议题 Topics: Identifying transmission modes and assessing intervention effectiveness for COVID-19

Weekly Literature Review 文献导读

Sheng Li, MPH, PhD
Assistant Prof. of Epidemiology & Systems Science
City Univ. of New York School of Public Health
Sheng.Li@sph.cuny.edu

Research field: Flu, measles, HIV, obesity, Drug overdose

Modeling methods: systems model, statistical regression, machine learning

议题 Topics: Identifying transmission modes and assessing intervention effectiveness for COVID-19

Purpose of research models:

1) "model data" for prediction & seeking association; are often wrong

-"All models are wrong, but some are useful"

- often fit the observed data well, predict future poorly (almost all COVID models)

2) "model theory" for explanation and discovering causality

- Simplify reality, develop causal theory first, then collect data to validate the theory (scientific model)

Commonly used Model types: statistical model (frequentist/bayesian, AI/Machine learning), systems model (SD, network, ABM); qualitative, quantitative & mixed method

Many researchers focus on modeling data with fancy models, however model theory can be more important.

-"science is to discover underlying theory, and is not for prediction" – J Koopman

议题 Topics: Identifying transmission modes and assessing intervention effectiveness for COVID-19

Purpose of this review:

Provide an example to show: **research topic > Fancy model technics**

My pickup: **A univariate linear regression analysis of COVID case and death data**

Identifying airborne transmission as the dominant route for the spread of COVID-19
Renyi Zhang, Yixin Li, Annie L. Zhang, Yuan Wang, and Mario J. Molina
PNAS June 30, 2020 117 (26) 14857-14863; first published June 11, 2020
Free open access at https://www.pnas.org/content/117/26/14857

Why a simple analysis was able to publish in PNAS?

- This study analyze "frequently used covid case and death count" data; BUT view the data from a **different perspective**.
- This study uses ONLY univariate linear regression model; BUT answer a "**CURRENT (now, not 2 months ago)" &** "an extremely **important & urgent public health question**".

议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

1. 研究背景　Background
    1. Disease Burden is dramatic with many uncertainty and unknowns
    2. Face covering Effectiveness Studies for COVID are particularly needed; but previous findings vary, mainly from ODE models with unidentifiability problem and intervention co-implementation.
    3. Multiple transmission modes are important for respiratory infections: China’s COVID guidelines was updated from 1 to 3 modes!
    4. Dominant transmission mode determines effective interventions!
    -SARS, Flu and Ebola examples: success and failure.

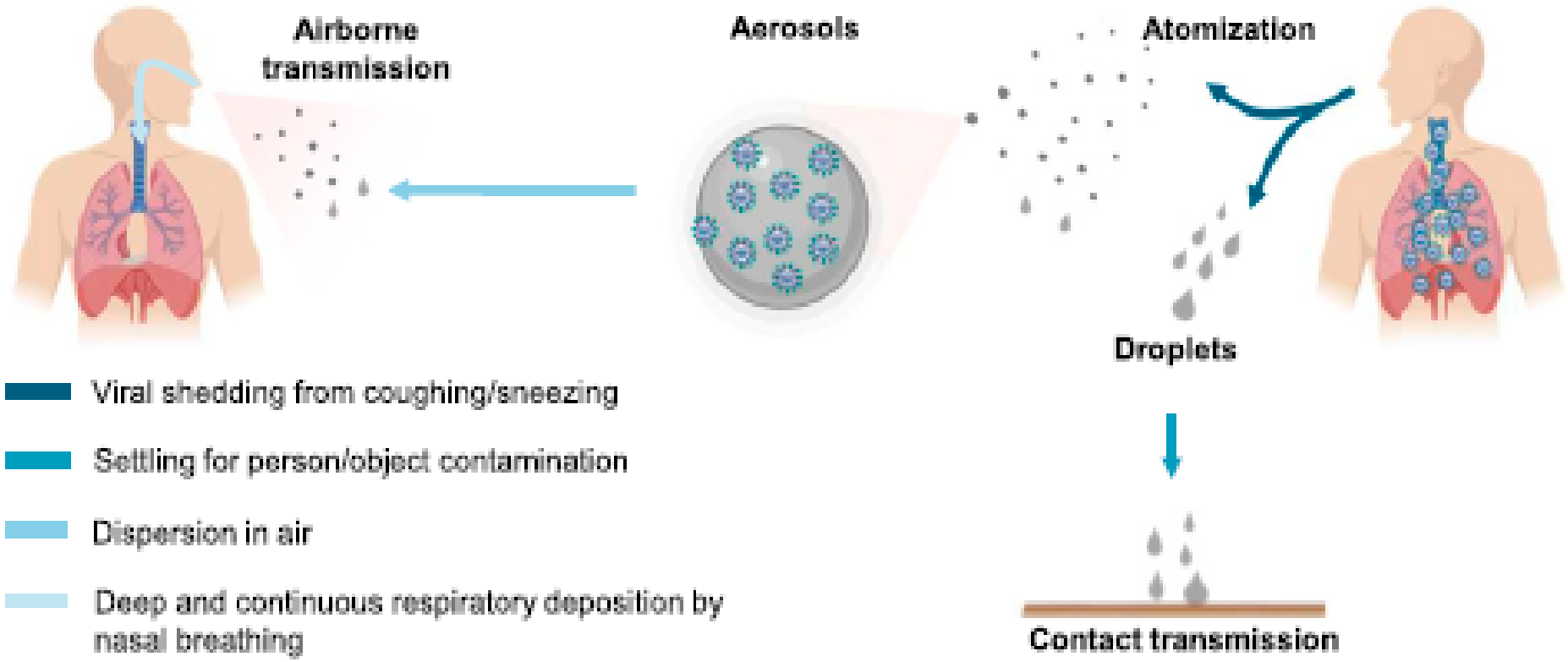
议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

1. 数据
   A. Disease outcome: Infection & Death from COVID (March-May 2020)
   B. Region and population: Wuhan, Italy, NYC|USA (diff definitions)
   C. Intervention implementation dates
2. 方法
   A. Linear regression (simple and beautiful)

议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

1. 结果解读： Define Transmission routes for COVID

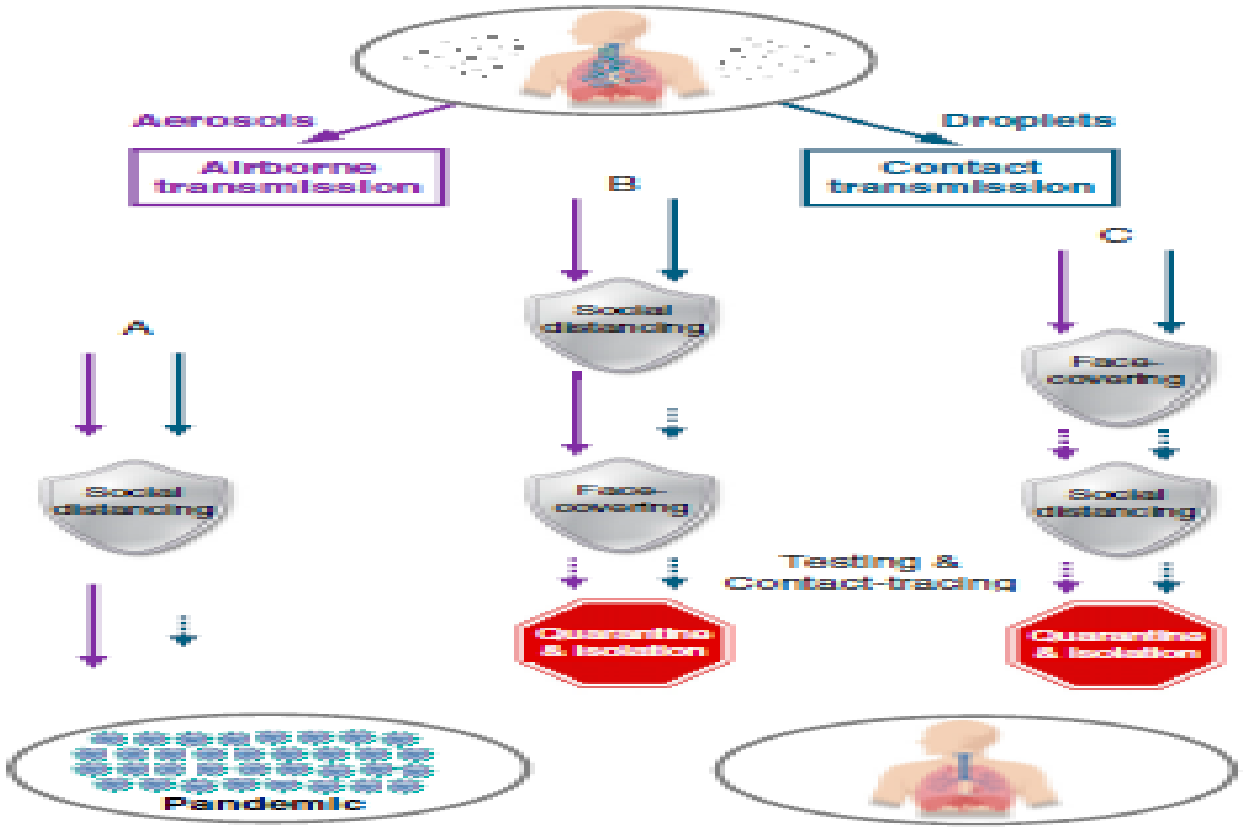
- Based on surrogates lab studies



议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

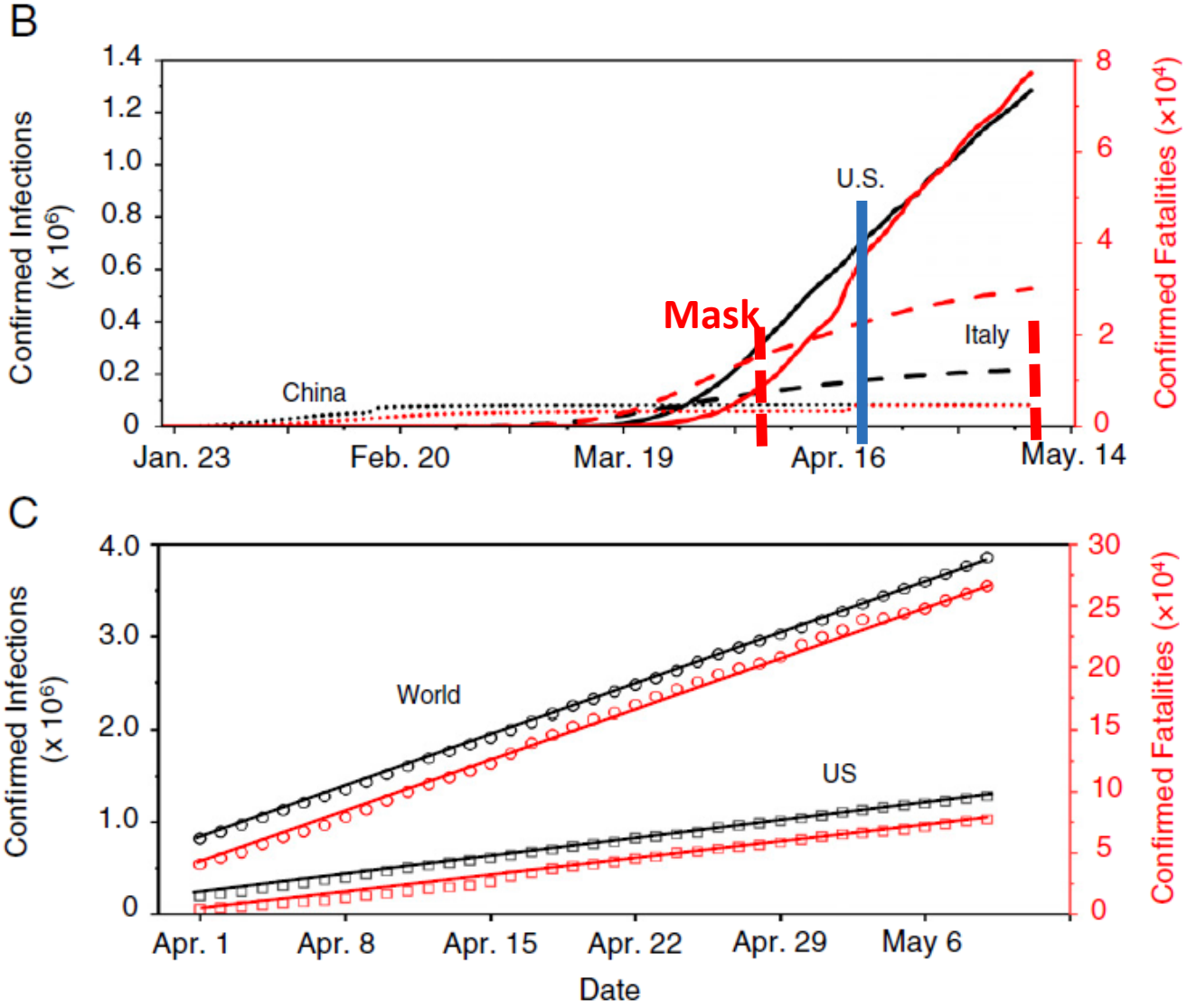
2. 结果解读:

“Transmission routes” determines Interventions policy making



议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

3. 结果解读： varying patterns; linear trends



(B) confirmed infections and fatalities between China, Italy, and United States.

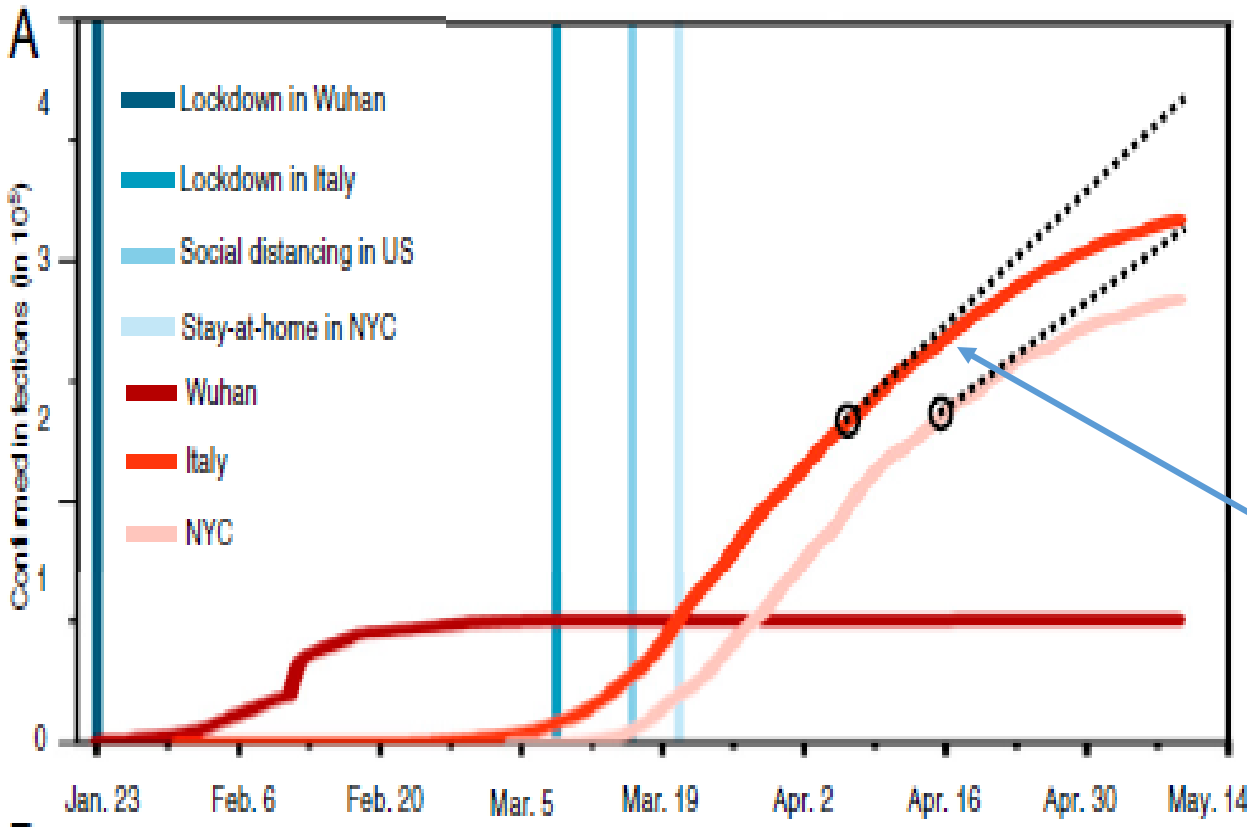
***Definitions are different.**

(C) Linear regression of the confirmed infections and fatalities for WORLD and in USA.

- **Linear regression fits data well** (R^2 higher
y = 79,398x + 810,167 (**R2 = 0.999**)
y = 6,075x + 39,409 (**R2 = 0.998**)
- Linear trend has no change in USA and WORLD, might due to “no face covering these 2 regions”; indicating other conditions (interventions, whether, mobility..) might have been stable.

议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

4. 结果解读： effectiveness of face covering: Observed Vs Fitted

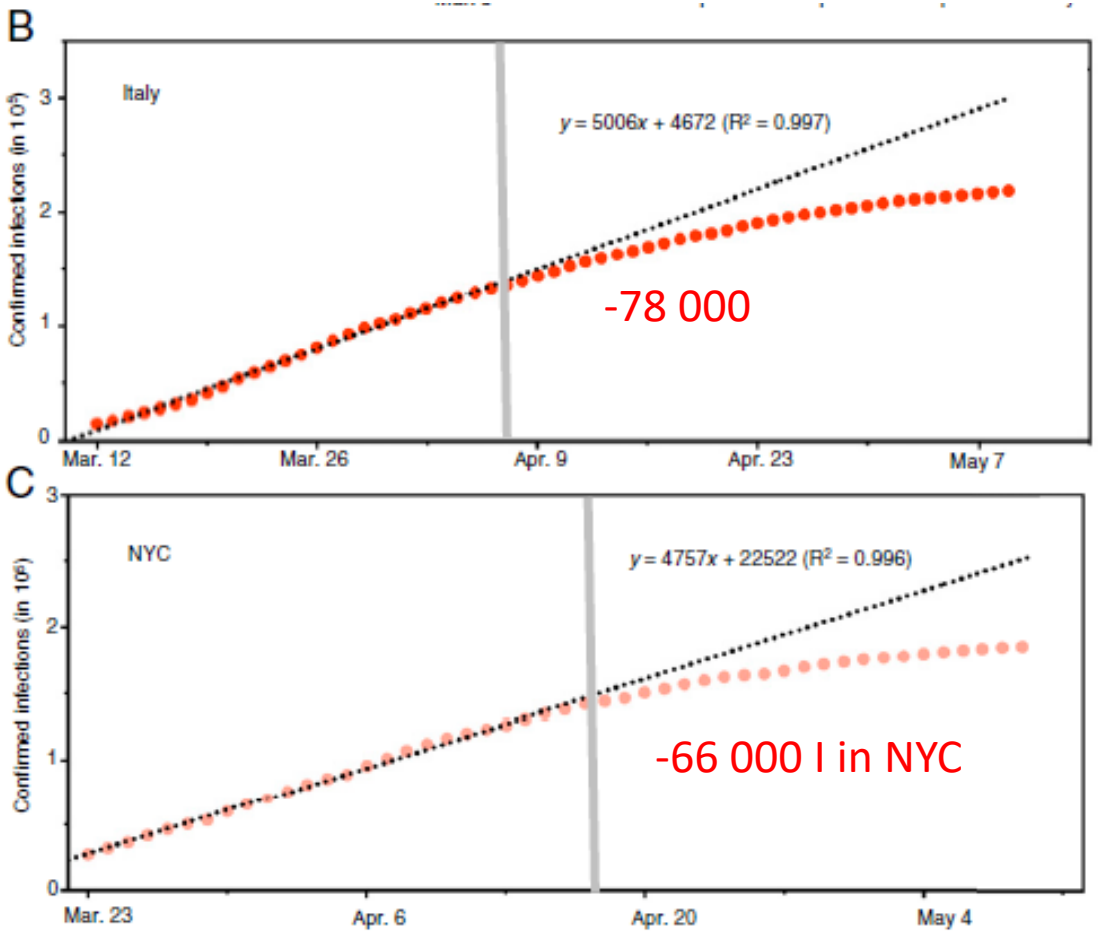


vertical lines - date for measures.
black circles - dates for mask implementation April6 northern Italy and April 17- NYC.
black dashed lines - projection w/o mask. 26-d prior to.

Delayed effect: Infection continuous rise right after implementing face covering, then decrease!!!

议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

5. 结果解读： effectiveness of face covering: Italy Vs NYC



(B) Linear regression - confirmed infections **for 26-d** data prior to implementing - **Italy.**
- reduce 78 000

(C) **NYC** [circles - reported values; dotted line – fitting]
-reduce 66 000 Inf

议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

6. 结果解读： effectiveness of face covering – NYC Vs USA

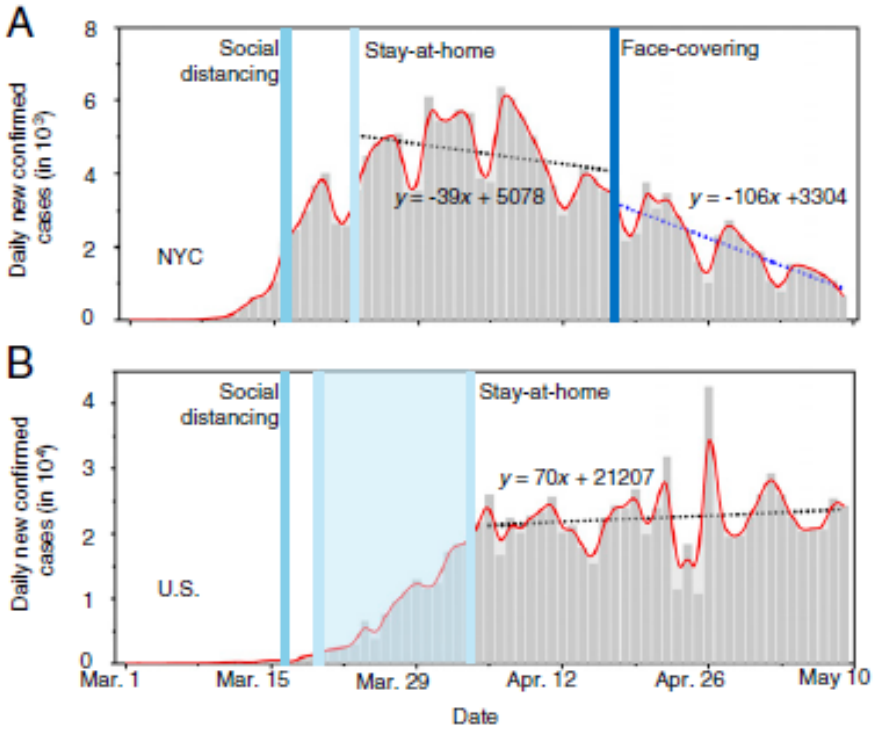


Fig. 3. Contrasting the trends of new infections between NYC and the United States. Daily new confirmed infections in (*A*) NYC and (*B*) the United States. The dotted lines represent linear fitting to the data between April 17 and May 9 in NYC and between April 4 and May 9 in the United States. In *B*, the number in NYC was subtracted from that in the United States. The vertical lines label the dates for social distancing, stay-at-home orders, and mandated face-covering.

(A) **NYC - having conditional face covering**
- Slope: decrease in NYC

(B) **NYCUSA (w/o NYC)** - No face covering
-Slope: increase in USA

Assumptions: no changes on non-mask interventions and other driving factors in these regions????

议题 Topics: Identifying transmission modes & assessing intervention effectiveness for COVID-19

1. 总结与讨论

- 本文在原有文献基础上有何扩展（可能包括立意、立论、数据、检验目标、核心方法、应用对象等）？
  - The research question is urgent needed

- 本文是否有可重复与可复制性？
  - Yes if have similar intervention relevant data
  - **Extend** to including “other intervention”; - using similar data; follow this idea
  - **Extend** to using other modeling methods (systems model, more advanced regression)

- 本文研究有何局限之处？
  - Based on many assumptions to reach conclusions
  - The quality and definition of the data variables were not discussed enough.
  - Biological knowledge of transmission model was not explained clearly.

References

1. World Health Organization, Coronavirus disease (COVID-2019) situation reports. https://www.who.int/emergencies/diseases/novel-coronavirus-2019/situation-reports/. Accessed 9 May 2020.
2. A. R. Fehr, S. Perlman, Coronaviruses: An overview of their replication and pathogenesis. *Methods Mol. Biol.* **1282**, 1–23 (2015).
3. J. S. Kutter, M. I. Spronken, P. L. Fraaij, R. A. Fouchier, S. Herfst, Transmission routes of respiratory viruses among humans. *Curr. Opin. Virol.* **28**, 142–151 (2018).
4. J. W. Tang *et al.*, Airflow dynamics of human jets: Sneezing and breathing - potential sources of infectious aerosols. *PLoS One* **8**, e59970 (2013).
5. N. H. L. Leung *et al.*, Respiratory virus shedding in exhaled breath and efficacy of face masks. *Nat. Med.* **26**, 676–680 (2020).
6. V. Stadnytskyi, C. E. Bax, A. Bax, P. Anfinrud, The airborne lifetime of small speech droplets and their potential importance in SARS-CoV-2 transmission. *Proc. Natl. Acad. Sci. U.S.A.* **117**, 11875–11877 (2020).
7. R. Zhang *et al.*, Formation of urban fine particulate matter. *Chem. Rev.* **115**, 3803–3855 (2015).
8. R. Tellier, Aerosol transmission of influenza A virus: A review of new studies. *J. R. Soc. Interface* **6** (suppl. 6), S783–S790 (2009).