Expiring eviction moratoriums and COVID-19 incidence and mortality

Kathryn M. Leifheit PhD MSPH,[a] Sabriya L. Linton PhD MPH,[b] Julia Raifman ScD SM,[c] Gabriel L. Schwartz PhD,[d] Emily A. Benfer JD LLM,[e] Frederick J. Zimmerman PhD,[a] Craig Evan Pollack MD, MHS[f,g, h]

[a] Department of Health Policy and Management, University of California, Los Angeles Fielding School of Public Health, Los Angeles, CA

[b] Department of Mental Health, Johns Hopkins University School of Public Health, Baltimore, MD

[c] Department of Health Law, Policy, & Management, Boston University School of Public Health, Boston, MA

[d] Philip R. Lee Institute for Health Policy Studies, University of California, San Francisco, San Francisco, CA

[e] Wake Forest University School of Law, Winston-Salem, NC

[f] Department of Health Policy and Management, Johns Hopkins School of Public Health, Baltimore, MD

[g] Department of Medicine, Johns Hopkins University School of Medicine, Baltimore, MD

[h] Johns Hopkins School of Nursing, Baltimore, MD

Corresponding Author:

Kathryn M. Leifheit, PhD, MSPH
Postdoctoral Fellow in Health Policy and Management
UCLA Fielding School of Public Health
650 Charles Young Dr. S
Los Angeles, CA 90095
Email: kleifheit@g.ucla.edu

Background

The COVID-19 pandemic and associated economic crisis has rendered millions of U.S. households unable to pay rent, placing them at risk for eviction.[1] The Centers for Disease Control and Prevention (CDC) issued an order to temporarily halt residential evictions nationwide through December 2020, effective September 4 through December 31, 2020. The order was based on the premise that halting evictions could prevent the spread of COVID-19 by facilitating self-isolation, supporting stay-at-home and social distancing directives, and reducing the risk of overcrowded living environments. Indeed, a recent simulation study found that, by forcing households to merge, evictions can alter the shape of COVID-19 epidemic curves in U.S. cities.[2]

Leveraging variation in the expiration of state-based moratoriums during the summer of 2020 as a natural experiment, this study tested whether lifting eviction moratoriums was associated with COVID-19 incidence and mortality.

Methods

The sample consisted of states that enacted eviction moratoriums over the study period (3/13/2020-9/3/2020). States entered the study on the date they first implemented a moratorium blocking one or more stages of the eviction process (i.e. notice, filing, court hearing, court order, or enforcement of order), based on data drawn from the COVID-19 Eviction Moratoria & Housing Policy database.[3] Outcome measures were daily, state-

level counts of confirmed cases and deaths, drawn from the Johns Hopkins Center for Systems Science and Engineering COVID-19 time series data.[4]

We modeled associations using a difference-in-differences approach with an event-study specification.[5,6] The exposure was coded using a set of binary indicators representing lead and lags of eviction moratoriums lifting (i.e. weeks since a state's moratorium was lifted). For states that never lifted moratoriums, all binary indicators for leads and lags were set to zero. We ran population-averaged negative binomial regression models, with state-day as the unit of analysis, state population included in the model as an offset, and a first-order autoregressive correlation structure. Models included fixed effects for state and calendar week and controlled for time-varying indicators of each state's test count (derived from the COVID Tracking Project[7] and lagged by 1 week) as well as major public-health interventions: lifting of stay-at-home orders, school closures, and mask mandates (0, 1, 2, 3, 4, or >4 weeks since implementation, derived from the COVID-19 US state policy database[8]). Appendix 1 details model specifications as well as exposure and outcome definitions. Appendix 4 details alternate specifications related to lags and inclusion of covariates. Additional sensitivity analyses are provided in Appendices 5-7. We used the models to calculate cases and deaths associated with the lifting of eviction moratoriums as a difference between predicted counts under observed moratorium conditions versus predicted counts under a counterfactual scenario in which no state lifted its moratorium during the study period. We then calculated cumulative counts associated with eviction

moratoriums lifting by day, within states, then summed across states to generate nationwide estimates. Analyses were conducted in Stata/SE v.15.1.

Findings

Forty-three states and the District of Columbia instituted a moratorium as early as March 13th and as late as April 30th, 2020.[3] These 44 states/districts contributed a total of 7208 state-day observations, on average 176 days per state. Twenty-seven of these states (63%) lifted their moratorium during the study period (Appendix Figure 2a). Among the states that lifted their moratoriums, the median moratorium duration was 9.9 weeks (IQR 8.3, 15.1), with a median of 12 weeks (IQR 7, 14) of observations with no moratorium protection (Appendix Figure 2b).

Before moratoriums were lifted, incidence rate ratios and mortality rate ratios were relatively constant (Figure 1), suggesting little evidence of preexisting trends in states that went on to lift their moratoriums. COVID-19 incidence was significantly increased in states that lifted their moratoriums starting ten weeks after lifting, with 1.6 times the incidence (95% Confidence Interval [CI] 1.0,2.3) of states that maintained their moratoriums. COVID-19 mortality was significantly increased after seven weeks, with 1.6 times higher mortality (CI 1.2,2.3). The magnitude of these differences increased over the follow-up period; sixteen or more weeks after lifting their moratoriums, states had, on average, 2.1 times higher incidence (CI 1.1, 3.9) and 5.4 times higher mortality (CI 3.1,9.3). Although increases in mortality reached statistical significance earlier than

increases in incidence, this appears to be an artifact of less precision in our incidence estimates, rather than a true lag in incidence. Nationally, the results translate to a total of 433,700 excess cases (CI 365200, 502200) and 10,700 excess deaths (CI 8900, 12500) associated with eviction moratoriums lifting over the course of the study period (Figure 2; state-level estimates provided in Appendix 3). Results of sensitivity analyses are shown in Appendices 4-7.

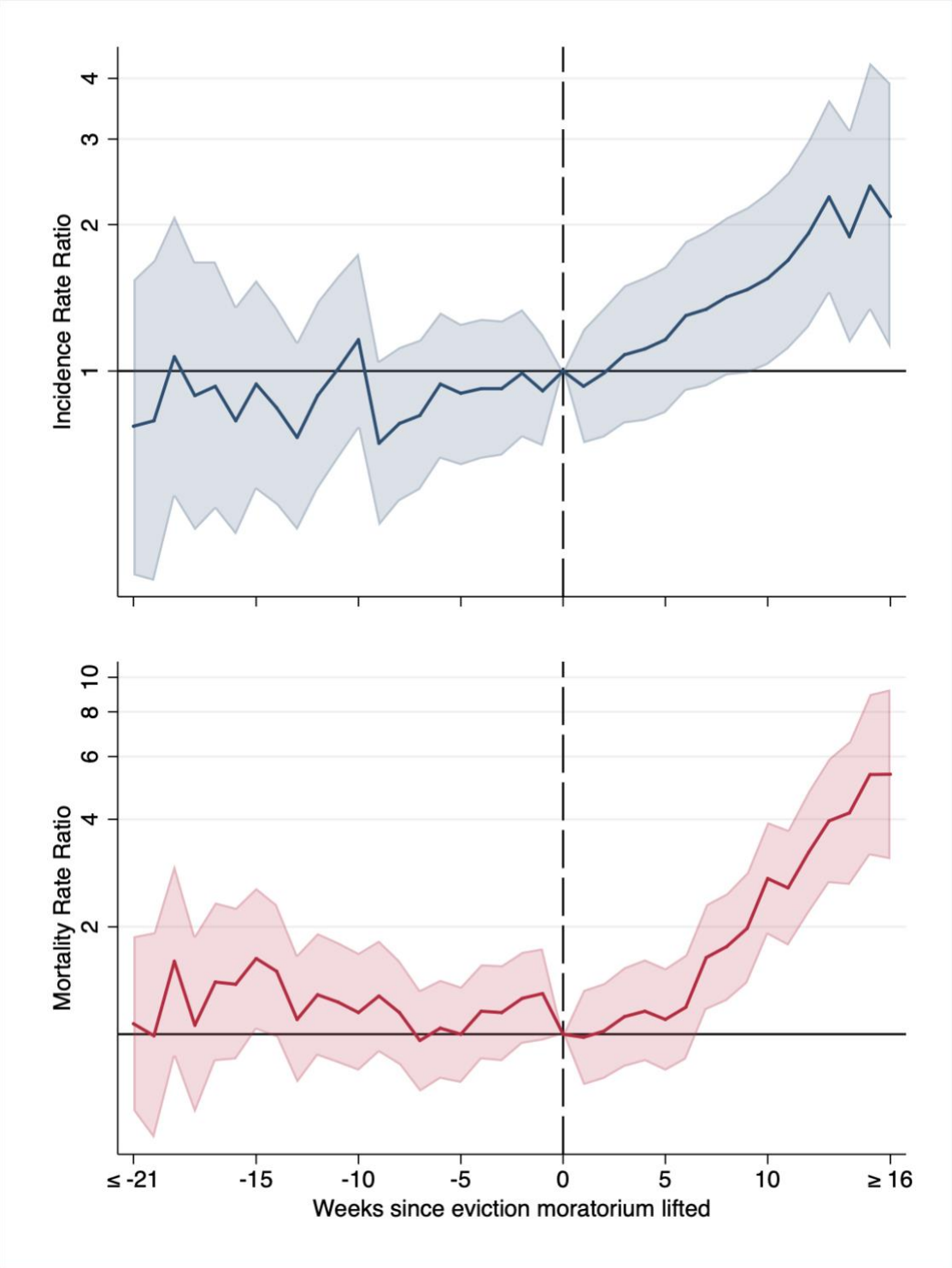
Discussion

Lifting eviction moratoriums was associated with increased COVID-19 incidence and mortality in U.S. states, supporting the public health rationale for use of eviction moratoriums to prevent the spread of COVID-19. Effects grew over time, perhaps due to mounting displacement, crowding, and/or homelessness as evictions proceeded.[9] The finding of a larger effect size for mortality than for incidence may relate to the fact that COVID-19 deaths are better ascertained than cases. The finding may also suggest that the cases associated with evictions were more severe than the average for the state's population. This is plausible, given that poor health and costs associated with healthcare may drive eviction risk.[10,11] Moreover, structural racism and poverty, fundamental causes of eviction risk,[12] also manifest as comorbidities and poor access to care in Black and Latinx communities and low-income households, creating vulnerabilities to COVID-19 case fatality.[13] Future research should investigate associations between lifting moratoriums and racial/ethnic disparities in COVID-19 outcomes.

Because this study does not measure policy implementation (i.e. executed evictions), the estimates represent intent-to-treat effects. That being said, Princeton's Eviction Lab has documented a strong correlation between state moratoriums and eviction filings.[14] The study relies on public-health surveillance of confirmed COVID-19 cases and deaths, likely underestimating true incidence and mortality. Additionally, local moratoriums, rent relief, and other protective policies are not captured, nor do we model potential spillover effects of policies from bordering states. Though we control for three key public-health interventions, there may be concurrent policies or time-varying features of states that contribute to observed trends.

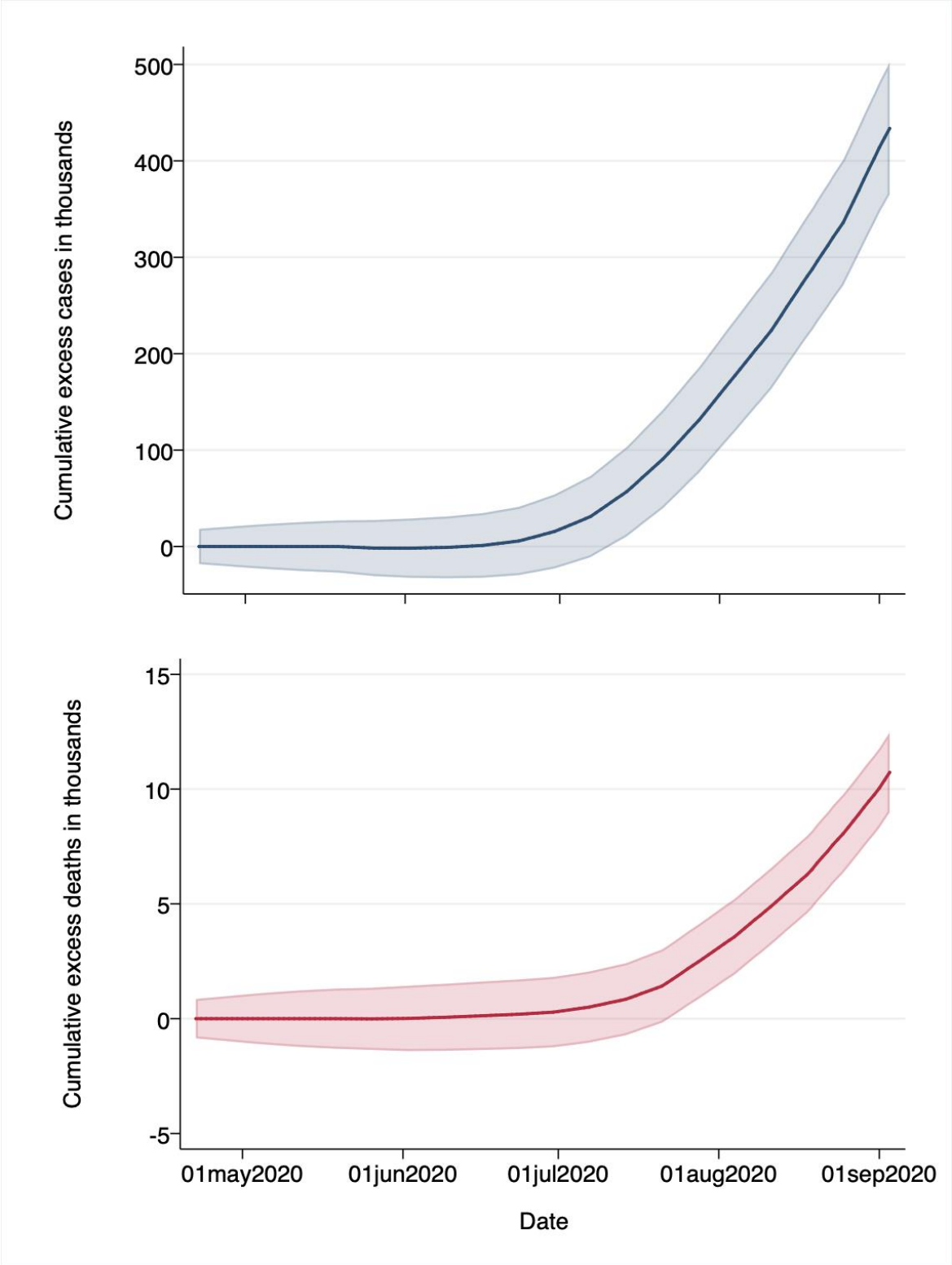
Federal, state, and local eviction moratoriums may reduce COVID-19 incidence and mortality. While much-needed, moratoriums may delay evictions without preventing them. Looking to 2021, policymakers should consider extending federal, state and local moratoriums alongside rent relief, and other legal and supportive protections to prevent future evictions, COVID-19 transmission, and associated harms.

Figure 1. Adjusted rate ratios comparing daily COVID-19 incidence (new cases per population) and mortality (deaths per population) between states that lifted eviction moratoriums and states that maintained moratoriums.



Notes: Rate ratios were modeled using negative binomial regression with fixed effects for state and calendar week, adjusting for testing rate, stay-at-home orders, school closures, and mask mandates.

Figure 2. Cumulative excess case and deaths associated with lifting of eviction moratoriums (national estimates).



References

1. Pollack CE, Leifheit KM, Linton SL. When Storms Collide: Evictions, COVID-19, And Health Equity. *Heal Aff Blog*. Published online August 4, 2020. Accessed August 26, 2020. https://www.healthaffairs.org/do/10.1377/hblog20200730.190964/full/
2. Sheen J, Nande A, Walters EL, et al. The effect of eviction moratoriums on the transmission of SARS-CoV-2. *medRxiv*. Published online January 1, 2020:2020.10.27.20220897. doi:10.1101/2020.10.27.20220897
3. Benfer EA, Adam K, Koehler R, Mark A. COVID-19 Eviction Moratoria & Housing Policy: Federal (CDC), State, Commonwealth, and Territory. Published 2020. Accessed November 4, 2020. https://docs.google.com/spreadsheets/d/e/2PACX-1vTH8dUIbfnt3X52TrY3dEHQCAm60e5nqo0Rn1rNCf15dPGeXxM9QN9UdxUfEjxwvfTKzbCbZxJMdR7X/pubhtml
4. Johns Hopkins Center for Systems Science and Engineering. COVID-19 Time Series Data. Published 2020. Accessed November 4, 2020. https://github.com/CSSEGISandData/COVID-19/tree/master/csse_covid_19_data/csse_covid_19_time_series
5. Goodman-Bacon A. Difference-in-Differences with Variation in Treatment Timing. *Natl Bur Econ Res*. Published online 2018. doi:10.1017/CBO9781107415324.004
6. Goodman-Bacon A, Marcus J. Using Difference-in-Differences to Identify Causal Effects of COVID-19 Policies. *SSRN*. Published online 2020. https://ssrn.com/abstract=3603970
7. The COVID Tracking Project. Published 2020. Accessed November 3, 2020. https://covidtracking.com/data/download
8. Raifman J, Nocka K, Jones D, et al. COVID-19 US state policy database. Accessed September 1, 2020. www.tinyurl.com/statepolicies
9. Benfer E, Vlahov D, Long M, et al. Examining the Relationship Among Eviction, Housing Instability, Health Inequity, and COVID-19 Transmission. *J Urban Heal*. 2020;In press.
10. Allen HL, Eliason E, Zewde N, Gross T. Can medicaid expansion prevent housing evictions? *Health Aff*. 2019;38(9):1451-1457. doi:10.1377/hlthaff.2018.05071
11. Schwartz GL, Leifheit KM, Berkman L, Chen J, Arcaya M. Adverse health selection into eviction: low birthweight, prematurity, and neonatal medical needs and children's risk of eviction through age 5. *Prep*. Published online 2020.
12. Threet D. Household Pulse Survey Shows Continuing Struggle Among Lowest-Income Renters. National Low Income Housing Coalition. Published 2020. Accessed November 13, 2020. https://hfront.org/2020/09/17/household-pulse-survey-shows-continuing-struggle-among-lowest-income-renters/
13. United States Centers for Disease Control and Prevention. Assessing Risk Factors for Severe COVID-19 Illness. Accessed November 13, 2020. %0AAssessing Risk Factors for Severe COVID-19 Illness%0A
14. The Eviction Lab, Benfer EA. COVID-19 Eviction Tracking System. Published 2020. Accessed November 23, 2020. https://evictionlab.org/eviction-tracking/

Acknowledgements

Specific Contributions:
Study concept and design: KM Leifheit, SL Linton, CE Pollack
Acquisition, analysis, or interpretation of data: All authors
Drafting of the manuscript: KM Leifheit
Critical revision of the manuscript for important intellectual content: All authors
Statistical analysis: KM Leifheit
Administrative, technical, or material support: J Raifman, GL Schwartz, EA Benfer
Study supervision: CE Pollack

Access to data: KM Leifheit had full access to all the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis. EA Benfer reviewed eviction moratorium dates and takes responsibility for the integrity of these data.

Conflicts of Interest: Dr. Pollack owns stock in Gilead Pharmaceuticals. The work detailed here does not evaluate any specific drug or intervention produced by Gilead. Dr. Pollack is an unpaid member of Enterprise Community Partners' Health Advisory Council and was a paid consultant to the Open Communities Alliance. Dr. Pollack works part time on a temporary assignment with the Department of Housing and Urban Development (HUD), assisting the department on housing and health issues. The findings and conclusions in this article are those of the authors and do not necessarily represent those of HUD or other government agencies. Preliminary results from this research were cited in an Amici Curiae Brief filed October 9th in support of the CDC's national moratorium on eviction as a public health measure. KM Leifheit, SL Linton, J Raifman, GS Schwartz, EA Benfer, and CE Pollack signed on to the brief as amici and EA Benfer was the lead author of the brief. EA Benfer and KM Leifheit have provided expert testimony to legislative bodies regarding potential public health effects of eviction.

Sources of Funding: KM Leifheit was supported by a postdoctoral fellowship from the Agency for Healthcare Research and Quality (AHRQ 2T32HS000046). Julia Raifman was supported by the Robert Wood Johnson Foundation Evidence for Action program, and the National Center for Advancing Translational Sciences, National Institutes of Health through the Boston University Clinical and Translational Science Institute grant, 1UL1TR001430. The funders had no role in study design, collection, analysis, and interpretation of data, writing this report, or the decision to submit the report for publication. The content is solely the responsibility of the authors and does not necessarily represent the official views of the funding agencies.

The authors thank Usama Bilal and Lelia Chaisson for methodological review. We thank the COVID-19 US State Policy Database team, including Kristen Nocka, Rachel A. Scheckman, Claire Sontheimer and Alexandra Skinner. We also thank project leads Karna Adam, Anne Kat Alexander (Eviction Lab), and Robert Koehler, as well as the entire COVID-19 Eviction Moratoria & Housing Policy: Federal, State, Commonwealth, and Territory research team.

Appendix 1: Methods supplement

Model Specification

$(cases)_{it}$ = (≥ 21 weeks prior)$_{it}$ + (20 weeks prior)$_{it}$ + (19 weeks prior)$_{it}$ + (18 weeks prior)$_{it}$ + (17 weeks prior)$_{it}$ + (16 weeks prior)$_{it}$ + (15 weeks prior)$_{it}$ + (14 weeks prior)$_{it}$ + (13 weeks prior)$_{it}$ + (12 weeks prior)$_{it}$ + (11 weeks prior)$_{it}$ + (10 weeks prior)$_{it}$ + (9 weeks prior)$_{it}$ + (8 weeks prior)$_{it}$ + (7 weeks prior)$_{it}$ + (6 weeks prior)$_{it}$ + (5 weeks prior)$_{it}$ + (4 weeks prior)$_{it}$ + (3 weeks prior)$_{it}$ + (2 weeks prior)$_{it}$ + (1 week prior)$_{it}$ + (1 week post)$_{it}$ + (2 weeks post)$_{it}$ + (3 weeks post)$_{it}$ + (4 weeks post)$_{it}$ + (5 weeks post)$_{it}$ + (6 weeks post)$_{it}$ + (7 weeks post)$_{it}$ + (8 weeks post)$_{it}$ + (9 weeks post)$_{it}$ + (10 weeks post)$_{it}$ + (11 weeks post)$_{it}$ + (12 weeks post)$_{it}$ + (13 weeks post)$_{it}$ + (14 weeks post)$_{it}$ + (15weeks post)$_{it}$ + (≥ 16 weeks post)$_{it}$ + (tests)$_{it-7}$ + (weeks since stay at home orders were lifted)$_{it}$ + (weeks since schools closed)$_{it}$ + (weeks since mask mandate)$_{it}$ + (week)$_{t}$ + (state)$_{i}$ + ln(population)$_{i}$ + ε_{it}

$(deaths)_{it}$ = (≥ 21 weeks prior)$_{it}$ + (20 weeks prior)$_{it}$ + (19 weeks prior)$_{it}$ + (18 weeks prior)$_{it}$ + (17 weeks prior)$_{it}$ + (16 weeks prior)$_{it}$ + (15 weeks prior)$_{it}$ + (14 weeks prior)$_{it}$ + (13 weeks prior)$_{it}$ + (12 weeks prior)$_{it}$ + (11 weeks prior)$_{it}$ + (10 weeks prior)$_{it}$ + (9 weeks prior)$_{it}$ + (8 weeks prior)$_{it}$ + (7 weeks prior)$_{it}$ + (6 weeks prior)$_{it}$ + (5 weeks prior)$_{it}$ + (4 weeks prior)$_{it}$ + (3 weeks prior)$_{it}$ + (2 weeks prior)$_{it}$ + (1 week prior)$_{it}$ + (1 week post)$_{it}$ + (2 weeks post)$_{it}$ + (3 weeks post)$_{it}$ + (4 weeks post)$_{it}$ + (5 weeks post)$_{it}$ + (6 weeks post)$_{it}$ + (7 weeks post)$_{it}$ + (8 weeks post)$_{it}$ + (9 weeks post)$_{it}$ + (10 weeks post)$_{it}$ + (11 weeks post)$_{it}$ + (12 weeks post)$_{it}$ + (13 weeks post)$_{it}$ + (14 weeks post)$_{it}$ + (15weeks post)$_{it}$ + (≥ 16 weeks post)$_{it}$ + (tests)$_{it-7}$ + (weeks since stay at home orders were lifted)$_{it}$ + (weeks since schools closed)$_{it}$ + (weeks since mask mandate)$_{it}$ + (week)$_{t}$ + (state)$_{i}$ + ln(population)$_{i}$ + ε_{it}

…Where
$(cases)_{it}$ = Daily case count
$(deaths)_{it}$ = Daily death count
$(x\ weeks\ prior)_{it}$ = binary indicator of whether outcome was observed x weeks prior to the week the moratorium was lifted (among states that ever lifted; always 0 for states that never lifted)
$(x\ weeks\ post)_{it}$ = binary indicator of whether outcome was observed x weeks after the week the moratorium was lifted (among states that ever lifted; always 0 for states that never lifted)
$(tests)_{it-7}$ = Daily test count, measured 7 days prior to outcomes
$(weeks\ since\ stay\ at\ home\ orders\ were\ lifted)_{it}$ = factor variables representing weeks since initial orders were lifted or relaxed: 0, 1, 2, 3, 4, or >4. Coded as zero for states that never lifted, coded as 99 for states that never had stay at home orders or states that had not yet implemented orders.
$(weeks\ since\ schools\ closed)_{it}$ = factor variables representing weeks since implementation: 0, 1, 2, 3, 4, or >4. Coded as zero for states that never closed.
$(weeks\ since\ mask\ mandate)_{it}$ = factor variables representing weeks since implementation: 0, 1, 2, 3, 4, or >4. Coded as zero for states that never instituted a mandate.
$(week)_{t}$ = fixed effects for calendar week
$(state)_{i}$ = fixed effects for state
$\ln(population)_{i}$ = state population per the 2018 American Community Survey, included as an offset with coefficient constrained to 1

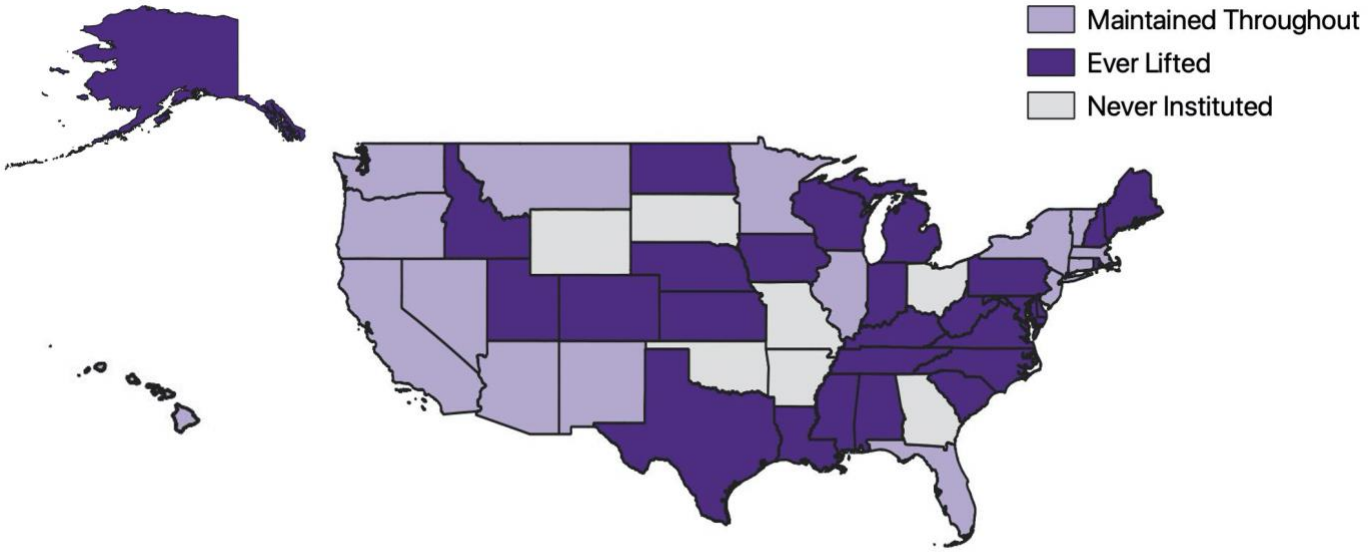
Eviction moratorium classification:

We define a moratorium start date as the first date any actor (i.e. governor, legislature, courts) issued an eviction moratorium. Court closures (even in the absence of specific language regarding eviction proceedings) were counted as moratoriums. For prospective orders, we use the effective date, whereas for retrospective orders, we use the date of issuance. We define a moratorium expiration date as the date a state's first eviction moratorium from any actor expired. For states that issued a second moratorium after their first moratorium had expired, we censor follow-up time after the second moratorium was instituted.

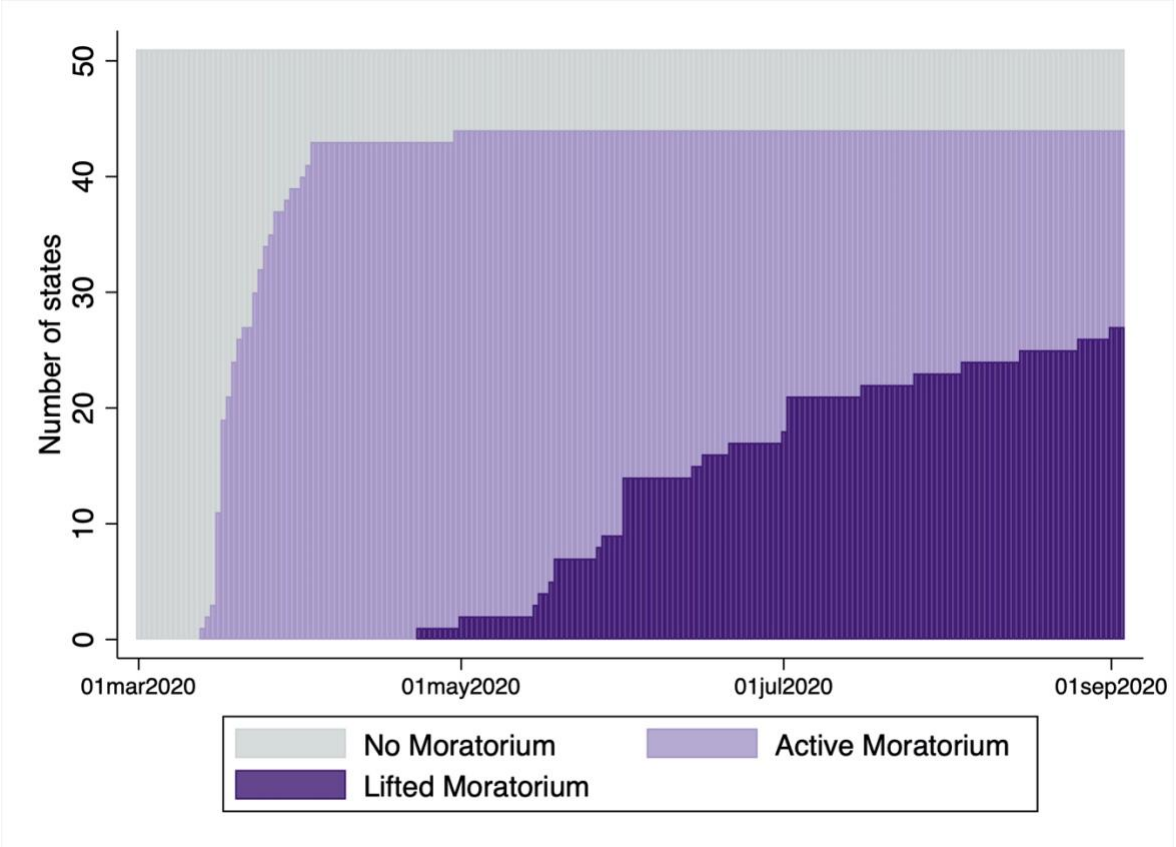
Daily case and death counts:

The Johns Hopkins Center for Systems Science and Engineering (CSSE) maintains COVID-19 time series data, read in from daily case reports. If, in its quality control process, CSSE identifies an inaccuracy in surveillance data, they update daily case reports, but not historical data. Given this, we reviewed cumulative case and death counts by day. In instances where the cumulative count for a state was adjusted down from one day to the next, suggesting that an overcount had been corrected, we back-imputed cumulative incidence and deaths until the cumulative counts increased by ≥0 between all observations. Note that this imputation was necessary for fewer than one percent of state-days.

Appendix 2a: Map of U.S. states indicating eviction moratorium status over the study period (March 13th – September 3rd, 2020)



Appendix 2b: Figure showing change in state eviction moratorium status over time



Appendix 3: State-level estimates of cumulative excess case and deaths associated with lifting of eviction moratoriums.

State*	Date first moratorium expired	Weeks without moratorium†	Excess Cases through September 3rd		Excess Deaths through September 3rd	
			Estimate**	95% CI	Estimate**	95% CI
Alabama	5/31/2020	14	**26470**	20180, 32770	**621**	530, 713
Alaska	6/30/2020	9	**470**	180, 760	**3**	0, 5
Colorado	6/13/2020	12	**8620**	5240, 11990	**254**	184, 323
Delaware	7/01/2020	9	**1280**	350, 2220	**28**	2, 55
Idaho	4/30/2020	18	**9730**	8270, 11190	**157**	142, 172
Indiana	8/14/2020	3	-300	-6190, 5590	2	-151, 154
Iowa	5/27/2020	14	**19360**	15370, 23350	**354**	304, 403
Kansas‡	5/31/2020	11	**5060**	3150, 6970	**64**	46, 82
Kentucky	8/25/2020	1	-60	-2810, 2700	0	-55, 55
Louisiana	6/15/2020	12	**29650**	20870, 38430	**959**	761, 1157
Maine	8/03/2020	5	40	-290, 370	1	-9, 11
Maryland	7/25/2020	6	2310	-4220, 8840	37	-134, 208
Michigan	7/15/2020	7	4270	-2360, 10900	97	-158, 352
Mississippi	5/31/2020	14	**22010**	17340, 26680	**804**	698, 911
Nebraska	5/31/2020	14	**11940**	9460, 14420	**134**	115, 154
New Hampshire	7/01/2020	9	**890**	340, 1450	**24**	7, 41
North Carolina	6/20/2020	11	**15690**	7400, 23980	**304**	186, 421
North Dakota	4/22/2020	19	**5260**	4500, 6010	**97**	89, 105
Pennsylvania	8/31/2020	1	-140	-9940, 9670	-1	-325, 324
Rhode Island	7/01/2020	9	**1840**	530, 3150	**54**	7, 101
South Carolina	5/14/2020	16	**37590**	31410, 43780	**1090**	983, 1196
Tennessee	5/31/2020	14	**40430**	32350, 48520	**556**	485, 626
Texas	5/18/2020	16	**148530**	120650, 176420	**4456**	4015, 4897
Utah	5/15/2020	16	**20380**	16950, 23800	**201**	182, 221
Virginia‡	5/17/2020	3	-200	-6560, 6160	10	-92, 112
West Virginia	5/18/2020	16	**2700**	2190, 3210	**79**	70, 88
Wisconsin	5/26/2020	14	**19840**	15540, 24130	**346**	298, 394
TOTAL			**443660**	365160, 502210	10731	8988, 12470

* Seventeen states/districts had eviction moratoriums for the entire study period and served as a comparison group: Arizona, California, Connecticut, the District of Columbia, Florida, Hawaii, Illinois, Massachusetts, Minnesota, Montana, Nevada, New Jersey, New Mexico, New York, Oregon, Vermont, and Washington. Seven states never implemented an eviction moratorium and were excluded from the analysis: Arkansas, Georgia, Missouri, Ohio, Oklahoma, South Dakota, and Wyoming.

** Statistically significant ($p<0.05$) estimates of excess cases and deaths on September 3rd appear in **bold**.

† "Weeks without moratorium" is defined as weeks between and including the expiration of the first moratorium up until the initiation of either a second state-level moratorium or the initiation of the CDC's national moratorium on September 4th 2020, whichever came first.

‡ Kansas instituted a second moratorium from August 19, 2020 to January 26, 2021. Virginia instituted a second moratorium from June 8th to June 28th, 2020 and a third moratorium from August 10th through September 7th, 2020. For these two states, we censor time after the second moratoriums were instituted, meaning that excess cases and deaths cease to accumulate beyond August 19th and June 8th, respectively.

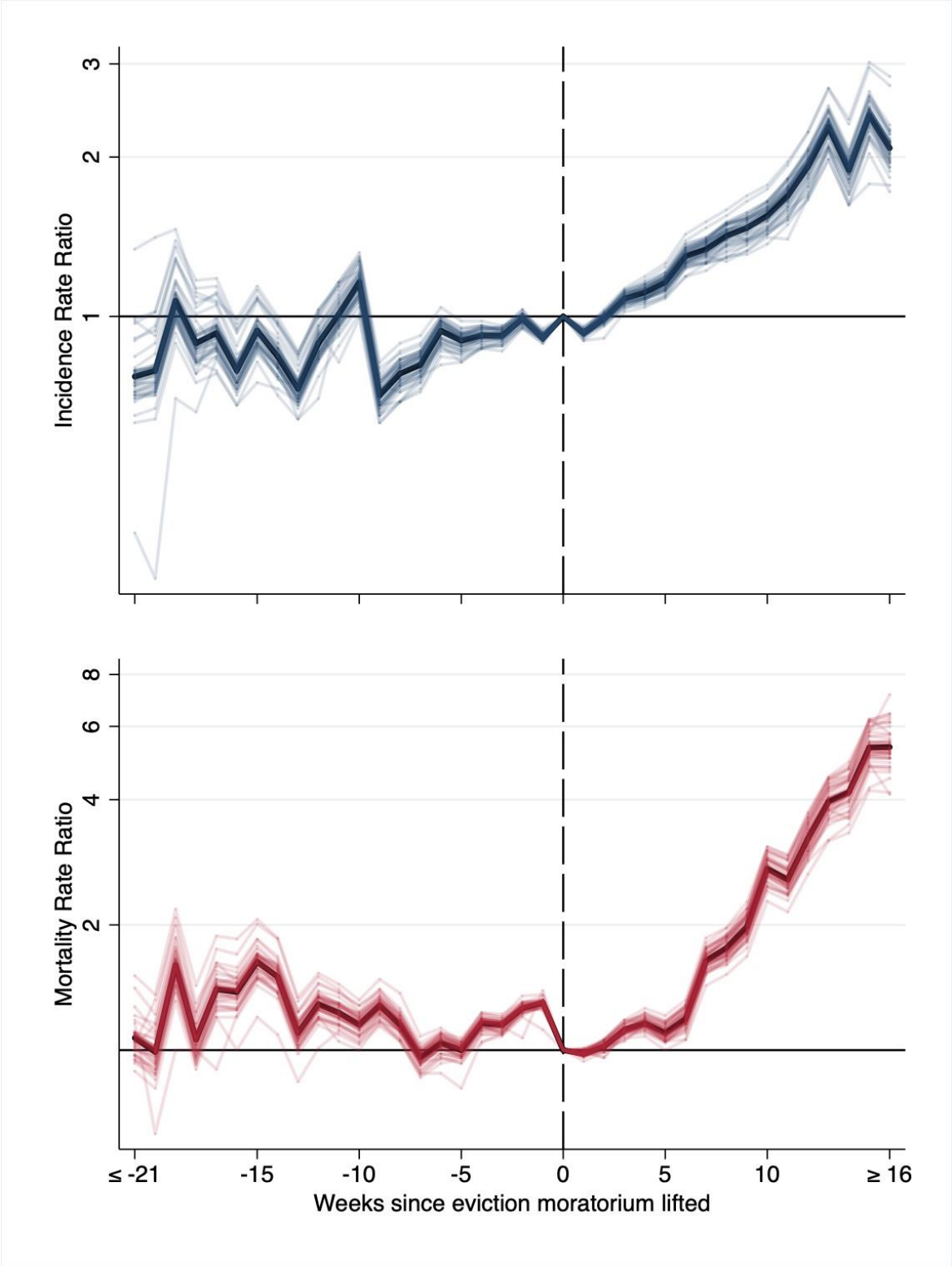
Appendix 4: Main model and alternate model specifications showing COVID Incidence Rate Ratio (IRR) and Mortality Rate Ration (MRR). Findings from alternate models were similar to those from the main model.

Weeks since lifted	Main model		Alternate specifications, detailed in notes by model number											
			1		2		3		4		5		6	
	IRR	MRR	IRR	MRR	IRR	MRR	IRR	MRR	IRR	MRR	IRR	MRR	IRR	MRR
N/A			**1.28**	**2.11**										
1	0.93	0.98			0.95	0.99	0.94	0.99	0.98	1.02	0.95	0.99	0.98	0.95
2	0.99	1.02			0.99	1.02	0.99	1.02	1.06	1.07	1.02	1.02	1.04	0.90
3	1.08	1.12			1.10	1.13	1.09	1.13	1.18	1.18	1.11	1.12	0.99	0.99
4	1.11	1.16			1.12	1.17	1.10	1.16	1.25	1.28	1.14	1.16	**1.24**	1.13
5	1.16	1.10			1.17	1.10	1.15	1.10	1.32	1.21	1.18	1.09	**1.40**	1.09
6	1.30	1.19			1.30	1.19	1.29	1.20	**1.48**	1.29	1.31	1.18	**1.55**	1.20
7	1.34	**1.64**			1.28	**1.62**	1.34	**1.65**	**1.57**	**1.84**	1.36	**1.62**	**1.78**	**1.69**
8	1.42	**1.76**			**1.68**	**1.84**	1.44	**1.79**	**1.69**	**2.03**	1.43	**1.72**	**1.76**	**1.71**
9	1.47	**1.98**			**1.51**	**1.89**	1.36	**1.88**	**1.78**	**2.35**	**1.48**	**1.94**	**2.02**	**2.27**
10	**1.55**	**2.73**			**1.63**	**2.72**	**1.55**	**2.85**	**1.82**	**3.25**	**1.56**	**2.67**	**1.89**	**3.08**
11	**1.69**	**2.57**			**1.71**	**2.51**	**1.65**	**2.57**	**1.97**	**3.12**	**1.70**	**2.52**	**2.03**	**2.94**
12	**1.92**	**3.23**			**2.10**	**3.29**	**1.92**	**3.30**	**2.16**	**3.72**	**1.93**	**3.15**	**2.60**	**3.44**
13	**2.28**	**3.96**			**2.35**	**3.83**	**2.20**	**3.85**	**2.62**	**4.53**	**2.29**	**3.86**	**3.15**	**4.89**
14	**1.89**	**4.17**			**1.99**	**4.24**	**1.89**	**4.40**	**2.27**	**4.76**	**1.90**	**4.05**	**2.96**	**5.04**
15	**2.40**	**5.34**			**2.48**	**5.21**	**2.31**	**5.23**	**3.00**	**6.33**	**2.40**	**5.17**	**2.96**	**5.52**
≥16	**2.08**	**5.35**			**2.21**	**5.30**	**2.02**	**5.42**	**2.98**	**6.88**	**2.09**	**5.21**	**3.88**	**8.39**

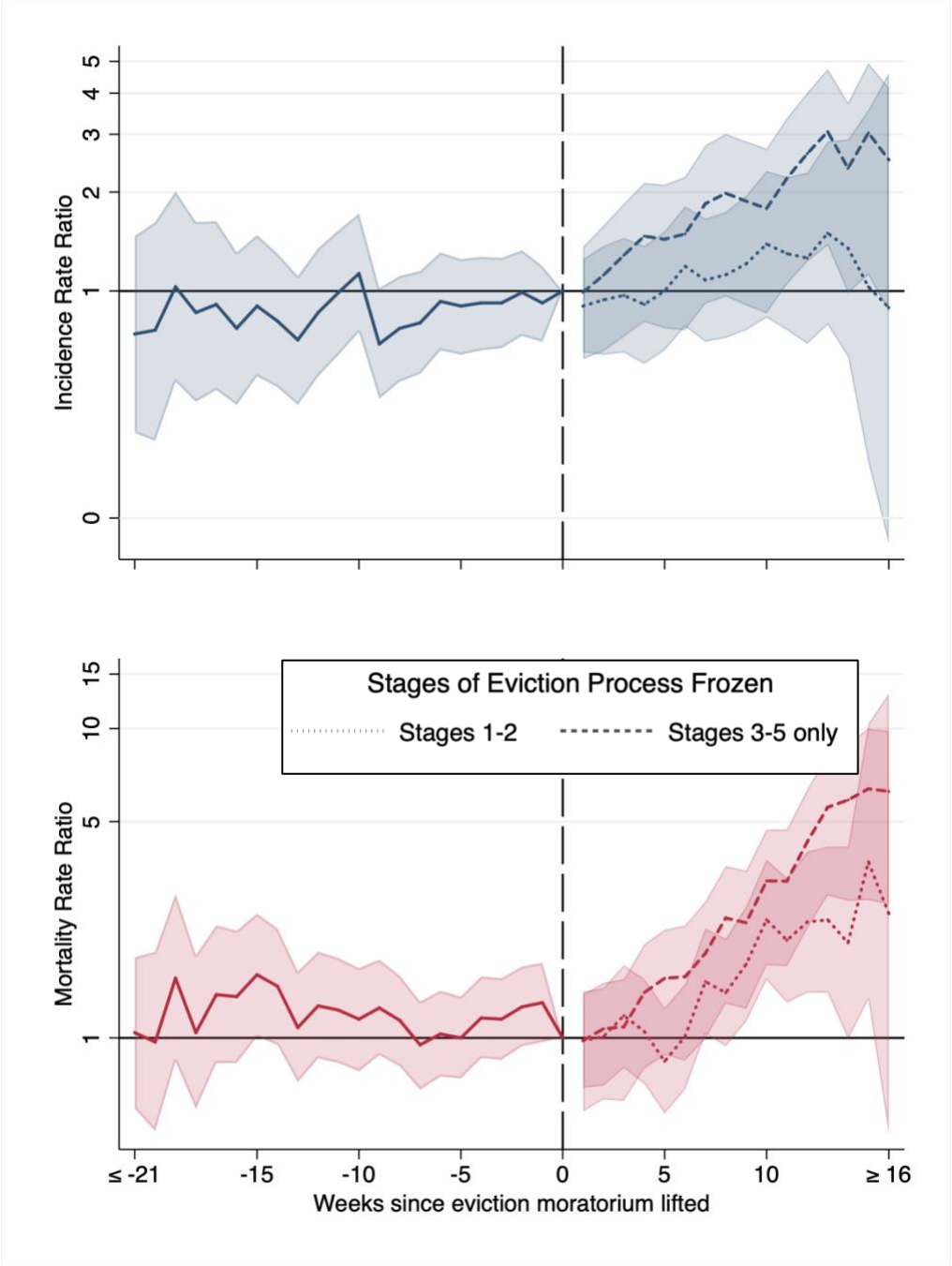
Model 1: Standard difference-in-difference model with 7-week lag in the exposure
Model 2: Assumes zero-day lag in testing rate
Model 3: Assumes 14-day lag in testing rate
Model 4: Other non-pharmaceutical interventions (stay-at-home orders, school closures, and mask mandates) coded as binary indicators rather than factor variables
Model 5: Weeks since bars/restaurants reopened included as a factor variable
Model 6: The 17 states that maintained their moratoriums are dropped from the analysis. We use a conditional fixed effects estimator (rather than population-averaged estimator with AR1 correlation structure) to allow for model convergence.

Statistically significant ($p<0.05$) Incidence Rate Ratio (IRR) and Mortality Rate Ratio (MRR) coefficients appear in **bold**

Appendix 5: Replication of Figure 1 showing COVID incidence and mortality rate ratios, respectively. Each line presents the estimates after dropping a single state from the study sample. The results demonstrate that no single state drives the observed association.



Appendix 6: Figure 1, stratified by stages of the eviction process frozen by the moratorium. Stages 1 and 2 are eviction notice and filing, respectively. Stages 3-5 are eviction court hearings, court orders, and enforcement of orders, respectively. Results show a larger magnitude of effects, sooner after lifting, in states with stage 3-5 moratoriums, relative to states with stage 1-2 moratoriums. We attribute lagged effects in states with stage 1-2 moratoriums to the fact that, in these states, tenants must proceed through the entire eviction process before being displaced. Conversely, in states with stage 3-5 moratoriums, evictions can be executed more quickly after moratoriums are lifted.



Note: For the purposes of this sensitivity analysis, we classify state moratoriums based on whether or not they *ever* froze stages 1-2 vs. stages 3-5 of the eviction process during the study period. This is a simplification: in reality, state moratoriums froze different stages of the eviction process at different time points.

Appendix 7: Figure 1, stratified by COVID-19 incidence on date moratorium was lifted. High incidence is classified as incidence above the median value of 5.16 cases per 100,000 population. Low incidence is classified as incidence at or below the median. Results show that, although effects of lifting moratoriums on COVID-19 incidence and mortality were larger initially in states with high incidence at lifting, this difference was attenuated over time, with effect estimates in states with low incidence at lifting eventually becoming larger than those in states with high incidence at lifting.