

**Estimating the effects of interventions on epidemics: Theory for vaccines
and prospects for addressing the question seriously for nonpharmaceutical
interventions during COVID-19**

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1:30PM-2:50PM

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Abstract:

This talk will introduce an ongoing research program on how to estimate the effects of interventions on disease transmission. It has long been recognized that this is a challenging task in causal inference because of interference: dependence of person i 's outcome on j 's exposure, especially (though not only) because j 's exposure, say a vaccine, can reduce i 's risk by reducing the probability that j infects i . Decades of theory have been developed for randomized trials to estimate aspects of these effects, but the field remains challenging. In particular, the most widely publicized estimates of the effects of nonpharmaceutical interventions for COVID-19 show a null effect on mortality in the first (pre-vaccine) year of the pandemic on COVID-19 mortality, but as I will argue, these publications have major limitations.

In this talk I will:

- 1) describe recent work to estimate vaccine effects under the realistic setting where they are nonrandomly distributed and rolled out over time. This work was undertaken as ground-clearing for #2 but proved both more challenging and more interesting than expected.
- 2) describe the limitations of existing work that estimates the impact of COVID-19 nonpharmaceutical interventions in 2020 (prior to vaccine availability) including reverse causality, inappropriate aggregation, inappropriate choice of time scale, and inattention to adherence to control measures.
- 3) sketch a path forward to do better, a project just getting started and for which I am seeking interested students and other collaborators.

Reading List:

Readings (sharing many, don't expect most people will read this much but lets them know the background)

1. 2 Technical papers on causal estimation of vaccine effects and one effort to do so:

Jia KM, Boyer CB, Wallinga J, Lipsitch M. Causal Estimands for Analyses of Averted and Avertible Outcomes due to Infectious Disease Interventions. *Epidemiology*. 2025 May 1;36(3):363-373. doi: 10.1097/EDE.0000000000001839. Epub 2025 Jan 24. PMID: 39855261; PMCID: PMC11957442.

Jia KM, Boyer CB, Bilinski A, Lipsitch M. Defining and Estimating Outcomes Directly Averted by a Vaccination Program when Rollout Occurs Over Time. *Epidemiology*. 2026 Jan 19:10.1097/EDE.0000000000001953. doi: 10.1097/EDE.0000000000001953. Epub ahead of print. PMID: 41570185; PMCID: PMC12922481.

Jia KM, Hanage WP, Lipsitch M, Johnson AG, Amin AB, Ali AR, Scobie HM, Swerdlow DL. Estimated preventable COVID-19-associated deaths due to non-vaccination in the United States. *Eur J Epidemiol*. 2023 Nov;38(11):1125-1128. doi: 10.1007/s10654-023-01006-3. Epub 2023 Apr 24. PMID: 37093505; PMCID: PMC10123459.

2. An estimate of nonpharmaceutical intervention effects during 1918 influenza

Hatchett RJ, Mecher CE, Lipsitch M. Public health interventions and epidemic intensity during the 1918 influenza pandemic. *Proc Natl Acad Sci U S A*. 2007 May 1;104(18):7582-7. doi: 10.1073/pnas.0610941104. Epub 2007 Apr 6. PMID: 17416679; PMCID: PMC1849867.

3. The two studies (not by our group) that I'll critique in the second part of the talk.

Chapter 5 of

[In Covid's Wake: How Our Politics Failed Us, Stephen Macedo and Frances Lee, Princeton, Princeton University Press, 2025 \(ISBN 0691267138\), xvi + 373 pp., Hb \\$29.95](#)

Bollyky TJ, Castro E, Aravkin AY, Bhangdia K, Dalos J, Hulland EN, Kiernan S, Lastuka A, McHugh TA, Ostroff SM, Zheng P, Chaudhry HT, Ruggiero E, Turilli I, Adolph C, Amlag JO, Bang-Jensen B, Barber RM, Carter A, Chang C, Cogen RM, Collins JK, Dai X, Dangel WJ, Dapper C, Deen A, Eastus A, Erickson M, Fedosseeva T, Flaxman AD, Fullman N, Giles JR, Guo G, Hay SI, He J, Helak M, Huntley BM, Iannucci VC, Kinzel KE, LeGrand KE, Magistro B, Mokdad AH, Nassereldine H, Ozten Y, Pasovic M, Pigott DM, Reiner RC Jr, Reinke G, Schumacher AE, Serieux E, Spurlock EE, Troeger CE, Vo AT, Vos T, Walcott R, Yazdani S, Murray CJL, Dieleman JL. Assessing COVID-19 pandemic policies and behaviours and their economic and educational trade-offs across US states from Jan 1, 2020, to July 31, 2022: an observational analysis. *Lancet*. 2023 Apr 22;401(10385):1341-1360. doi: 10.1016/S0140-6736(23)00461-0. Epub 2023 Mar 23. PMID: 36966780; PMCID: PMC10036128.