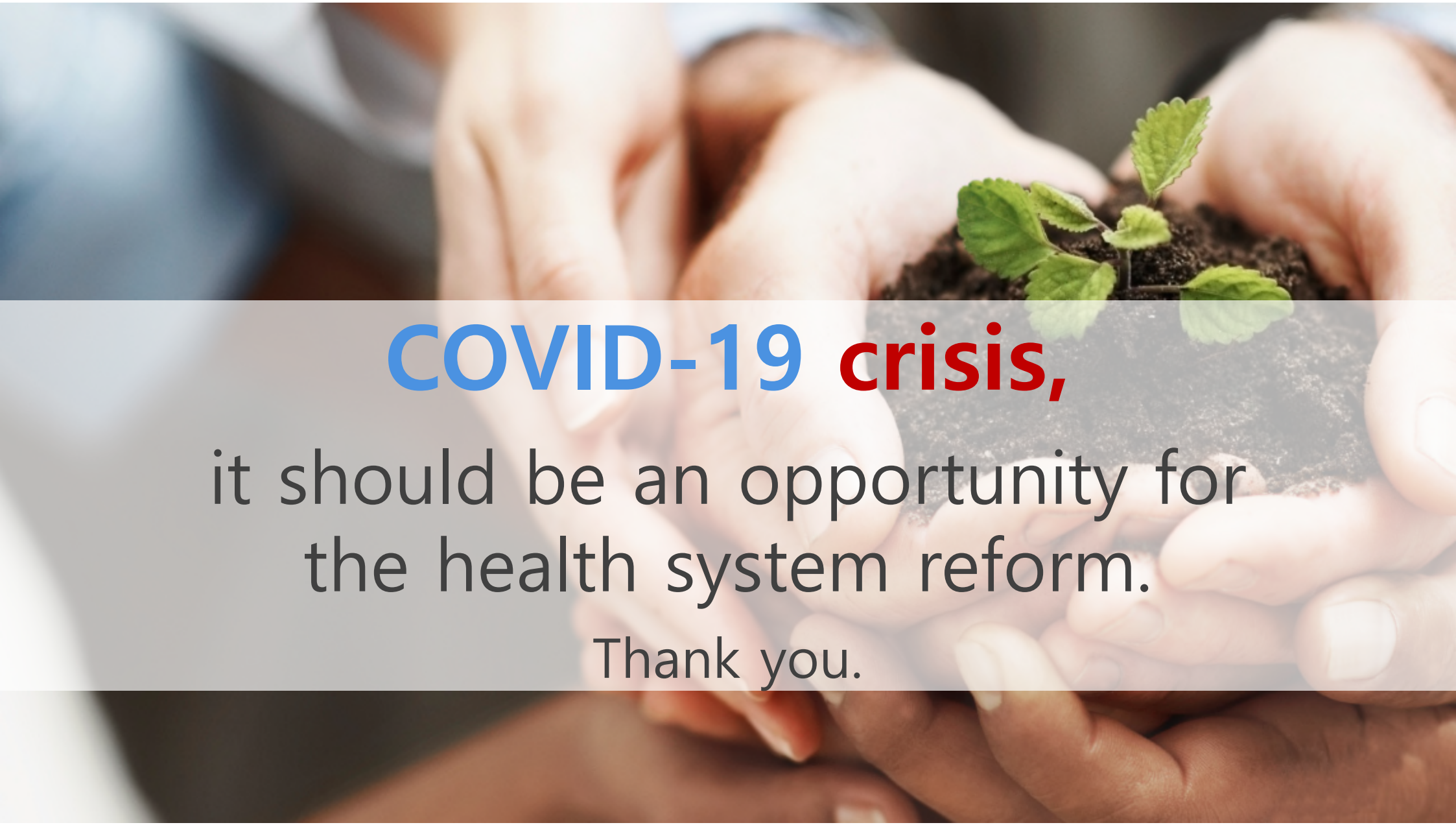
- Highly infectious in close contacts (R, 3-4)
- Highly fatal in old ages (20-30% in 80+)
- Transmission during subclinical stage
- Trace, Test and isolation reduce D (infectious period)
- Social distancing can stop infection transmission
- Keep face mask and hand sanitization
- Cheering and encouraging can be vaccines



COVID-19 Crisis

Issues

- Review and revise the surveillance system and guideline for the healthcare facilities : efficient patient management.
- Revision of the Act to preparedness and response to infectious disease : privacy and social protection
- Strategies for reducing crowding problem in long-term care facilities, religious facilities, entertainment facilities, and schools
- Development of human resources and policy evaluation system
- Risk communication and international solidarity


COVID-19 crisis,
it should be an opportunity for
the health system reform.
Thank you.