Onehealth.or.kr

Surveillance and its applications

Evaluation of syndromic-based sentinel surveillance of infectious diseases

Sukhyun Ryu, MD, PhD

ONE HEALTH Lab
with Computational Epidemiology

CATHOLIC UNIVERSITY OF KOREA
가톨릭대학교
THE CATHOLIC UNIVERSITY OF KOREA

10 Sept 2025

1. Surveillance

2. Evaluation

1. Surveillance

2. Evaluation

1. Surveillance

Public health surveillance is the continuous, systematic collection, analysis and interpretation (with result dissemi nation) of health-related data for action.

https://www.who.int/westernpacific/emergencies/surveillance

1. Surveillance

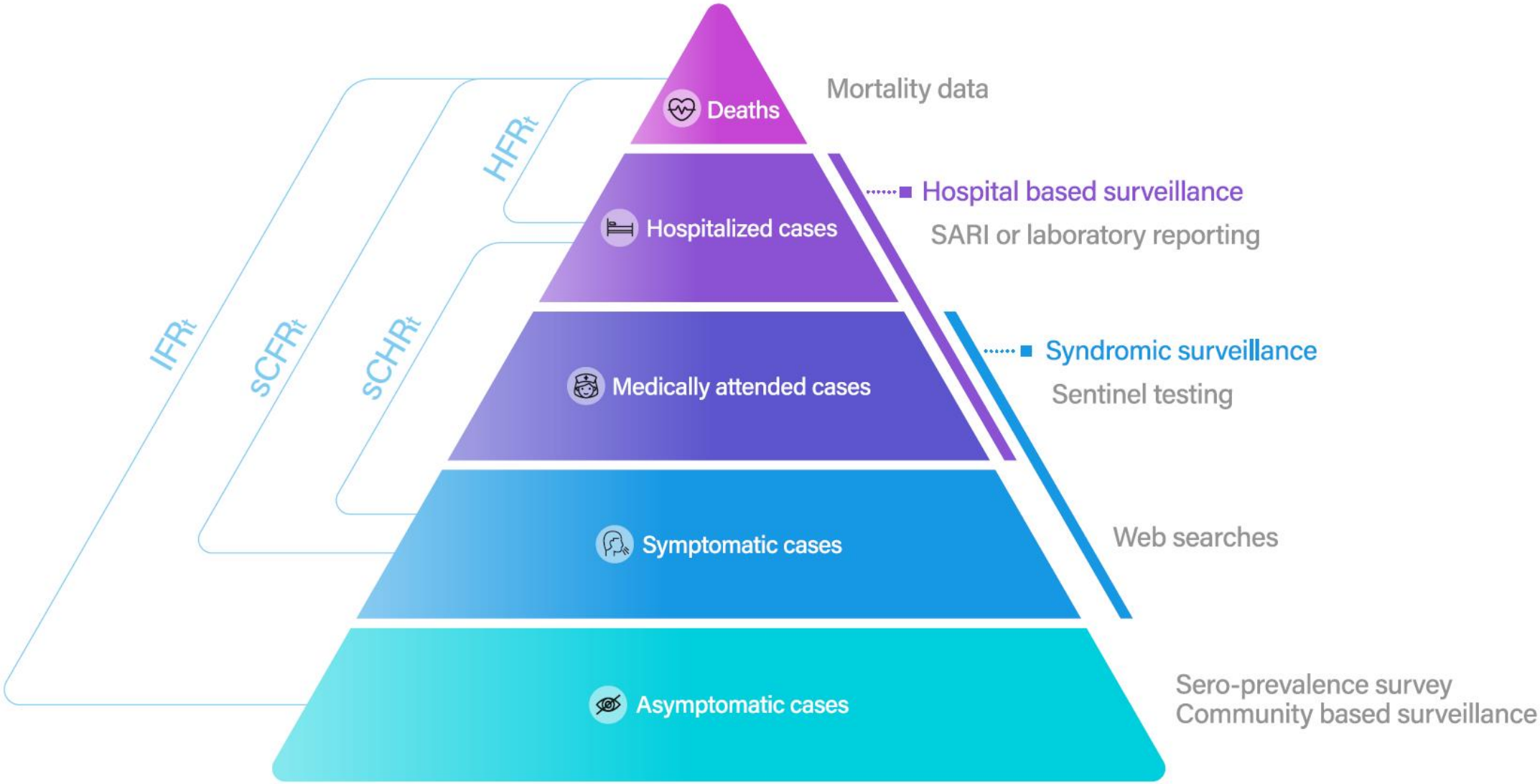
The goals of infectious disease surveillance are

- ① to describe the burden and epidemiology of disease,
- ② to monitor trends,
- ③ to identify outbreaks and new pathogens.

Murry J, et al. 2017 International Encyclopedia of Public Health.

1. Surveillance

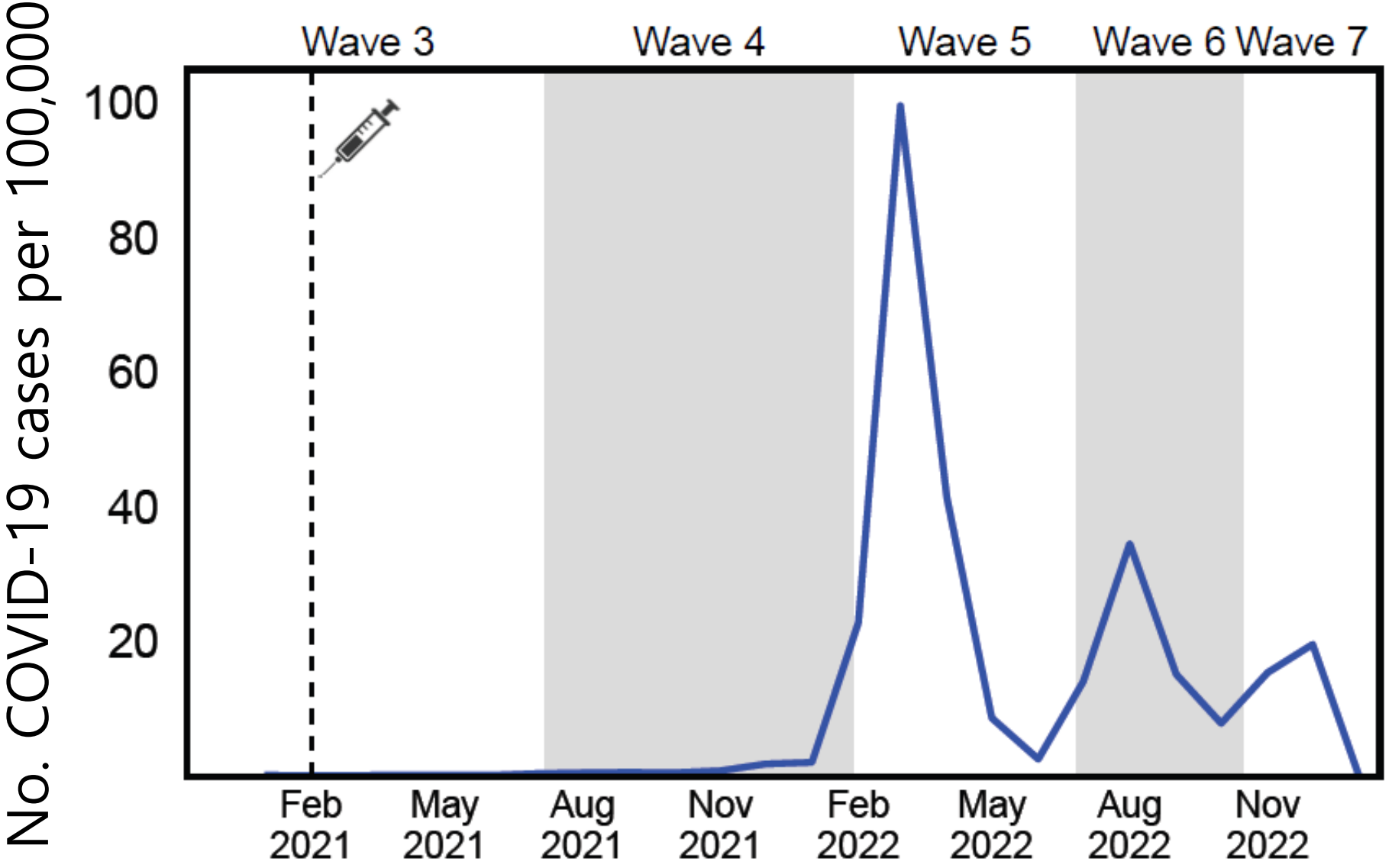
① to describe the burden and epidemiology of disease



Ryu S, et al. 2023. Viruses.

1. Surveillance

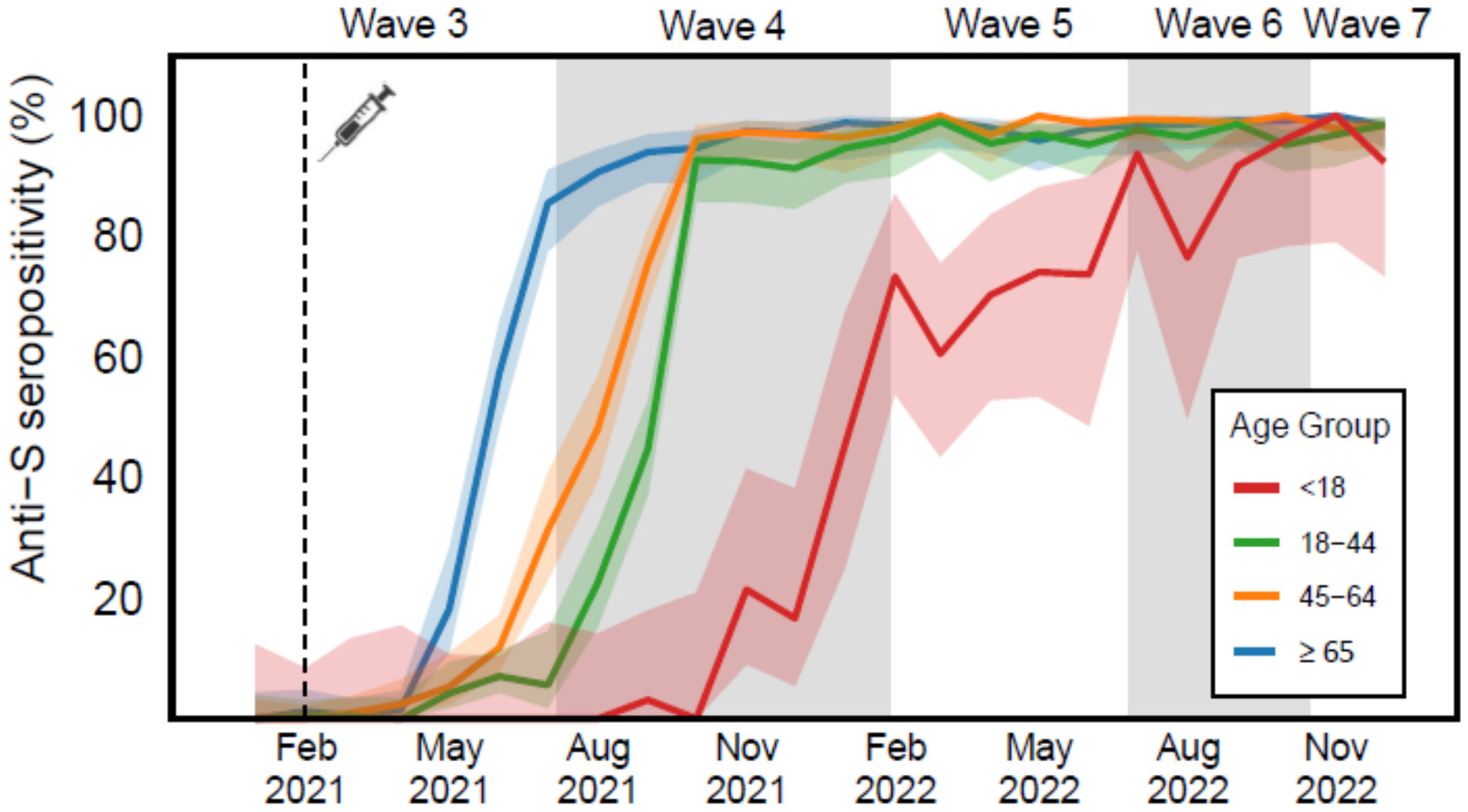
① to **describe the burden** and epidemiology of disease



Kim AR, et al. 2025 IORV

1. Surveillance

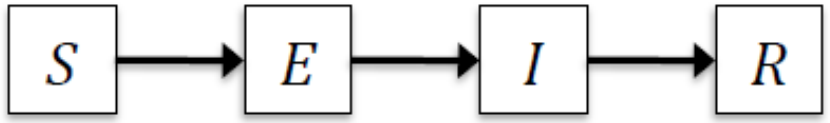
① to **describe the burden** and epidemiology of disease

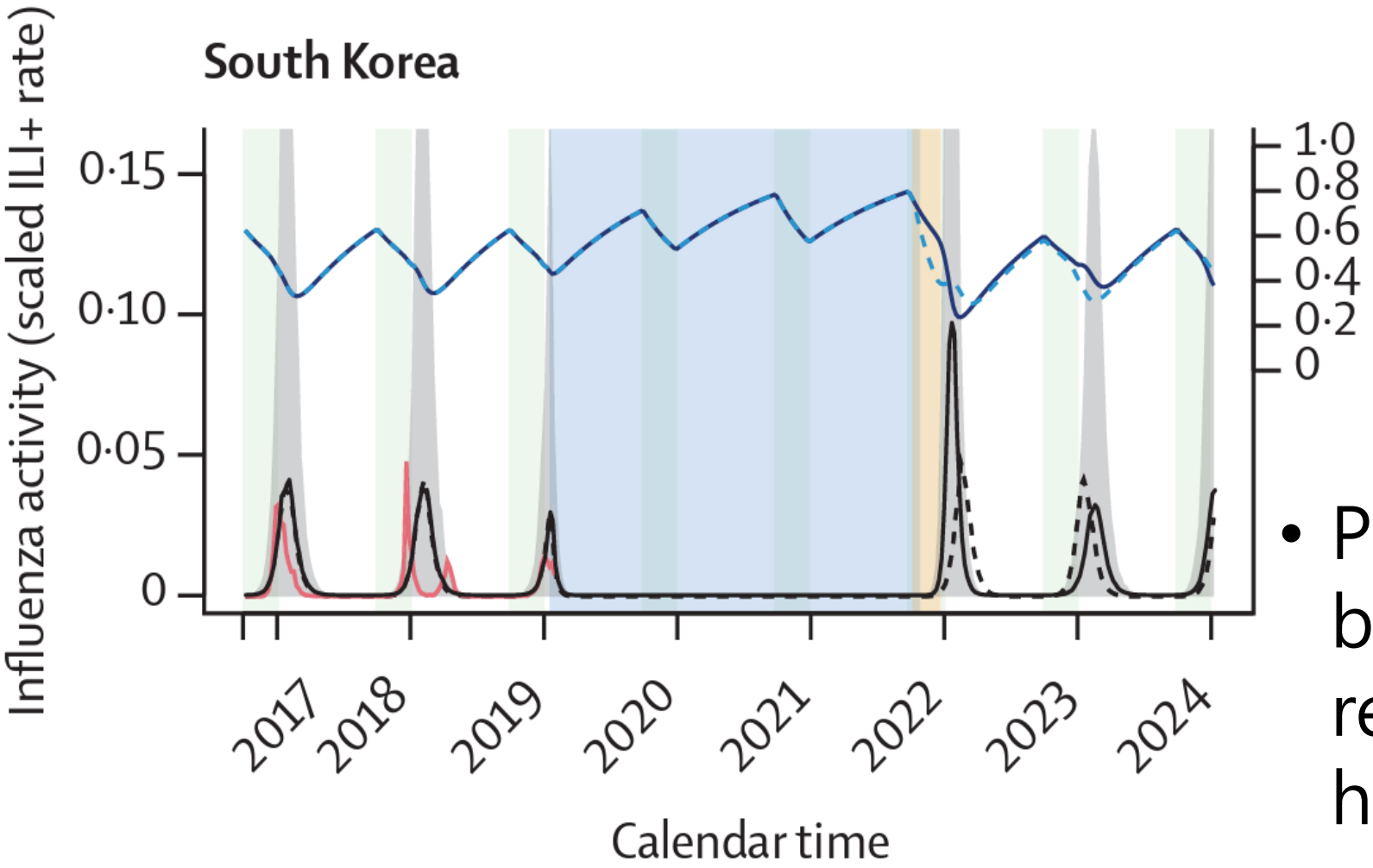


Kim AR, et al. 2025 IORV

1. Surveillance

① to **describe the burden** and epidemiology of disease



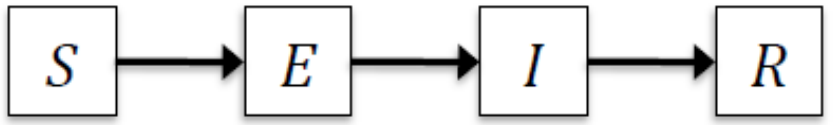


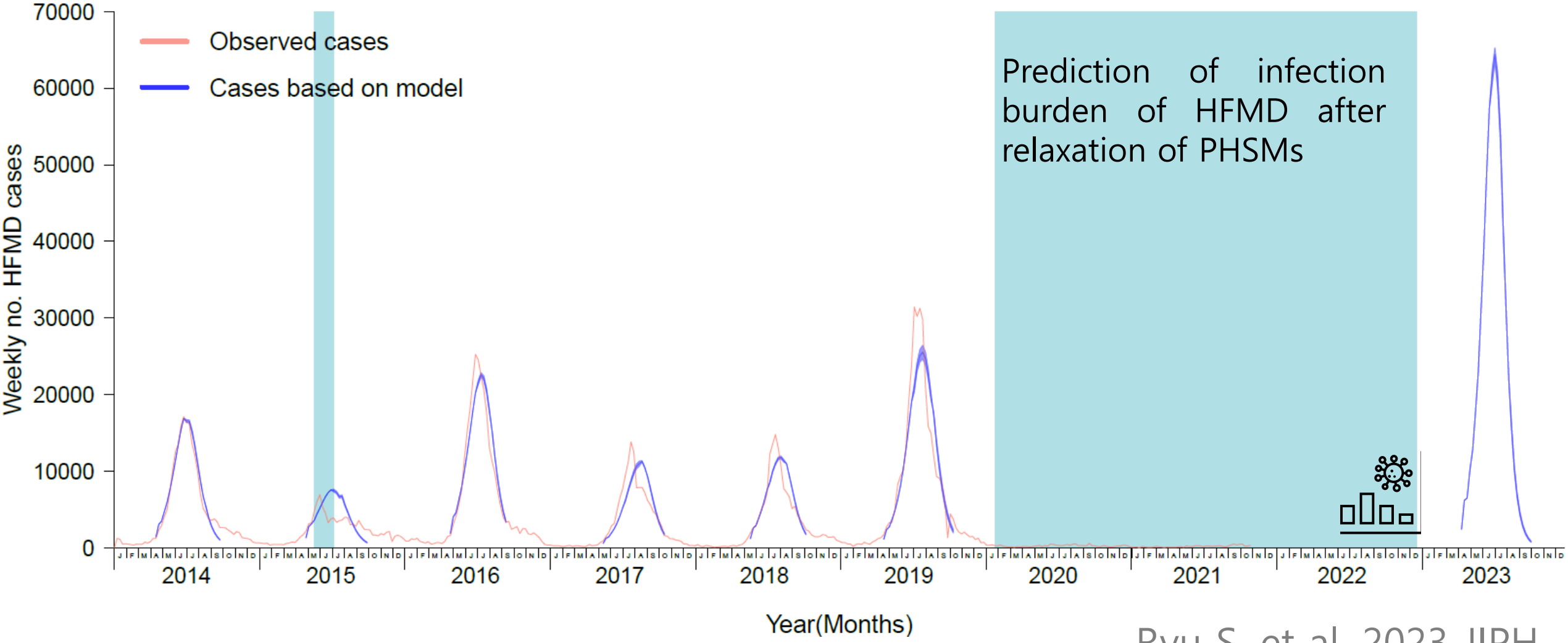
- Prediction of infection burden of influenza after relaxation of public health and social measures

Ali ST, et al. 2022 Lancet Global Health

1. Surveillance

① to **describe the burden** and epidemiology of disease

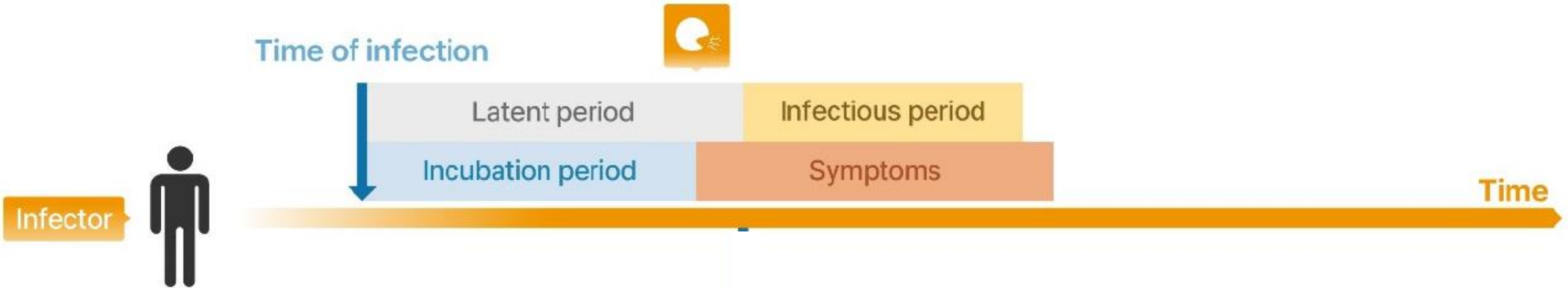




Ryu S, et al. 2023 JIPH

1. Surveillance

① to describe the burden and **epidemiology of disease**



Ryu S, et al. 2022. Viruses.

1. Surveillance

① to describe the burden and **epidemiology of disease**

Line list of lab-confirmed cases in Busan city

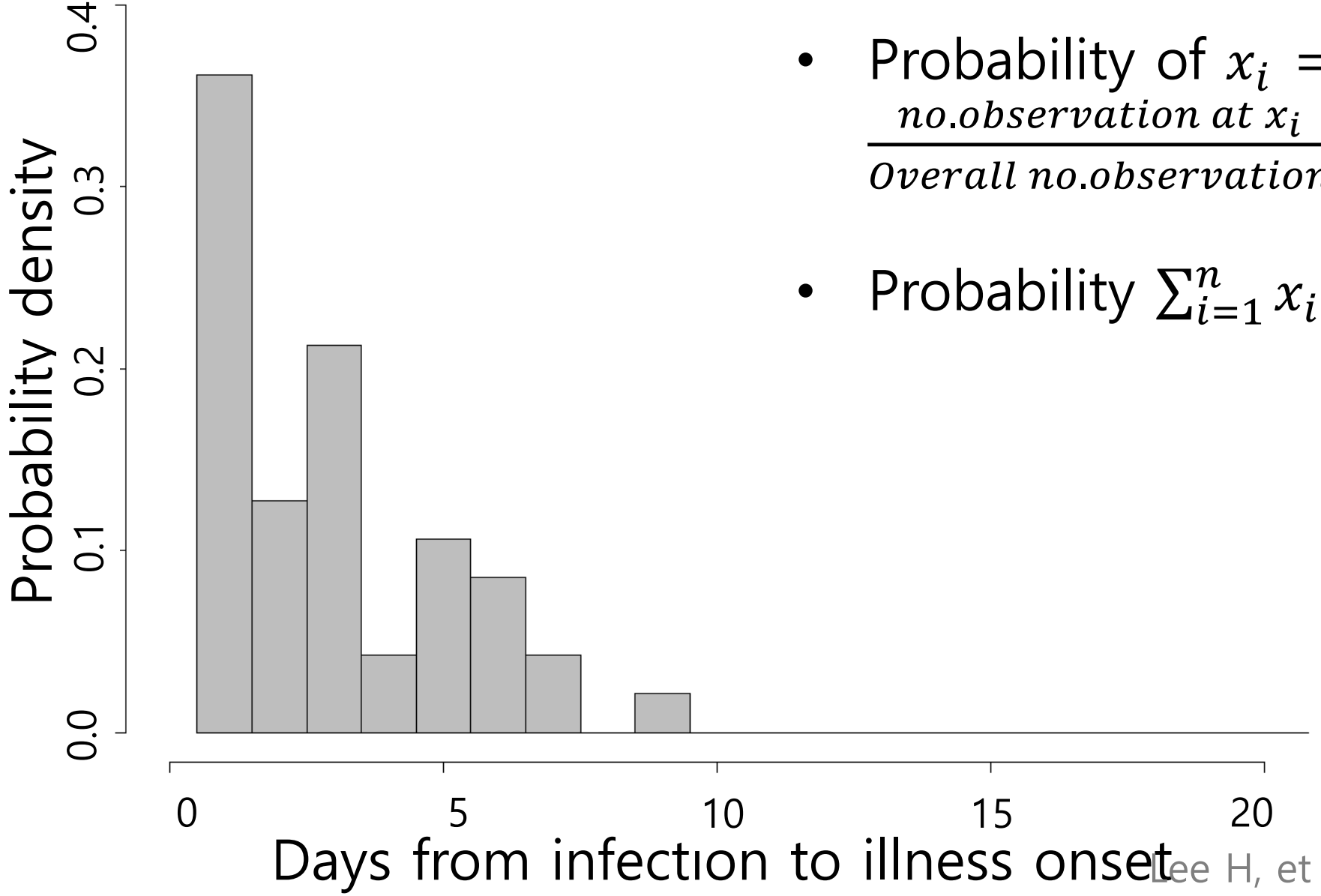
ase n	Exp_date_min	Exp_date_max	Symptom onset	Date of confirm	Type of symptom
1		19 Feb 2020	21 Feb 2020	21 Feb 2020	fever, headache
2	17 Feb 2020	18 Feb 2020	21 Feb 2020	21 Feb 2020	cough, chill
3		16 Feb 2020	21 Feb 2020	22 Feb 2020	headache
4		18 Feb 2020	19 Feb 2020	22 Feb 2020	
5	17 Feb 2020	19 Feb 2020	20 Feb 2020	22 Feb 2020	
6	17 Feb 2020	19 Feb 2020	21 Feb 2020	22 Feb 2020	chill
7	12 Feb 2020	21 Feb 2020	NA	22 Feb 2020	
8		19 Feb 2020	20 Feb 2020	22 Feb 2020	cough, sore throat
9	20 Feb 2020	21 Feb 2020	21 Feb 2020	22 Feb 2020	sore throat
10		18 Feb 2020	19 Feb 2020	22 Feb 2020	feverile sense, cough, sputum,headacl
11		17 Feb 2020	18 Feb 2020	22 Feb 2020	sore throat
12		16 Feb 2020	21 Feb 2020	22 Feb 2020	muscle ache, facial flushing
13	13 Feb 2020	15 Feb 2020	17 Feb 2020	22 Feb 2020	feverile sense, cough, chill, sore throat
14		19 Feb 2020	20 Feb 2020	22 Feb 2020	cough, feverile sense
15	15 Feb 2020	16 Feb 2020	21 Feb 2020	22 Feb 2020	feverile sense, cough
16		19 Feb 2020	20 Feb 2020	22 Feb 2020	feverile sense
17		NA	22 Feb 2020	23 Feb 2020	chill, muscle ache, headache
18	13 Feb 2020	15 Feb 2020	21 Feb 2020	23 Feb 2020	
19		21 Feb 2020	NA	23 Feb 2020	
20		17 Feb 2020	20 Feb 2020	23 Feb 2020	chill, feverile sense
21	14 Feb 2020	16 Feb 2020	NA	23 Feb 2020	
22	14 Feb 2020	16 Feb 2020	19 Feb 2020	23 Feb 2020	feverile sense, cough, sore throat, mu
23		21 Feb 2020	23 Feb 2020	23 Feb 2020	muscle ache, facial flushing
24		16 Feb 2020	22 Feb 2020	23 Feb 2020	feverile sense, muscle ache
25		19 Feb 2020	22 Feb 2020	23 Feb 2020	headache, chill, feverile sense

Sheet1 | 경기_가평 | 경기_과천 | 경기_광주 | 경기_성남 | 경기_구리 | 경기_김포

Lee H, et al. 2020. J Infect Chemo

1. Surveillance

① to describe the burden and **epidemiology of disease**

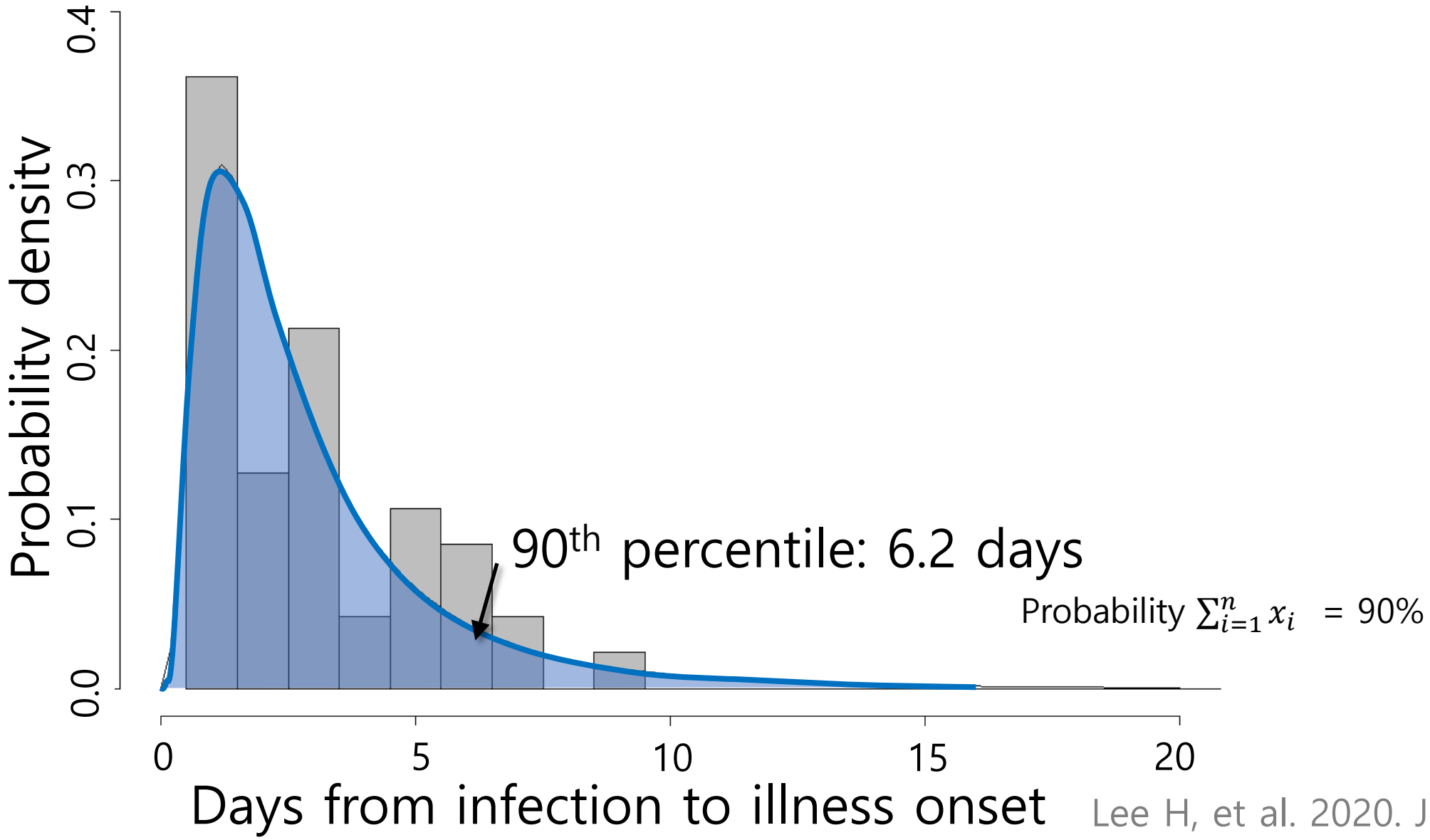


- Probability of x_i = $\frac{no.observation\ at\ x_i}{Overall\ no.observation}$ x 100%
- Probability $\sum_{i=1}^{n} x_i$ = 100% (i.e., 1)

Lee H, et al. 2020. J Infect Chemo

1. Surveillance

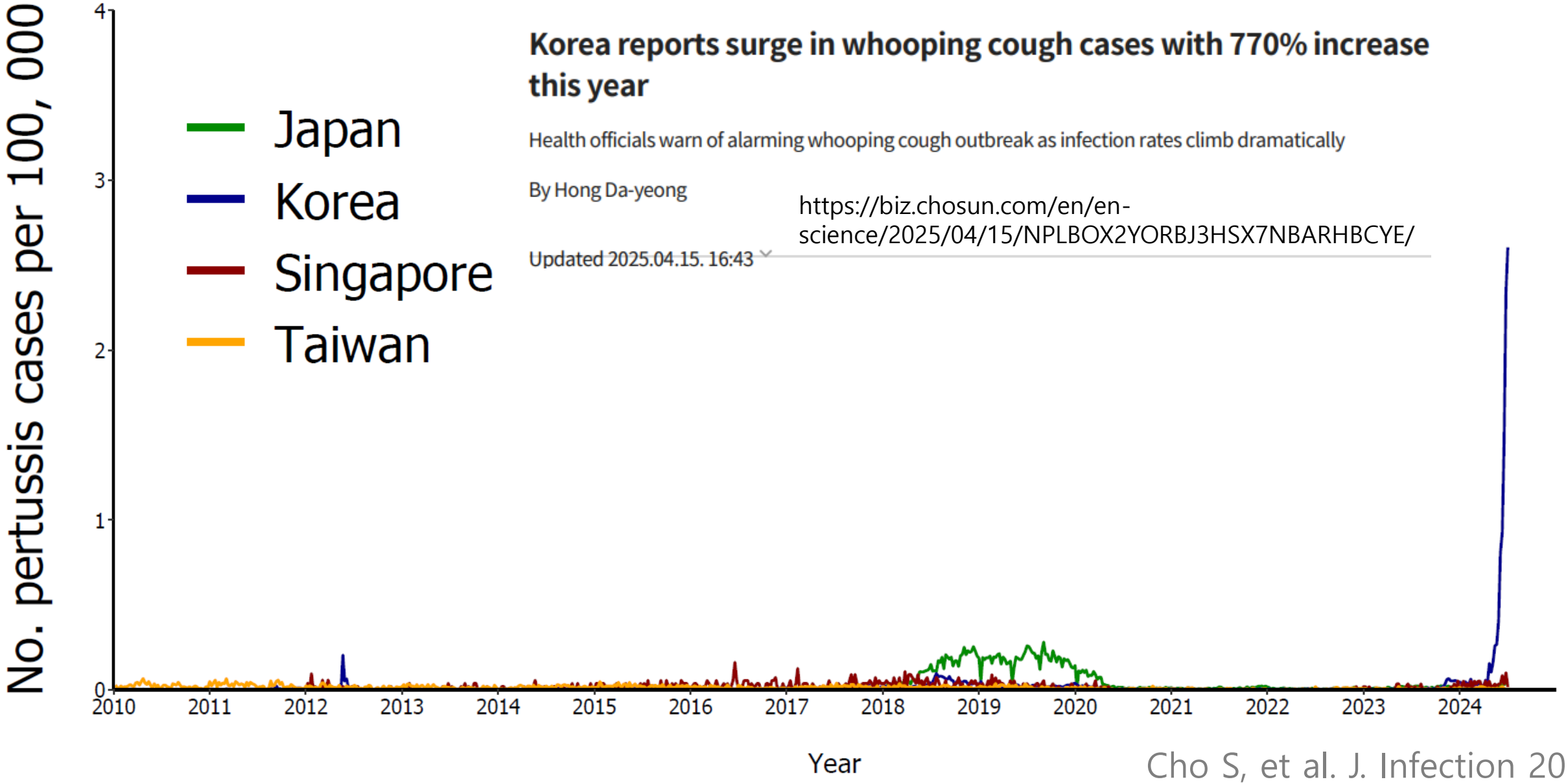
① to describe the burden and epidemiology of disease



Lee H, et al. 2020. J Infect Chemo

1. Surveillance

② to monitor trends



Korea reports surge in whooping cough cases with 770% increase this year

Health officials warn of alarming whooping cough outbreak as infection rates climb dramatically

By Hong Da-yeong

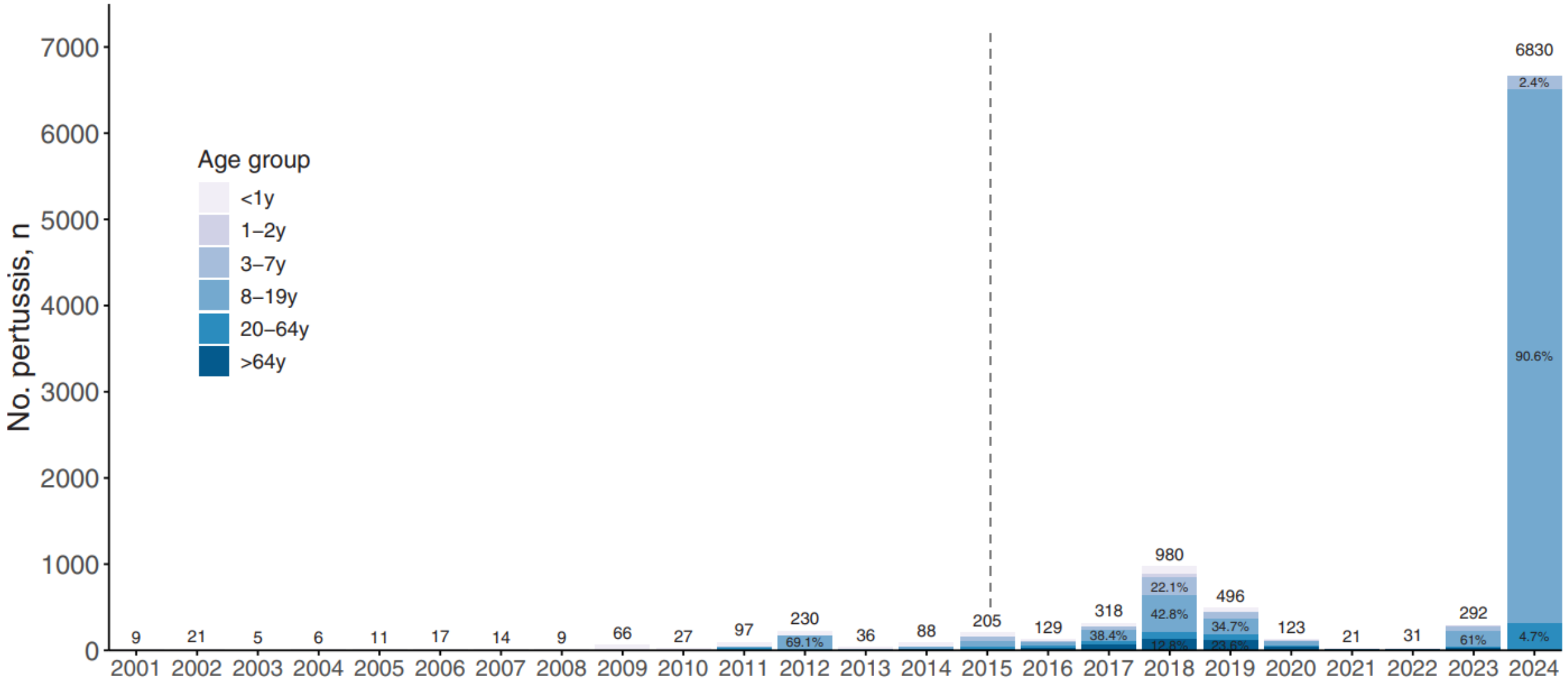
Updated 2025.04.15. 16:43

https://biz.chosun.com/en/en-science/2025/04/15/NPLBOX2YORBJ3HSX7NBARHBCYE/

Cho S, et al. J. Infection 2024

1. Surveillance

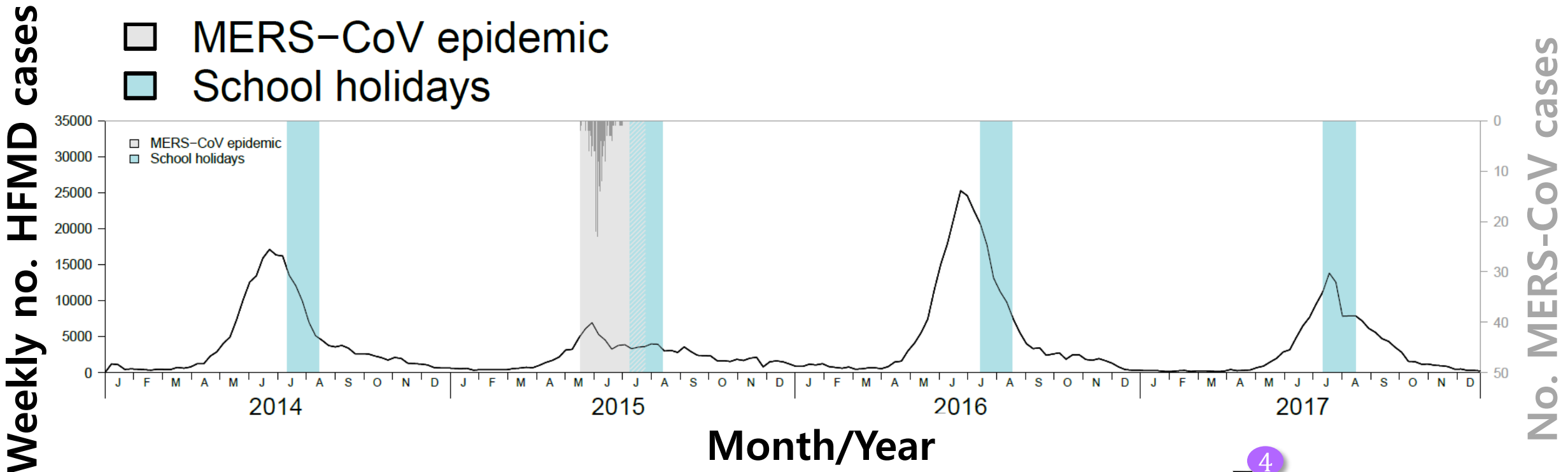
② to monitor trends



Cho S, et al. J. Infection 2024

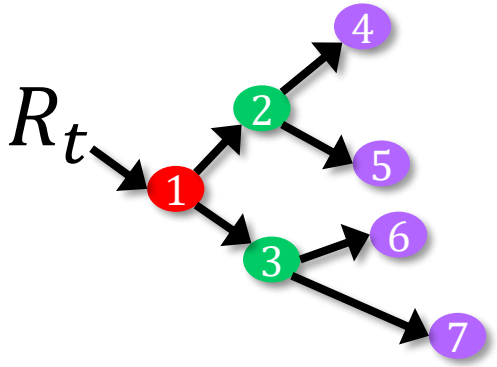
1. Surveillance

② to monitor trends



Measure for transmissibility of diseases

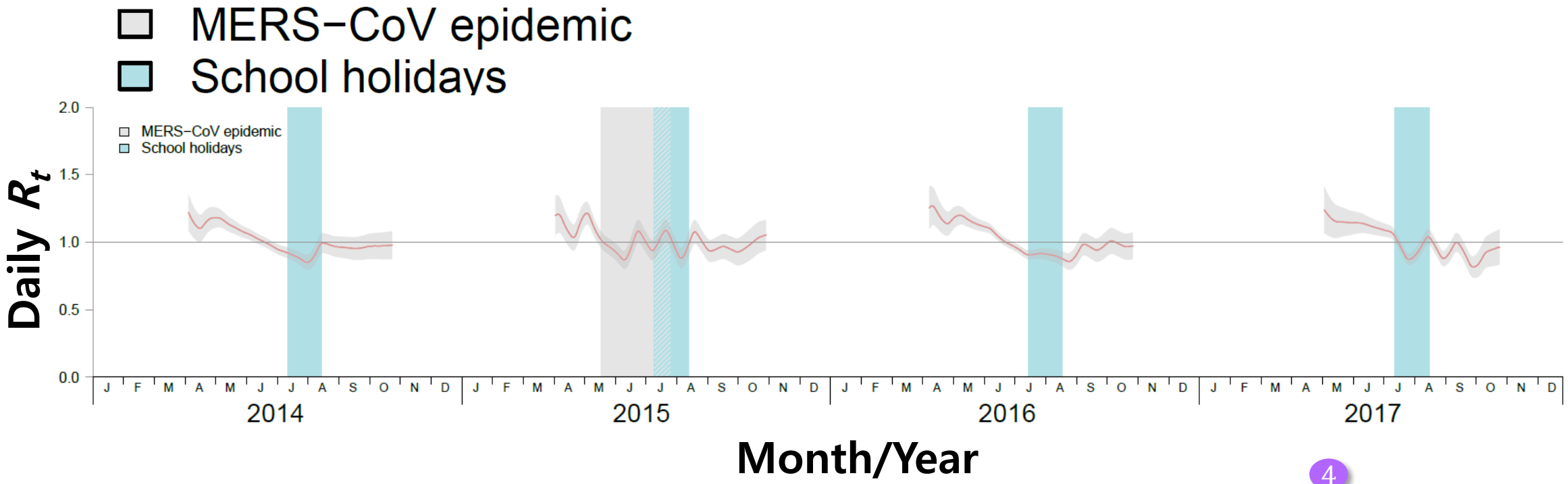
- Effective reproduction number (R_t)
  - Critical thresh hold : 1



Ryu S, et al. 2023. J Infect Public Health.

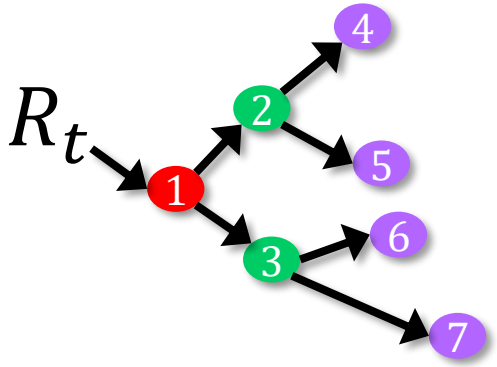
1. Surveillance

② to monitor trends



Measure for transmissibility of diseases

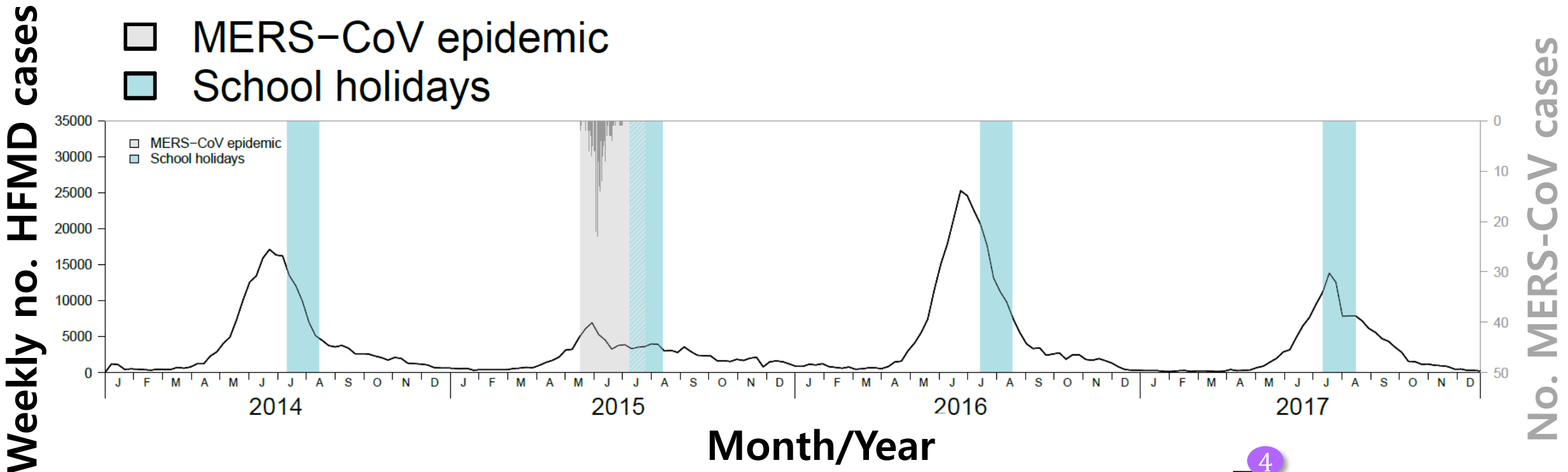
- Effective reproduction number (R_t)
  - Critical thresh hold : 1



Ryu S, et al. 2023. J Infect Public Health.

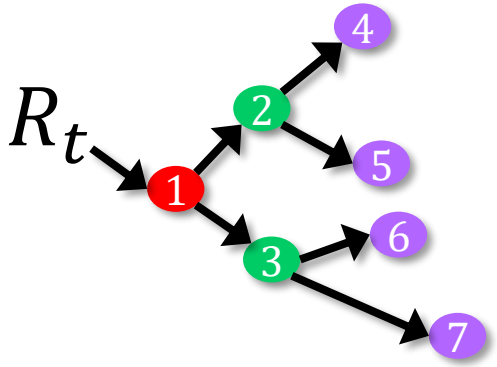
1. Surveillance

② to monitor trends



Measure for transmissibility of diseases

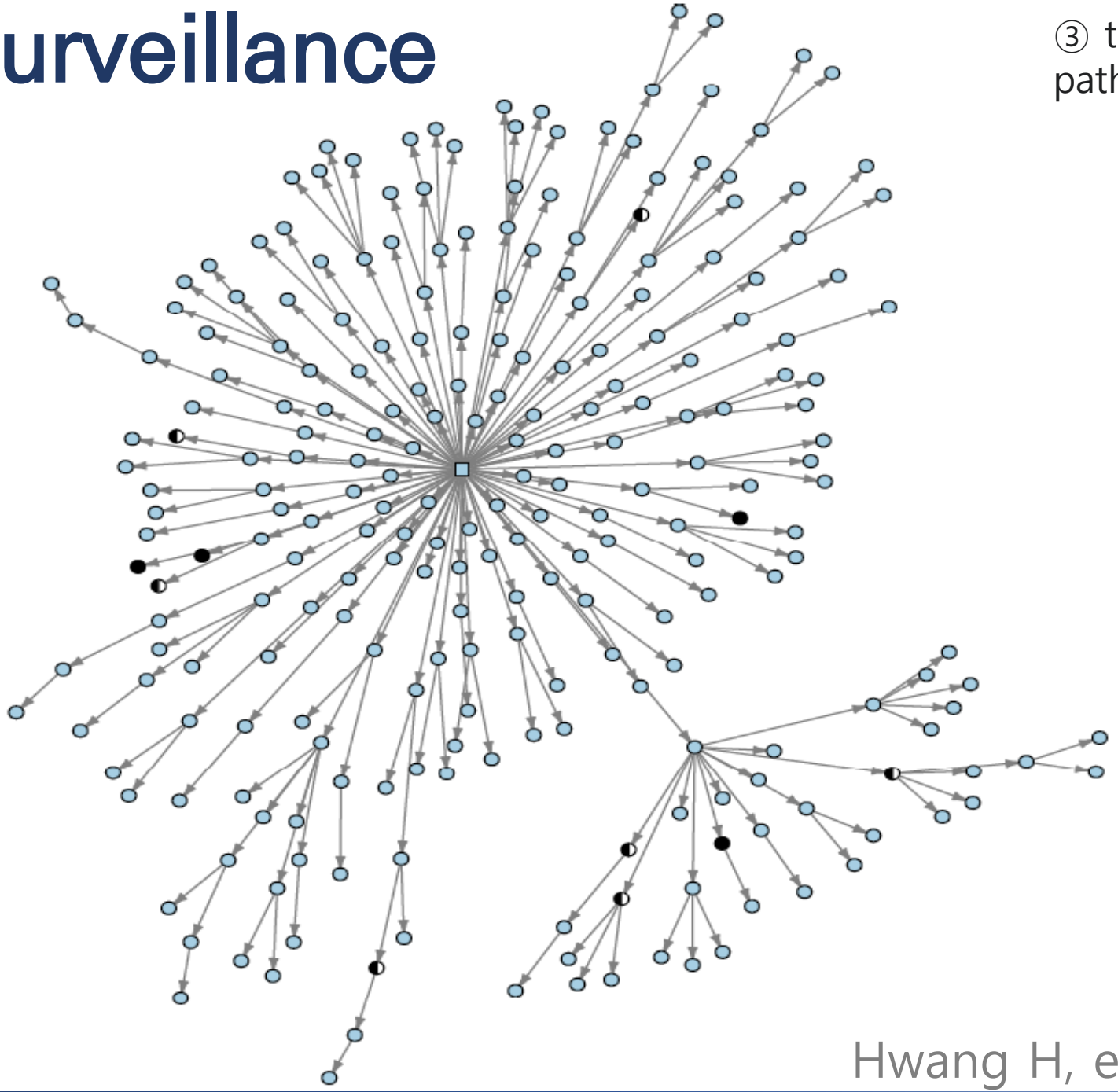
- Effective reproduction number (R_t)
  - Critical thresh hold : 1



Ryu S, et al. 2023. J Infect Public Health.

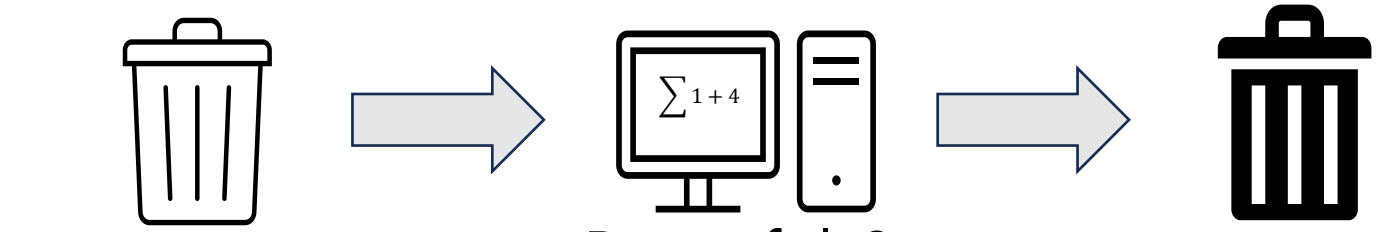
1. Surveillance

③ to identify outbreaks and new pathogens



Hwang H, et al. 2022. J Infect Dis.

Have you assessed the observation?



Observations

Powerful & fancy math model

??

1. Surveillance

2. Evaluation

2. Evaluation

Updated Guidelines for Evaluating Public Health Surveillance Systems

Structured framework based on the updated U.S. CDC guideline.

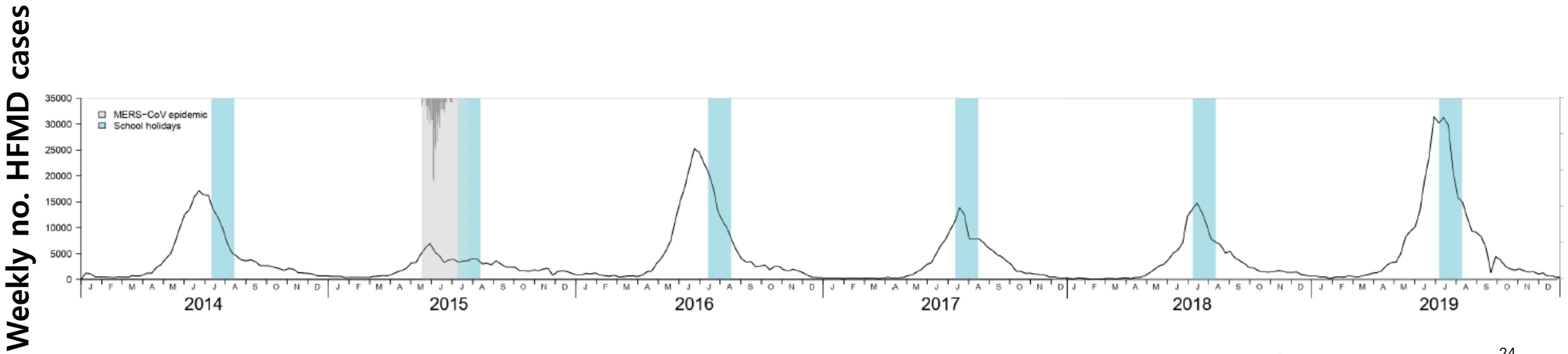
Attributes	Definition
① **Timeliness**	Timeliness is the time required for reporting/analysis/dissemination within the surveillance system.
② **Completeness**	Completeness is how completely the data to be collected through the surveillance system is reported.
③ **Sensitivity**	Sensitivity is the proportion of cases reported through the surveillance system among the total cases in the community.
④ **Representative-ness**	Representativeness refers to how accurately the system describes the di stribution of disease occurrence across people and places in a population over time.

German RR, et al. 2001 MMWR

2. Evaluation

Hand, foot, and mouth disease (HFMD) is a highly transmissible pediatric infectious disease characterized by a rash or vesicular appearance on the hands, feet, and tongue.

In South Korea, HFMD epidemics recur between April and August, and the annual economic burden is estimated to be 100 million USD



Ryu S, et al. 2023. J Infect Public Health.

2. Evaluation

Period: 1 January 2017 to 31 December 2022

Korea Disease Control and Prevention Agency

Weekly number of HFMD notifications from outpatient clinics from the Korean HFMD surveillance system

건강보험심사평가원
HEALTH INSURANCE REVIEW & ASSESSMENT SERVICE

Monthly number of HFMD patients based on the national health insurance reimburse ment data, covering around 97% of the South Korean population

2. Evaluation

Korea Disease Control and Prevention Agency

Web-based notification of hand, foot, and mouth diseases

Dissemination of result report

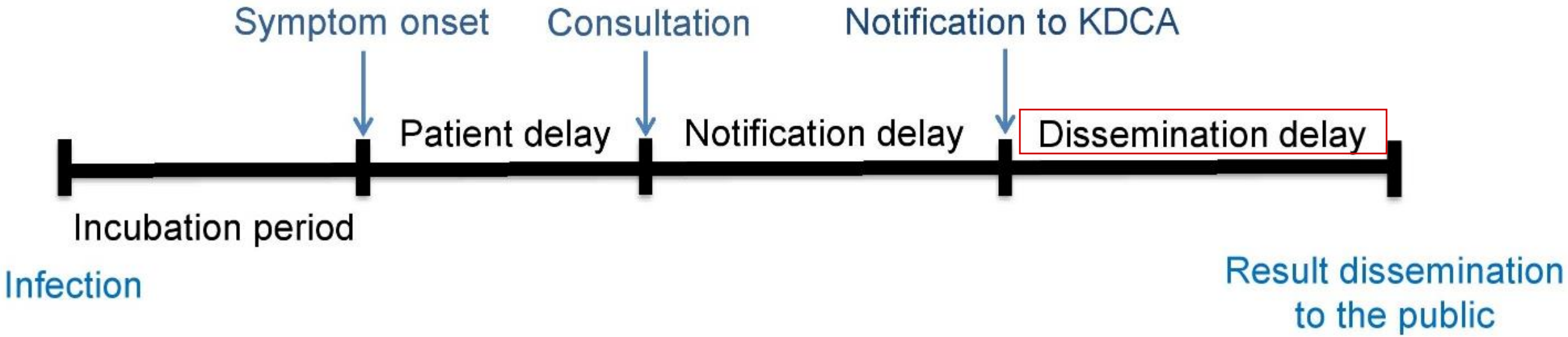
Sentinel sites

Year	2017	2018	2019	2020	2021	2022
Number of sentinel sites	93	97	97	109	109	110

Kim BI, et al. 2024. JMIR Public health Surveill (In press).

2. Evaluation

① Timeliness	Timeliness is the time required for reporting/analysis/dissemination within the surveillance system.



Kim BI, et al. 2024. JMIR Public health Surveill

2. Evaluation

Year	2017	2018	2019	2020	2021	2022
① Timeliness						
Mean time lag with SD	1.80 ± 1.40	1.69 ± 1.57	1.23 ± 0.43	1.01 ± 0.14	1.01 ± 0.01	1.01 ± 0.14
② Completeness						
Reporting rate‡	0.99	0.94	0.95	0.88	0.87	0.93
③ Sensitivity						
Correlation coefficient (P value)	0.99 (P < 0.01)	0.99 (P < 0.01)	0.99 (P < 0.01)	0.70 (P = 0.01)	0.77 (P < 0.01)	0.97 (P < 0.01)

Kim BI, et al. 2024. JMIR Public health Surveill (In press).

2. Evaluation

② Completeness

Completeness is how completely the data to be collected through the surveillance system is reported.

HFMD case notification form

Receipt: Director of the Korean Diseases Control and Prevention Agency (KDCA)

Period of surveillance: Week (YYYY/MM/DD – YYYY/MM/DD)

Age-Classification	0 year	1-6 years	7-12 years	13-18 years
Number of patients visited				
Number of patients diagnosed with hand foot and mouth disease				

Notification date: YYYY/MM/DD

Head of the sample monitoring agency:

Name of the sentinel:

Institution code:

Phone number:

Kim BI, et al. 2024. JMIR Public health Surveill.

2. Evaluation

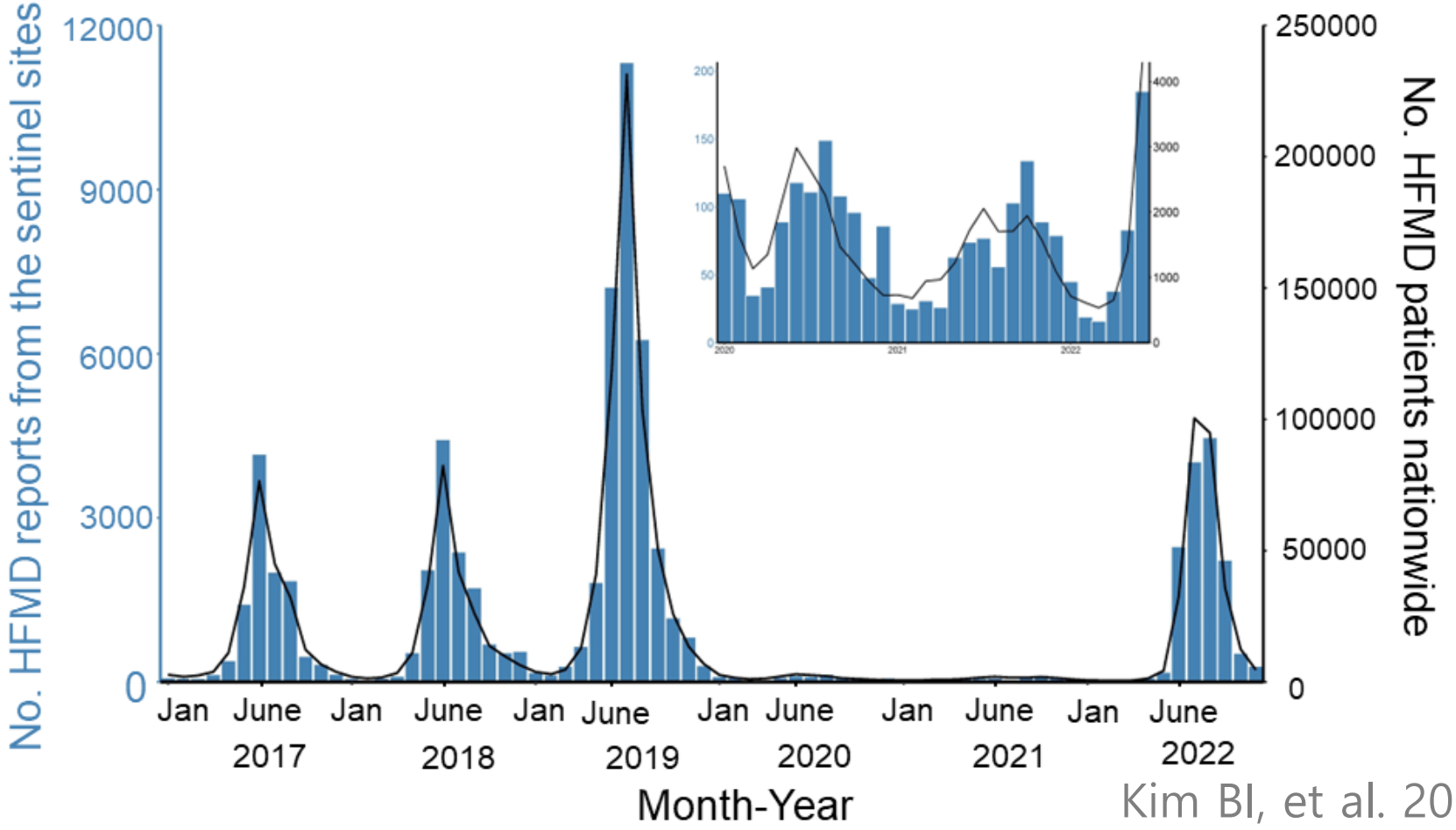
Year	2017	2018	2019	2020	2021	2022
① Timeliness						
Mean time lag with SD	1.80 ± 1.40	1.69 ± 1.57	1.23 ± 0.43	1.01 ± 0.14	1.01 ± 0.01	1.01 ± 0.14
② Completeness						
Reporting rate‡	0.99	0.94	0.95	0.88	0.87	0.93
③ Sensitivity						
Correlation coefficient (P value)	0.99 (P < 0.01)	0.99 (P < 0.01)	0.99 (P < 0.01)	0.70 (P = 0.01)	0.77 (P < 0.01)	0.97 (P < 0.01)

Kim BI, et al. 2024. JMIR Public health Surveill.

2. Evaluation

③ Sensitivity

Sensitivity is the proportion of cases reported through the surveillance system among the total cases in the community.



건강보험심사평가원
HEALTH INSURANCE REVIEW & ASSESSMENT SERVICE

Kim BI, et al. 2024. JMIR Public health Surveill.

2. Evaluation

Year	2017	2018	2019	2020	2021	2022
① Timeliness						
Mean time lag with SD	1.80 ± 1.40	1.69 ± 1.57	1.23 ± 0.43	1.01 ± 0.14	1.01 ± 0.01	1.01 ± 0.14
② Completeness						
Reporting rate‡	0.99	0.94	0.95	0.88	0.87	0.93
③ Sensitivity						
Correlation coefficient (P value)	0.99 (P < 0.01)	0.99 (P < 0.01)	0.99 (P < 0.01)	0.70 (P = 0.01)	0.77 (P < 0.01)	0.97 (P < 0.01)

Kim BI, et al. 2024. JMIR Public health Surveill.

2. Evaluation

④Representativeness — Representativeness refers to how accurately the system describes the distribution of disease occurrence across people and places in a population over time.

The age representativeness of the hand, foot, and mouth disease surveillance system in South Korea, 2017-2022.

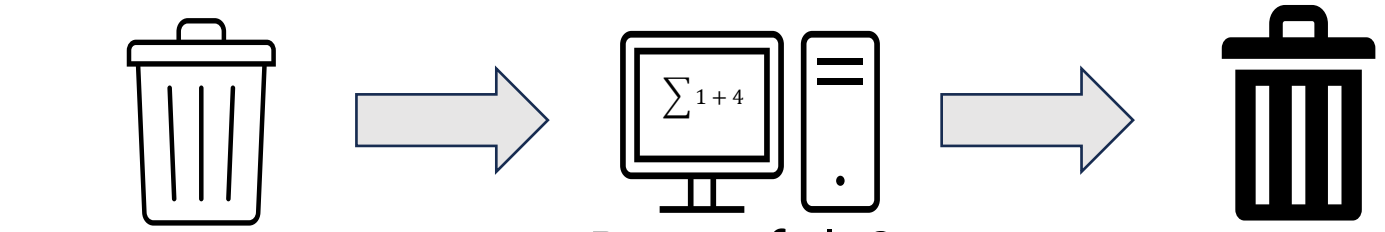
Year	2017	2018	2019	2020	2021	2022
Sentinel surveillance data from KDCA†						
< 7-years-old	4,612	5,599	10,477	452	434	11,817
Overall no. HFMD report	4,833	5,933	11,049	487	478	12,326
Proportion of < 7-year olds	95.4%	94.4%	94.8%	92.8%	90.8%	95.9%
Health insurance reimbursement data from the KHIRA ‡						
< 7-years-old	221,489	219,814	566,762	19,360	14,597	275,124
Overall no. HFMD patients	241,871	242,494	637,131	22,974	18,431	300,635
Proportion of < 7-year-olds	91.6%	91.0%	89.0%	79.9%	79.2%	91.5%
Differences between the proportions from KDCA and KHIRA				↓	↓	
Differences	3.8%	3.4%	5.8%	12.9%	11.6%	4.4%

Kim BI, et al. 2024. JMIR Public health Surveill.

2. Evaluation

- In conclusion, the completeness, sensitivity, and age representativeness of the HFMD surveillance system performance were temporarily reduced during the acute period of the COVID-19 pandemic.

Evaluation needs to be conducted to produce a reliable outcome



Thank you

Email: gentryu@onehealth.or.kr