Chasing COVID-19 pandemic through modeling

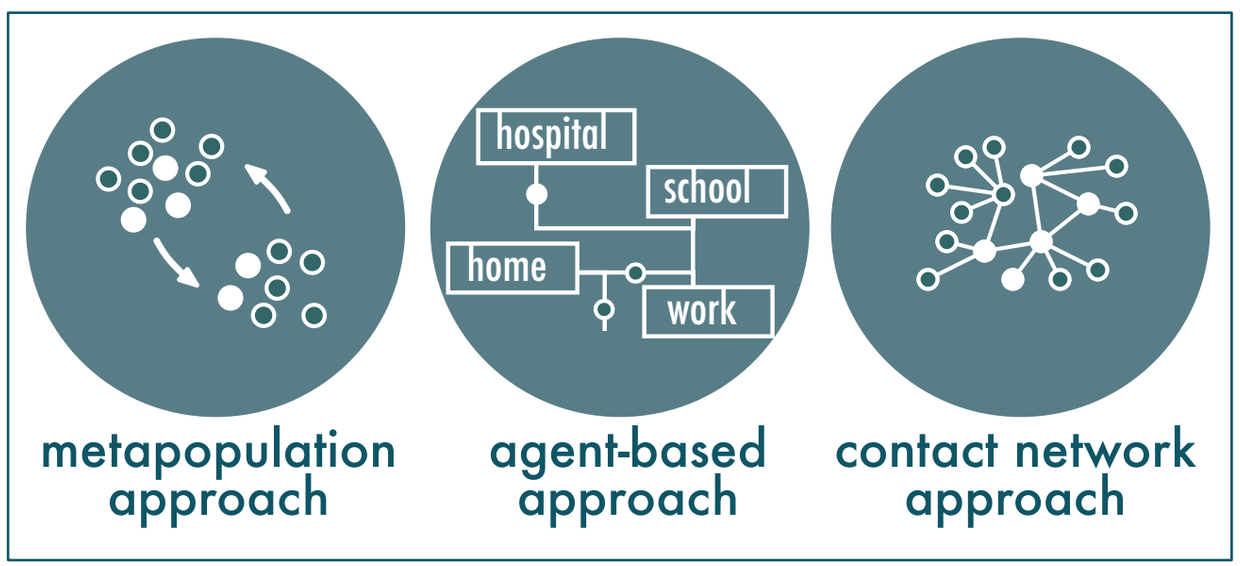
Vittoria Colizza
INSERM
Sorbonne Université
Paris, France

EPIcx lab: www.epicx-lab.com

Infectious disease epidemics:

- tracking
- preparedness
- response

Mathematical & Computational epidemiology



Digital epidemiology

- contacts
- mobility
- demography
- health

Modeling for outbreak response

- few/poor data
- no time
- many assumptions
- evolving landscape
- scarce resources
- data interpretation

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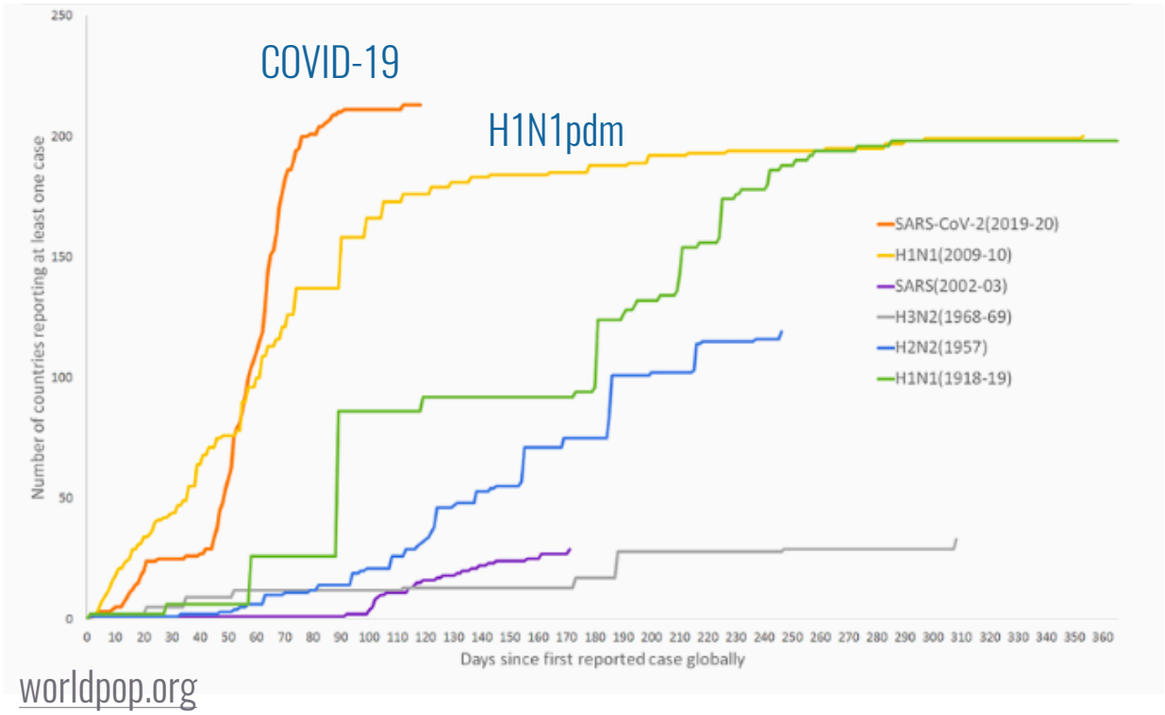
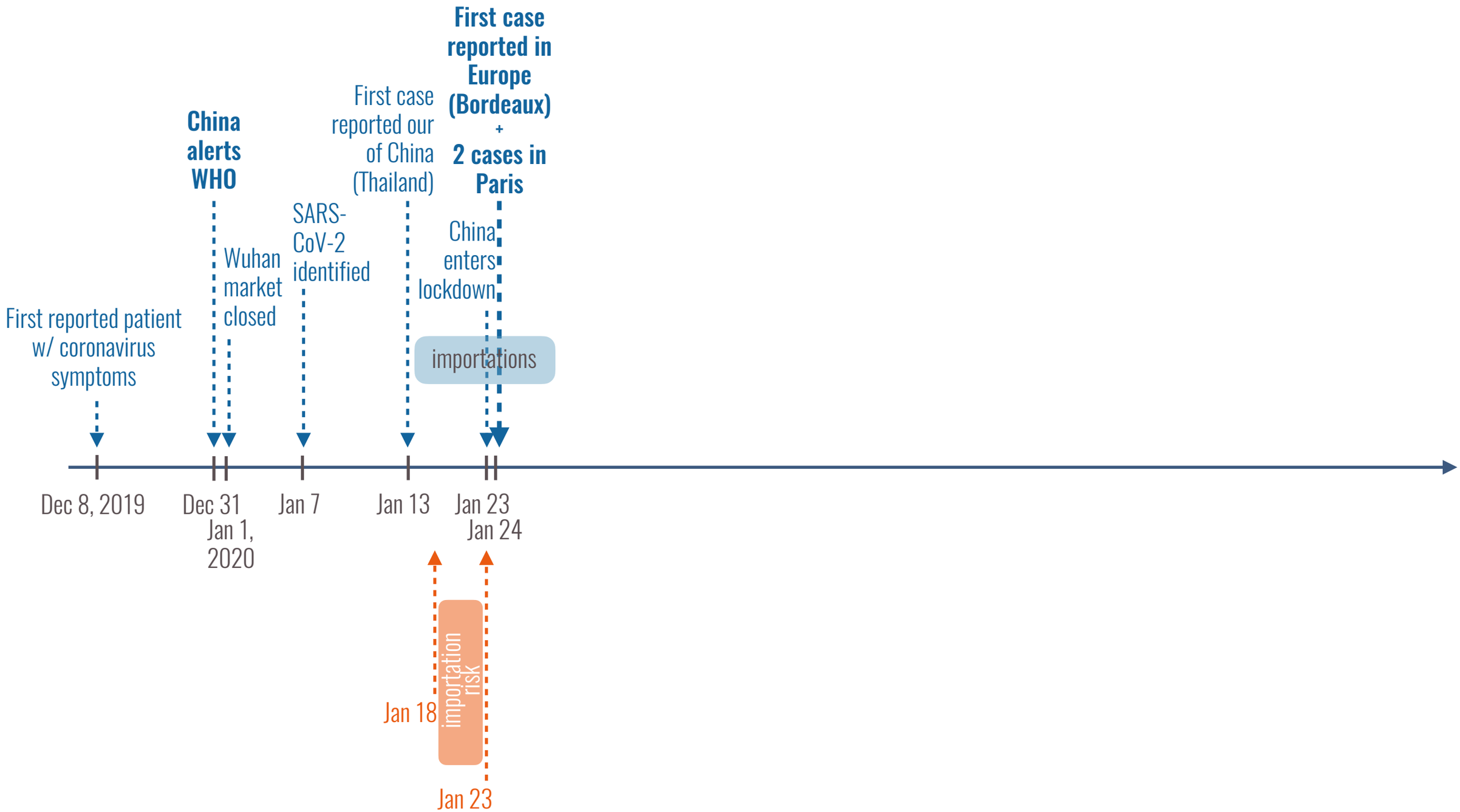


worldpop.org

COVID-19 timeline vs. our timeline

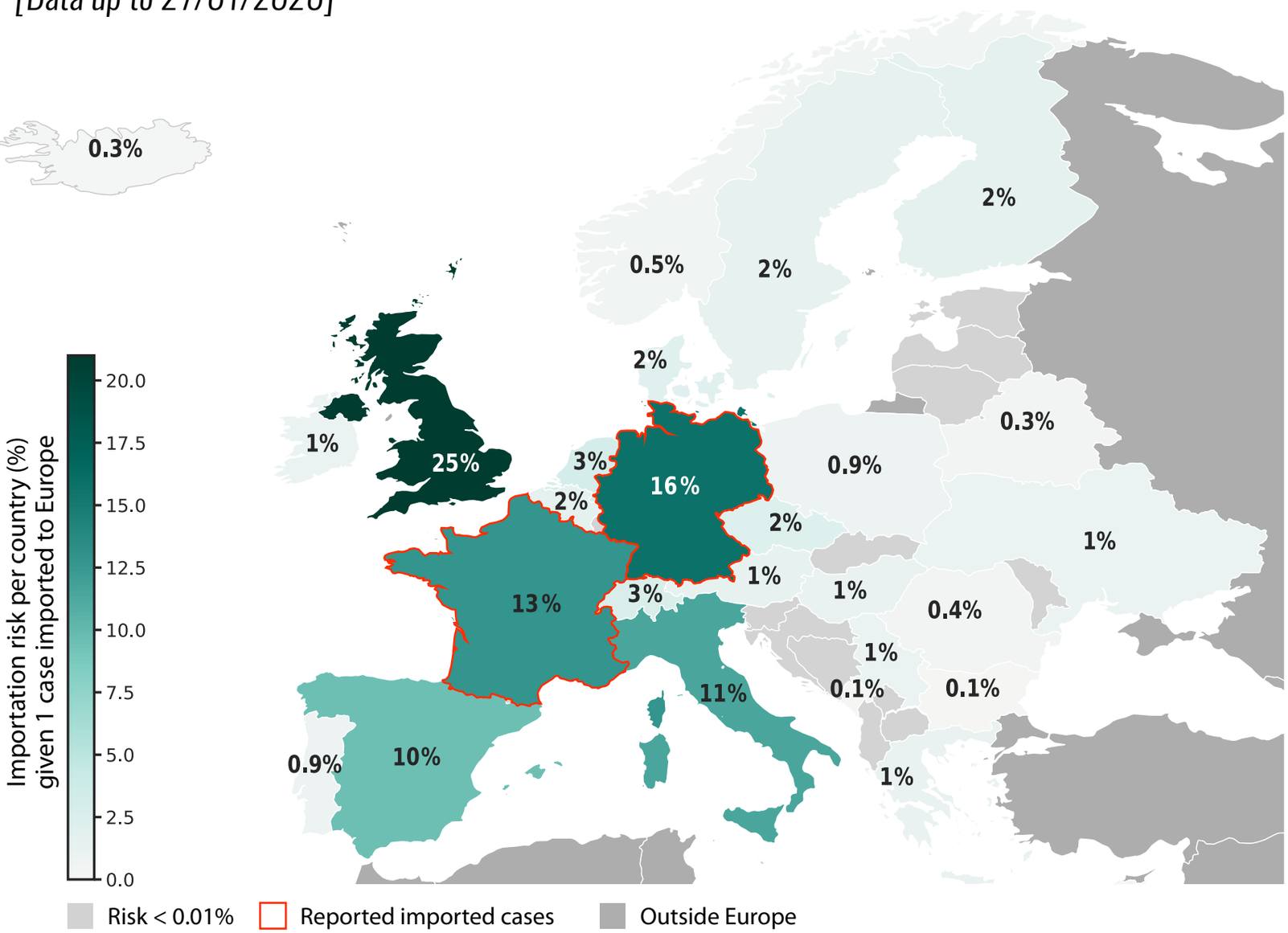


#1. IMPORTATION

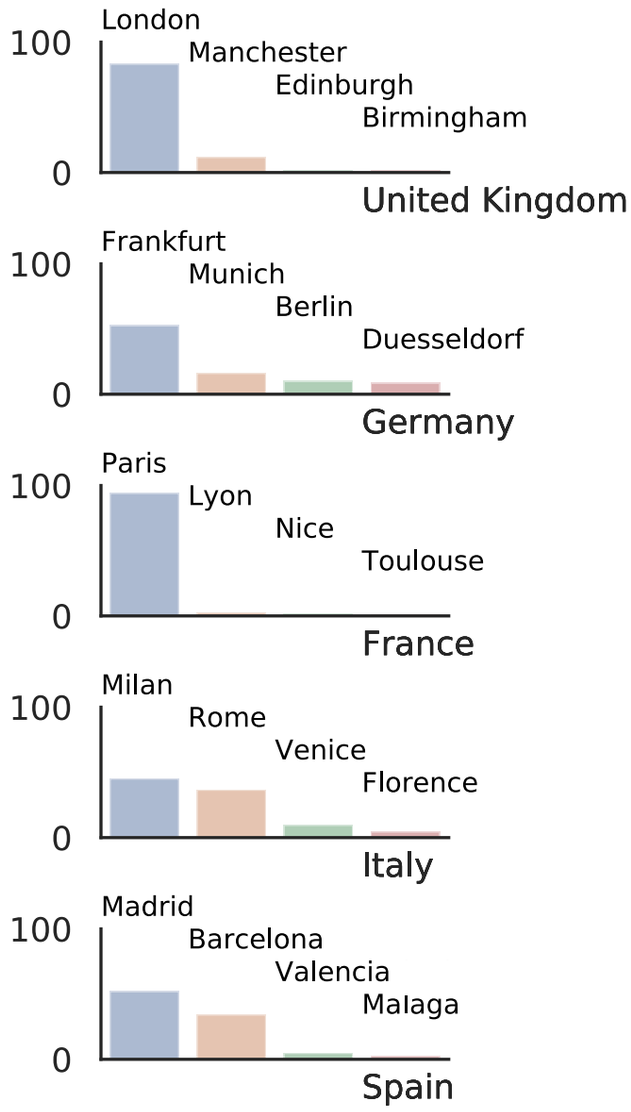
Importation risk

Risk of importation per country, given 1 case imported to Europe

[Data up to 27/01/2020]



Relative risk by airport*



*Only the top 4 airports with largest contributions are shown

Pullano et al Eurosurveillance 2020

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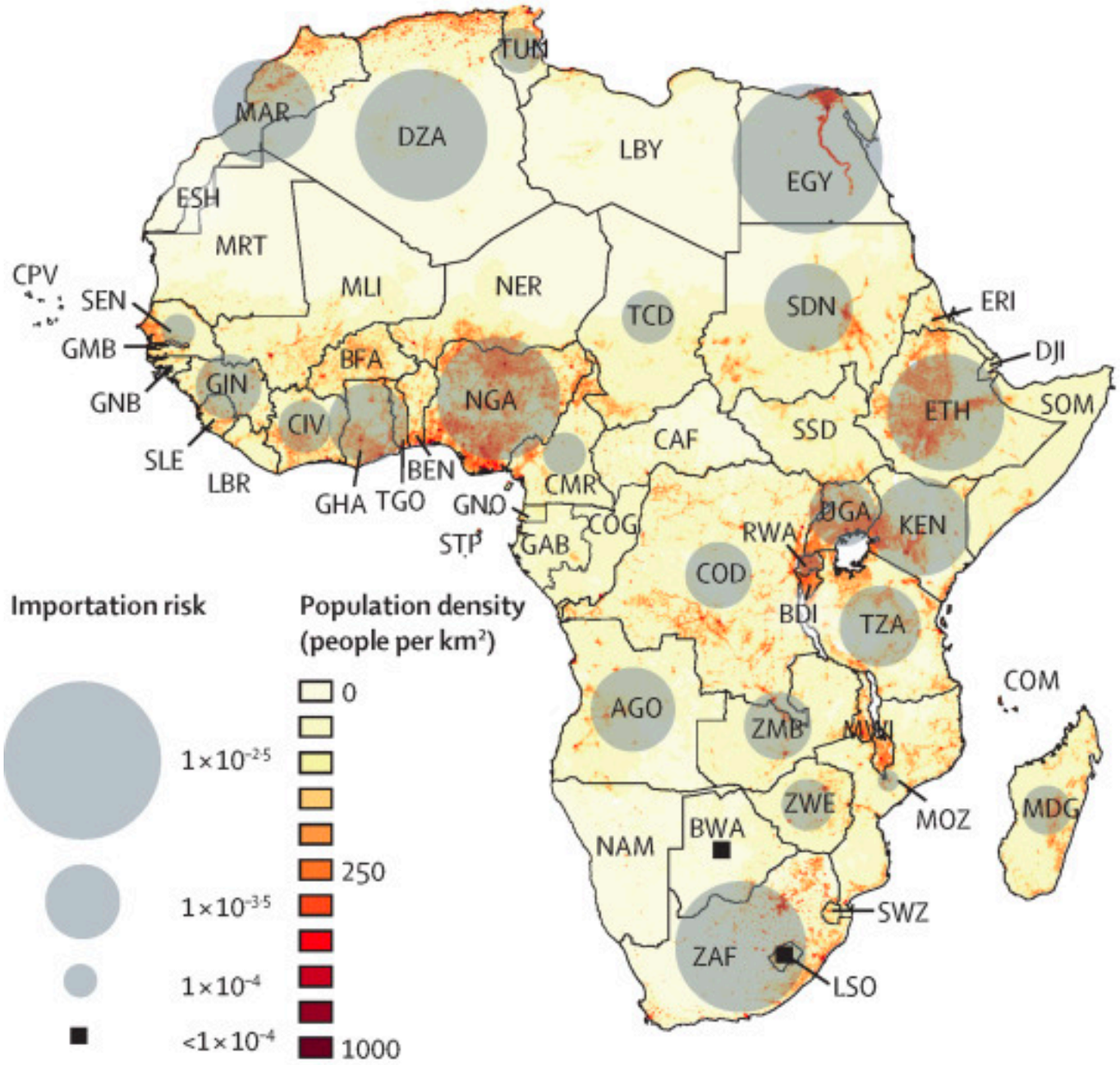
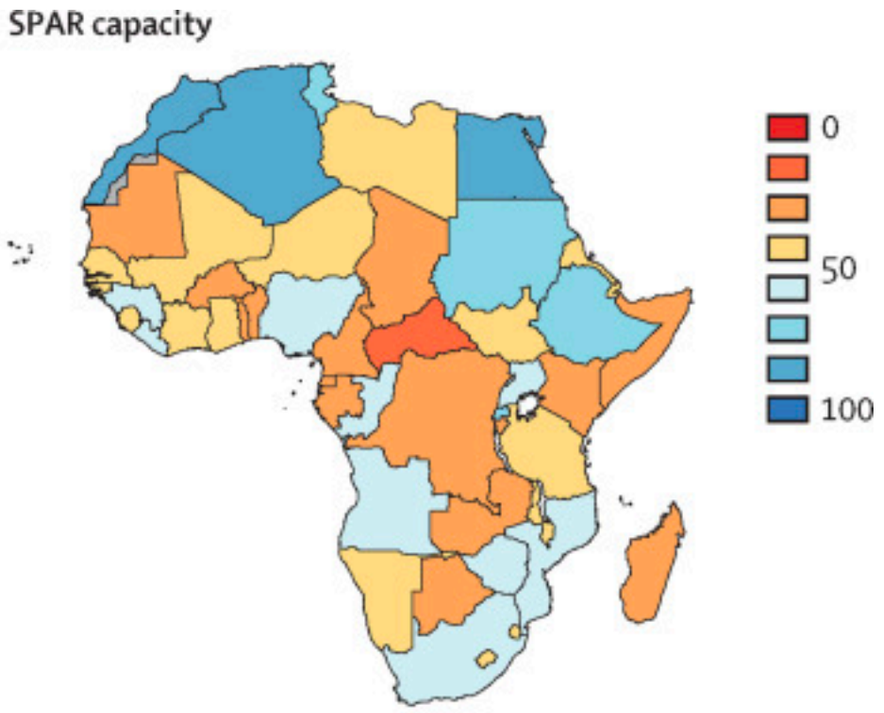
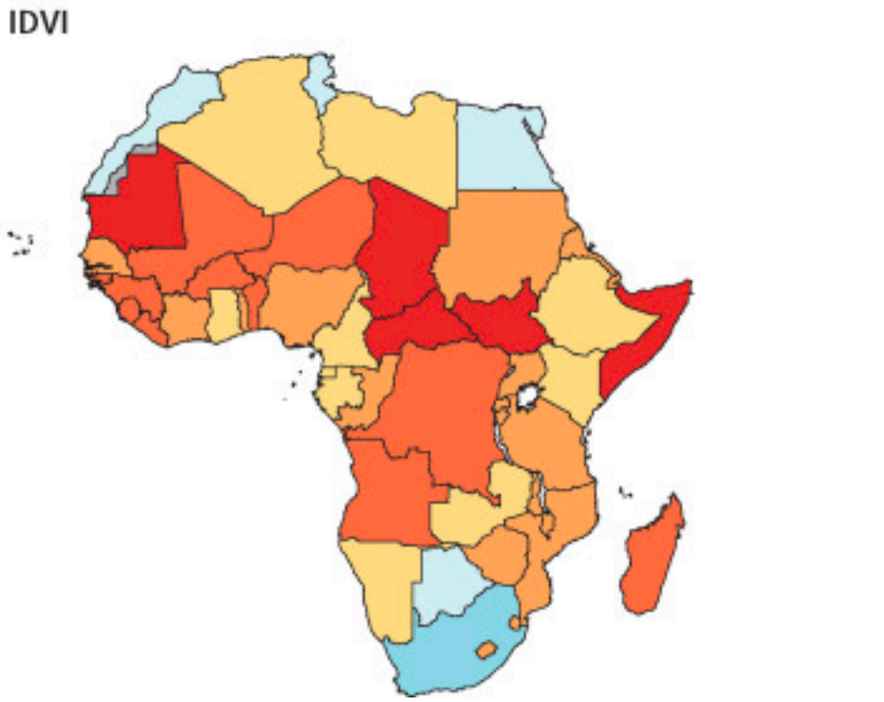
Preparedness

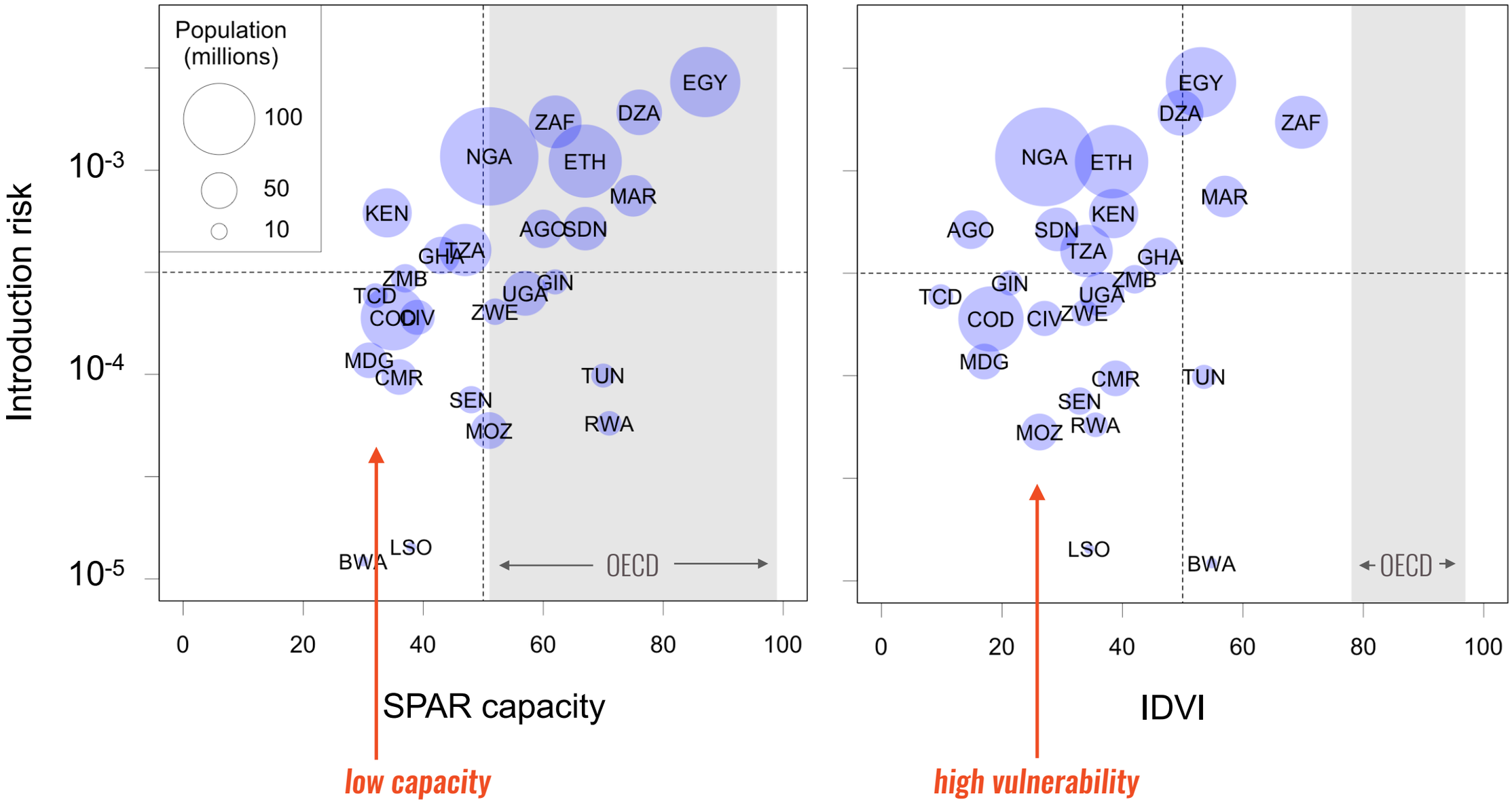






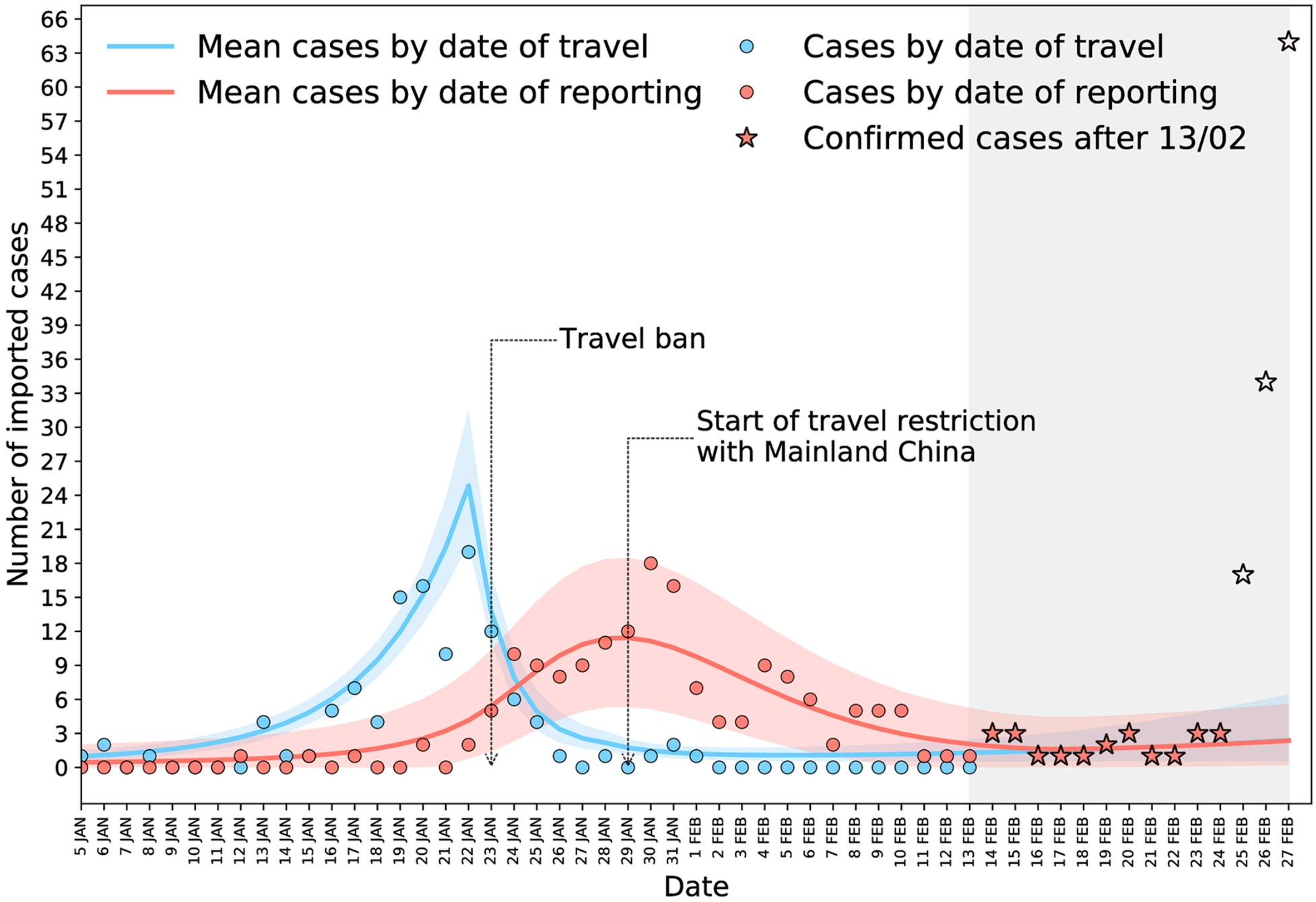
Gilbert et al Lancet 2020

Preparedness



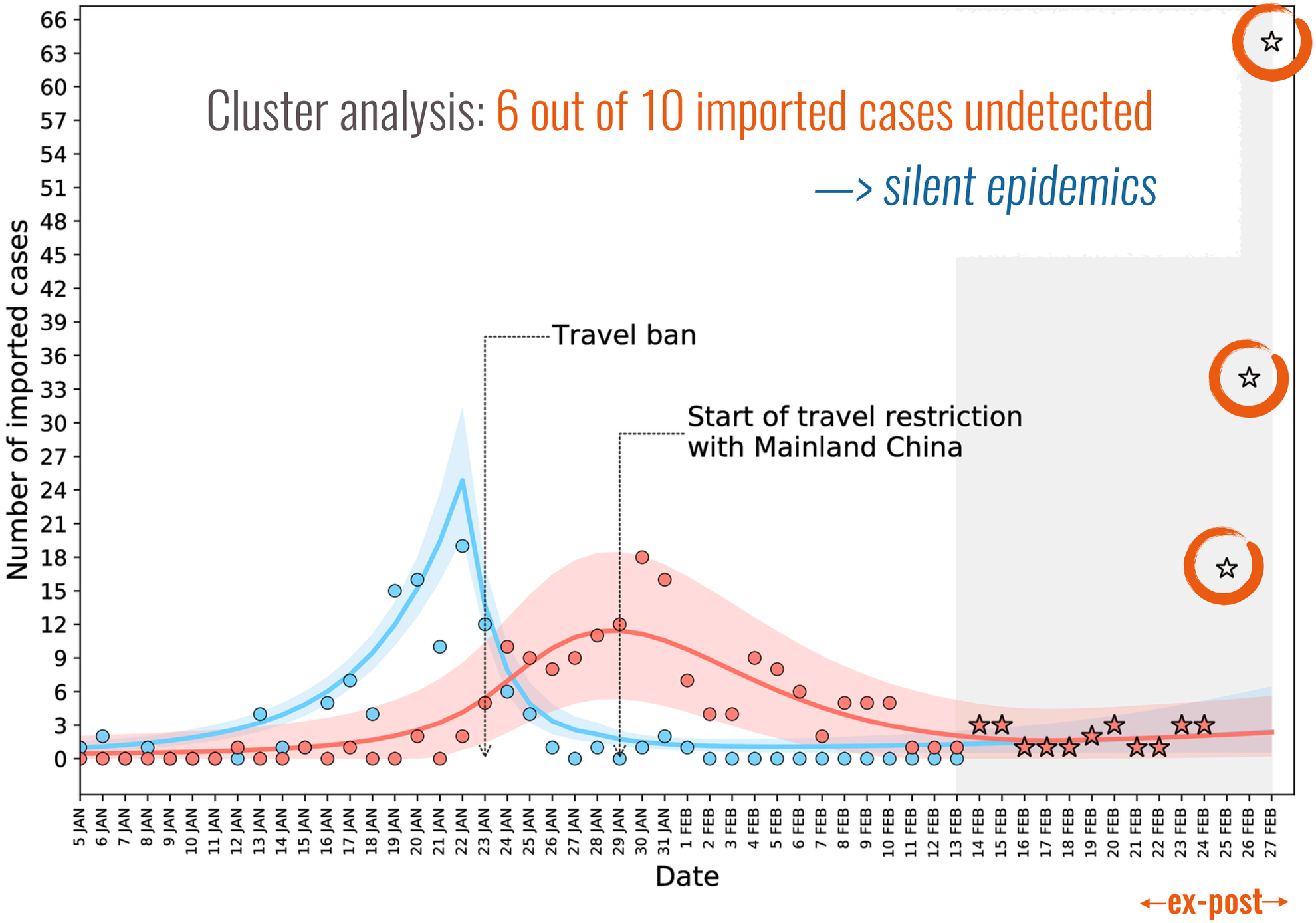
Gilbert et al Lancet 2020

First 288 cases out of China



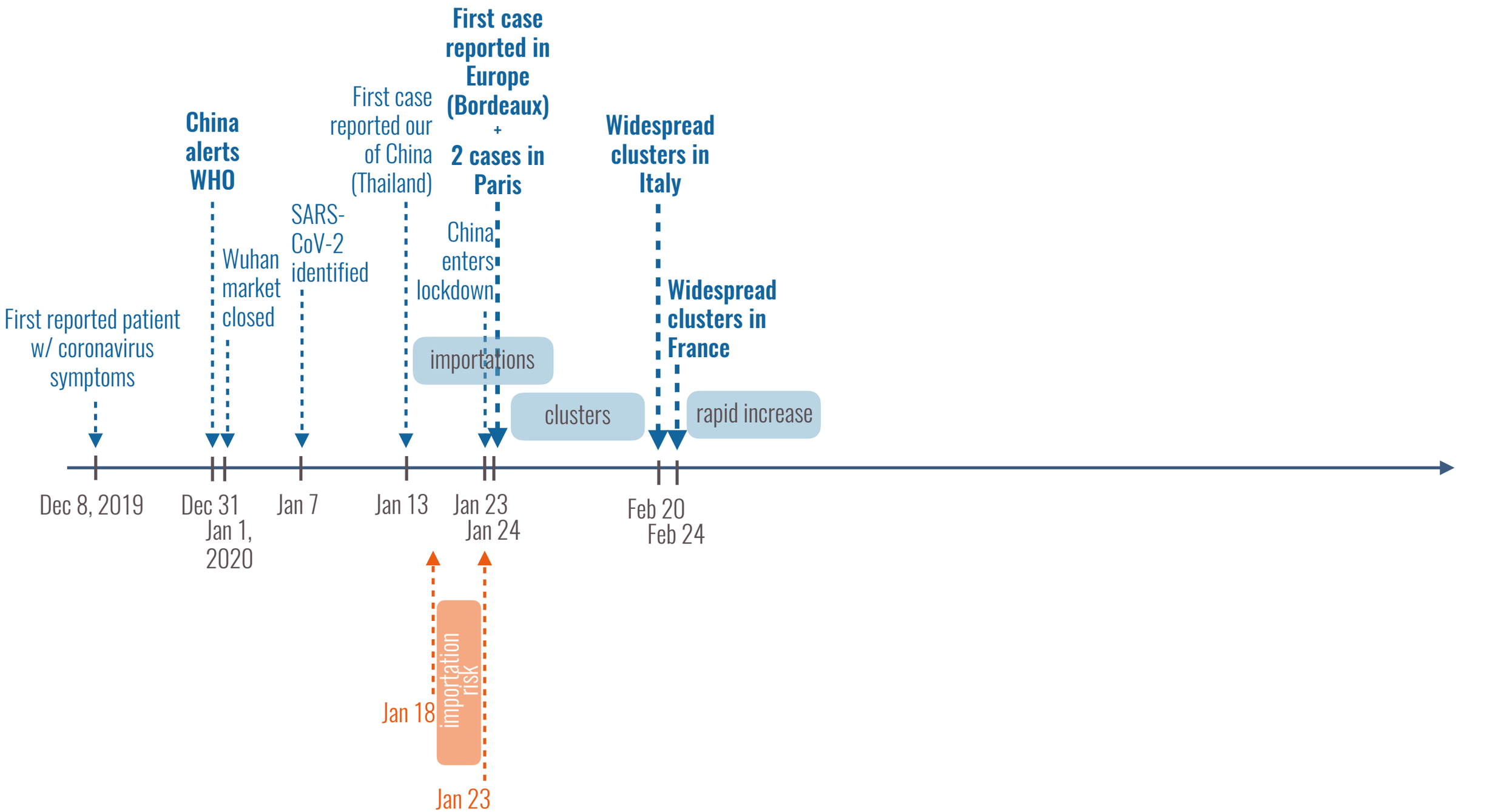
Pinotti et al PLOS Medicine 2020

Risk of silent epidemics



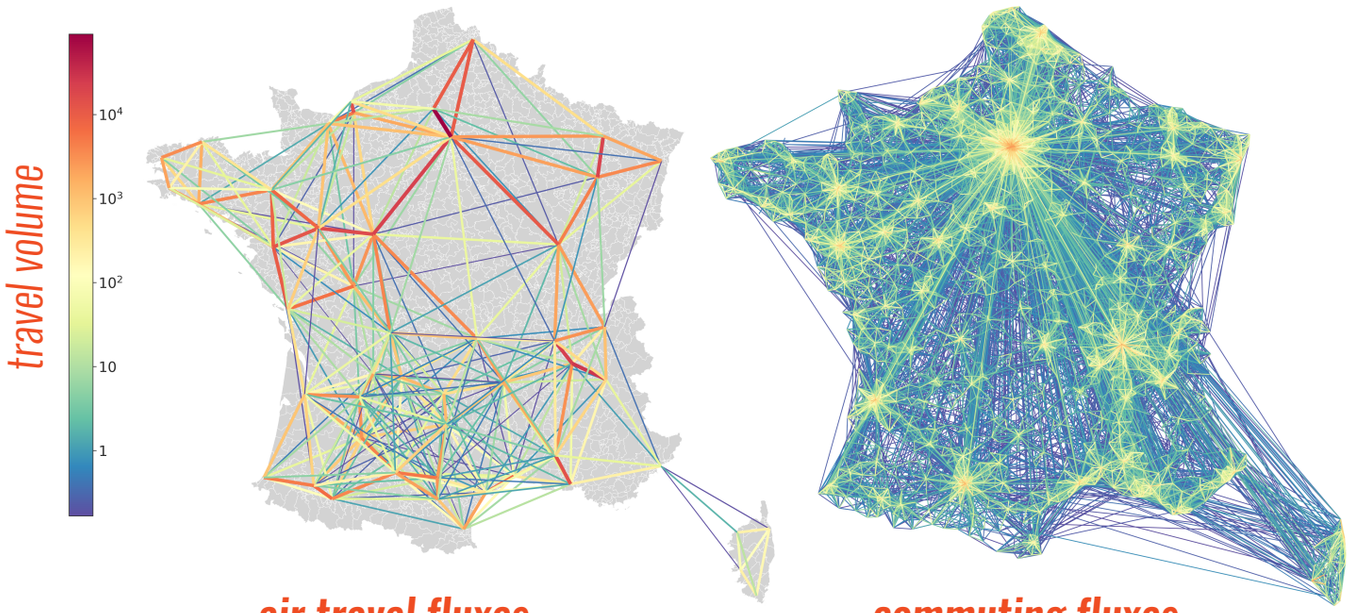
Pinotti et al PLOS Medicine 2020

COVID-19 timeline vs. our timeline



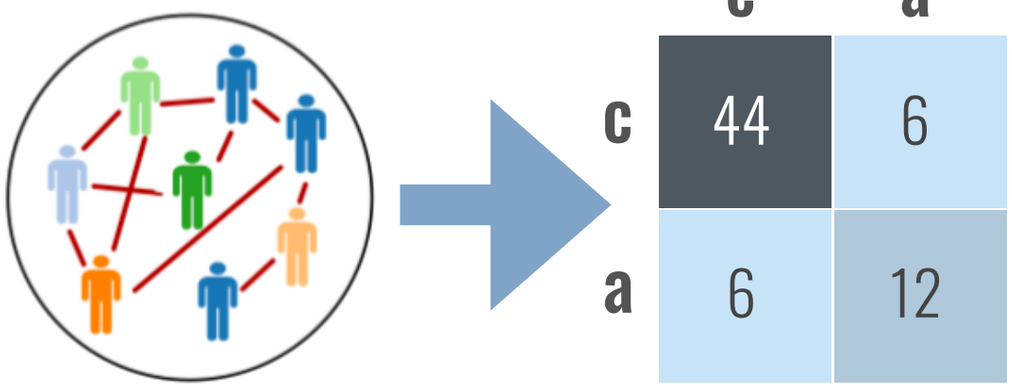
#2. CONTROL

Models are not ready/fast enough



air travel fluxes

commuting fluxes

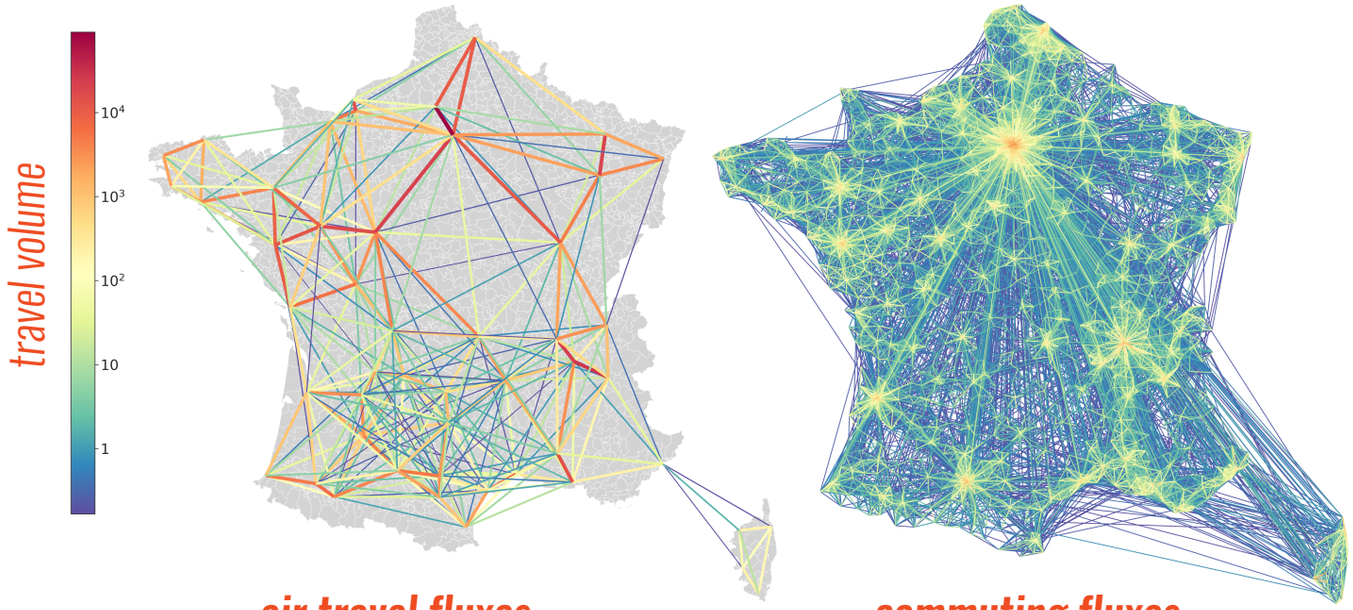


contacts: *week/weekend*
regular/holiday
home/school/workplace

De Luca et al. BMC Inf Dis 2018

Boelle et al Eurosurveillance 2020

Models are not ready/fast enough



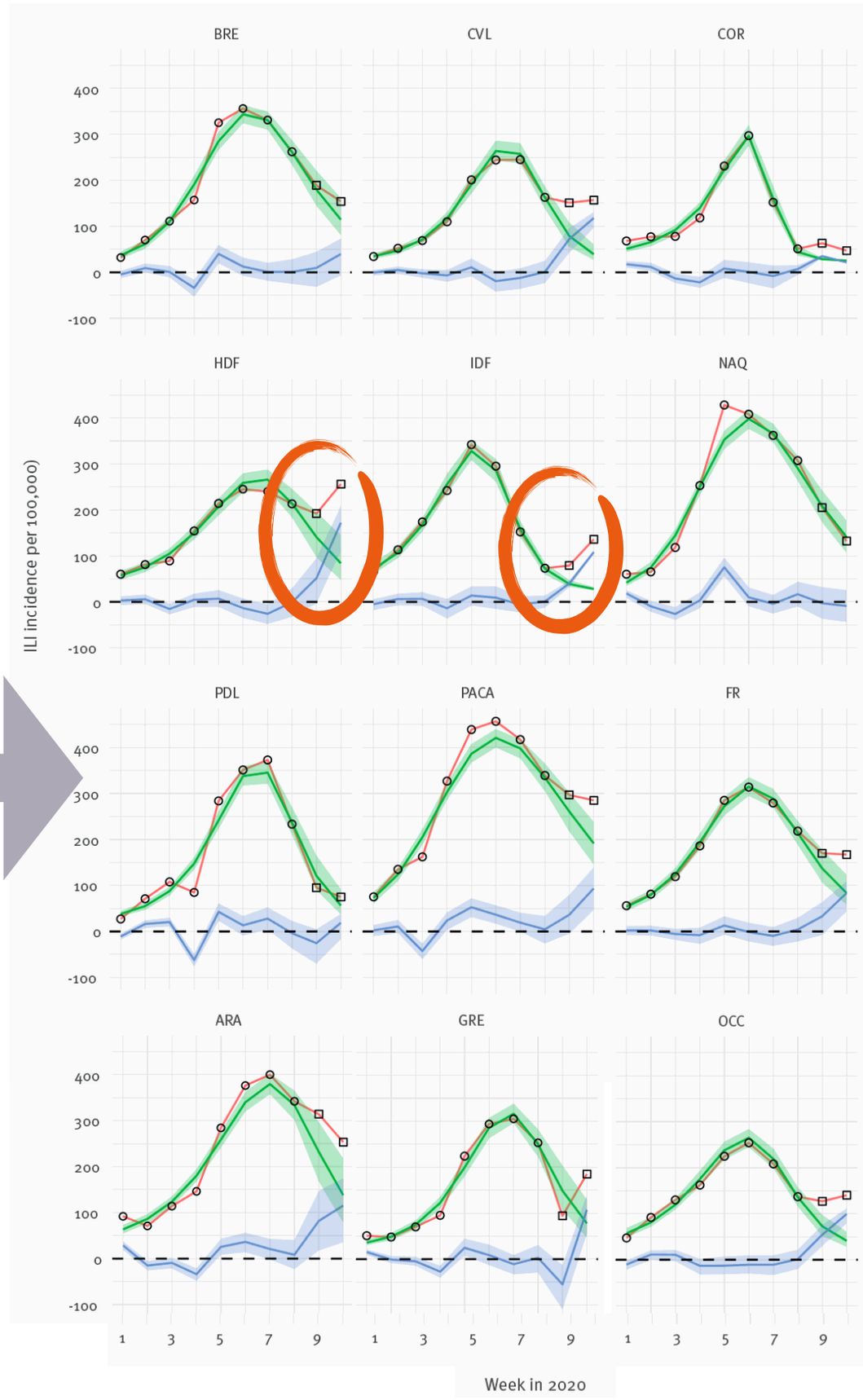
air travel fluxes

commuting fluxes

	c	a
c	44	6
a	6	12

contacts: *week/weekend*
regular/holiday
home/school/workplace

De Luca et al. BMC Inf Dis 2018

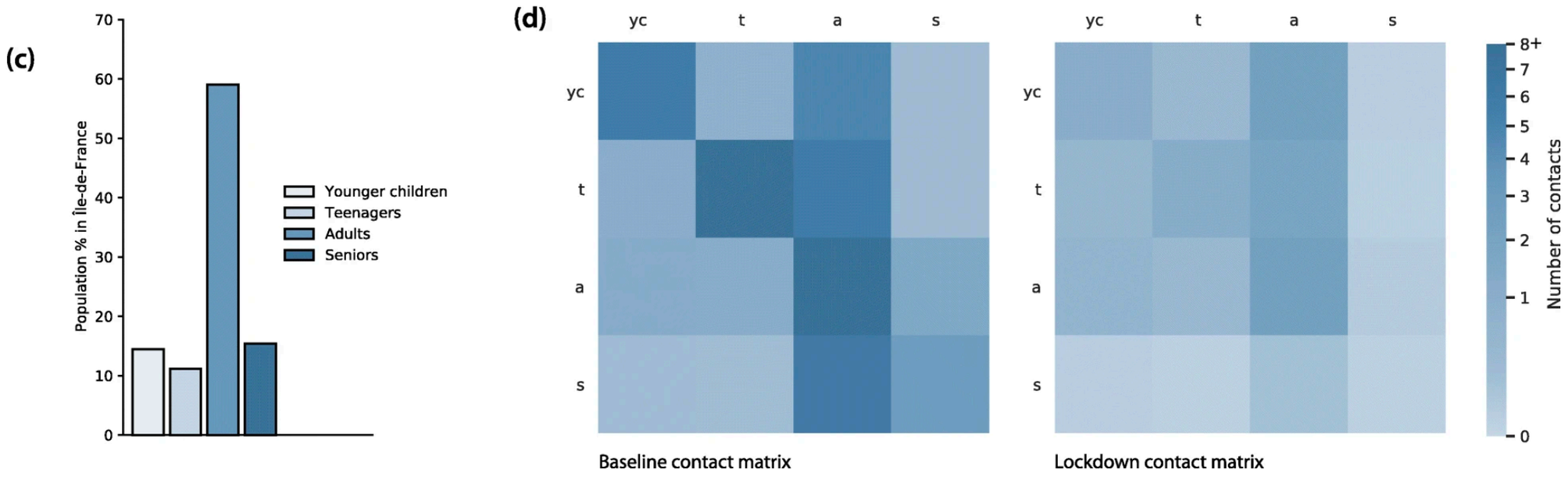


Boelle et al Eurosurveillance 2020

Simplifying: Ile-de-France

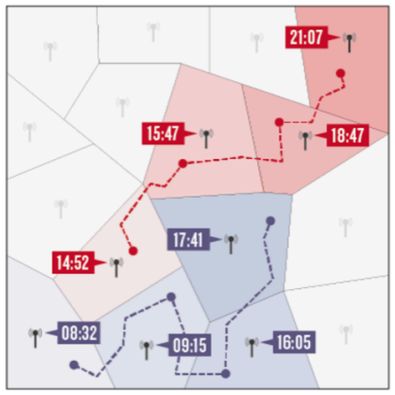
	School closure	Telework (individuals not going to work)	Senior isolation	Closure non-essential activities	Case isolation
Lockdown	Yes; 100% contacts of children on transports removed	70% [39]	Yes, with 90% contact reduction	Yes, 100% closure	No

mobility data

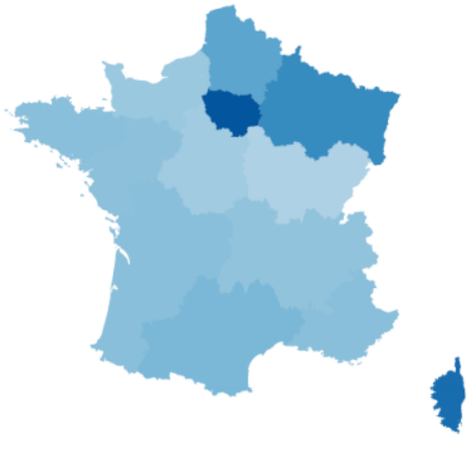


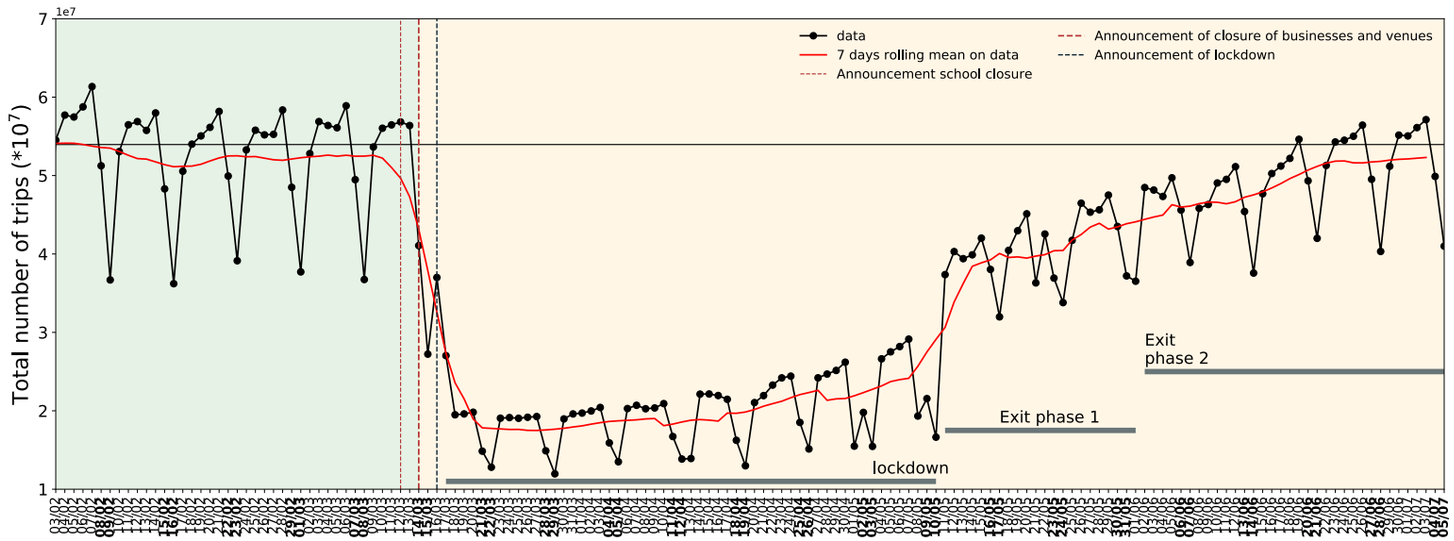
Di Domenico et al BMC Medicine 2020

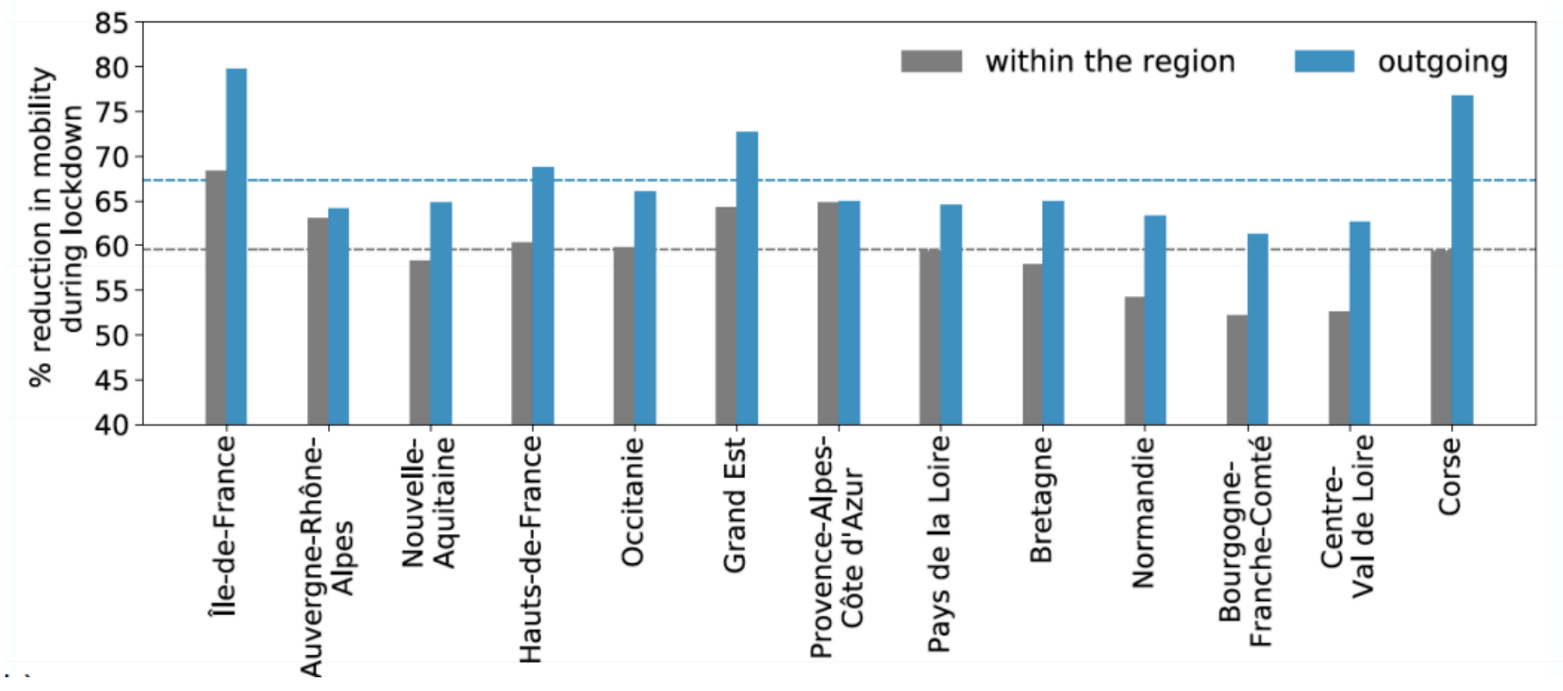
Mobility



Maximen 2019







Pullano et al https://www.medrxiv.org/content/10.1101/2020.05.29.20097097v1

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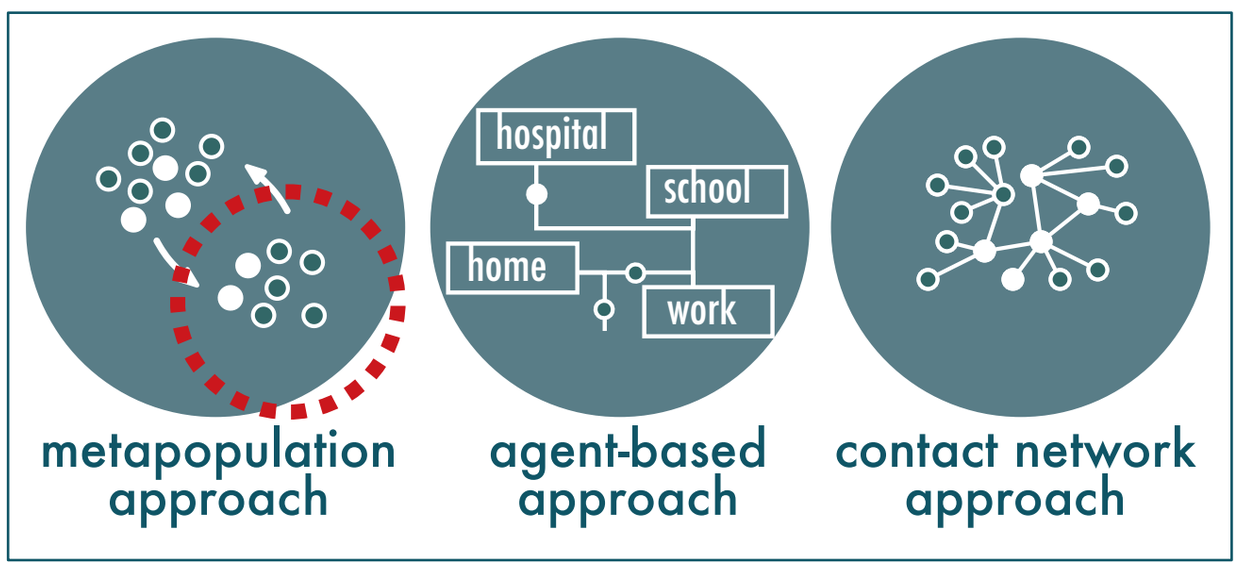
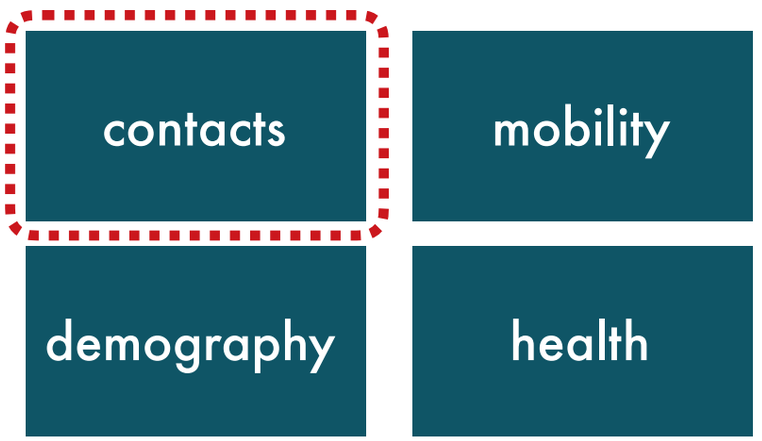
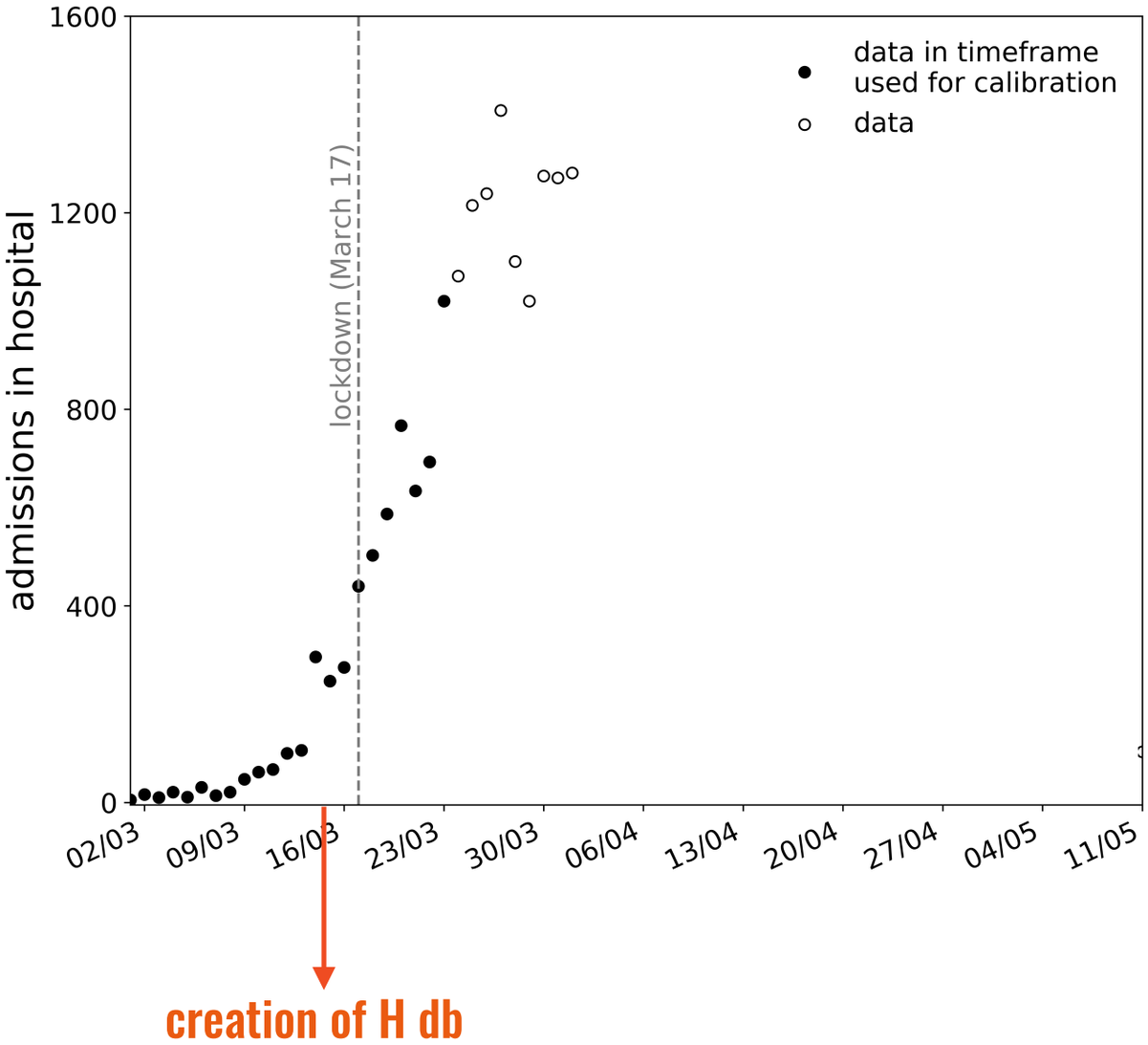
Mathematical & Computational epidemiology

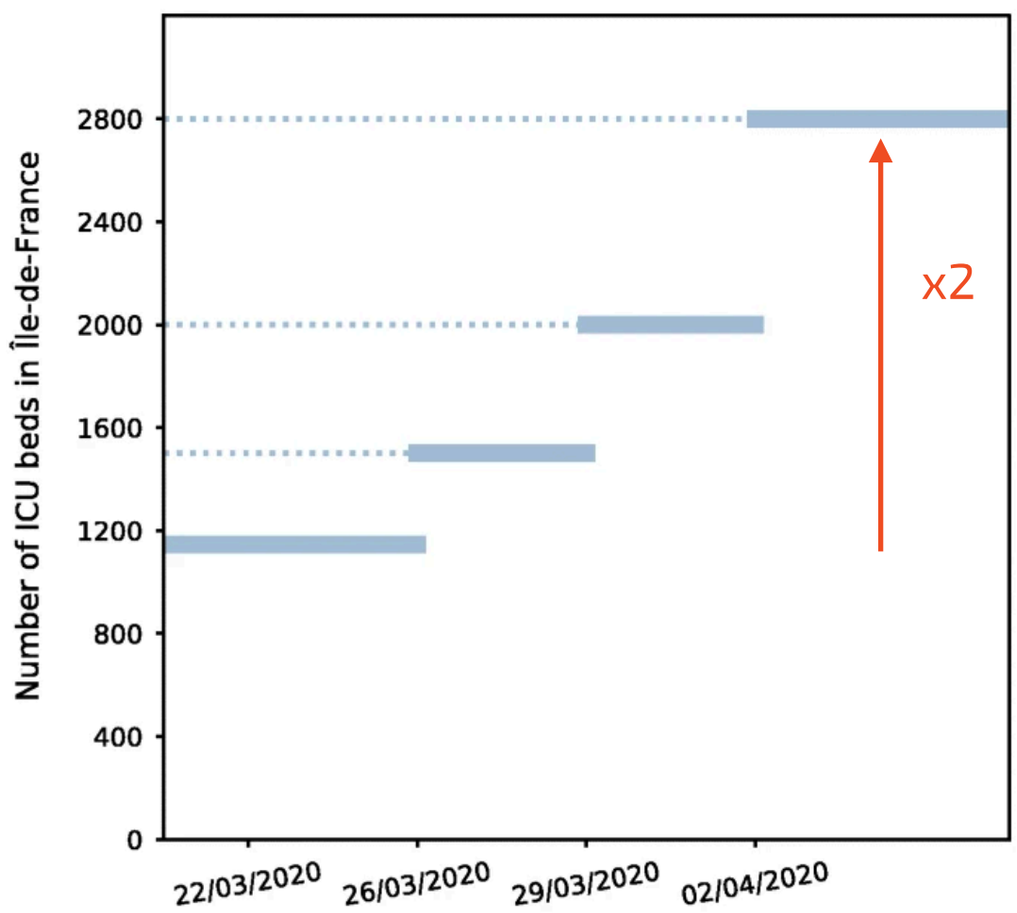


Digital epidemiology



Data are not ready/fast enough





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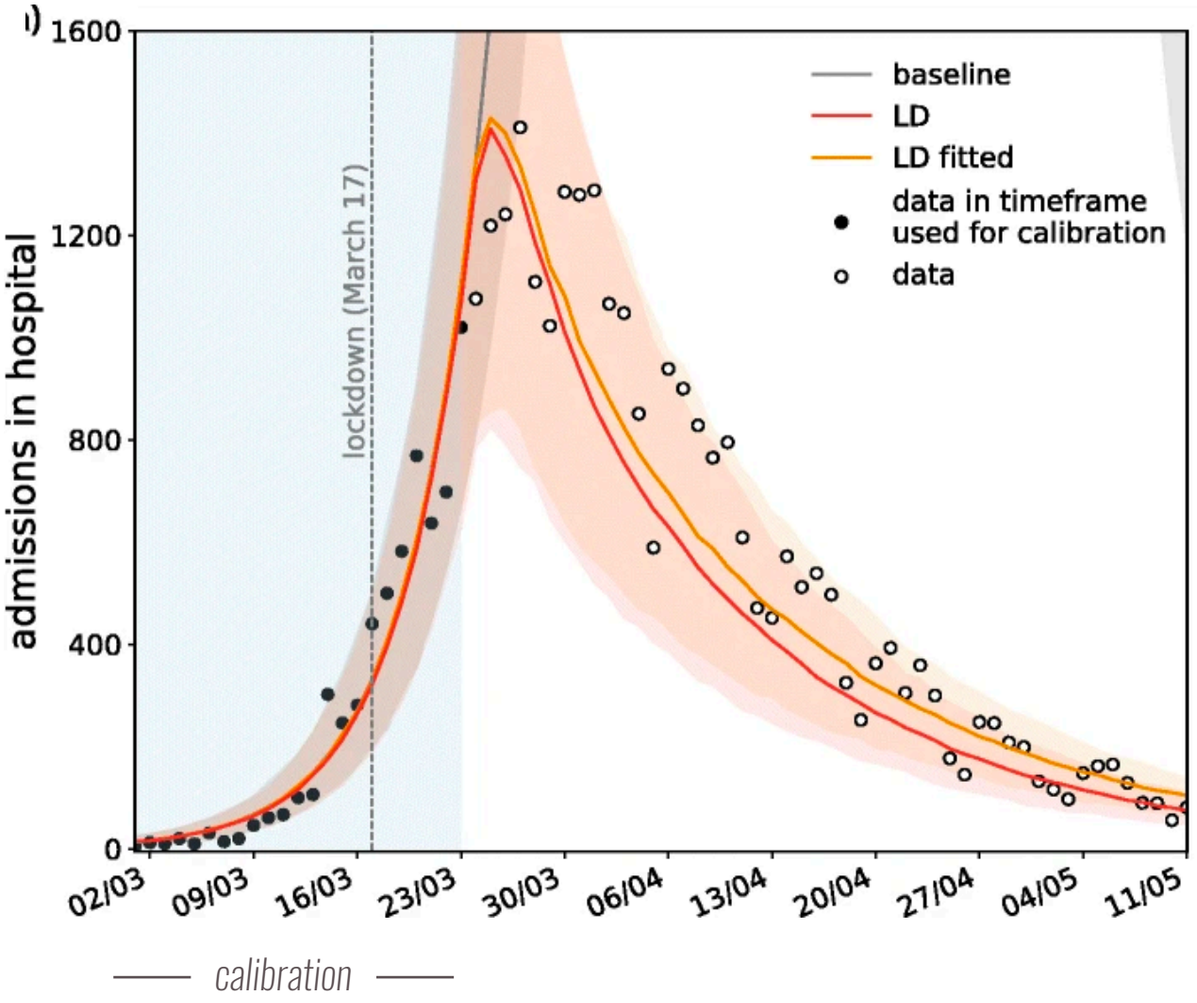
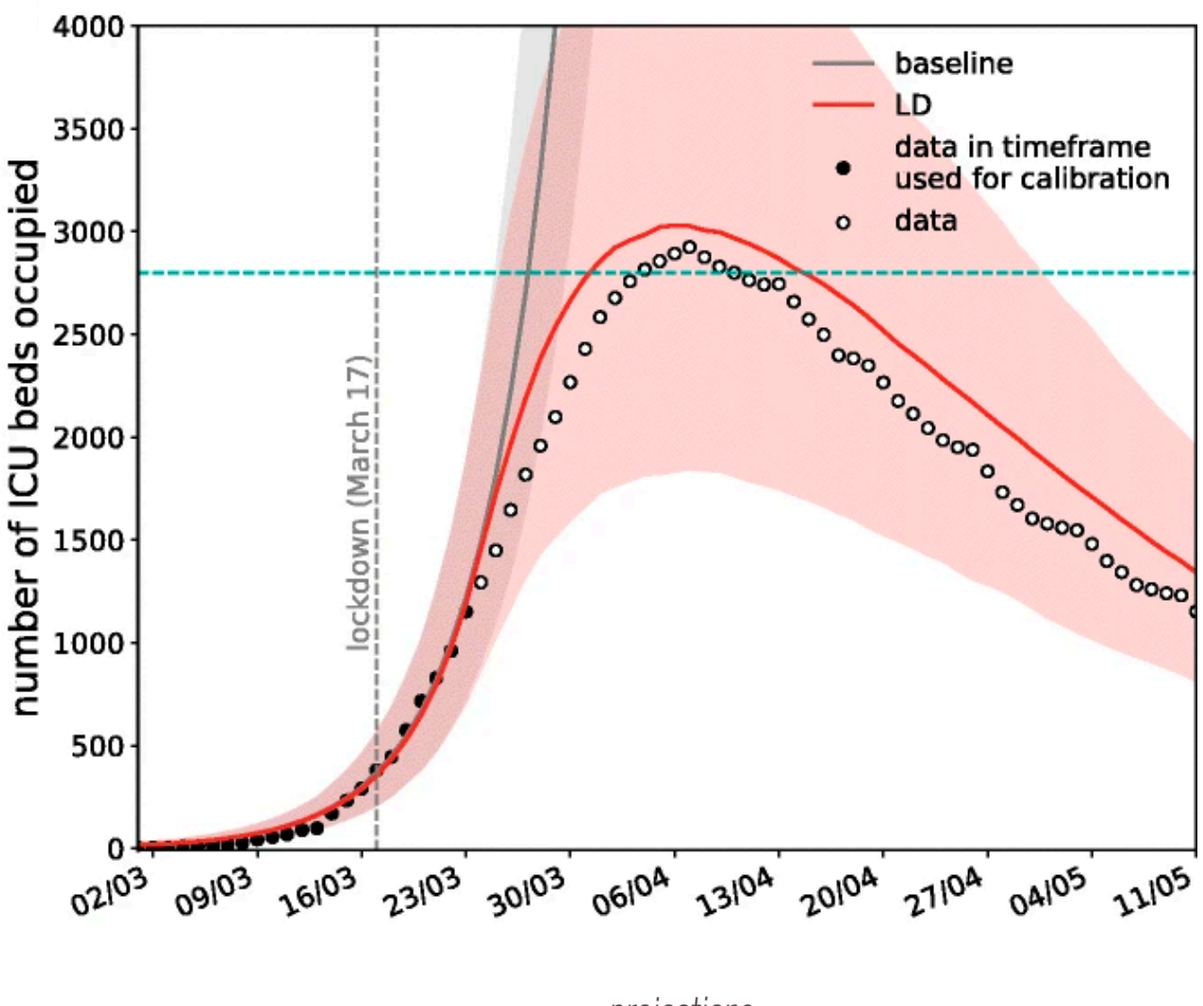
R_0 >> 2-2.5



calibration



projections

R_0=3.18 [3.09, 3.24], R_{LD}=0.68 [0.66, 0.69]

81% reduction of contacts

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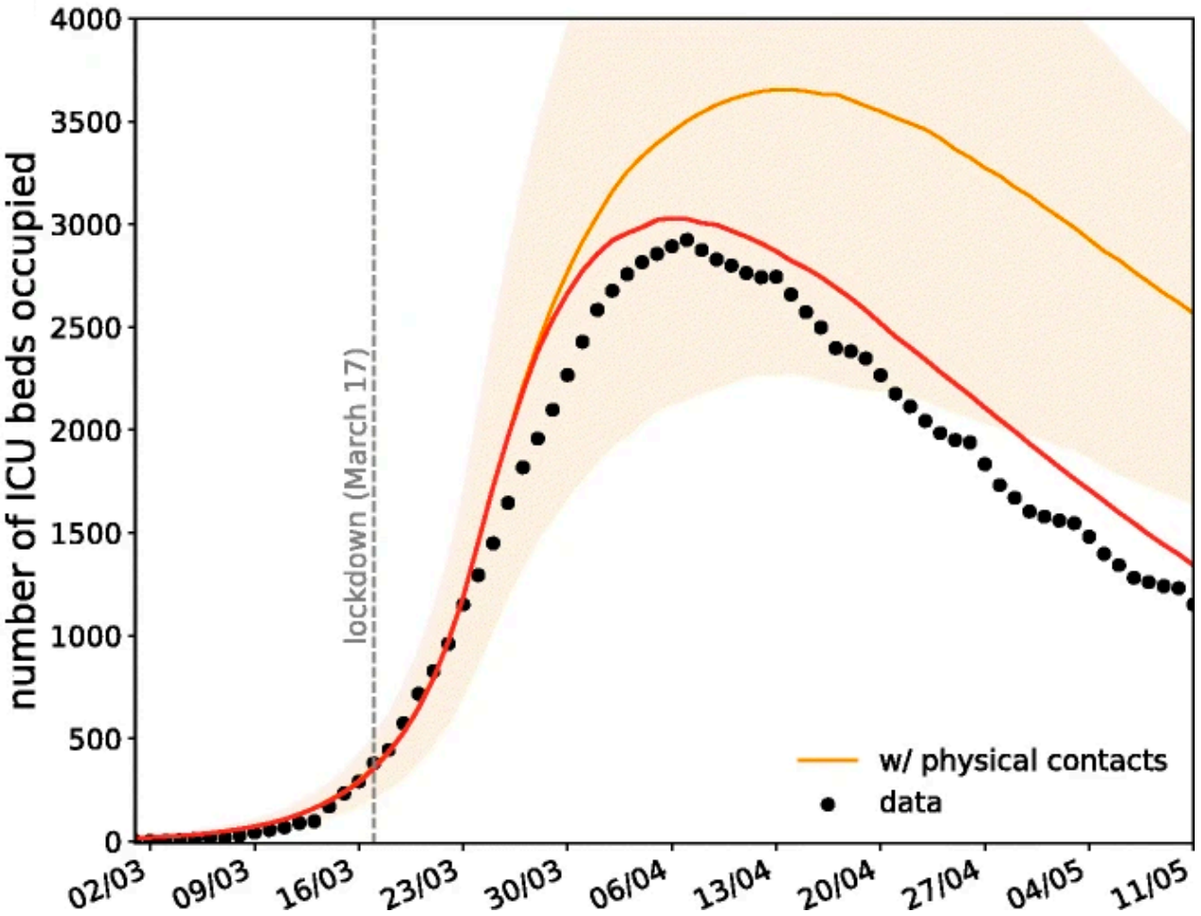
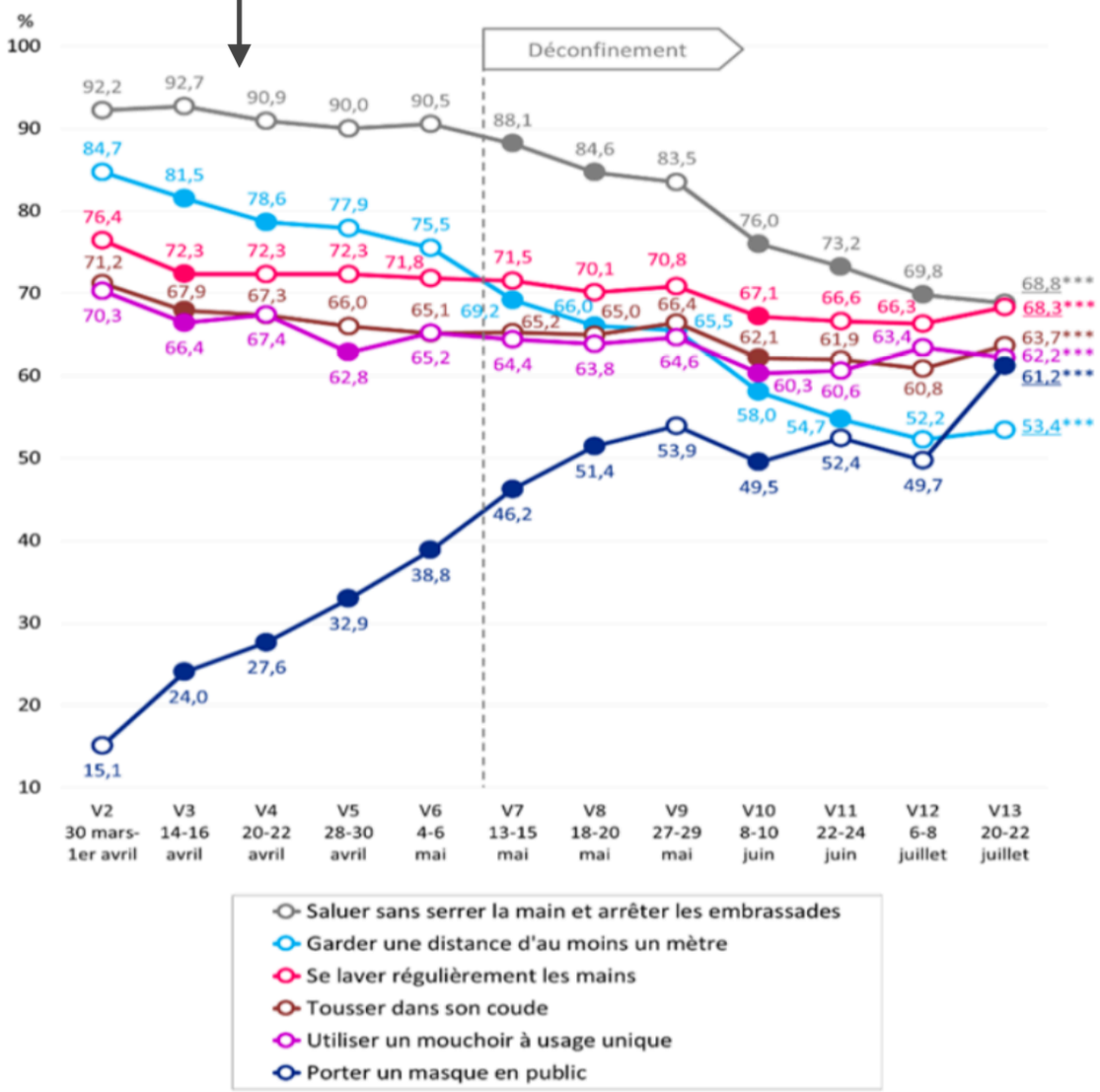
Physical contacts



% avoiding physical contacts



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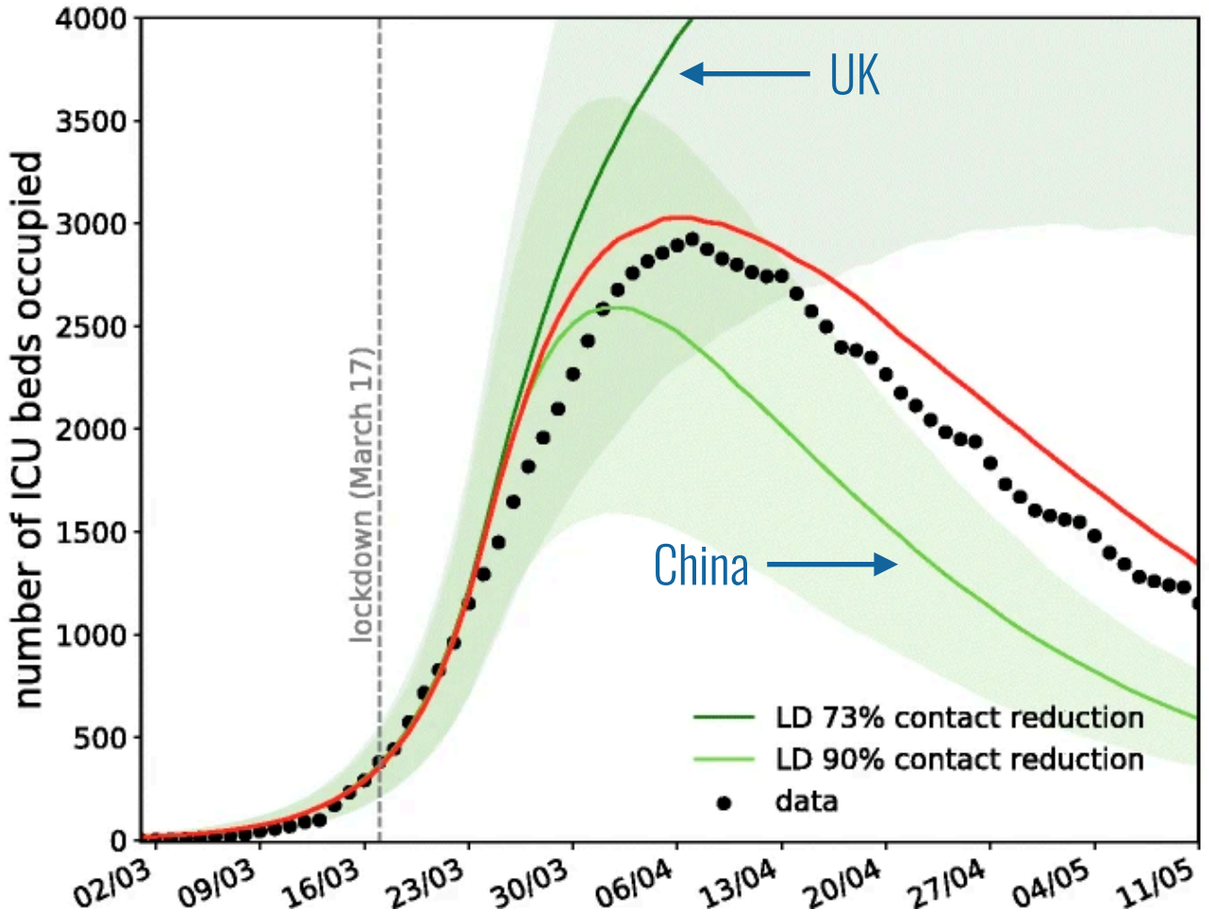
Lockdown *"as in"* China or UK



Jarvis et al BMC Medicine 2020

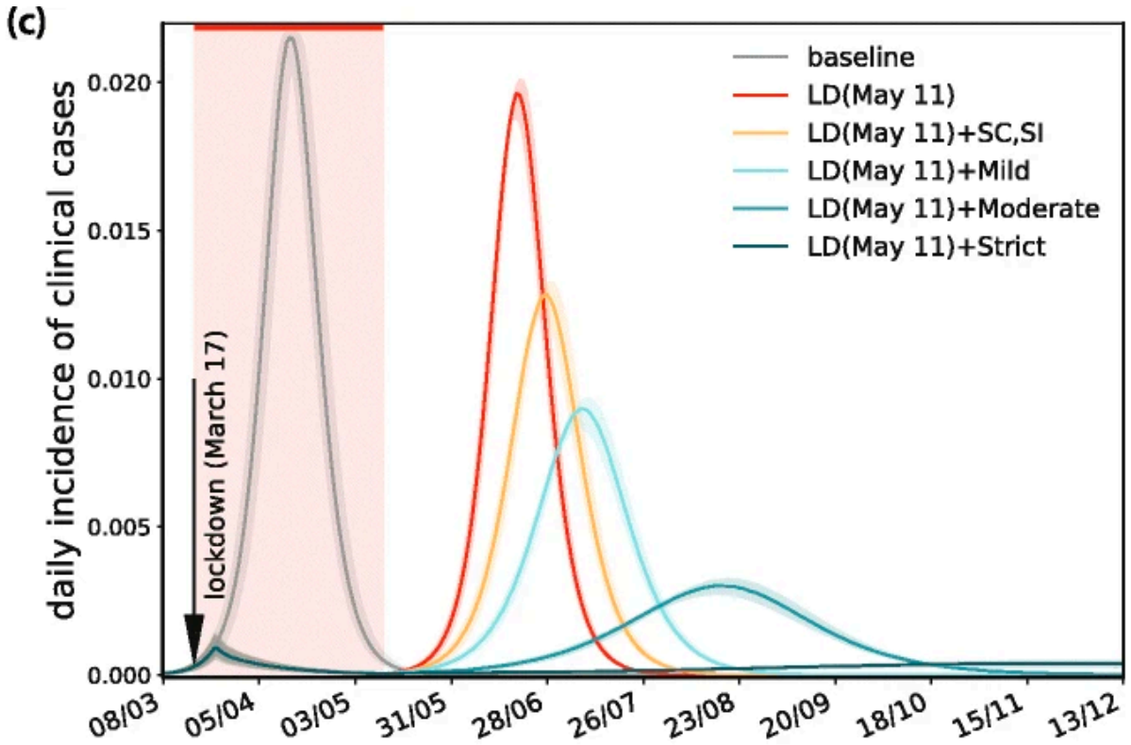
Zhang et al Science 2020

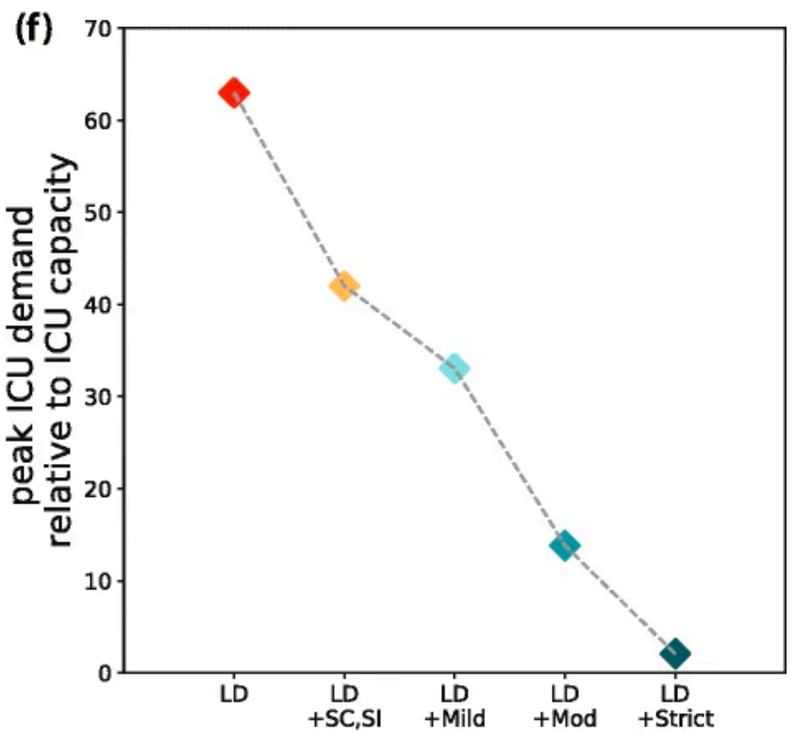
Di Domenico et al BMC Medicine 2020

#3. EXIT

Need for test and trace

	School closure	Telework (individuals not going to work)	Senior isolation	Closure non-essential activities	Case isolation
Lockdown	Yes; 100% contacts of children on transports removed	70% [39]	Yes, with 90% contact reduction	Yes, 100% closure	No
Set of strict interventions	Yes; 100% contacts of children on transports removed	50% [38]	Yes, with 75% contact reduction	Yes, 100% closure	No
Set of moderate interventions	Yes; 50% contacts of children on transports removed	50% [38]	Yes, with 75% contact reduction	Yes, 50% closure	No
Set of mild interventions	Yes; contacts of children on transports are not removed	25%	Yes, with 75% contact reduction	No	No





2 * capacity

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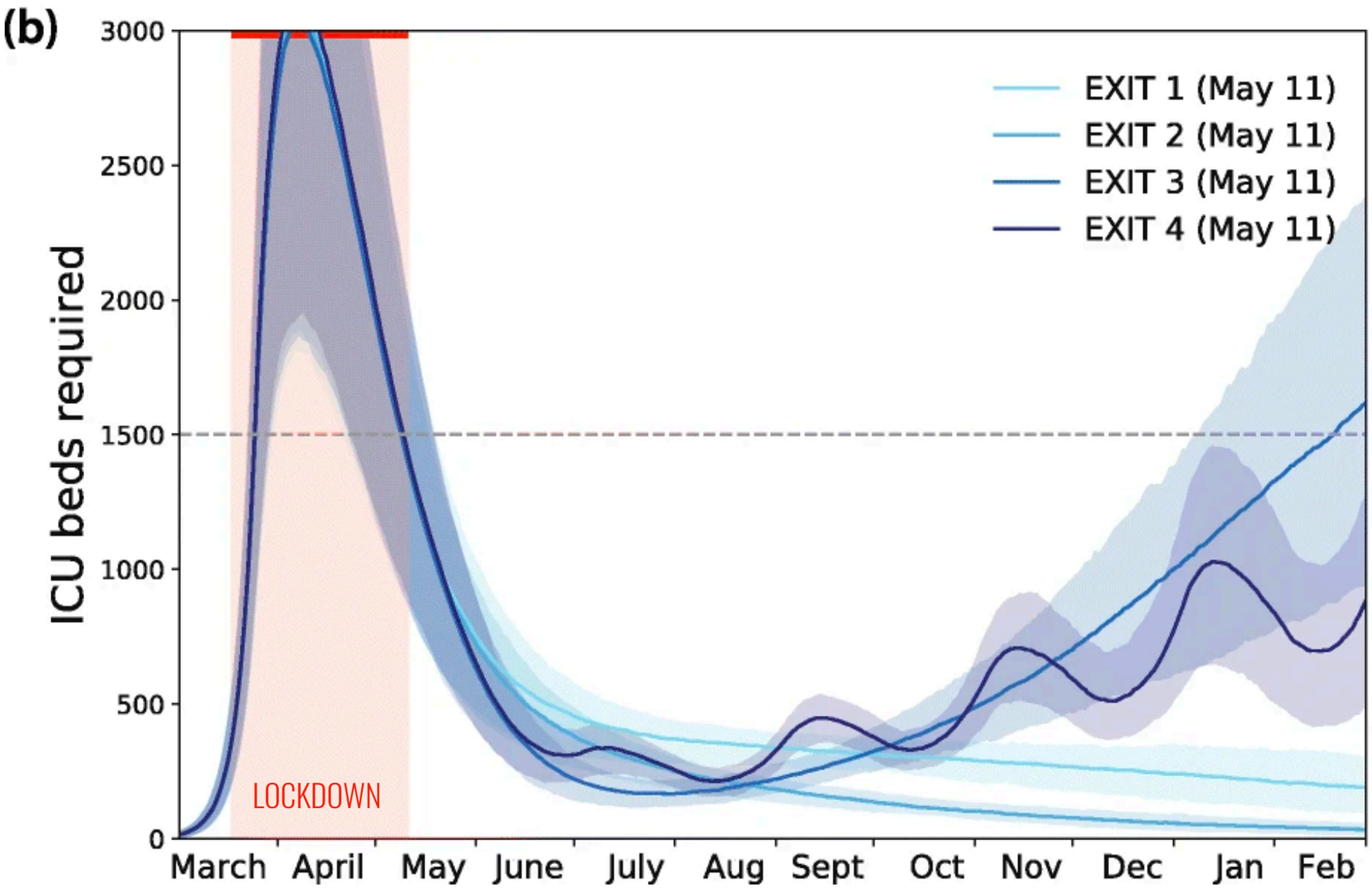
With aggressive case isolation



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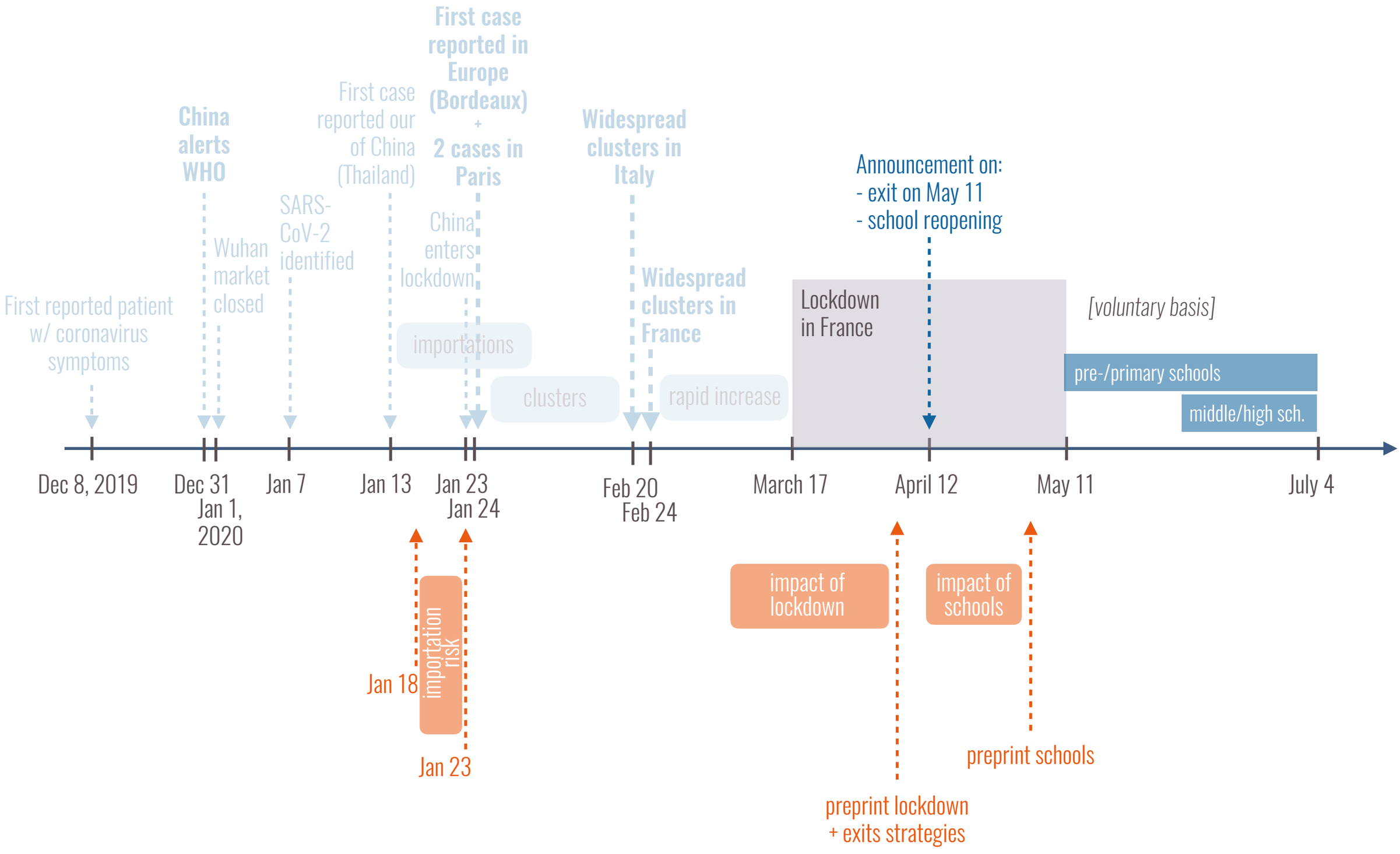
#4. SCHOOLS

COVID-19 timeline vs. our timeline

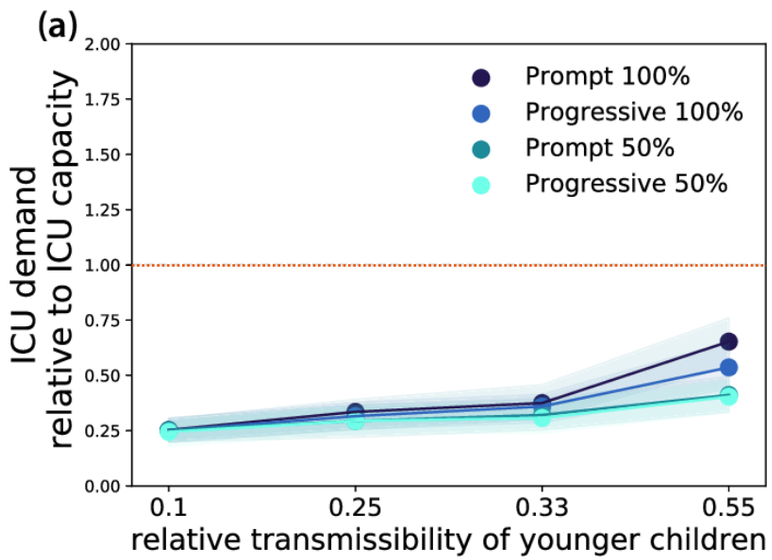


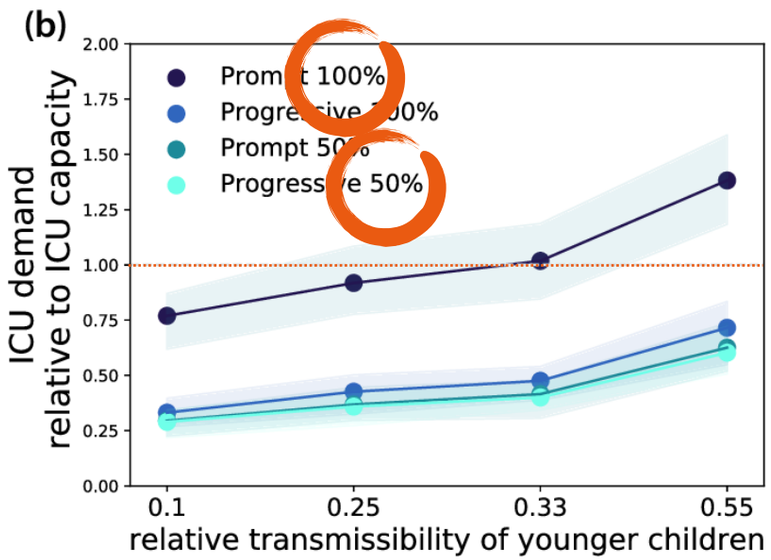
Synthesis of projections

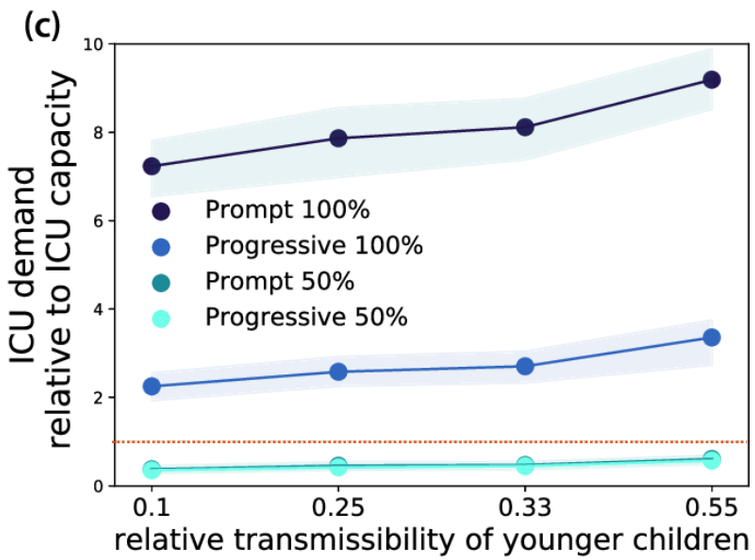
only pre-/primary schools reopen

+ middle/high schools reopen 1 month after

all school levels reopen







"safe"

"safe"

middle/high schools only partial attendance

Di Domenico et al. https://www.medrxiv.org/content/10.1101/2020.05.08.20095521v1

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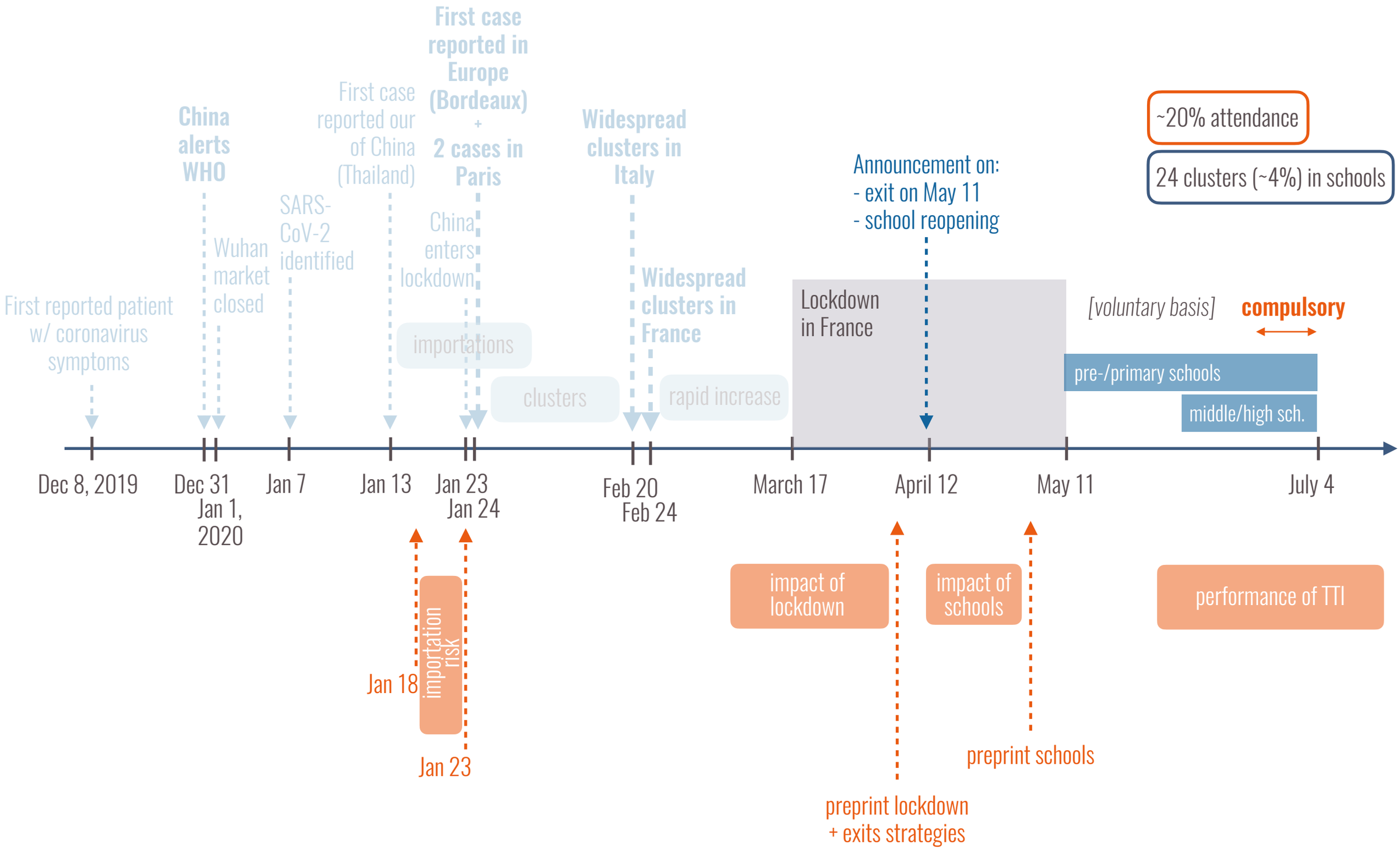
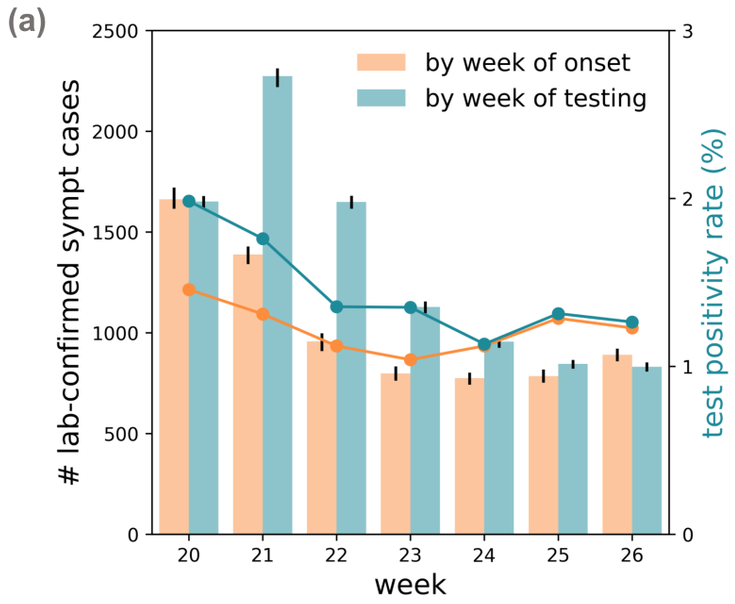
COVID-19 timeline vs. our timeline



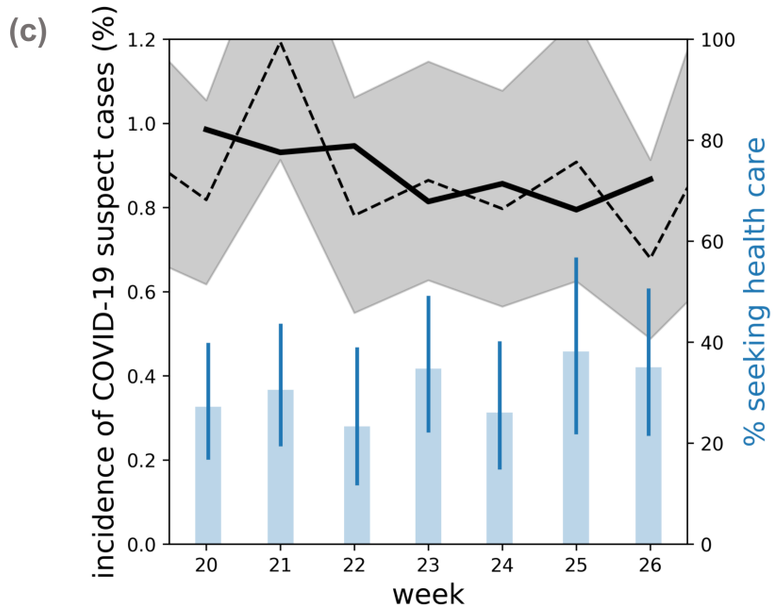
#4. TESTING

Data

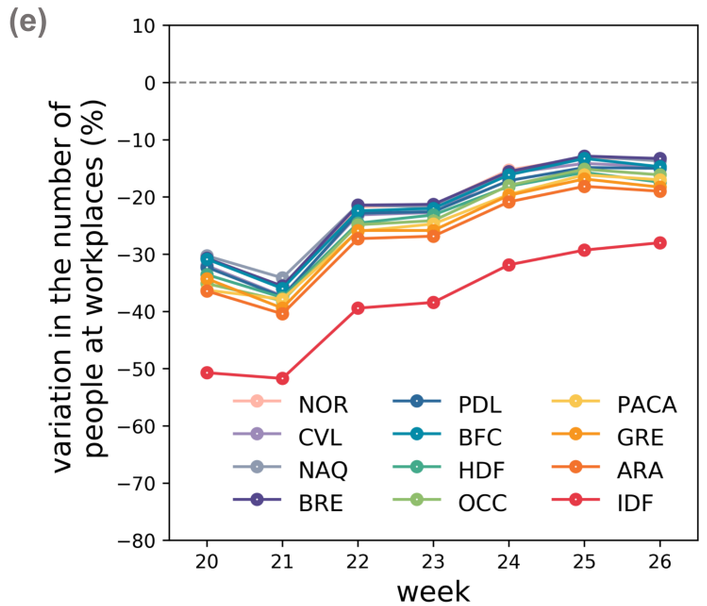
Virological data



Participatory surveillance data



Behavioral data



Pullano et al. https://www.medrxiv.org/content/10.1101/2020.08.10.20171744v1

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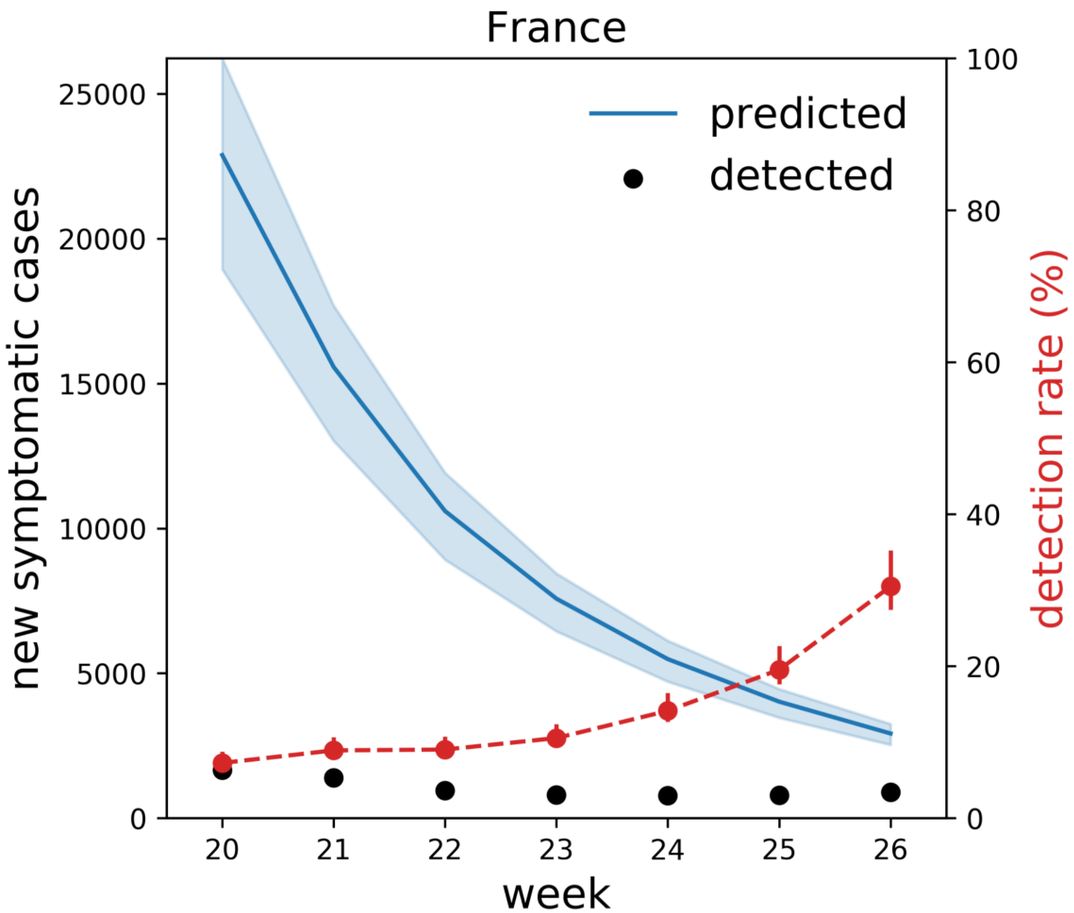
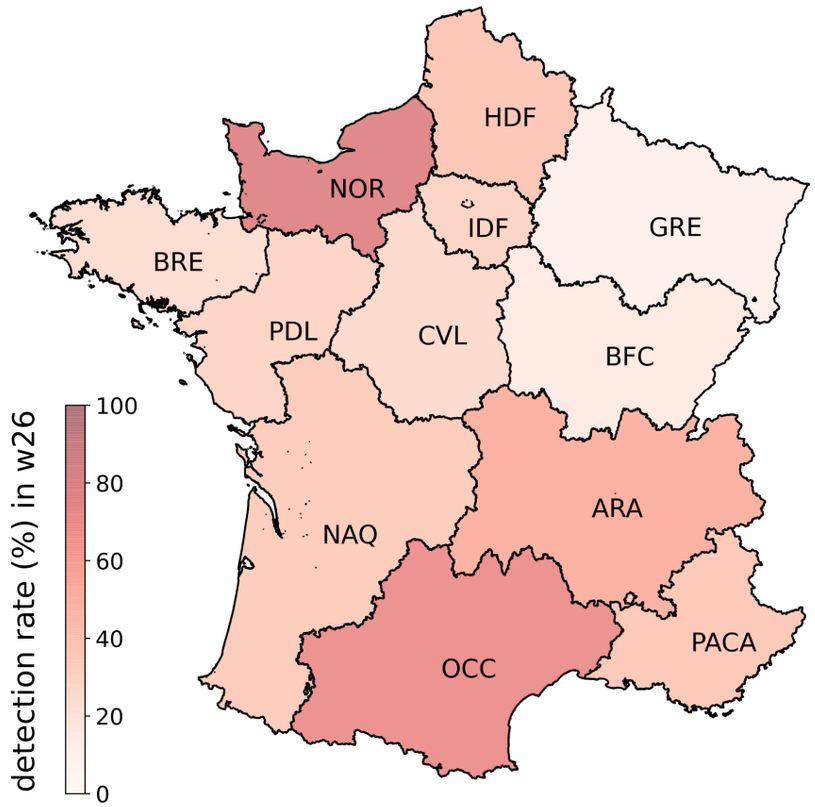
1 in 10 detected in May-June; 1 in 3 end of June





Pullano et al. https://www.medrxiv.org/content/10.1101/2020.08.10.20171744v1

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www.epicx-lab.com/covid-19.html

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REACTing
research & action
targeting emerging infectious diseases

AGENCE NATIONALE DE LA RECHERCHE
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European Commission

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