Learning from the COVID-19 Data in Wuhan, US and World

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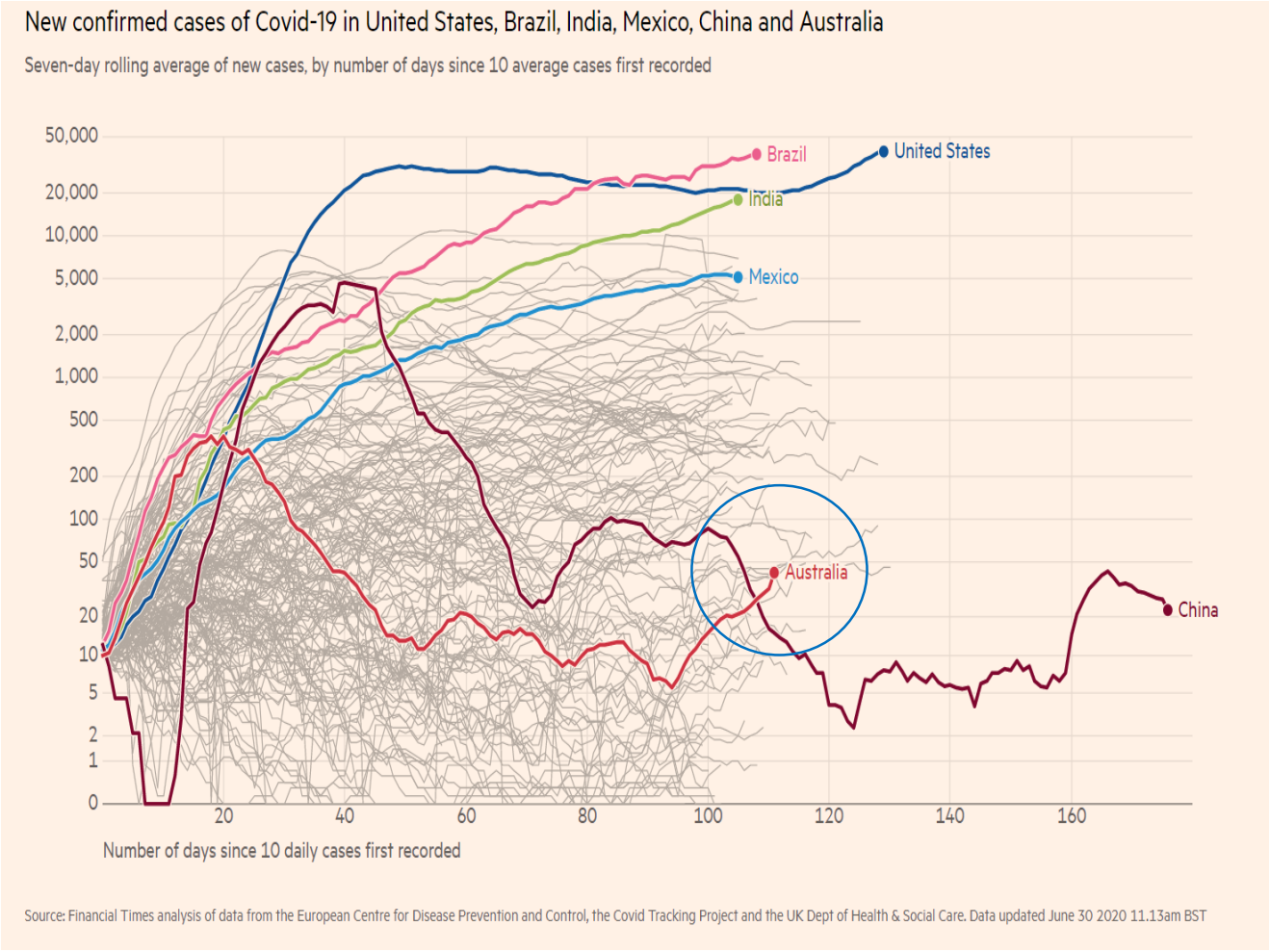
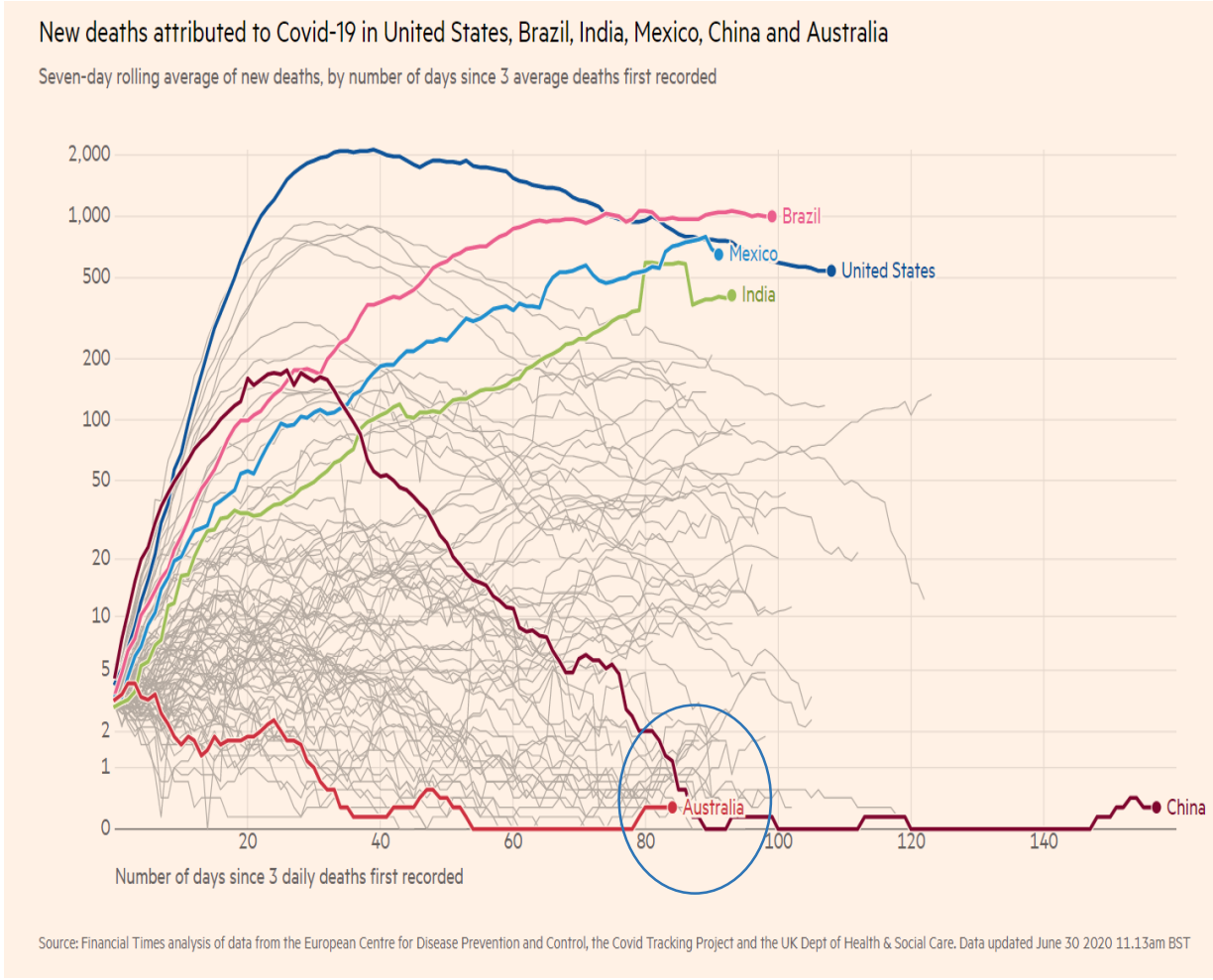
Pandemic:10 Million COVID-19 Cases & 496K Deaths in the World





Huge Multi-Faceted Impact:
Lives, Economy, Education, Research

Learning from COVID-19 Data in Wuhan, US and World

Wuhan, China

Changjiang river in the background

East Lake, Cherry Blossom

COVID-19 outbreak happened in December, 2019

A Pre-print of Analysis of 26,000 COVID-19 cases until Feb 18 in Wuhan was posted immediately in MedRxiv on March 6, 2020

medRxiv
THE PREPRINT SERVER FOR HEALTH SCIENCES

CSH Cold Spring Harbor Laboratory BMJ Yale

Comment on t

Evolving Epidemiology and Impact of Non-pharmaceutical Interventions on th Outbreak of Coronavirus Disease 2019 in Wuhan, China

Chaolong Wang, Li Liu, Xingjie Hao, Huan Guo, Qi Wang, Jiao Huang, Na He, Hongjie Yu, Xihong Lin, An Pan, Sheng Wei, Tangchun Wu

doi: https://doi.org/10.1101/2020.03.03.20030593

Huazhong Science and Technology University

Article usage: March 2020 to April 2020

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Total	114,652

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- Picked up by **85** news outlets
- Blogged by **2**
- Referenced in **3** policy documents
- Tweeted by **5420**
- On **1** Facebook pages
- Highlighted by **1** platforms

Chaolong Wang

Abstract views=124K
Pdf downloads=48K

- A summary of the key findings is at my tweet @XihongLin

Part I of the Updated MedRxiv Preprint was Published in JAMA, April 10: Analysis of 32,000 cases Until March 8, 2020

Original Investigation

FREE

April 10, 2020

Association of Public Health Interventions With the Epidemiology of the COVID-19 Outbreak in Wuhan, China

An Pan, PhD[1]; Li Liu, MD, PhD[1]; Chaolong Wang, PhD[1]; et al

» Author Affiliations | Article Information

JAMA. 2020;323(19):1915-1923. doi:10.1001/jama.2020.6130

An Pan

Top 0.01% among 15 millions of articles

Media Coverage and Interview

Testified in the Science and Technology Committee of the UK Parliament on April 17

Weekly update

17 April 2020

This week (the week commencing 13 April)

As part of our inquiry into UK science, research and technology capability and influence in global disease outbreaks, we held our third public evidence session. We focussed on the effectiveness and longevity of social distancing measures in the UK, the wider implications of these measures for the population, and international strategies for relaxing social distancing measures.

This week, we took evidence from:

- Dr James Rubin, Reader in the Psychology of Emerging Health Risks, King's College London
- Professor Graham Medley, Professor of infectious disease modelling, London School of Hygiene and Tropical Medicine
- Professor Xihong Lin, Professor of biostatistics, Harvard T.H. Chan School of Public Health

Committee writes to the Prime Minister: Lessons learned so far from the COVID-19 pandemic

19 May 2020

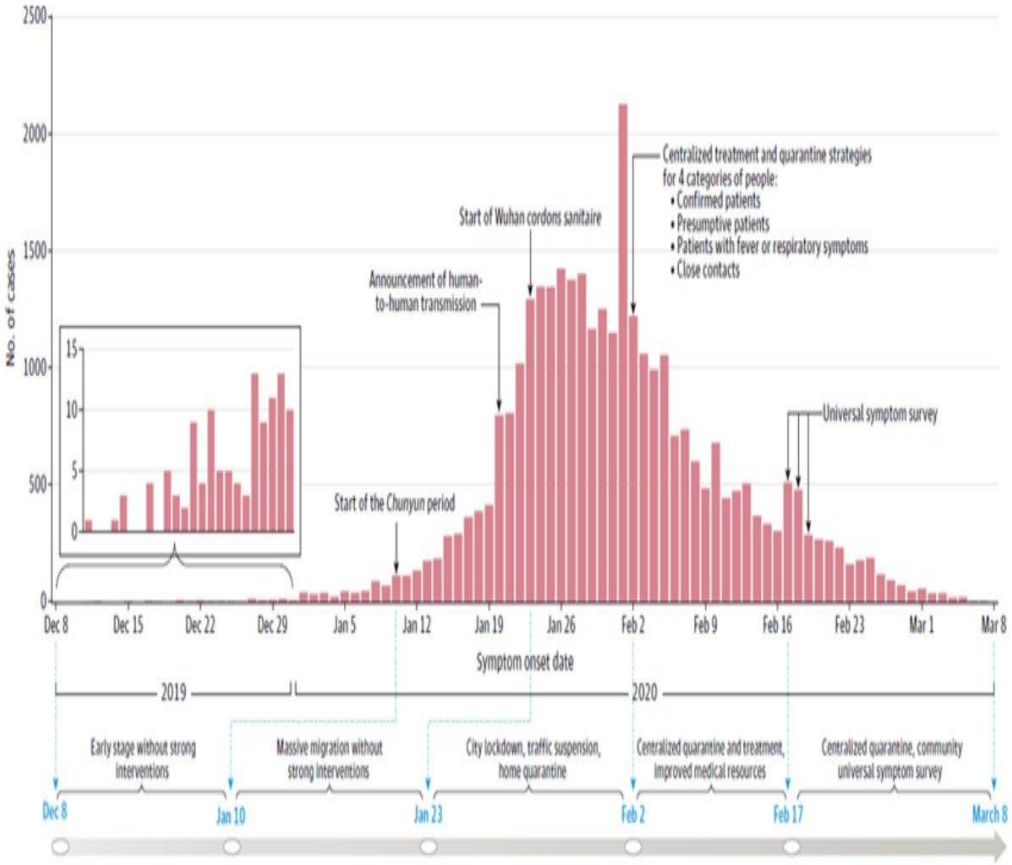
May 19, 2020

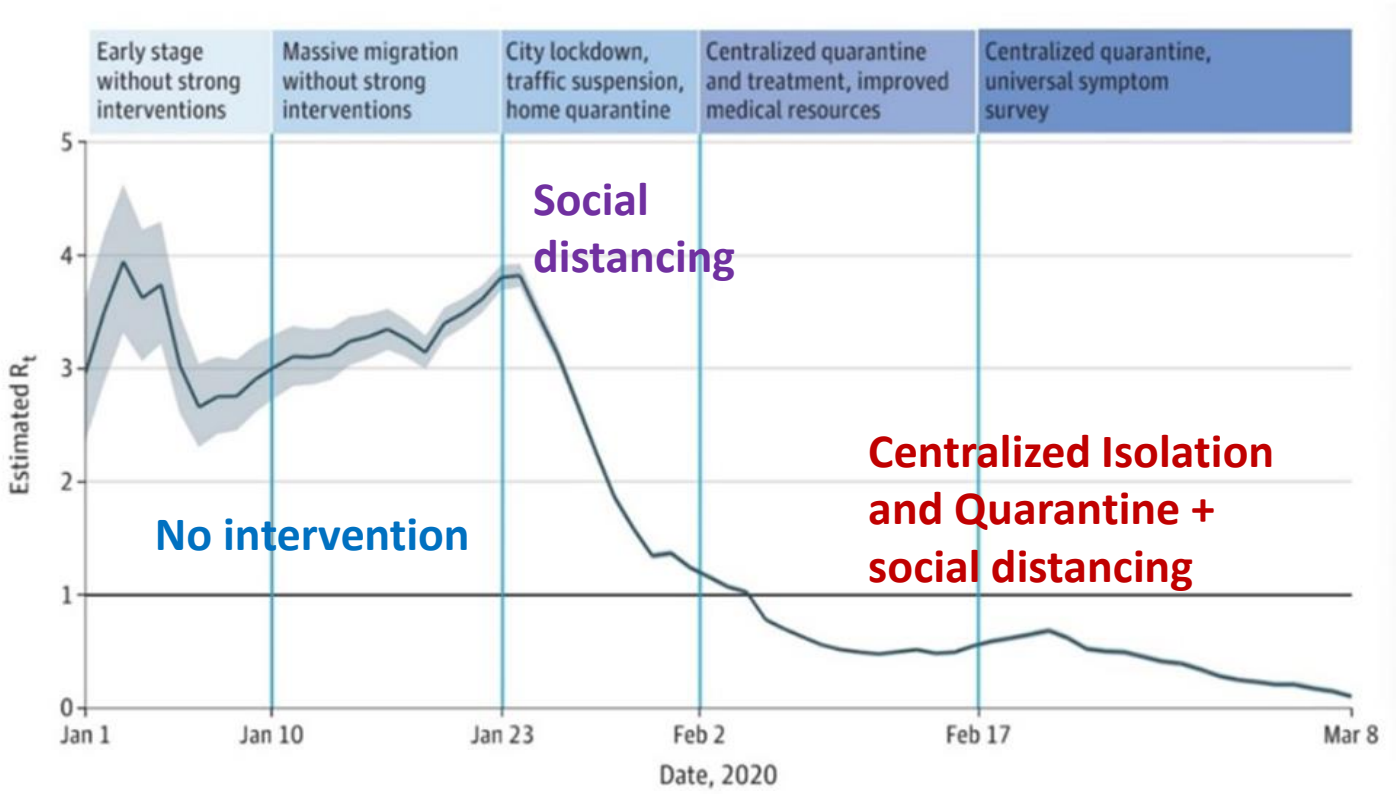
The Science and Technology Committee has today shared a series of findings in a letter written to Prime Minister Boris Johnson. The 19 page letter, which sets out a number of recommendations to the

https://committees.parliament.uk/committee/135/science-and-technology-committee-commons/news/146472/committee-writes-to-the-prime-minister-lessons-learned-so-far-from-the-covid19-pandemic/

10 recommendations

Updated Analysis Using 32,000 Cases Until March 8 (JAMA, April 8)





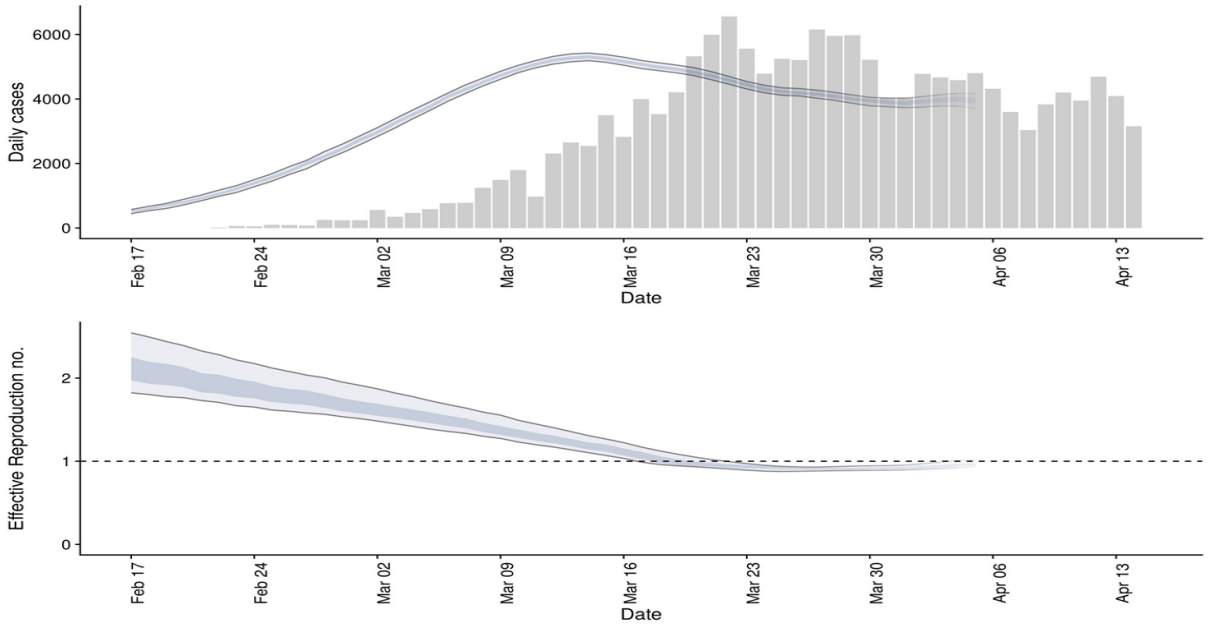
Rt = Effective Reproductive Number
=# of infected subjects/case

Rt=0.1 on March 8

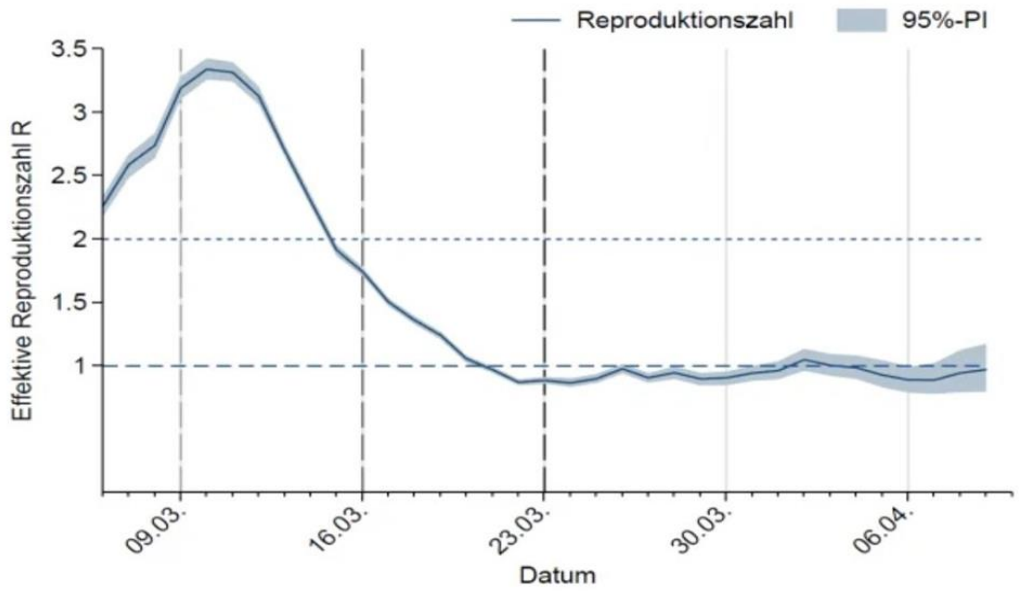
Method: Epiestim

The results that social distancing reduces R to linger around 1 have been replicated in many countries

Italy (Feb 17-April 13)



Germany (Mar 8-April 6)



Rt≈ 1 for a month

https://epiforecasts.io/covid/posts/national/italy/

Robert Koch Institut, Epidemiologisches Bulletin, April 23, 2020

Takeaway #1: Social Distancing Greatly Helped Flatten the Curve but Was not Enough

- Social distance helps block community transmission (between-household transmission)
- Family/within-household transmission is common.
- Infected cases might infect household members and close contacts
- Social distancing helped reduce R to be around 1, but was not good enough

Within-Household and Closed Place Transmission is Common

NEW YORK The New York Times SUBSCRIBE NOW

The Coronavirus Outbreak | LIVE Latest Updates Maps Markets U.S. Impact Com

March 18, 2020

Coronavirus Ravages 7 Members of a Single Family, Killing 4

The matriarch of the large New Jersey family died Wednes night without ever knowing that her two oldest children hac before her.

Rochester First.com NEWS WEATHER SPORTS VIDEO CENTER LIFESTYLE COMMUNITY REPORT IT!

NEWS

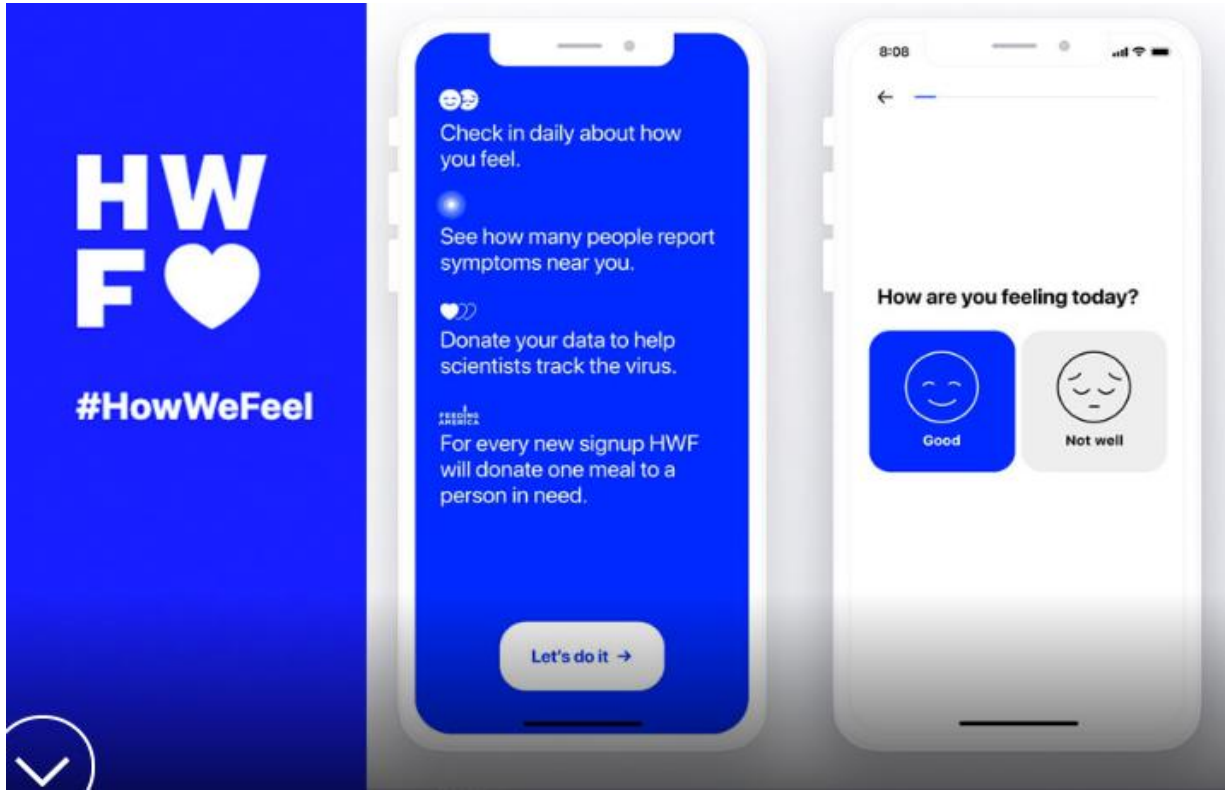
28 members of California family test positive for COVID-19

June 27, 2020

Posted: Jun 27, 2020 / 12:39 PM EDT / Updated: Jun 27, 2020 / 12:39 PM EDT

US: How We Feel Project

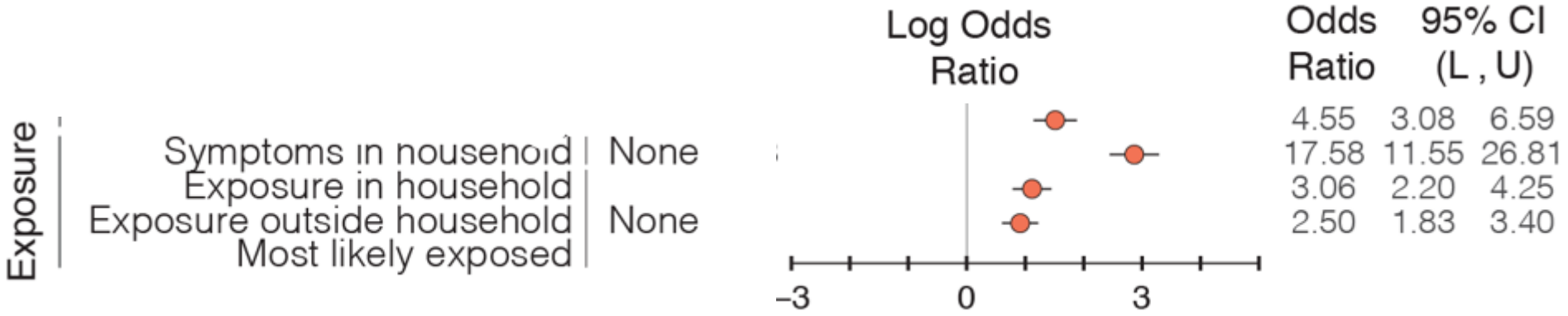
https://howwefeel.org/



Harvard PI: X Lin

- App for COVID symptoms and health status
- Launched on April 4
- Joint with Feng Zhang at Broad Institute and Ben Silbermann at Pinterest
- >550K users and >4M responses in US.

HowWeFeel (US): High Risk of Infection with Within-Household Exposure

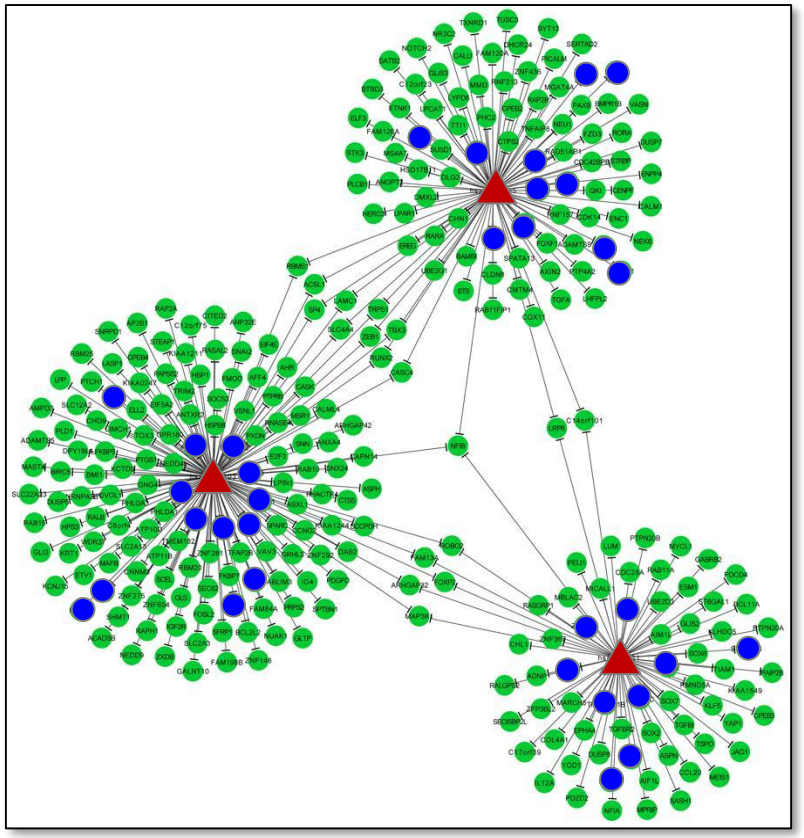


- Adjusted odds ratio of a positive PCR test associated with
  - within-household exposure to COVID vs no exposure is 17.6.
  - community exposure to COVID vs no exposure is 3.1

- Need to break the household and closed place (e.g, nursing homes, homelss shelters, prisons) transmission chains

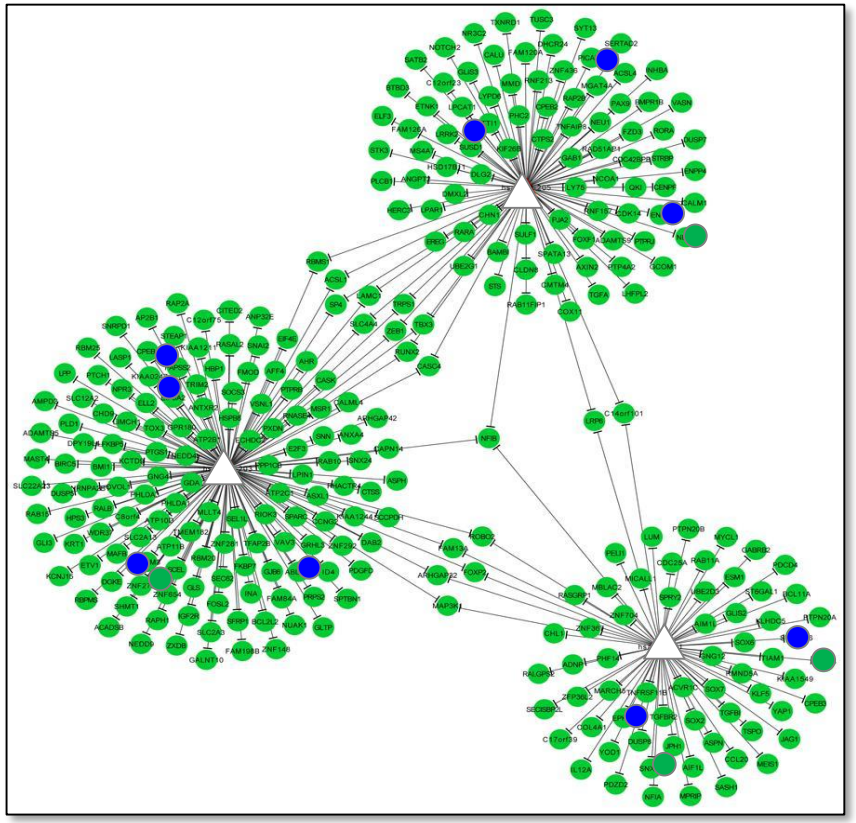
Key Idea: Isolation of Infected and Quarantine of Suspected Cases & Close Contacts

Control the source of infection → **Reduce the number of new infections** → **Stop the outbreak**



Red: Infected index cases

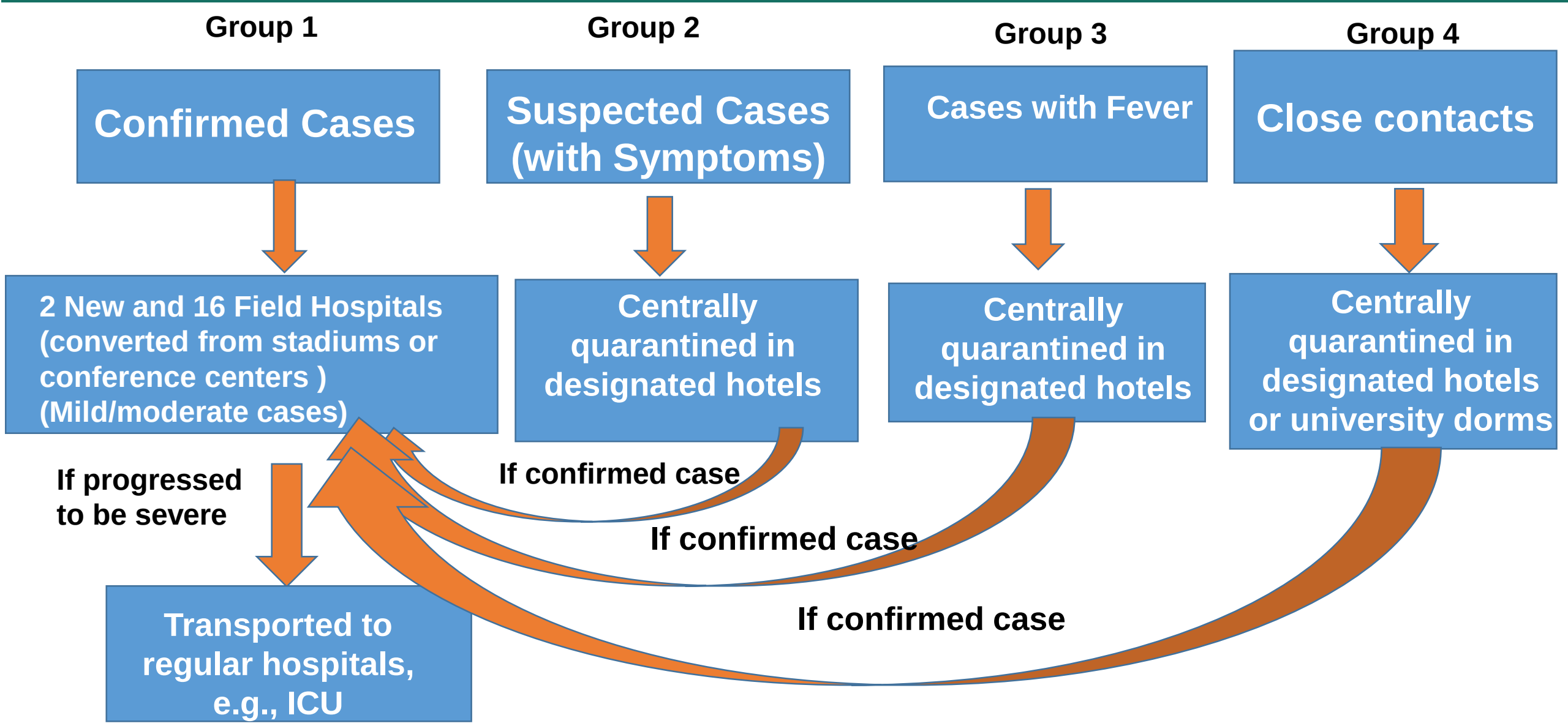
Blue: infected family members, close contacts and community members



Home Quarantine

Centralized Quarantine: Take infected and suspected cases out of home and family network and admit them to new or field hospitals for medical care

Wuhan Centralized Isolation and Quarantine Strategy After Feb 1, 2020



March 18: No new confirmed cases in Hubei Province
April 8: Wuhan reopened the city

Nature News & Comment
@NatureNews

On 18 March, Hubei, the Chinese province at the centre of the coronavirus outbreak recorded no new cases of COVID-19 for the first time since the beginning of the epidemic.

Takeaway #2: Adding Centralized Isolation and Quarantine to Social Distancing Bended the Curve and Stopped the Epidemic in Wuhan

- **Block within-household transmission**: Prevent infected cases from infecting household members

- **Patients received medical care immediately**
- **Prevent disease progression and deaths**: With timely medical care of mild cases, reduce the chance of progression to becoming severe cases and deaths.

Takeaway #3: A Multi-pronged Approach is needed to control the epidemic

Six pillars:

- Mask wearing
- Social distancing
- Widespread testing
- Contact tracing
- Isolation and quarantine
- Treat infected patients

The New York Times

Opinion

The United States Needs a 'Smart Quarantine' to Stop the Virus Spread Within Families

Evidence from around the world shows that stay-at-home orders take us only so far.

By Harvey V. Fineberg, Jim Yong Kim and Jordan Shlain

Dr. Fineberg, Dr. Kim and Dr. Shlain specialize in public health.

April 7, 2020

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THE NEW YORKER

MEDICAL DISPATCH

IT'S NOT TOO LATE TO GO ON OFFENSE AGAINST THE CORONAVIRUS

By Jim Yong Kim

April 20, 2020

Test-Trace-Isolate: Bend the Curve

Community Tracing Collaborative

Partners In Health

MA launched the first contact tracing program

Tri-states (CT, NJ, NY) launched COVID test and trace programs

WHO

UK

Who have been tested in US?

CDC symptoms and essential workers are being preferentially tested

medRxiv
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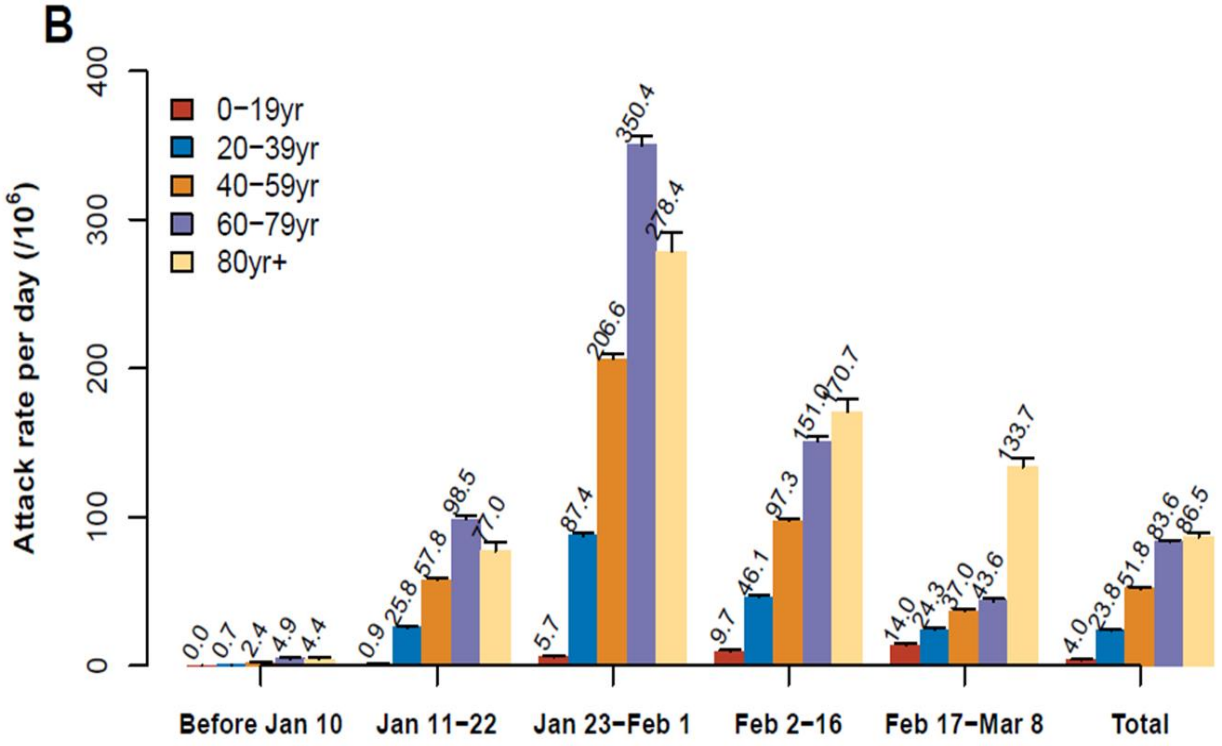
Population-scale Longitudinal Mapping of COVID-19 Symptoms, Behavior, and Testing Identifies Contributors to Continued Disease Spread in the United States

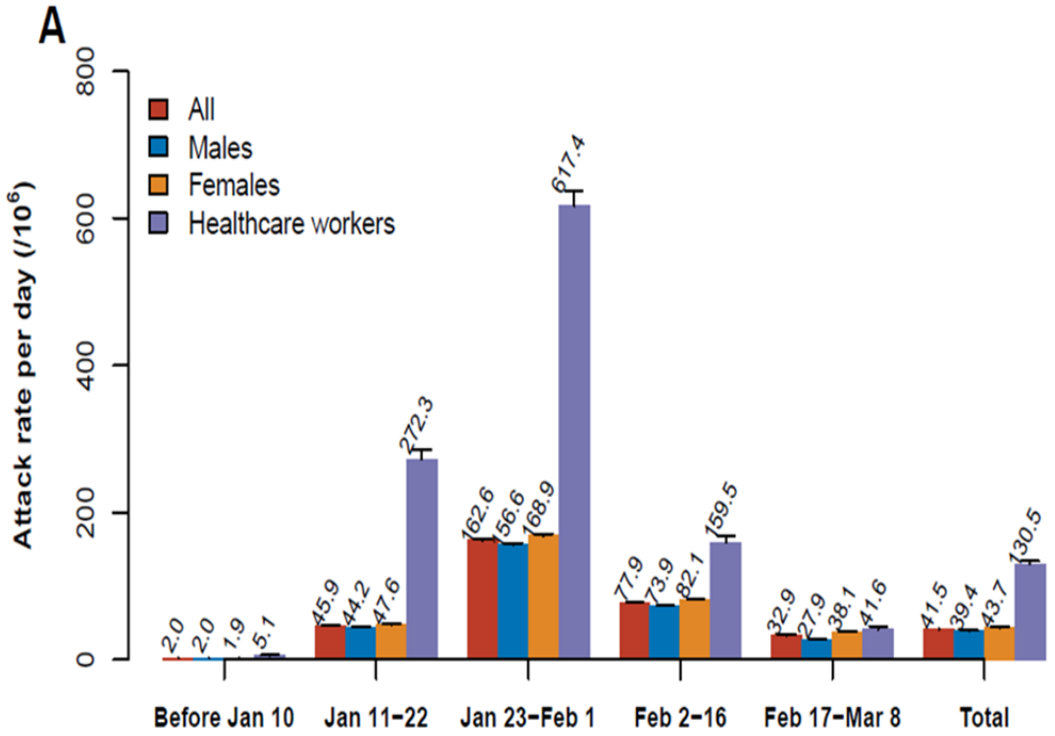
William E Allen, Han Altae-Tran, James Briggs, Xin Jin, Glen McGee, Rumya Raghavan, Andy Shi, Mireille Kamariza, Nicole Nova, Albert Pereta, Chris Danford, Amine Kamel, Patrik Gothe, Evrhet Milam, Jean Aurambault, Thorben Primke, Claire Li, Josh Inkenbrandt, Tuan Huynh, Evan Chen, Christina Lee, Michael Croatto, Helen Bentley, Wendy Lu, Robert Murray, Mark Travassos, John Openshaw, Brent Coull, Casey Greene, Ophir Shalem, Gary King, Ryan Probasco, David Cheng, Ben Silbermann, Feng Zhang, Xihong Lin

doi: https://doi.org/10.1101/2020.06.09.20126813

Risk Factors for Infection (Wuhan Data): Age and HCWs

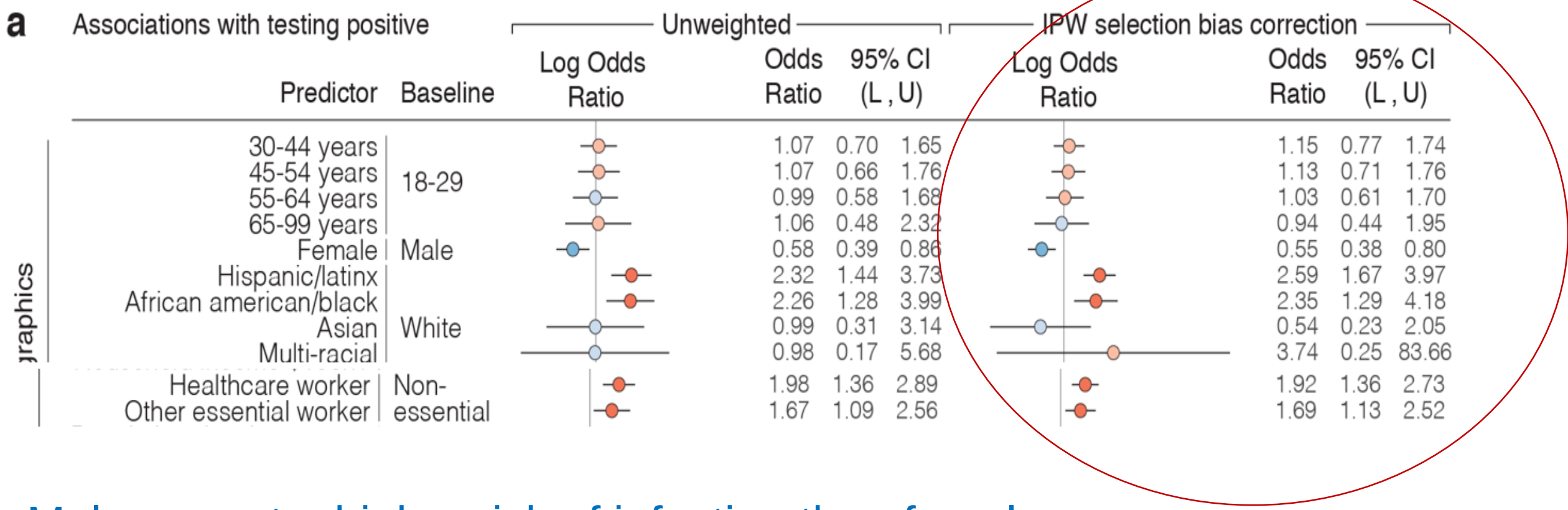


Older people had a high risk of infection



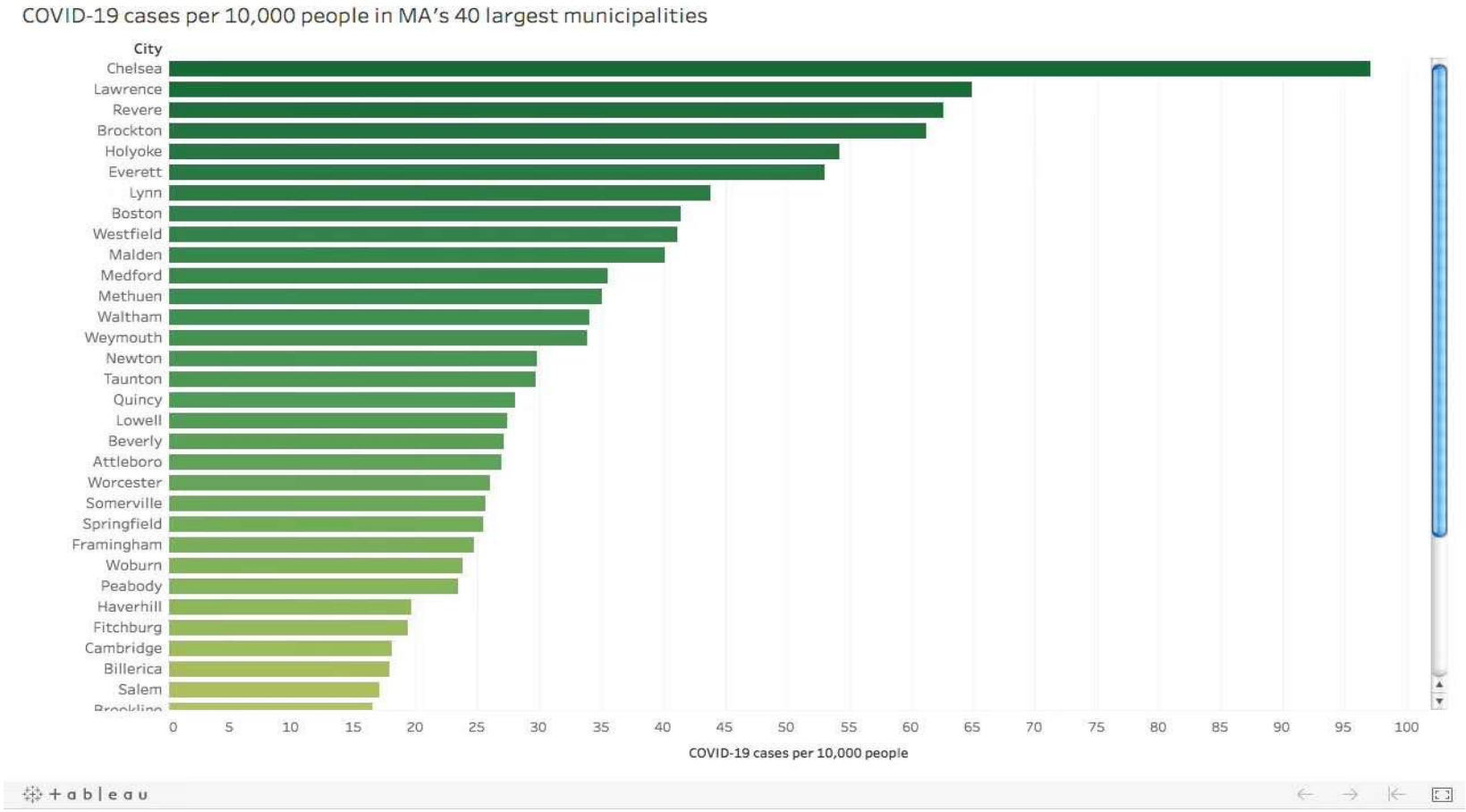
Health care workers (HCWs) have a much higher risk of infection especially when not protected by PPE

Risk Factor for Infection US (HowWeFeel): Gender, Race, HCWs and Essential Workers



- Males are at a higher risk of infection than females
- **Health Disparity:** Blacks and Hispanics are higher risks than Whites.
- Health care workers and essential workers are at a higher risk of infection

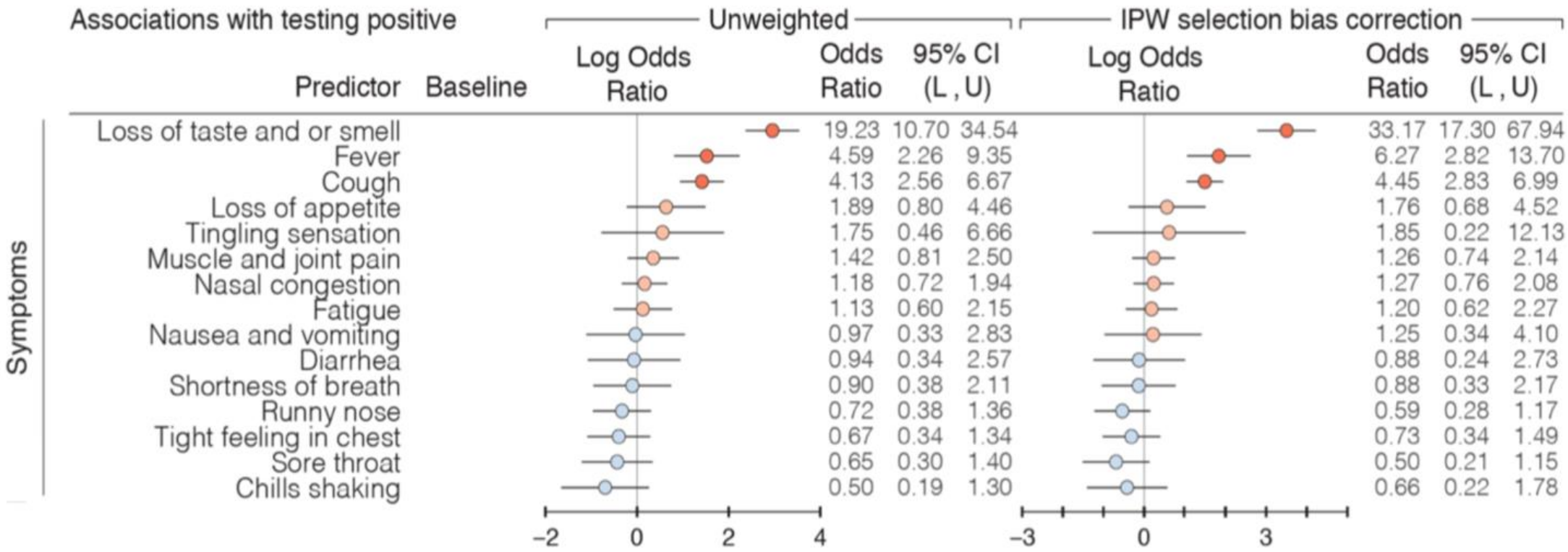
Health Disparity: Top 7 MA towns with the highest infection rates are all low income towns with high % of URMs



- **Chelsea**
- **Lawrence**
- **Revere**
- **Brockton**
- **Holyoke**
- **Everett**
- **Lynn**

URM=Under-Representative Minority

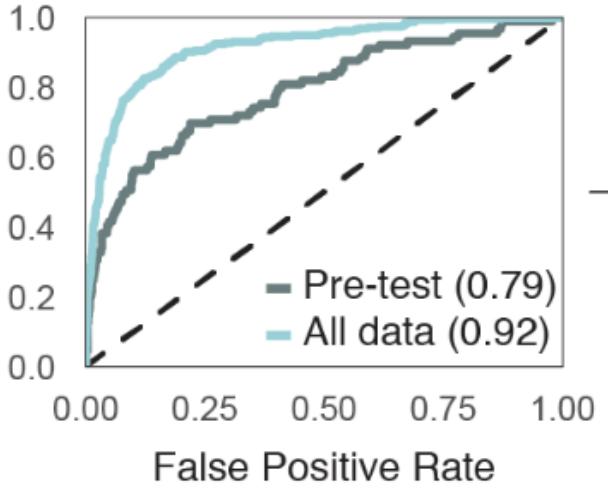
HowWeFeel: Significant Symptoms for Testing Positive



- **Loss of taste/smell (OR=33.2)**
- Fever (OR=6.3)
- Cough (OR=4.5)

Symptoms + Exposure Can Yield High Accurate Prediction of Positive Test

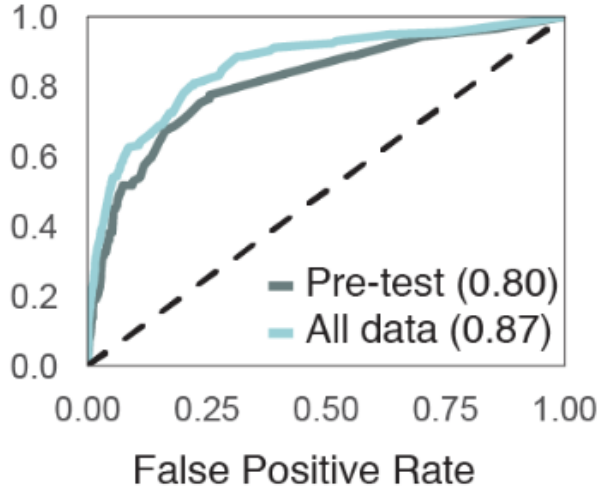
Major HWF survey questions



4 question survey sample

1) Are you experiencing loss of taste and or smell?
2a) Were you exposed to someone with COVID-19?
2b) If yes, do they live with you?
3) Does anyone in your household have COVID-19 symptoms?

4 question survey



Four questions based prediction model:

Loss of taste and smell; exposure (household+community)

Takeaway #3: Protect the Five Vulnerable Groups

- Healthcare workers
- Elderly people
- Family members and close contacts of infected cases
- Essential workers
- People of color: Black and Hispanic (US)

Challenges: Crowded housing, poverty, lack of health insurance, have to go to work, hard to do social distancing and isolation.

Rt Map: How is Epidemic Spread at Different Resolutions?

metrics.covid19-analysis.org

- Calculate Rt curves and maps at country, US state and county levels
- Compare Rts between different countries, US states and counties
- Identify hotspots

metrics.covid19-analysis.org

Not secure | metrics.covid19-analysis.org

Apps

Other bookmark

Use slider to adjust date. Click on an area to see its Rt over time.

Click play button to animate Rt over time.

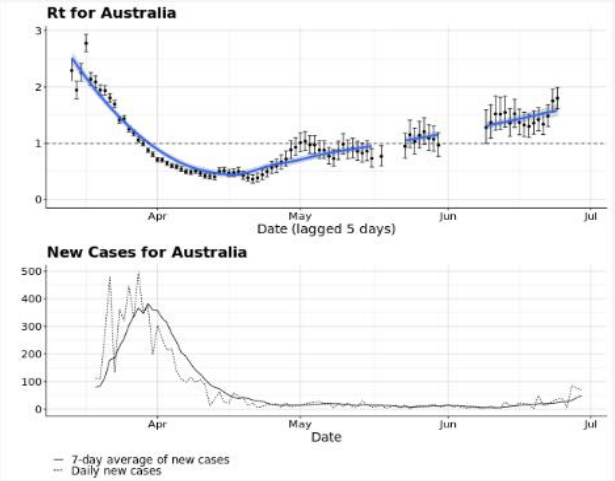
Note the Rt is lagged by 5 days.

Date

2020-03-14 — 2020-06-24

Resolution:

World



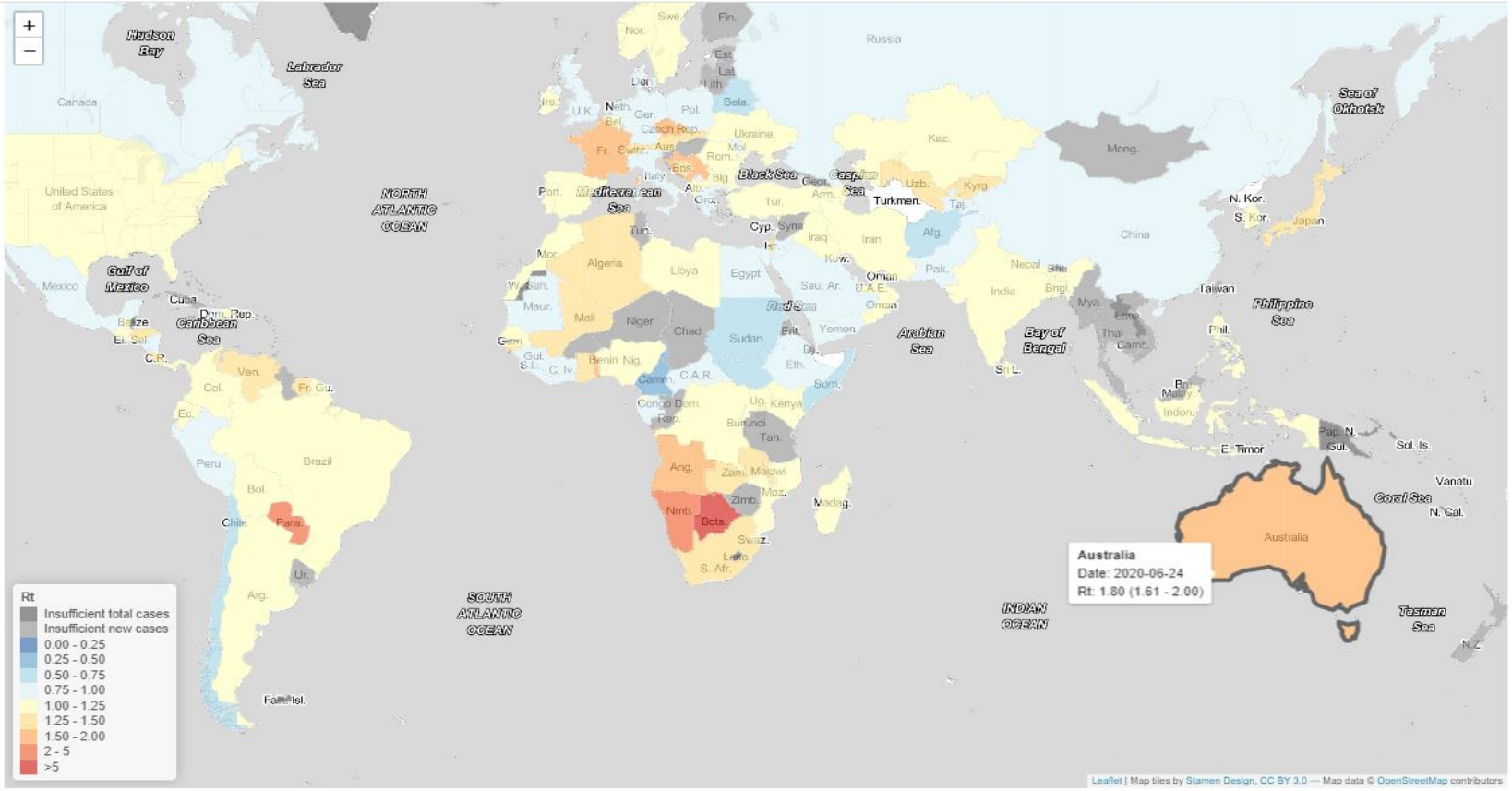


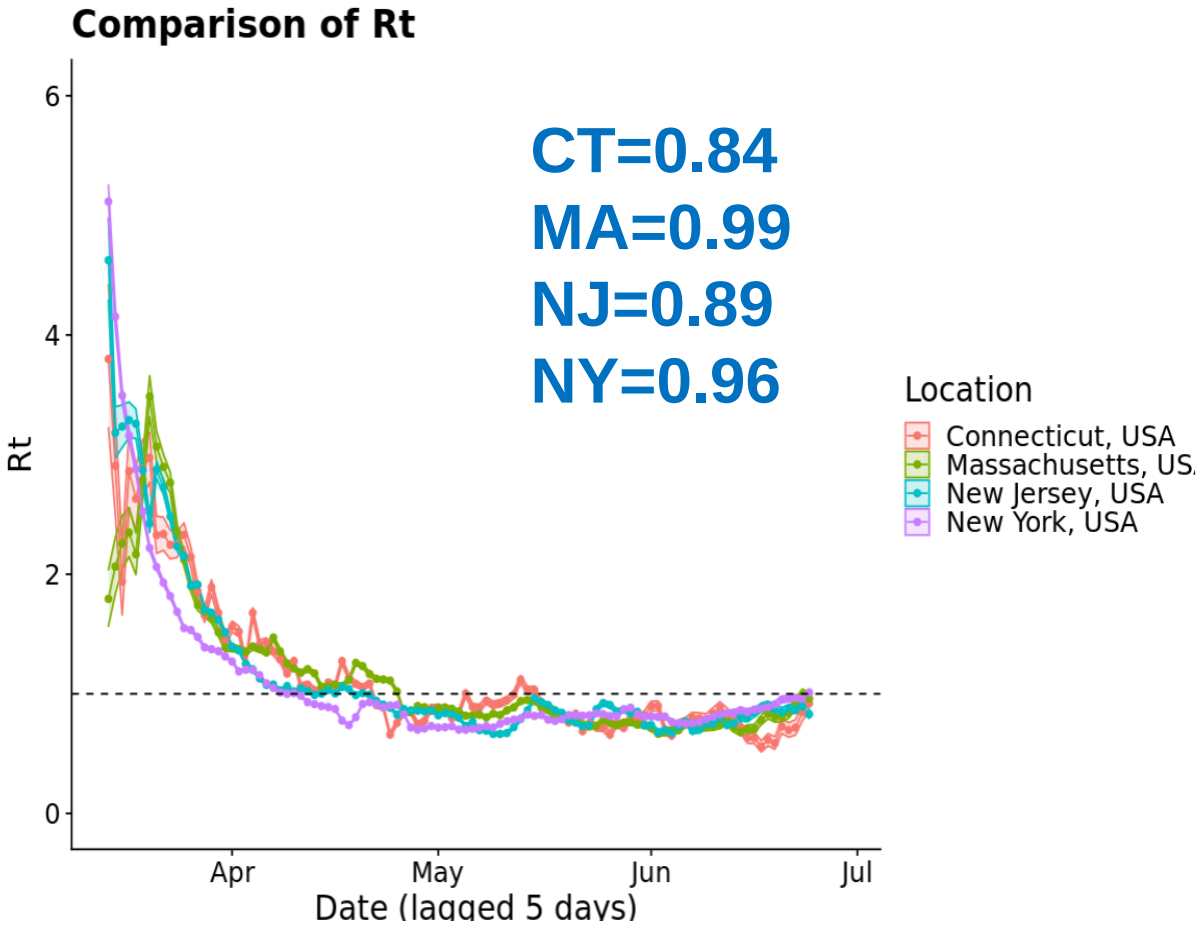
Table of metrics for 2020-06-29. Rt calculated for 2020-06-24 (5-day lag).

Show 25 entries

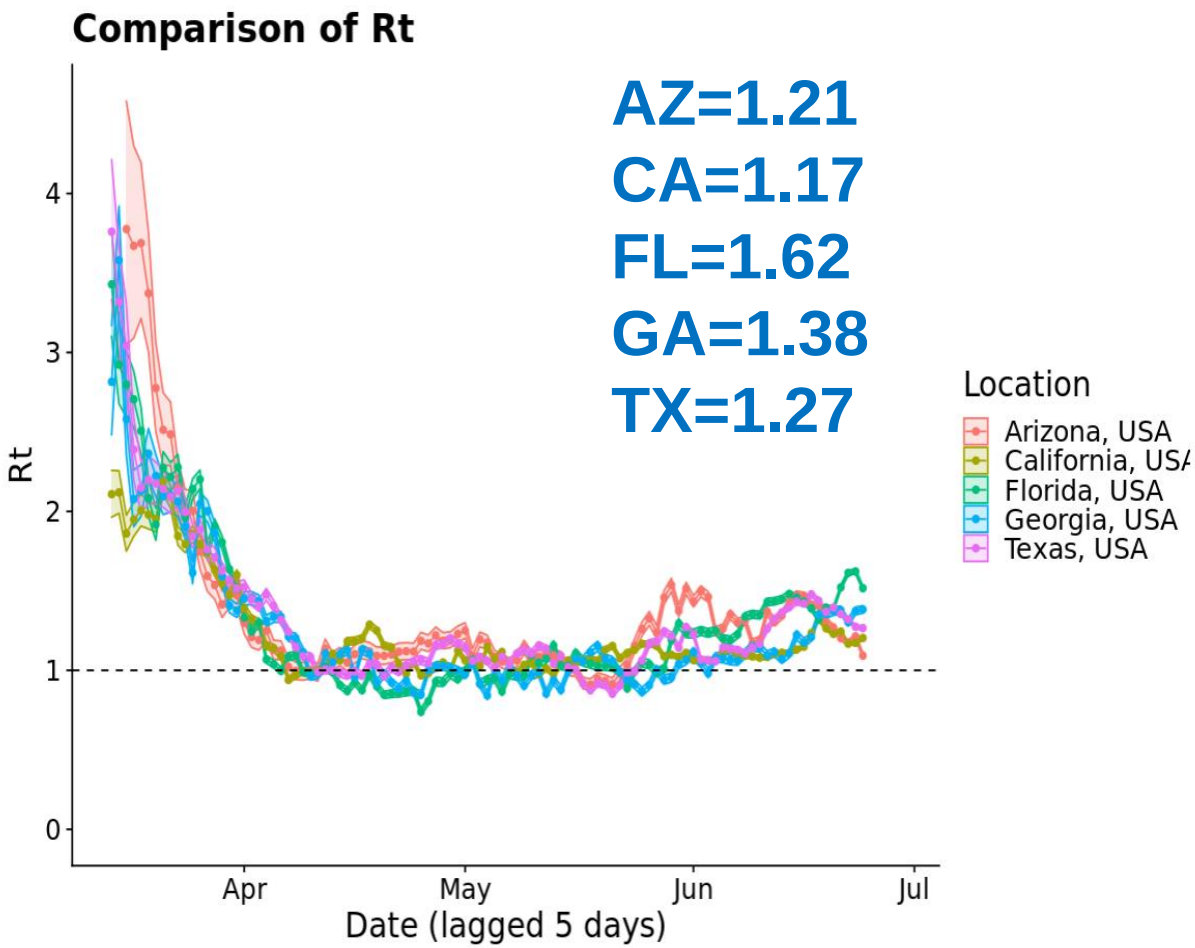
Search:

	Location	Rt	CI Lower	CI Upper	New Cases	New Cases per Million	Cum. Cases	Cum. Cases per Million	New Deaths	New Deaths per Million	Cum. Deaths	Cum. Deaths per Million
1	Botswana	7.12	5.71	8.7	83	35.29	175	74	0	0	1	0
2	Paraguay	2.13	1.98	2.28	64	8.97	2191	307	1	0.14	16	2

Estimated Rt Curves in US: Northeast, South, West (June 28)



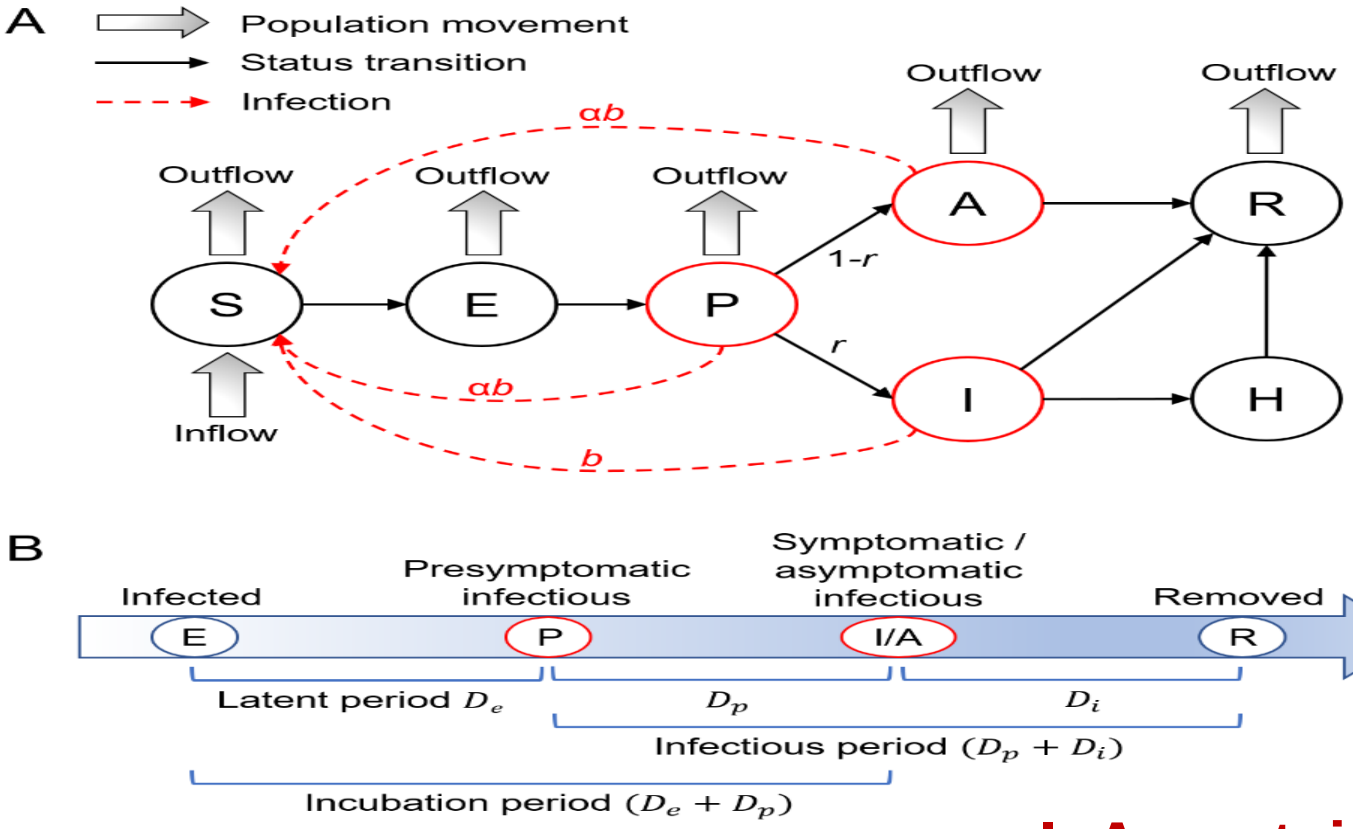
CT=0.84
MA=0.99
NJ=0.89
NY=0.96



AZ=1.21
CA=1.17
FL=1.62
GA=1.38
TX=1.27

These states have test-trace-isolate

SHAPIRE: Full-spectrum Epidemic Model for Understanding Asymptomatic and Presymptomatic Transmissions



Full-spectrum dynamics of the coronavirus disease outbreak in Wuhan, China: a modeling study of 32,583 laboratory-confirmed cases

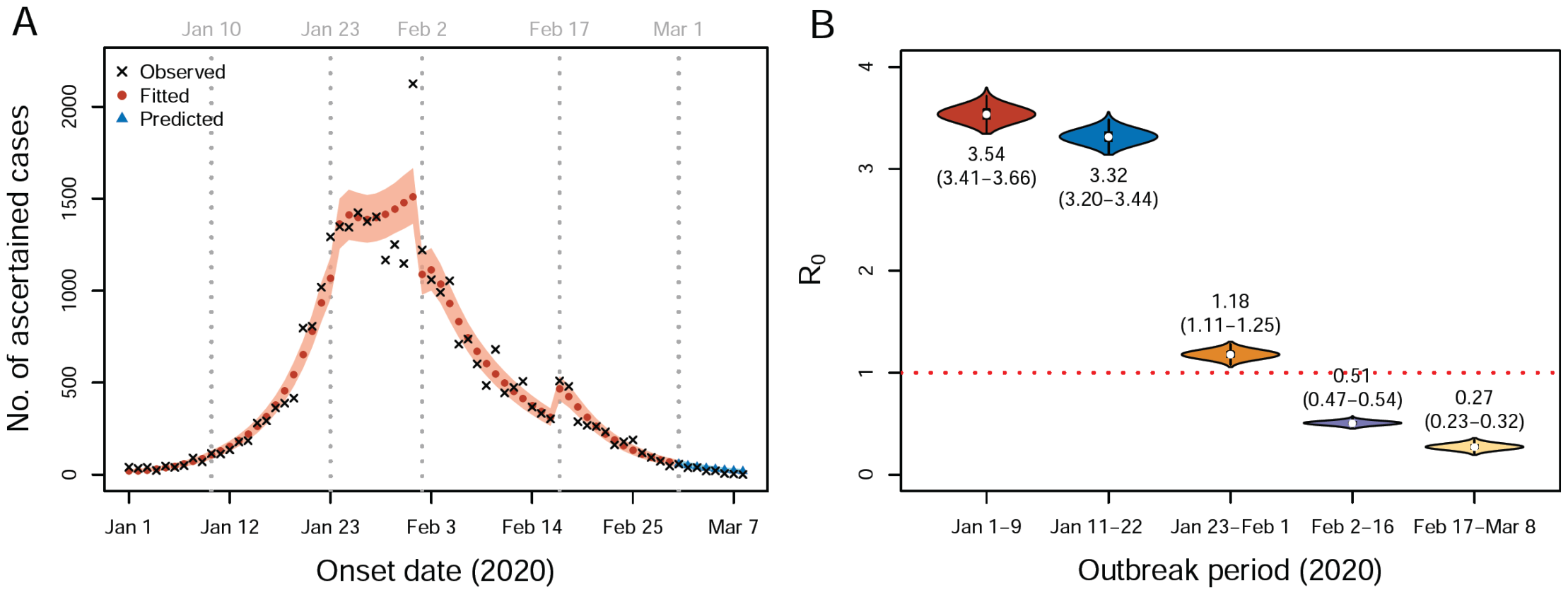
Xingjie Hao, Shanshan Cheng, Degang Wu, Tangchun Wu, Xihong Lin, Chaolong Wang

doi: https://doi.org/10.1101/2020.04.27.20078436

I: Ascertained **A: Unascertained**

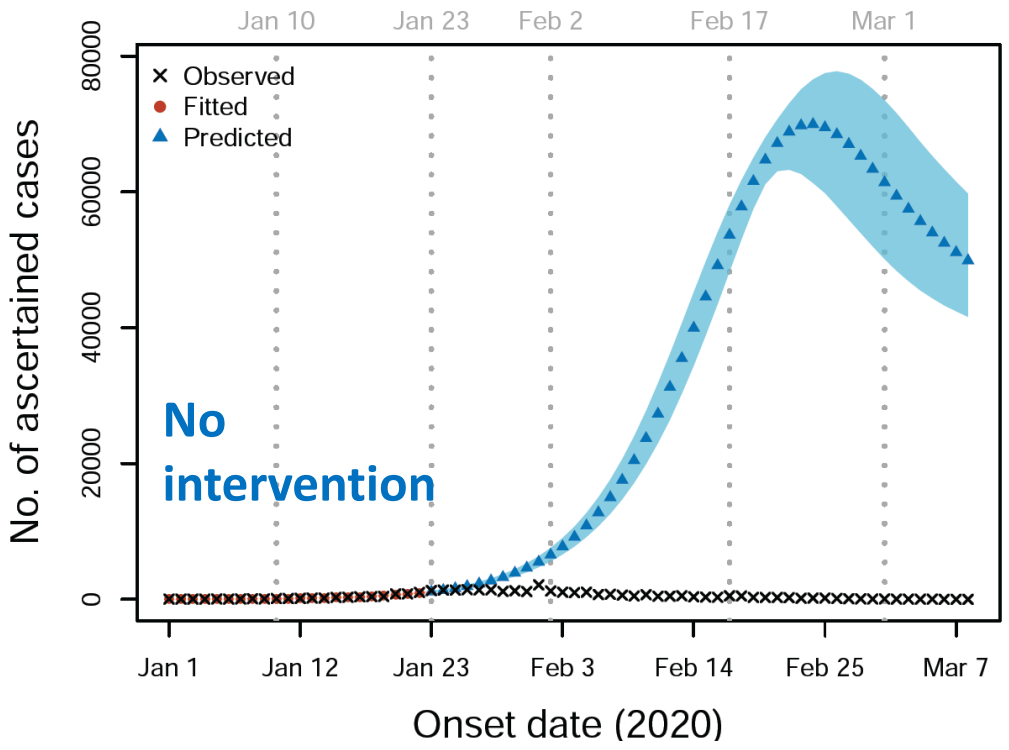
Extension of SEIR (Poisson model with differential equations)

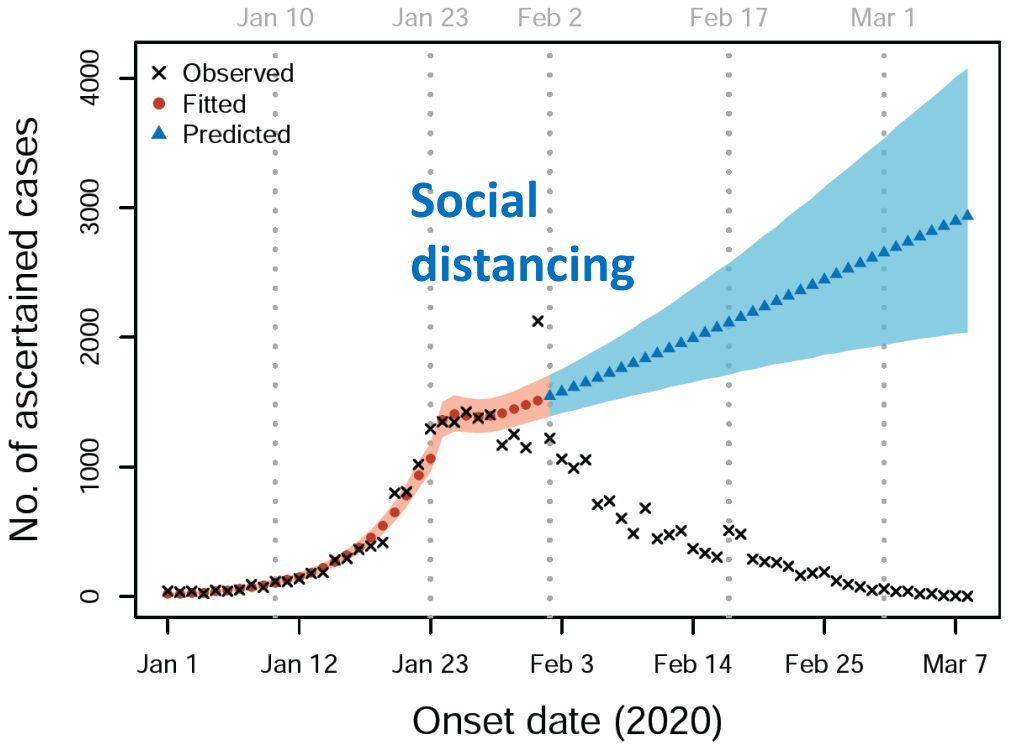
SHAPIRE (Wuhan): *R* decreases from 3.54 to 0.27 after interventions



Model prediction fits the data well.

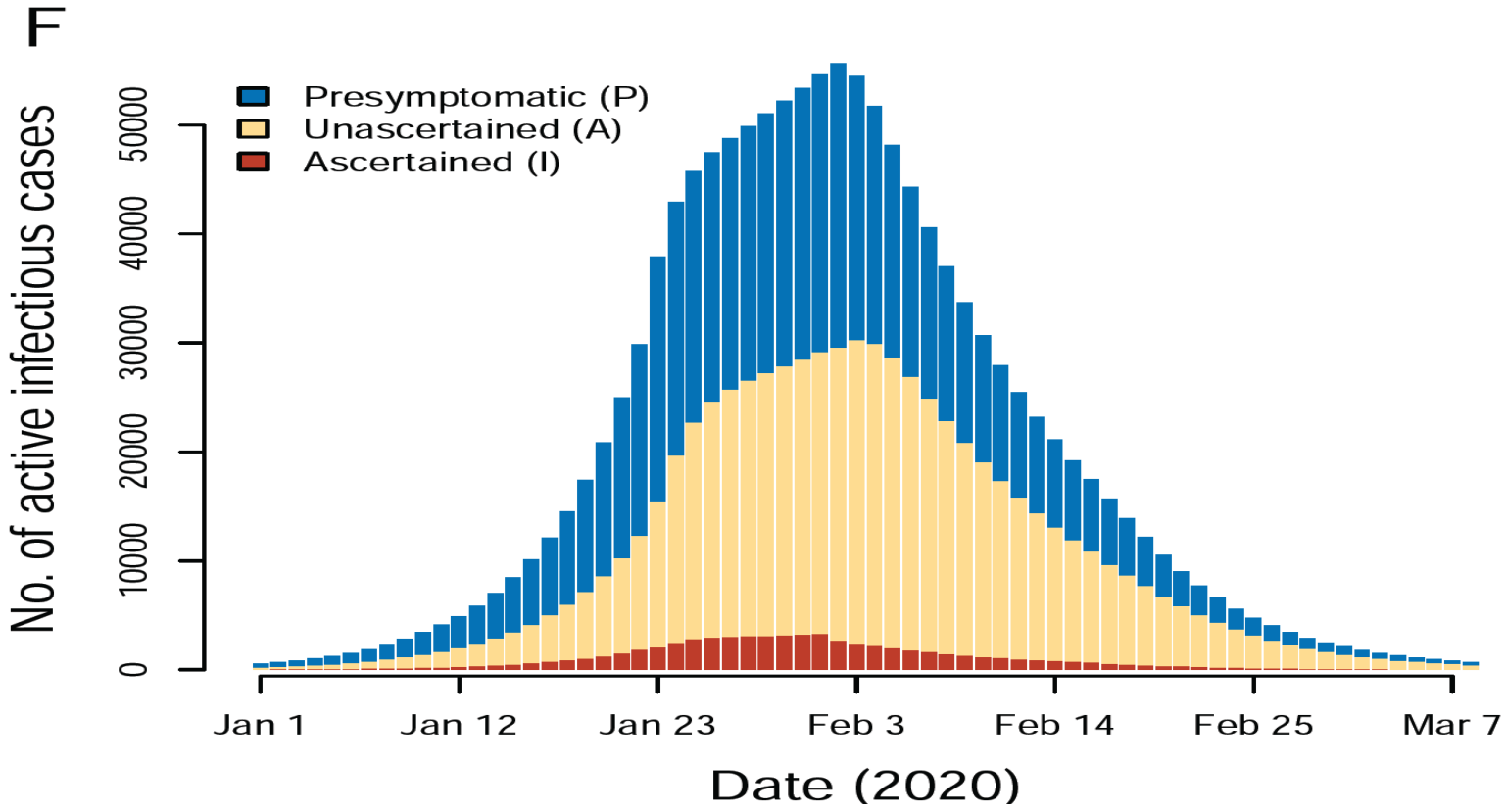
Wuhan: Interventions contained the size of the outbreak





Interventions after Jan 23 together reduced the size by 96.1%.
Interventions after Feb 2 together reduced the size by 69.5%.

Wuhan: Estimated Proportion of Ascertained and Un-ascertained Cases

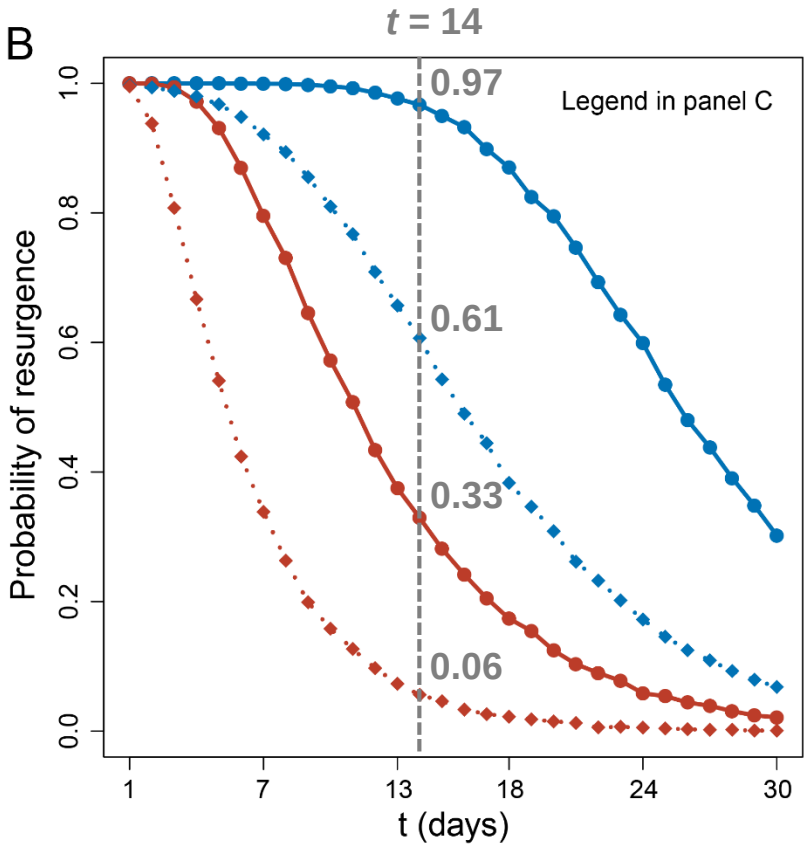


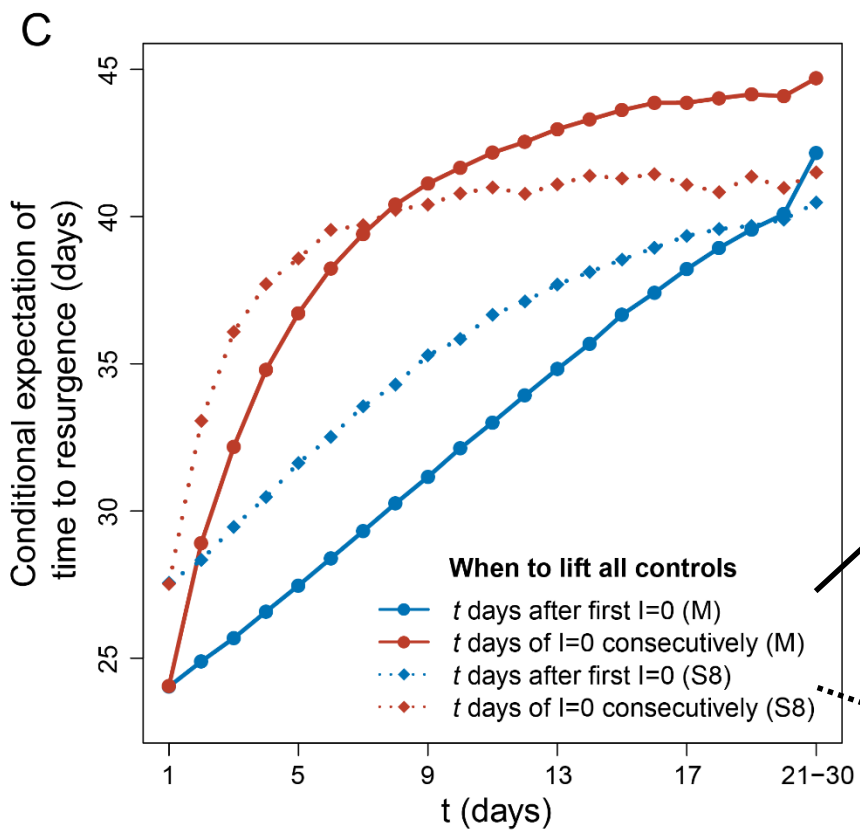
87% of daily new cases were unascertained (asymptomatic, pre-symptomatic or mildly symptomatic

Implications from Unascertained Cases: Lifting Controls Too Early Leads to Higher Probability of Resurge

Probability of resurgence

When resurgence will occur

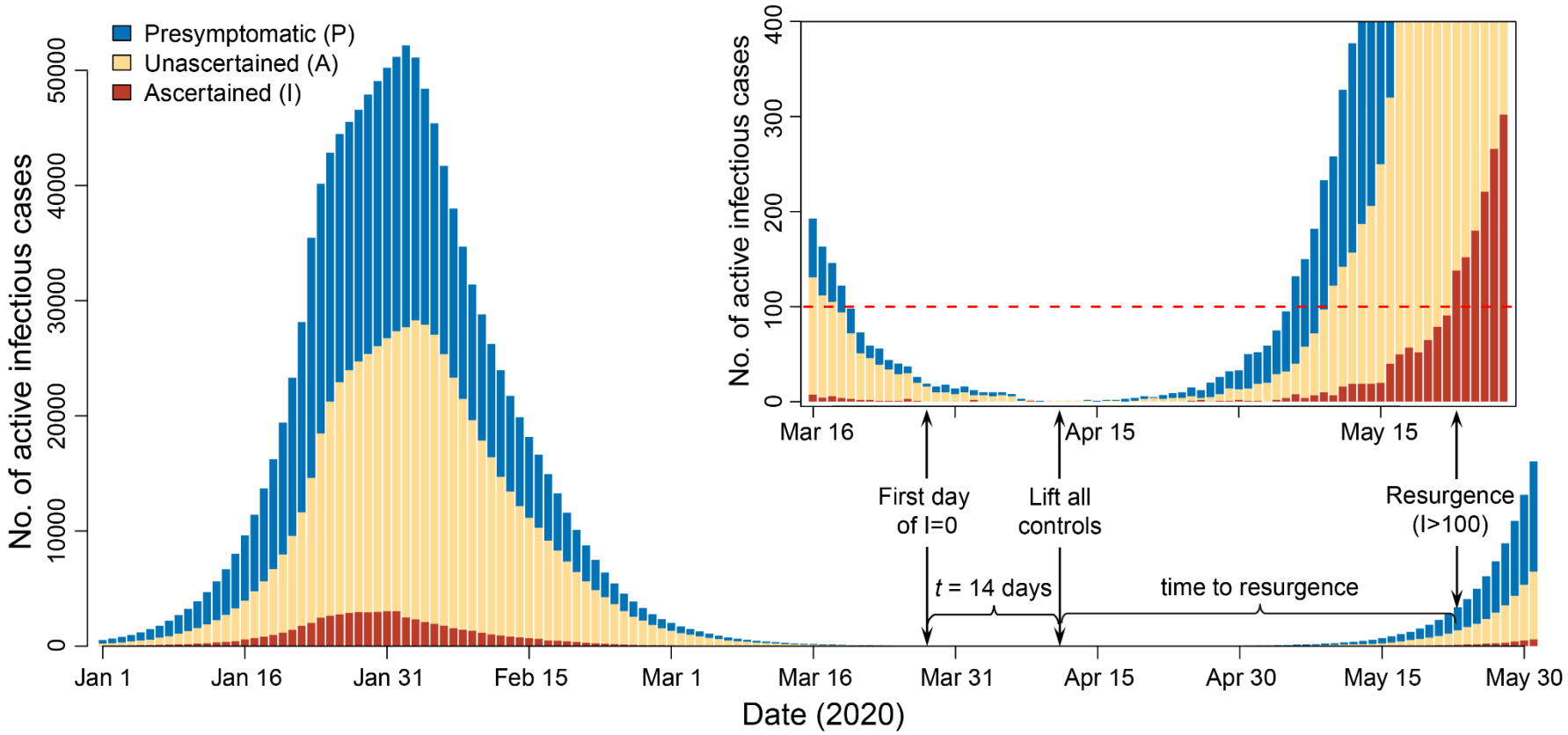




Model M: 87% unascertained

Model S8: 54% unascertained

Wuhan: Implications of Unascertained Cases on Second Wave



Stochastic simulations and define resurgence as when the number of actively infectious cases reaches 100 (i.e., I>100 in the model).

Takeaway #5: Give testing priority to the five vulnerable groups and asymptomatic and pre-symptomatic cases

- Shortage of testing capacity and supplies, e.g., swabs
- Common testing priorities: symptomatic subjects
- With increasing testing capacity, consider giving priority to the five vulnerable groups, especially asymptomatic and pre-symptomatic cases.

Testing

Takeaway #6: Reopen slowly and in phases

- Reopen when #s of cases are small and at multiple phases
- Continue intervention measures: mask wearing, social distancing, test-trace-isolate
- Resurge is expected if all measures are lifted and reopen too early.

Be United: Everyone is a team member to combat COVID-19

- Wuhan experience helps us not start from zero.
- Let the data speak and develop evidence-based strategies
- Multi-faceted interventions are needed to combat COVID-19
- Detect pre-symptomatic and asymptomatic cases
- Reopen slowly when #s of cases are small and in phases with intervention measures on.

Acknowledgement

HSTU, Wuhan

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- Tangchu Wu

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- Andy Shi
- Hui Li
- Zilin Li
- Corbin Quick
- Jingwen Zhang

How We Feel

- Feng Zhang, Broad and MIT
- Ben Silbermann, Pinterest
- David Cheng
- Ryan Probasco

+ Many other team members

- William Allen, Harvard Society of Fellows
- Han Altae-Tran, Broad Institute/MIT
- James Briggs, Broad Institute
- Xin Jin, Harvard Society of Fellows
- Mireille Kamariza, Harvard Society of Fellows
- Glenn McGee, Harvard School of Public Health
- Rumya Raghavan, Broad Institute/MIT
- Andy Shi, Harvard School of Public Health