Shifting patterns of infectious diseases following social distancing measures for COVID-19 in South Korea

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Introduction

- As severe acute respiratory syndrome, coronavirus 2 (SARSCoV- 2) disseminated rapidly throughout the world in 2020
- Many countries implemented statewide social distancing measures and other preventive interventions to mitigate the spread of coronavirus disease 2019 (COVID-19)
- These strategies have been shown to delay outbreaks and flatten the epidemic curve in various settings
- Moreover, social distancing has been associated with the additional benefit of reducing the incidence of other communicable diseases

Social Distancing

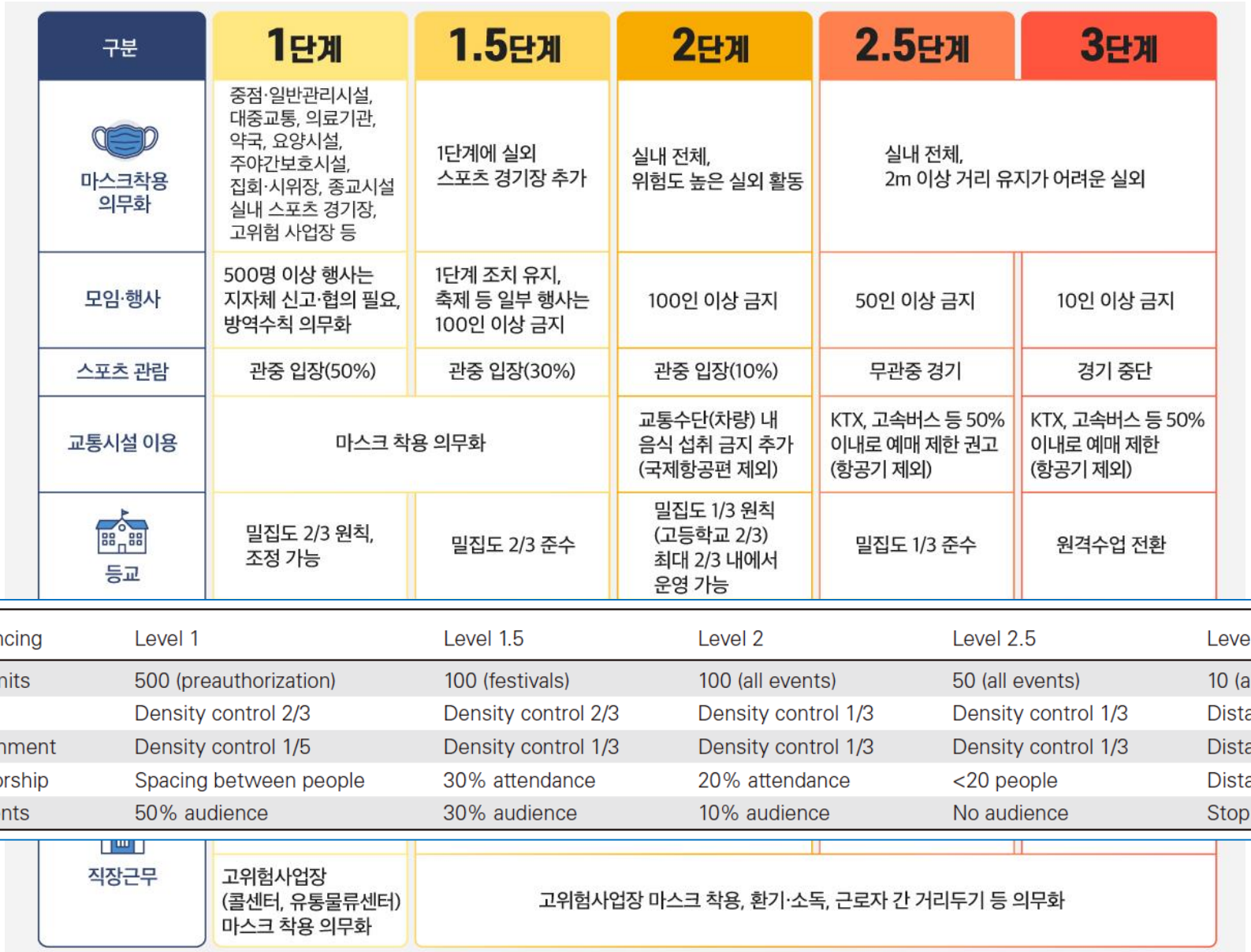
- Definition
  - A set of non-pharmaceutical interventions (NPIs) or measures intended **to prevent the spread of a contagious disease by maintaining a physical distance** between people and reducing the number of times people come into close contact with each other.

Social Distancing

- Measures
  - Avoiding physical contact
  - School closures
  - Workplace closures
  - Canceling mass gatherings
  - Travel restrictions
  - Shielding
  - Quarantine

Stevens, Washington Post 2020

Five-tier social distancing system in response to COVID-19 outbreak, South Korea

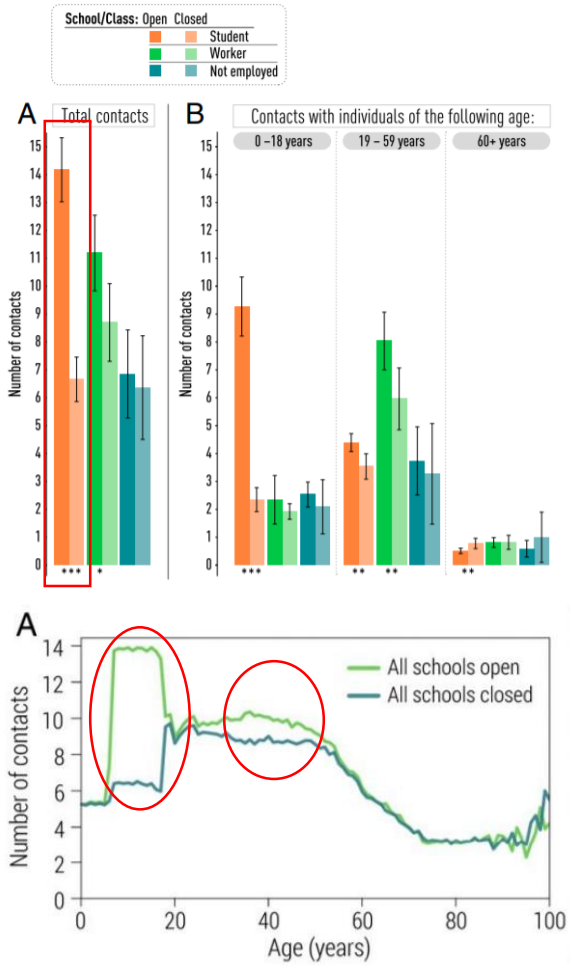


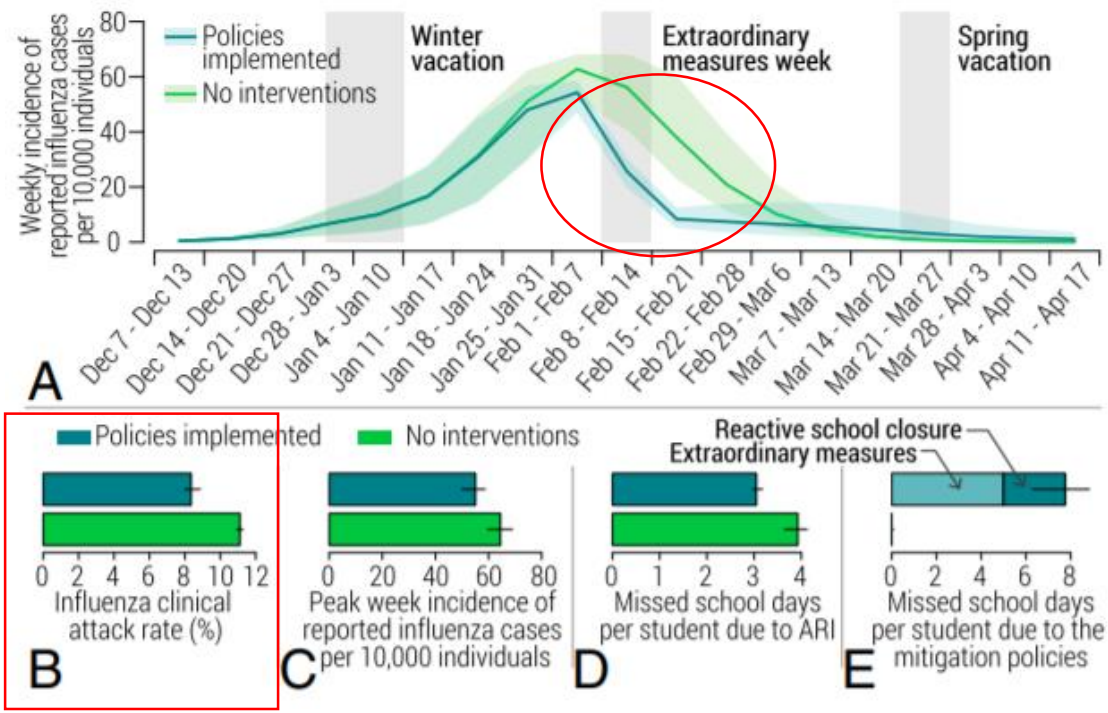
구분	1단계	1.5단계	2단계	2.5단계	3단계
마스크착용 의무화	중점·일반관리시설, 대중교통, 의료기관, 약국, 요양시설, 주야간보호시설, 집회·시위장, 종교시설 실내 스포츠 경기장, 고위험 사업장 등	1단계에 실외 스포츠 경기장 추가	실내 전체, 위험도 높은 실외 활동	실내 전체, 2m 이상 거리 유지가 어려운 실외	
모임·행사	500명 이상 행사는 지자체 신고·협의 필요, 방역수칙 의무화	1단계 조치 유지, 축제 등 일부 행사는 100인 이상 금지	100인 이상 금지	50인 이상 금지	10인 이상 금지
스포츠 관람	관중 입장(50%)	관중 입장(30%)	관중 입장(10%)	무관중 경기	경기 중단
교통시설 이용	마스크 착용 의무화		교통수단(차량) 내 음식 섭취 금지 추가 (국제항공편 제외)	KTX, 고속버스 등 50% 이내로 예매 제한 권고 (항공기 제외)	KTX, 고속버스 등 50% 이내로 예매 제한 (항공기 제외)
등교	밀집도 2/3 원칙, 조정 가능	밀집도 2/3 준수	밀집도 1/3 원칙 (고등학교 2/3) 최대 2/3 내에서 운영 가능	밀집도 1/3 준수	원격수업 전환
직장근무	고위험사업장 (콜센터, 유통물류센터) 마스크 착용 의무화	고위험사업장 마스크 착용, 환기·소독, 근로자 간 거리두기 등 의무화			

Social Distancing	Level 1	Level 1.5	Level 2	Level 2.5	Level 3
Gathering limits	500 (preauthorization)	100 (festivals)	100 (all events)	50 (all events)	10 (all events)
Schools	Density control 2/3	Density control 2/3	Density control 1/3	Density control 1/3	Distance learning
Work environment	Density control 1/5	Density control 1/3	Density control 1/3	Density control 1/3	Distance working
Places of worship	Spacing between people	30% attendance	20% attendance	<20 people	Distance service
Sporting events	50% audience	30% audience	10% audience	No audience	Stop games

Reactive school closure weakens the network of social interactions and reduces the spread of influenza

Following school closures, significant reduction in # of contacts made by students (14.2 → 6.5 contacts/day) resulting **33% reduction** in attack rate





Litvinova, *PNAS* 2019

Impact of NPIs to reduce COVID-19 mortality and healthcare demand

School closure as an isolated measure was predicted to **reduce total deaths by around 2–4% in UK**, whereas case isolation would be more effective, and a combination of measures would be the most effective

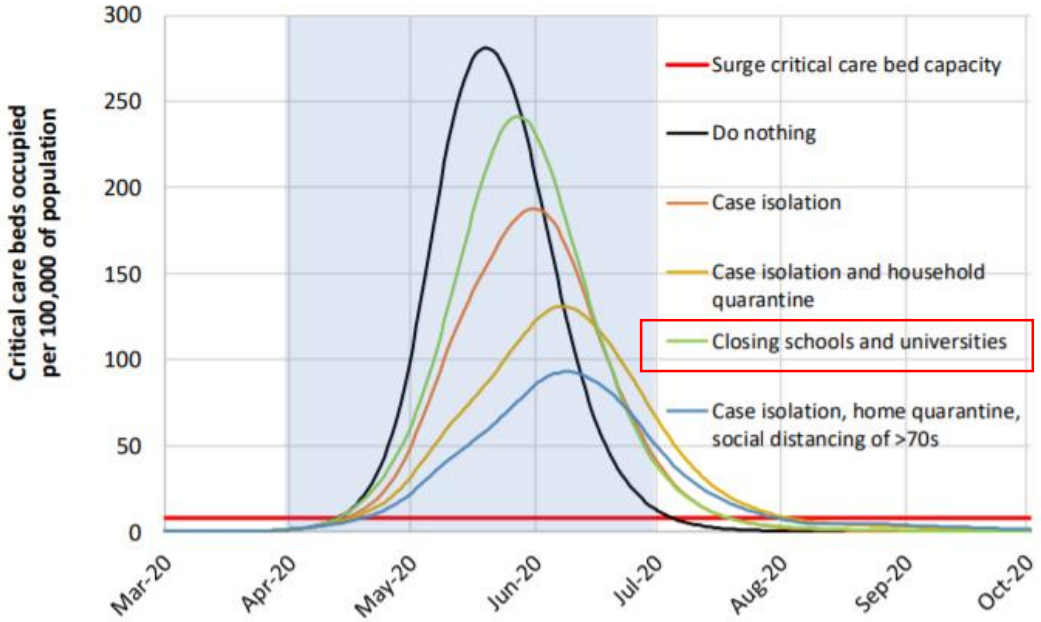
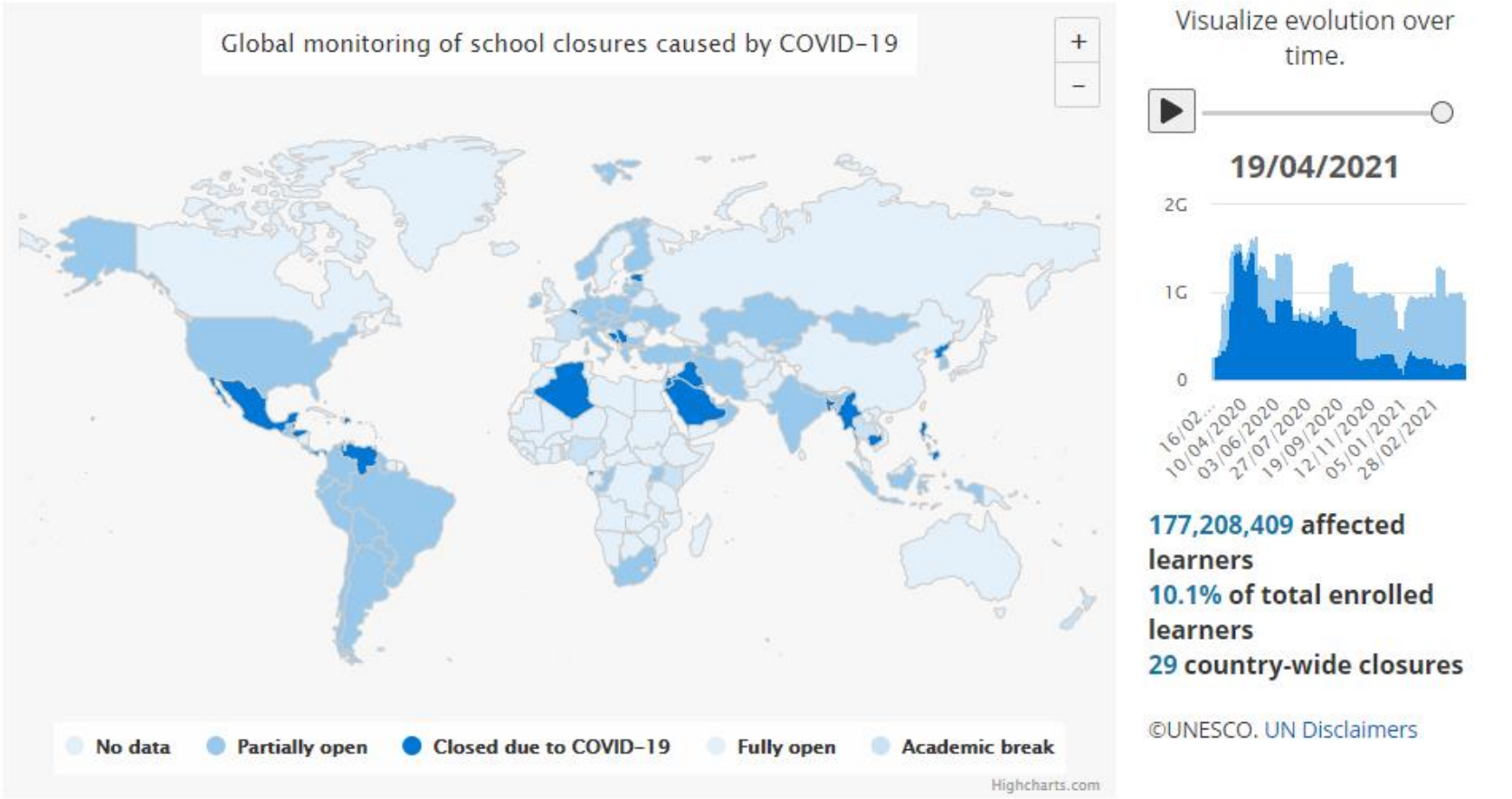


Figure 2: Mitigation strategy scenarios for GB showing critical care (ICU) bed requirements. The black line shows the unmitigated epidemic. The green line shows a mitigation strategy incorporating closure of schools and universities; orange line shows case isolation; yellow line shows case isolation and household quarantine; and the blue line shows case isolation, home quarantine and social distancing of those aged over 70. The blue shading shows the 3-month period in which these interventions are assumed to remain in place.

Ferguson, *Imperial College* 2020

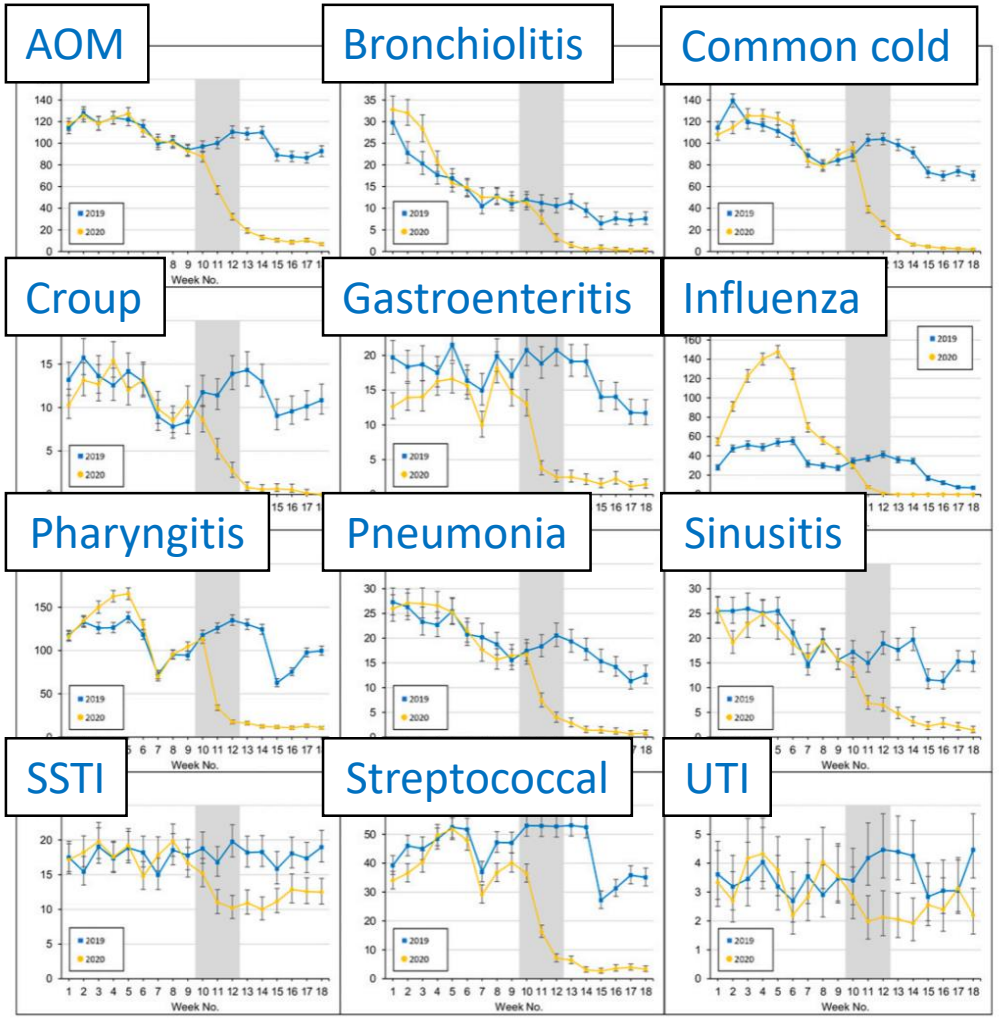
***Non-pharmaceutical intervention (NPI)**: mandatory mask, quarantine, distancing and traffic

Global monitoring of school closures



UNESCO

Social distancing for COVID-19 and diagnoses of other infectious diseases in children



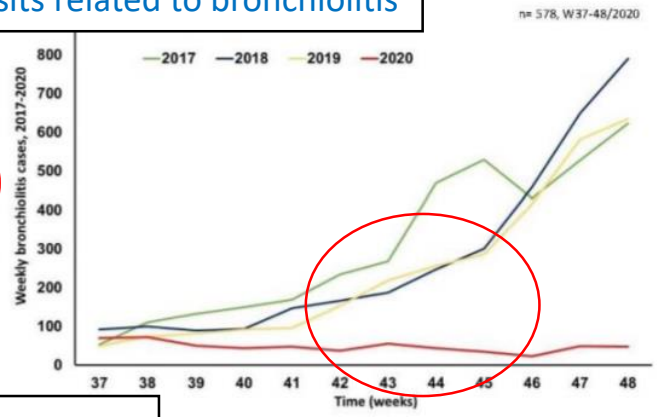
AOM: acute otitis media,
SSTIs: soft tissue infections,
UTI: urinary tract infection

Hatoun, Pediatrics 2020

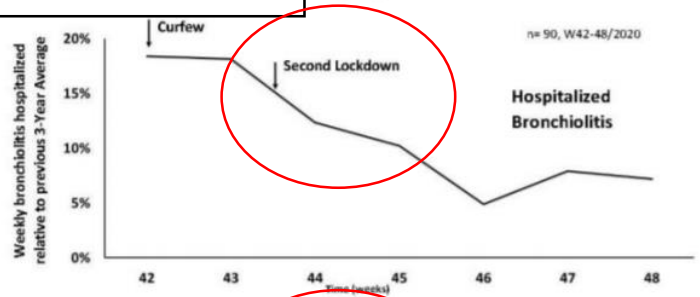
Unexpected lessons from the COVID-19 lockdowns in France

Weekly hospital admissions related to emergency visits

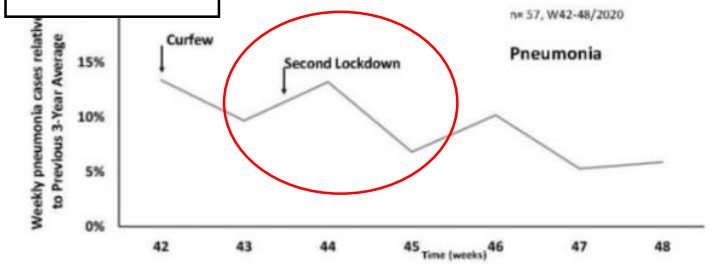
Visits related to bronchiolitis



Hospital admissions related to bronchiolitis



Pneumonia



Acute otitis media

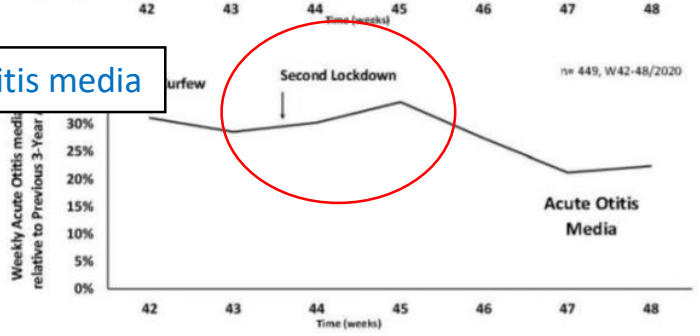
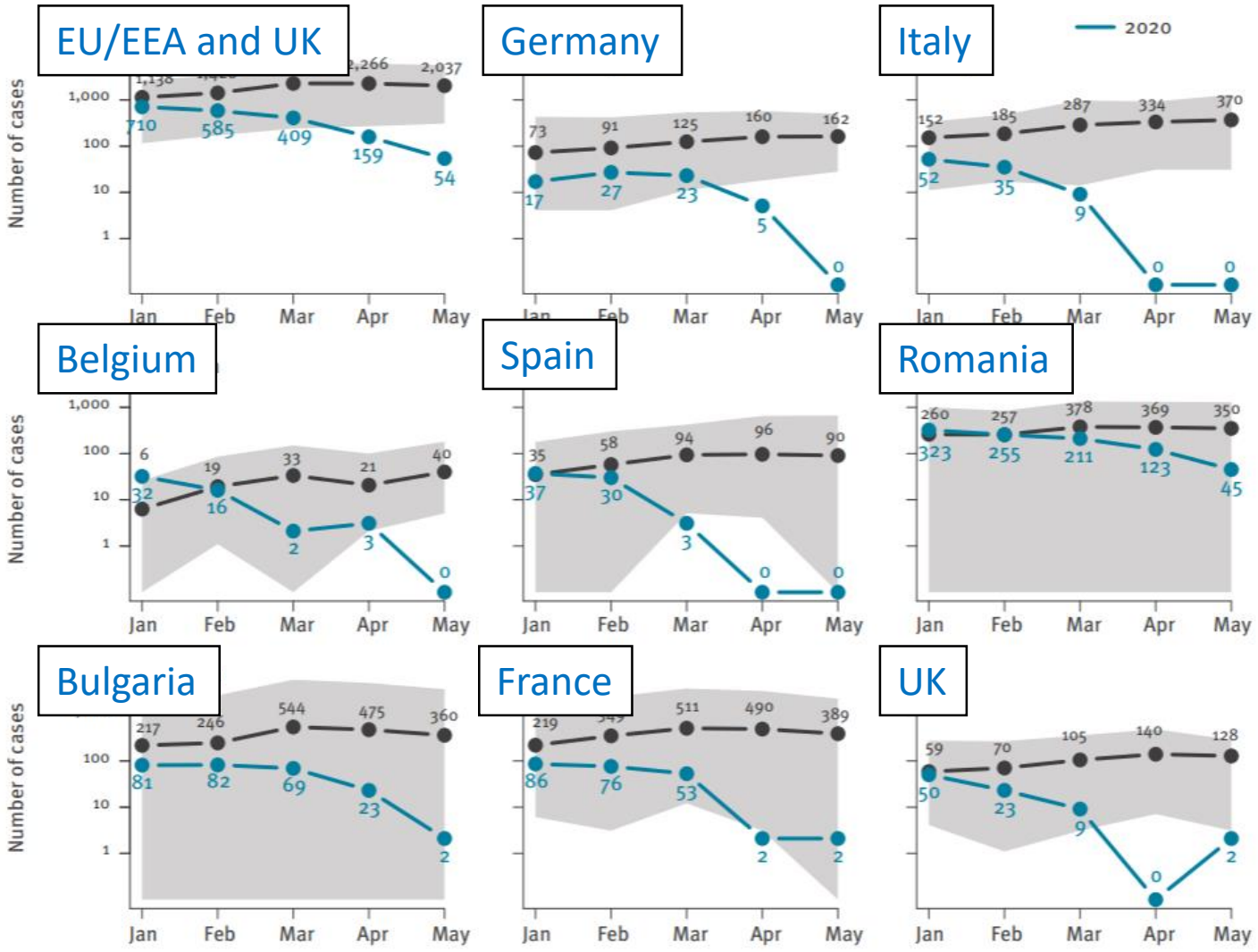


Figure 1: Weekly pediatric emergency visits and hospitalization during the weeks 1 to 48 of the calendar year.

A: Weekly hospital admissions related to emergency visits from Weeks 1 to 48 of 2020 were compared with the average for the three previous years (2017, 2018,2019). End of lockdown Step 1 begin on May 11th, 2020; Step 2 begin on June 2nd, 2020; Step 3 begin on June 22th, 2020. **B:** Visits related to bronchiolitis from Weeks 37 to 48 of 2017, 2018, 2019, and 2020. **C-E:** Weeks 42 to 48: 2020 compared with the average for 2017, 2018, and 2019 for hospital admission related to bronchiolitis (**C**), Pneumonia (**D**), and Acute Otitis Media (**E**)

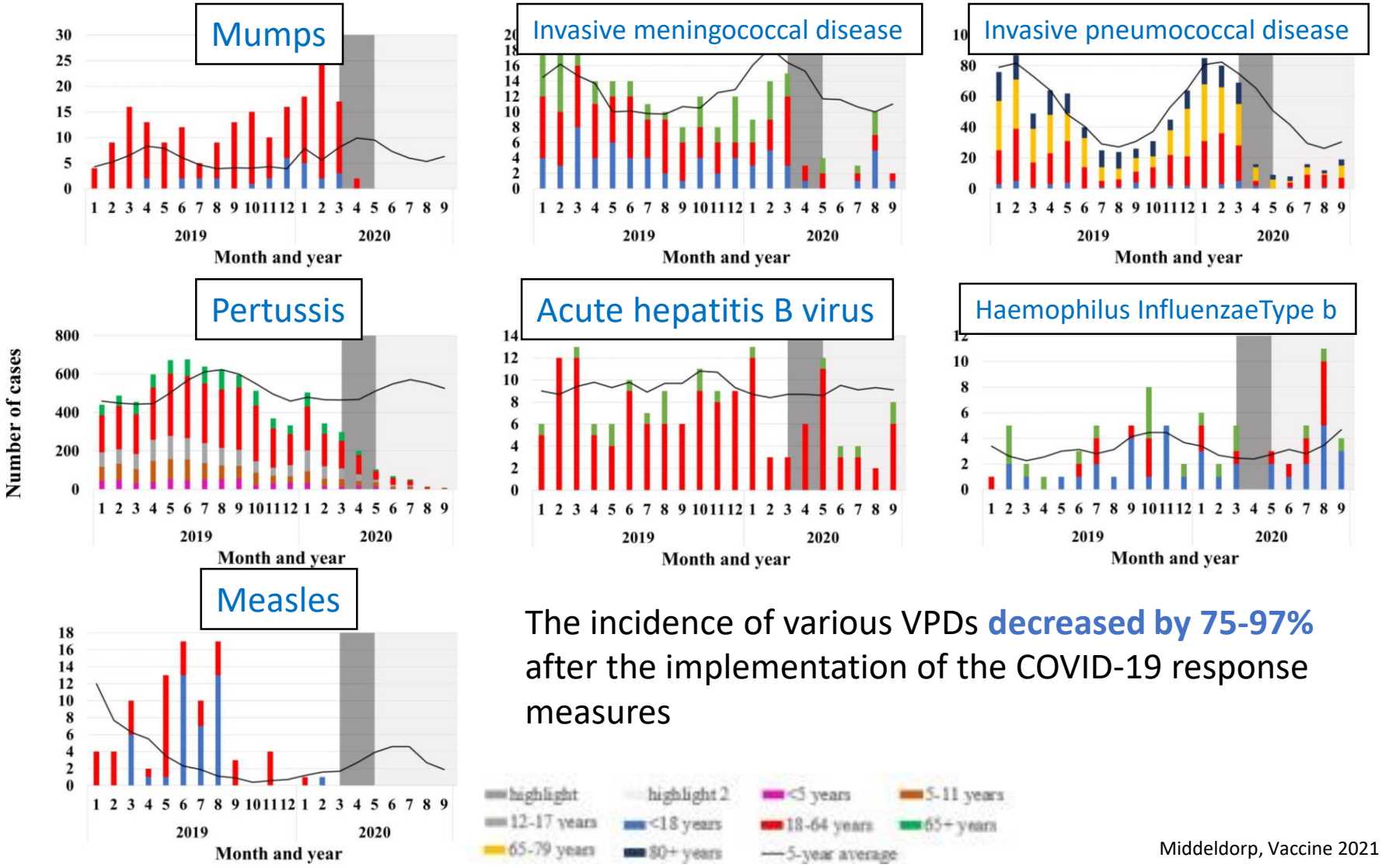
Skurnik, Clin Infect Dis 2020

Epidemiology of measles during the COVID-19 pandemic, a description of the surveillance data, 29 EU/EEA countries and the United Kingdom, January to May 2020



Nicolay, Euro Surveill 2020

Short term impact of the COVID-19 pandemic on incidence of vaccine preventable diseases in the Netherlands in the period March-September 2020



The incidence of various VPDs **decreased by 75-97%** after the implementation of the COVID-19 response measures

Middeldorp, Vaccine 2021

Impact of COVID-19 on pediatric emergencies and hospitalizations in Singapore

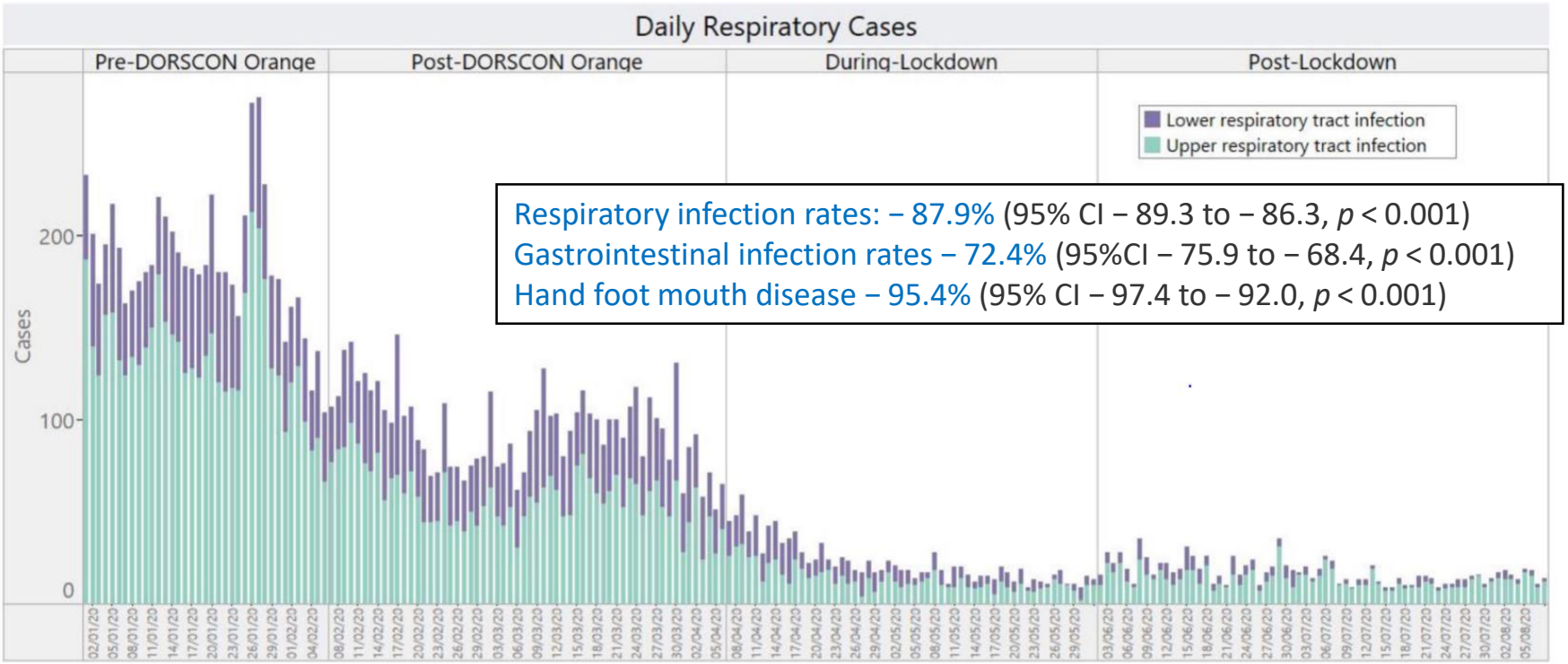
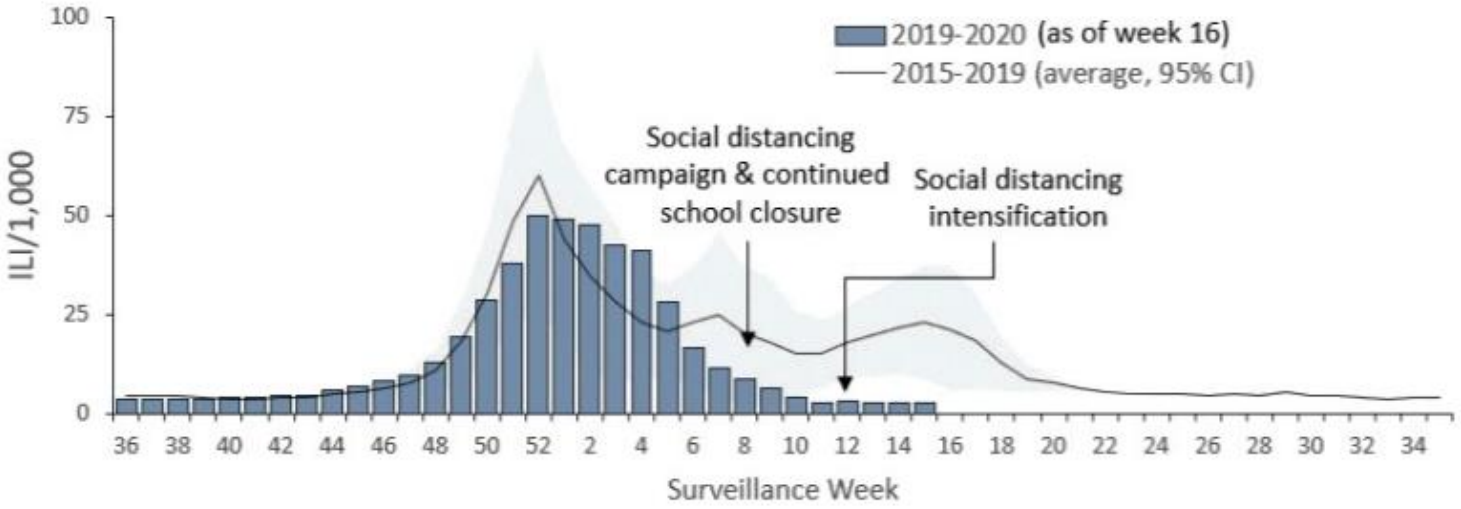


Fig. 2 Trend of total, upper and lower respiratory tract infections

Chong, BMC Pediatr 2020

The impact of social distancing on the transmission of influenza virus, South Korea, 2020



Impact of social distancing on influenza activity

Aim of the study

- Describe the **impact of sequential social distancing interventions on common respiratory viruses** in the context of universal face mask use and hand hygiene implemented in early 2020
- Report association between the introduction of NPI and reduction in the infection rates of **gastrointestinal pathogens**

Respiratory virus surveillance

- Laboratory sentinel surveillance system
  - Collects results of **laboratory tests for respiratory specimens** obtained from nonhospitalized patients with respiratory symptoms who visited **52 outpatient clinics** in 17 cities and provinces
  - **Reports weekly detection rates of respiratory viruses**
    - # of positive specimens / total # of tests
- Clinical sentinel surveillance system

Respiratory virus surveillance

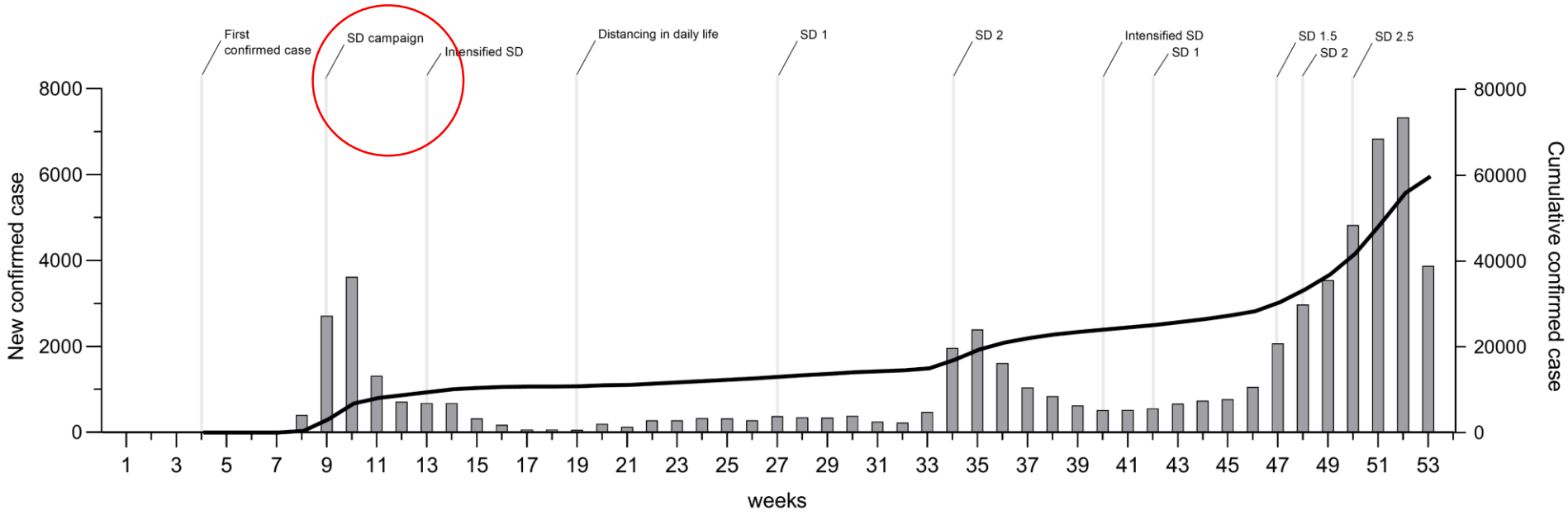
- Laboratory sentinel surveillance system
- Clinical sentinel surveillance system
  - Collects data from **hospitalized cases** **who have been confirmed to be infected with infectious disease pathogens** while displaying clinical symptoms consistent **with acute respiratory infection**
  - Reported from **214 nationally distributed sentinel hospitals**
  - Reports the **# of unique patients hospitalized** with respiratory viruses each week at sentinel hospitals

Data analysis

- Compare longitudinal trends in incidence for **2016-2019 vs 2020**
- The surveillance system collects results of multiplex RT-PCR assays for 8 human respiratory viruses
  - Adenovirus (ADV)
  - Parainfluenza virus (PIV)
  - Respiratory syncytial virus (RSV)
  - Influenza virus (IFV)
  - Human coronavirus (HCoV; non–SARS-CoV-2)
  - Human rhinovirus (HRV)
  - Human bocavirus (HBoV)
  - Human metapneumovirus (HMPV)
- Used χ^2 or Fisher exact tests

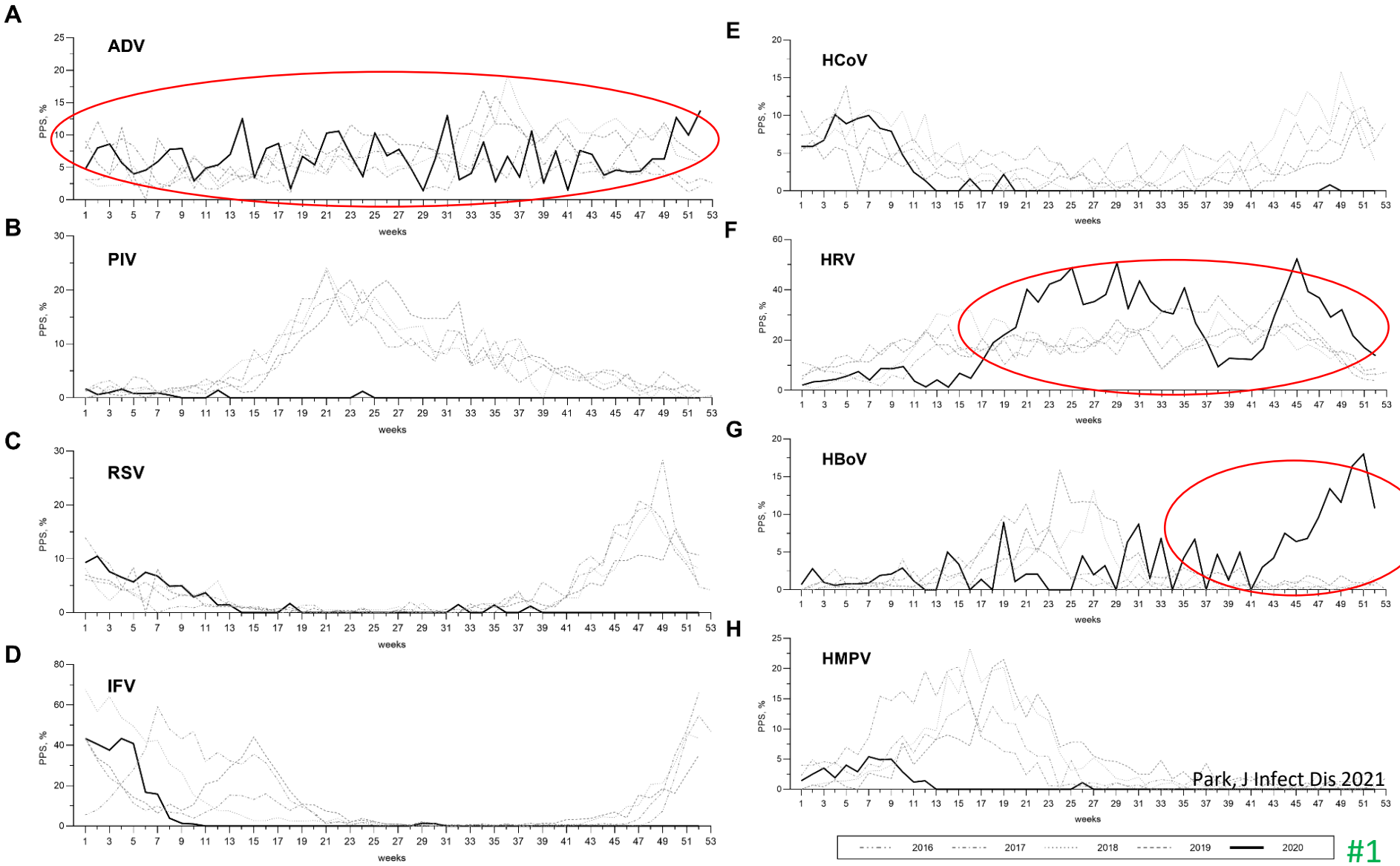
Weekly number of laboratory-confirmed coronavirus disease 2019 cases, South Korea, 2020

First confirmed case on Jan 20, 2020



Park, J Infect Dis 2021

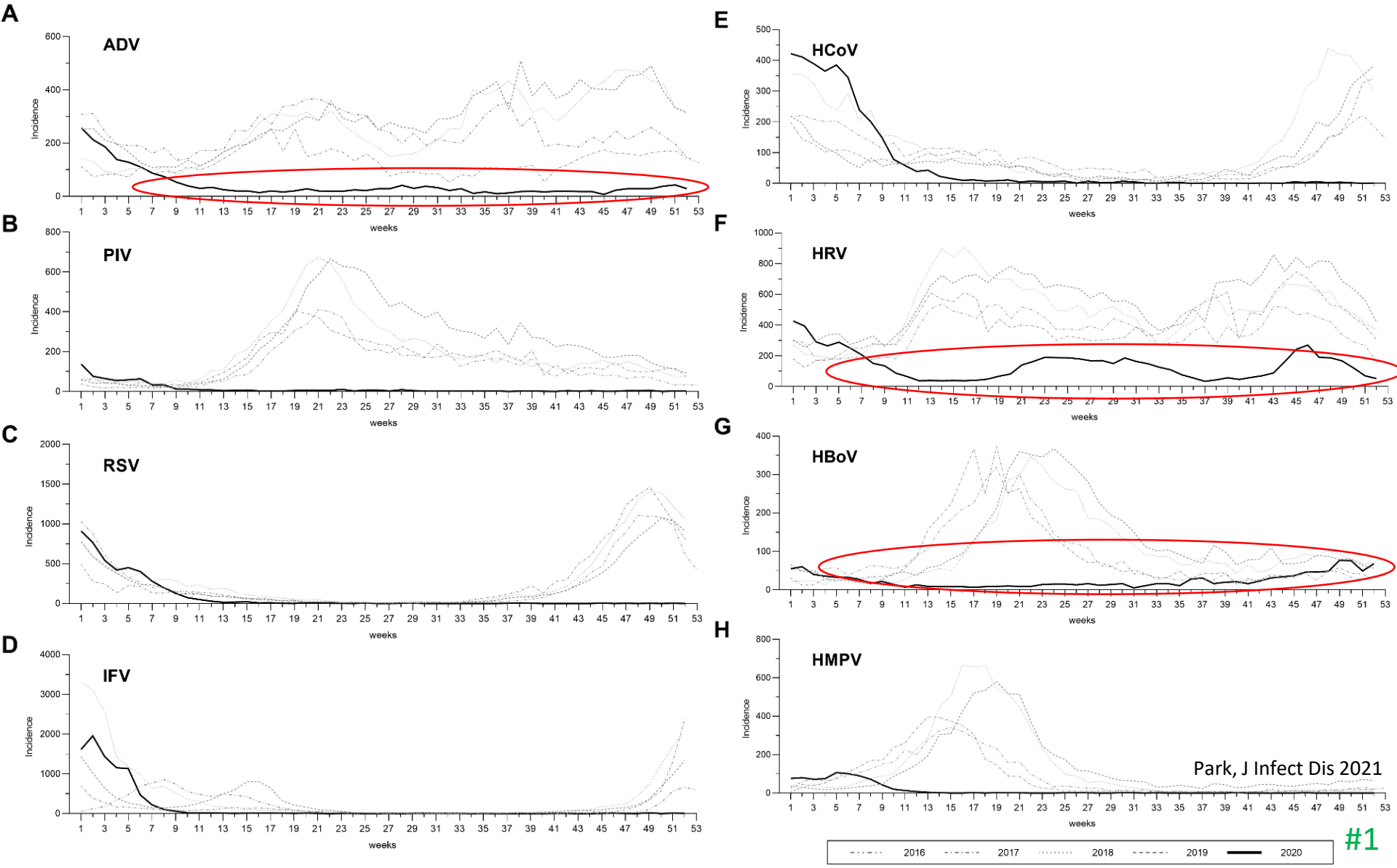
Monthly detection rates of respiratory viruses in outpatients



Park, J Infect Dis 2021

#1

Monthly incidence of respiratory viruses in hospitalized patients

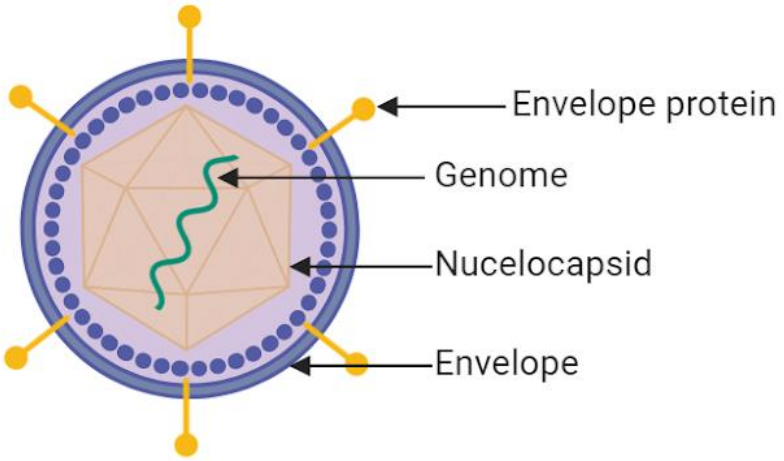


Park, J Infect Dis 2021

Discussion

- Factors that determine spread of pathogens include
  - Virological features
    - Virulence, fitness, and transmissibility (R0), immune evasion, and seasonal variations
  - Host characteristics
    - Age, comorbidities, asymptomatic viral carriage, personal hygiene, and proximity to other hosts
  - Environmental conditions
    - Temperature, humidity, and contamination of surfaces

Structure of a virus



https://www.ahmadcoaching.com/2021/02/what-is-the-structure-of-a-virus.html

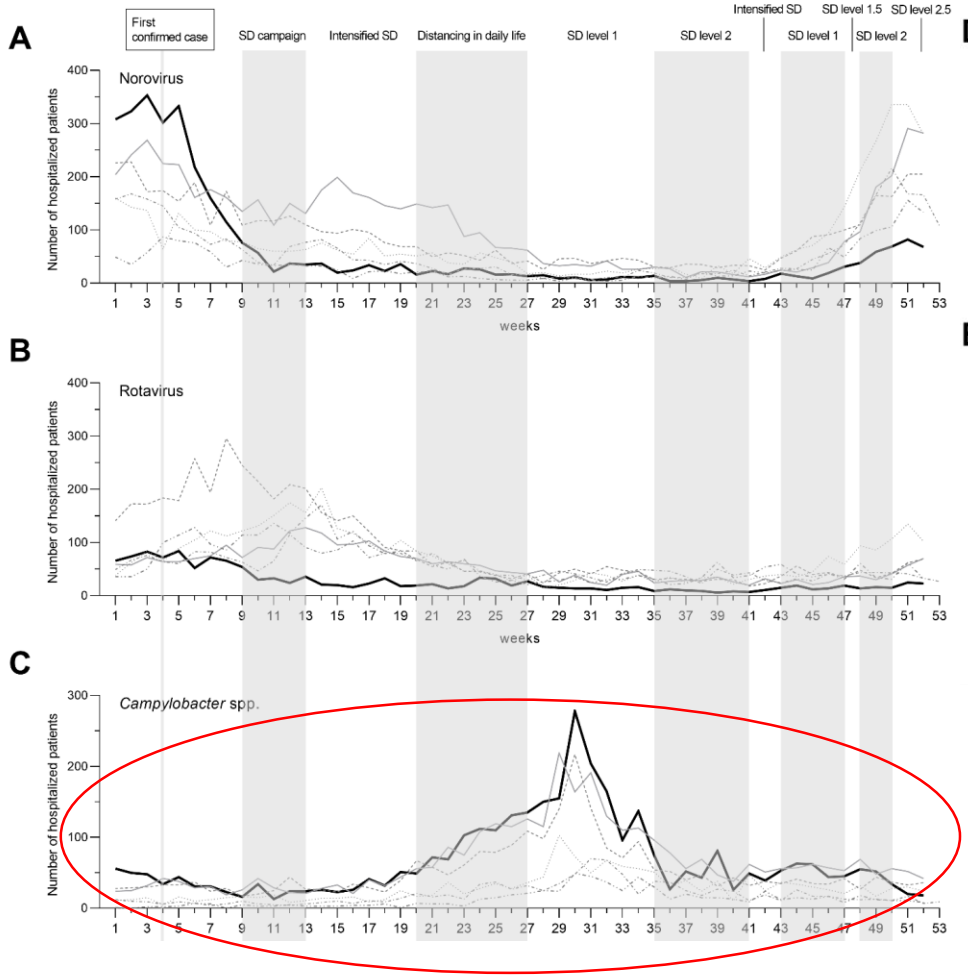
Discussion

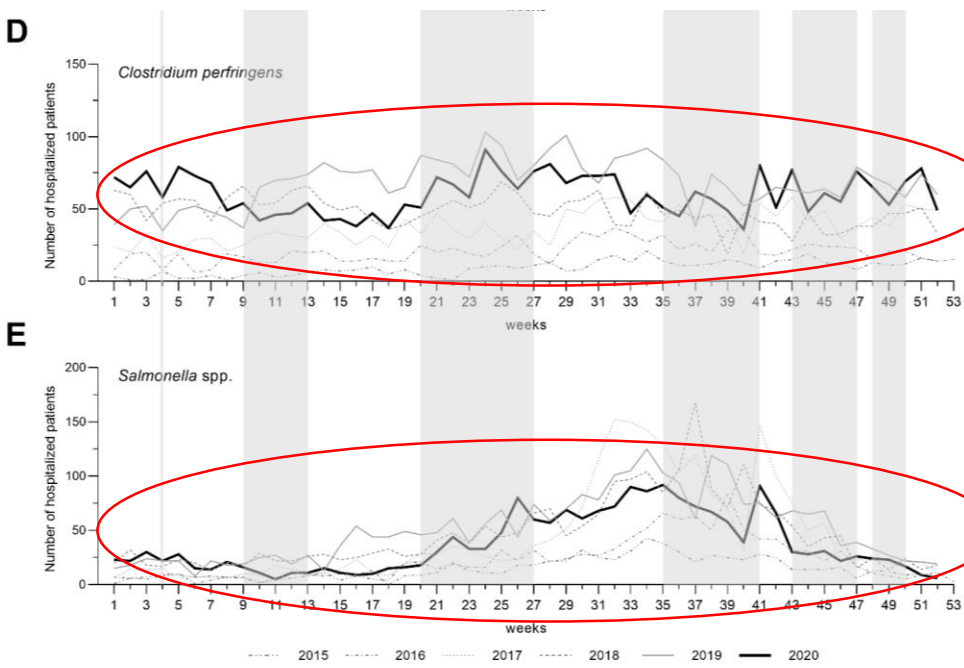
- The common virological feature missing in ADV, HRV, and HBoV but present in all other respiratory viruses is the **viral envelope**
  - The absence of **a lipid bilayer envelope renders these viruses more resistant** to inactivation by routine surface cleaning and disinfectants, desiccation, and heat
    - May explain their year-round persistence and ability to spread despite universal infection preventive measures
- Therefore, **enhanced infection control strategies may be required** to counter the biophysical robustness of these virions that enable them to survive on surfaces for extended periods

Data analysis

- Compare longitudinal trends in incidence for **2016-2019 vs 2020**
- Analyzed data from the national surveillance system that collects weekly reports from **196 sentinel centers** across the country
- The sentinel centers submitted data on laboratory-confirmed cases
  - Norovirus
  - Rotavirus
  - *Campylobacter* spp.
  - *Clostridium perfringens*
  - *Salmonella* spp.
- Used χ^2 or Fisher exact tests

Impact of NPI on incidences of gastrointestinal pathogens in South Korea, 2015-2019 vs 2020





Park, J Infect Dis 2021

Discussion

- Our findings are in accord with other investigations on the favorable impact of NPIs on **nonpolio enterovirus**, **norovirus**, **rotavirus**, and **shigellosis**.
- These findings suggest that nationwide **NPIs are highly effective in interrupting person-to-person transmission of gastrointestinal pathogens**

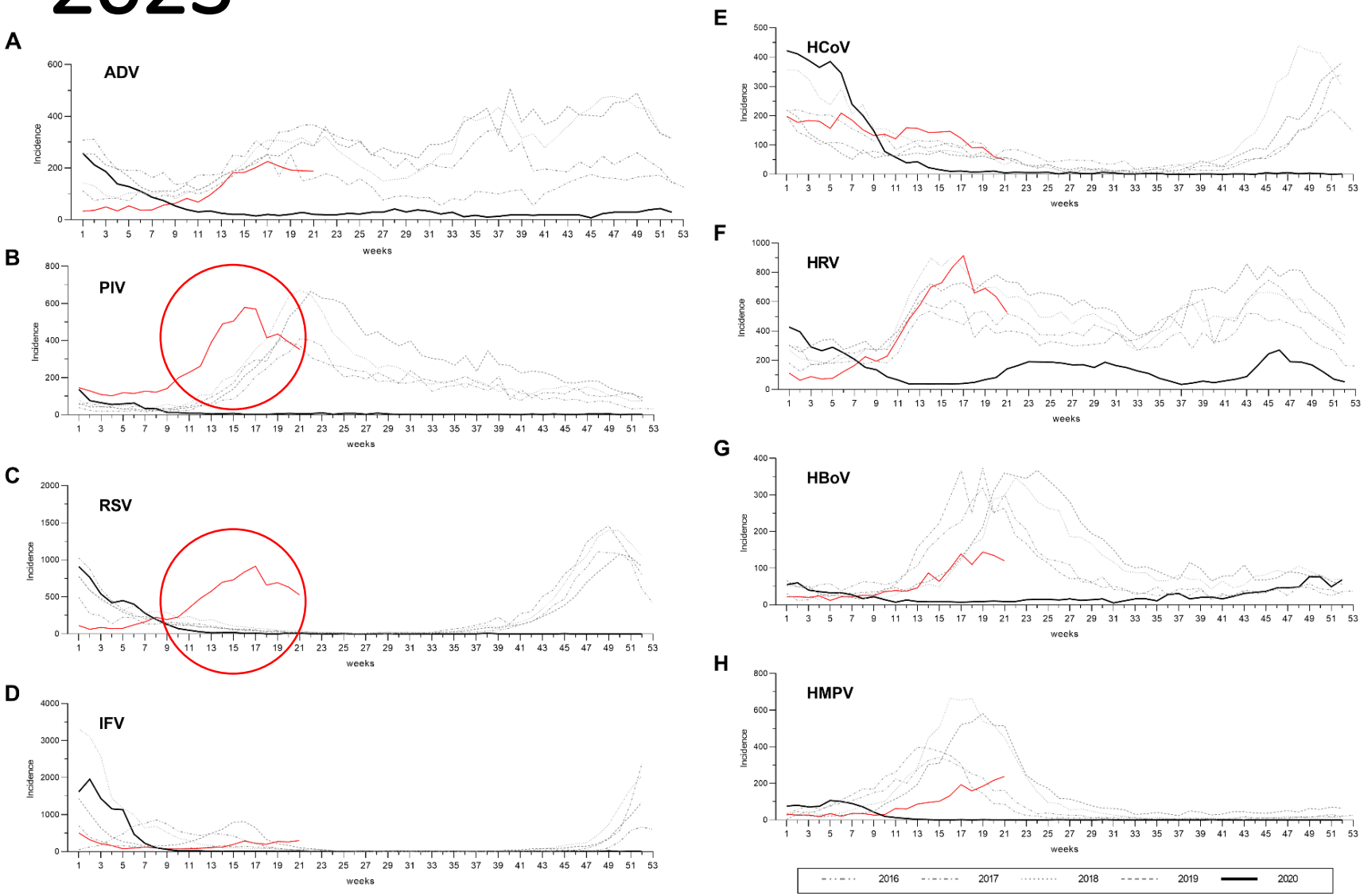
Conclusion

- **NPIs had the added benefit of reducing** the activity of several common **enveloped respiratory viruses**
  - On the other hand, the nonenveloped respiratory viruses (ADV, HRV, and HBoV) continued to be detected during 2020
- **Enhanced interventions targeting nonenveloped viruses are required** to mitigate their ongoing transmission.

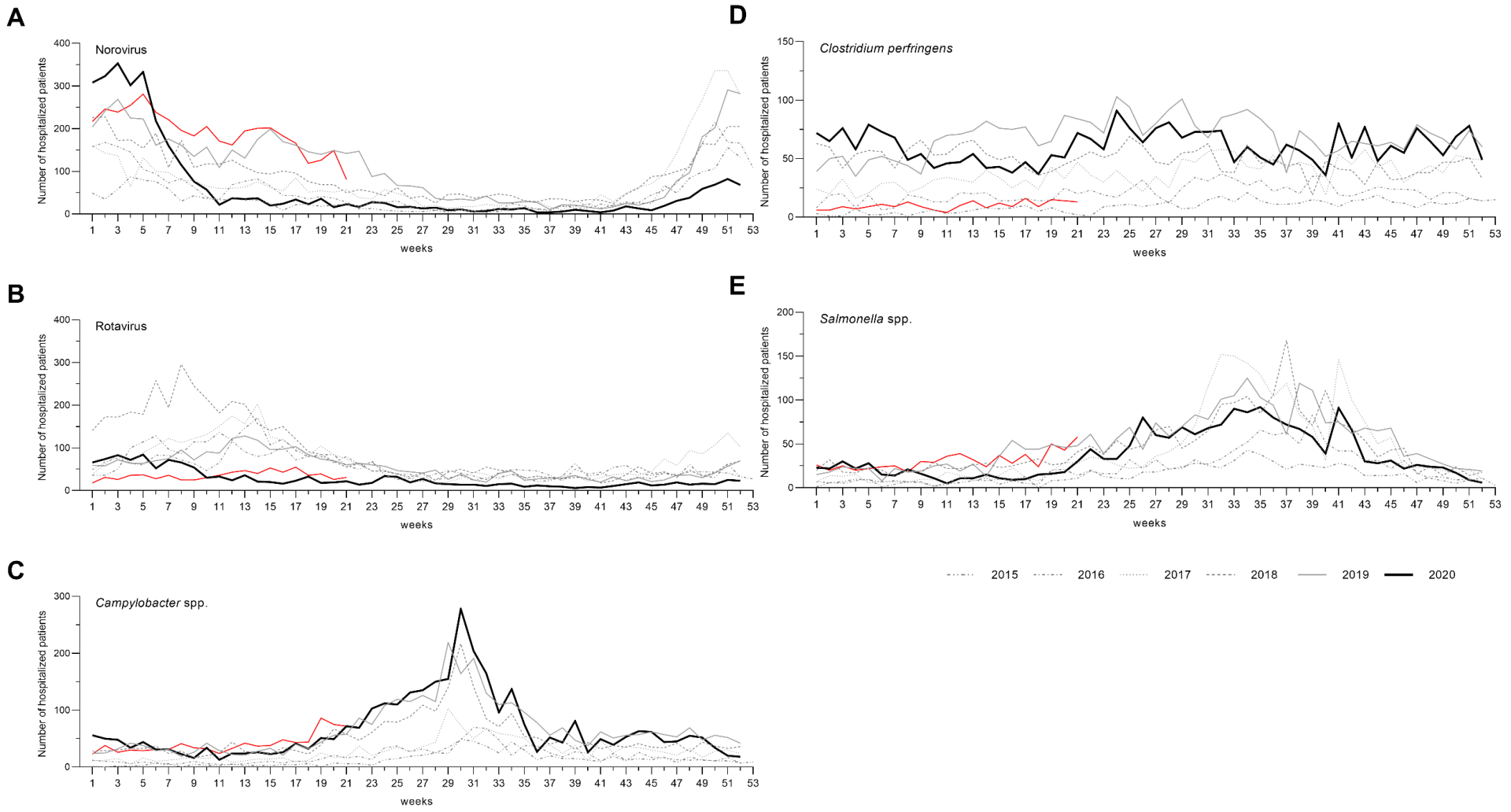
Conclusion

- NPIs have the greatest **impact on pathogens** that are **transmitted persons-to-person**
  - whereas the effect was **smaller for foodborne bacteria**

Incidence of respiratory viruses in 2023



Incidences of gastrointestinal pathogens in 2023



Thank you for your attention