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National Coordinating Center
Systems and Services Research to Build a Culture of Health

colorado school of public health

Multi-Dimensional COVID-19 Control in US: Identifying Counties with High and Low Levels of Success

Strategies to Achieve Alignment, Collaboration, and Synergy Across Delivery and Financing Systems

Research-in-Progress Webinar
April 21, 2021
12-1pm ET

Agenda

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Welcome Chris Lyttle, JD – Systems for Action

Presenters Beth Resnick, DrPH
Carolina Cardona Cabrera, MHS
David Bishai, MD, MPH, PhD
Johns Hopkins Bloomberg School of Public Health

Q&A

Presenter

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Beth A. Resnick, DrPH is a Senior Scientist at the Johns Hopkins Bloomberg School of Public Health, Department of Health Policy and Management. She is Assistant Dean for Public Health Practice and Training and Director of the MSPH Program in Health Policy. Her research and practice interests include assessing and improving the public health infrastructure, enhancing knowledge of potential environment and health connections, and developing effective public health policies.

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Presenter

Carolina Cardona Cabrera, MHS is a PhD candidate in Health Economics in the Department of Population, Family and Reproductive Health at the Johns Hopkins Bloomberg School of Public Health (JHSPH). She works as a research assistant at the Bill & Melinda Gates Institute for Population and Reproductive Health conducting research related to sexual and reproductive health. Carolina's research is focused primarily on the application of economics to solve public health problems, and her main area of research is economic demography. Carolina holds a Masters of Health Science from JHSPH, where she concentrated in health economics and during which she was a Fulbright scholar.

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David Bishai, MD, MPH, PhD was appointed as the Health Officer of Harford County in January 2021. He was born in Takoma Park, Maryland and after attending Harvard College received his medical degree from UC San Diego and his Masters in Public Health from UCLA. He earned a PhD from Wharton Business School at the University of Pennsylvania and later rose from assistant to full professor at the Johns Hopkins Bloomberg School of Public Health. His research and teaching focus on the economics of local health departments and their role in population health and economic prosperity. He has won several teaching awards and was elected as president of the faculty senate. He is board-certified in both internal medicine and pediatrics and practices in the Emergency Department of University of Maryland St Joseph's Medical Center in Towson, MD.

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Agenda for Today's Presentation

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- The social epidemiology of COVID-19
- Did past county and state level public health spending improve early COVID-19 control in 2020?
- Finding positive deviants in COVID-19 control
- Next steps moving forward

Our Strategy

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- Aim 1: Develop metrics for success across multiple dimensions of COVID-19 Control at the county level
- Aim 2: Use statistical analysis to adjust for obvious pre-existing advantages (e.g., age, income, race, etc.) to identify counties who did better than expected based on relative advantages
- Aim 3: Key informant interviews with star counties to explore structural factures for their success

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The Social Epidemiology of COVID-19

Background

- Social determinants of health can have a considerable effect on COVID-19 outcomes in individuals with higher social vulnerability.
  - Infection rate: black > 3 × white. Death rate: black > 6 × white
  - Harder to practice physical distance for low-income occupations
  - Housing insecurity leads to mixing pods
- But do social determinants also operate at the county level?
  - If so, can identify more resilient and less resilient counties
  - Which places performed better than predicted

Research Question

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- How many lives would have been saved if counties performed as well as top-performing counties of similar socioeconomic characteristics?

Data from 3,133 Counties

- COVID-19 mortality from New York Times: 1/21/2020 to 2/20/2021
- All-cause mortality from CDC WONDER
- Socioeconomic characteristics: Census Bureau and CDC

Methods

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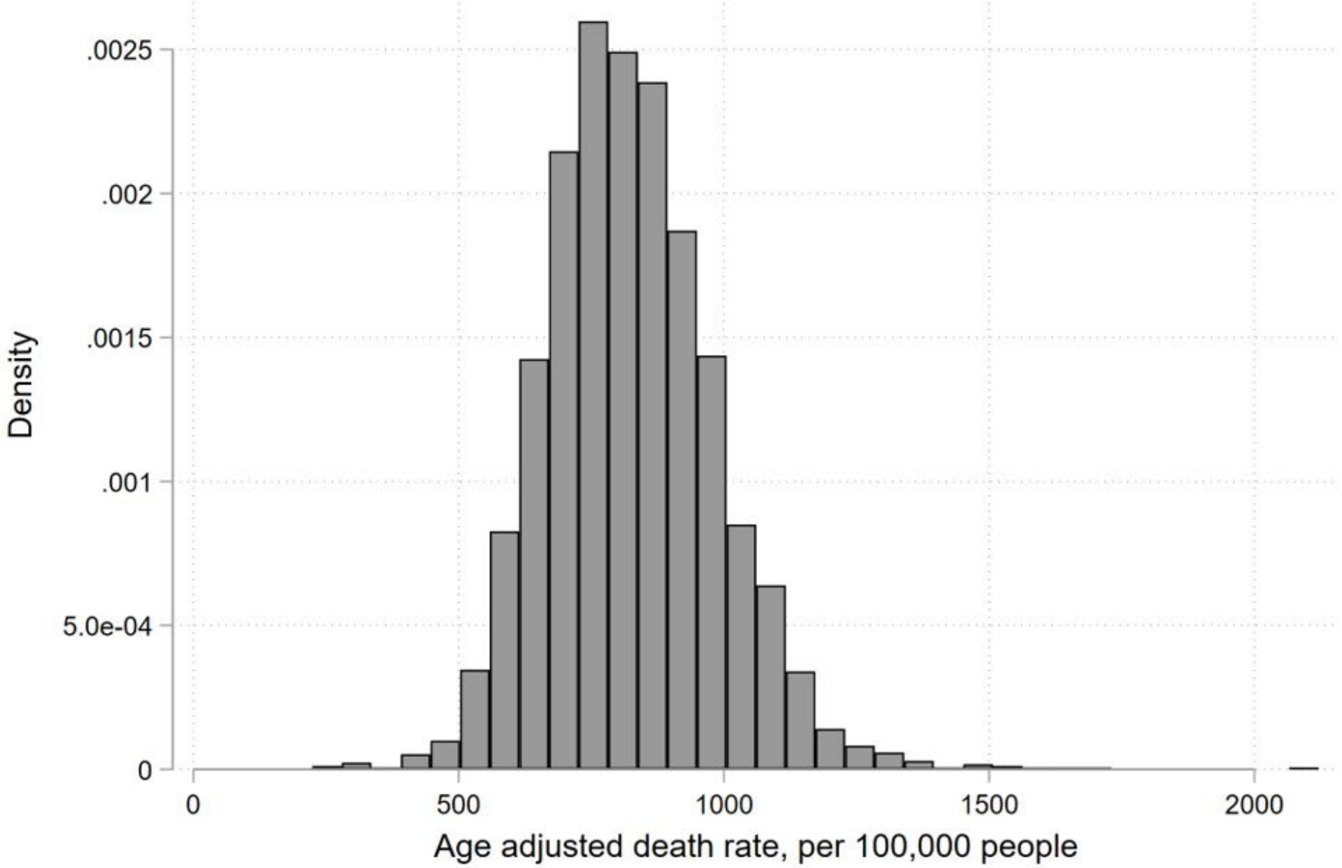
Simple OLS Regression

- Three outcomes of interest:
  - All-cause age adjusted death rate
  - All-cause Crude Death Rate(CDR)
  - COVID CDR
- Adjust county mortality by SES

Stratified Regression

- Use coarsened exact matching to make comparable strata of matched counties
- Find best performing counties within each stratum

All-Cause Mortality, Age-Adjusted Death Rate



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All-Cause Mortality, Crude Death Rate

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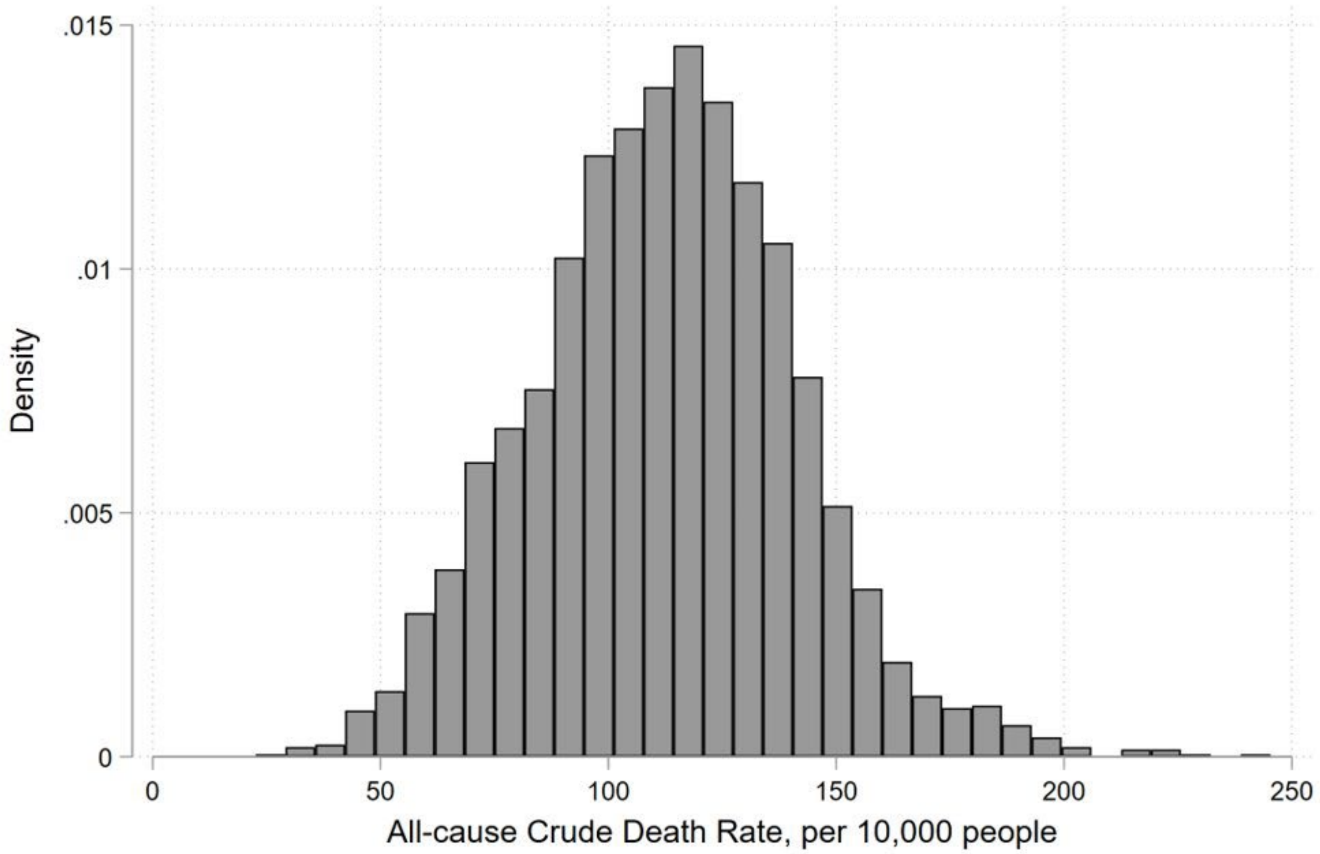

Log COVID Crude Death Rate

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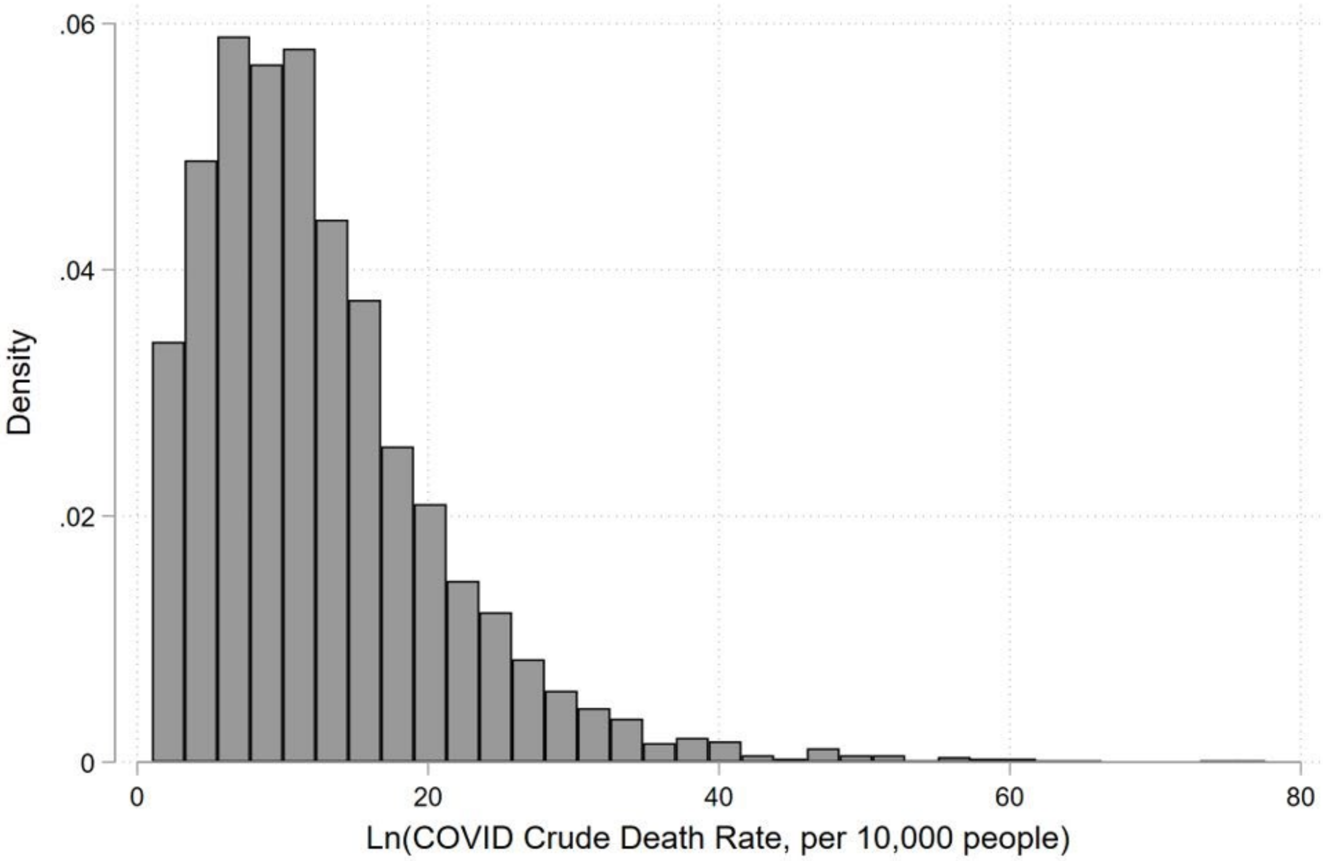

SES Associated with All-Cause and COVID Mortality

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VARIABLES	All-cause age adjusted death rate, per 100,000 people	All-cause Crude Death Rate, per 10,000 people	ln(COVID Crude Death Rate, per 10,000 people)	ln(COVID Crude Death Rate, per 10,000 people)
Ln(Revenue, per capita)	-34.933***	3.663***	1.797***	2.371***
% Age >= 65	-10.967***	3.012***	-0.125***	-0.076*
Ln(% Hispanic)	-28.087***	-5.619***	0.600***	0.728***
Ln(% African-American)	-32.542***	-3.819***	-2.033***	-2.127***
Median household income	-0.007***	-0.001***	-0.000***	-0.000***
Age adjusted death rate, per 100,000 people				0.003**
Constant	1,763.441***	81.571***	8.091**	-1.944
Observations	3,055	3,057	3,131	3,055
R-squared	0.464	0.643	0.085	0.091

Surprise Finding:
Five county variables (revenue, age, race, ethnicity, income) explain 46% of all-cause mortality and 8% county level COVID mortality

Formed Strata Using Coarse Exact Matching

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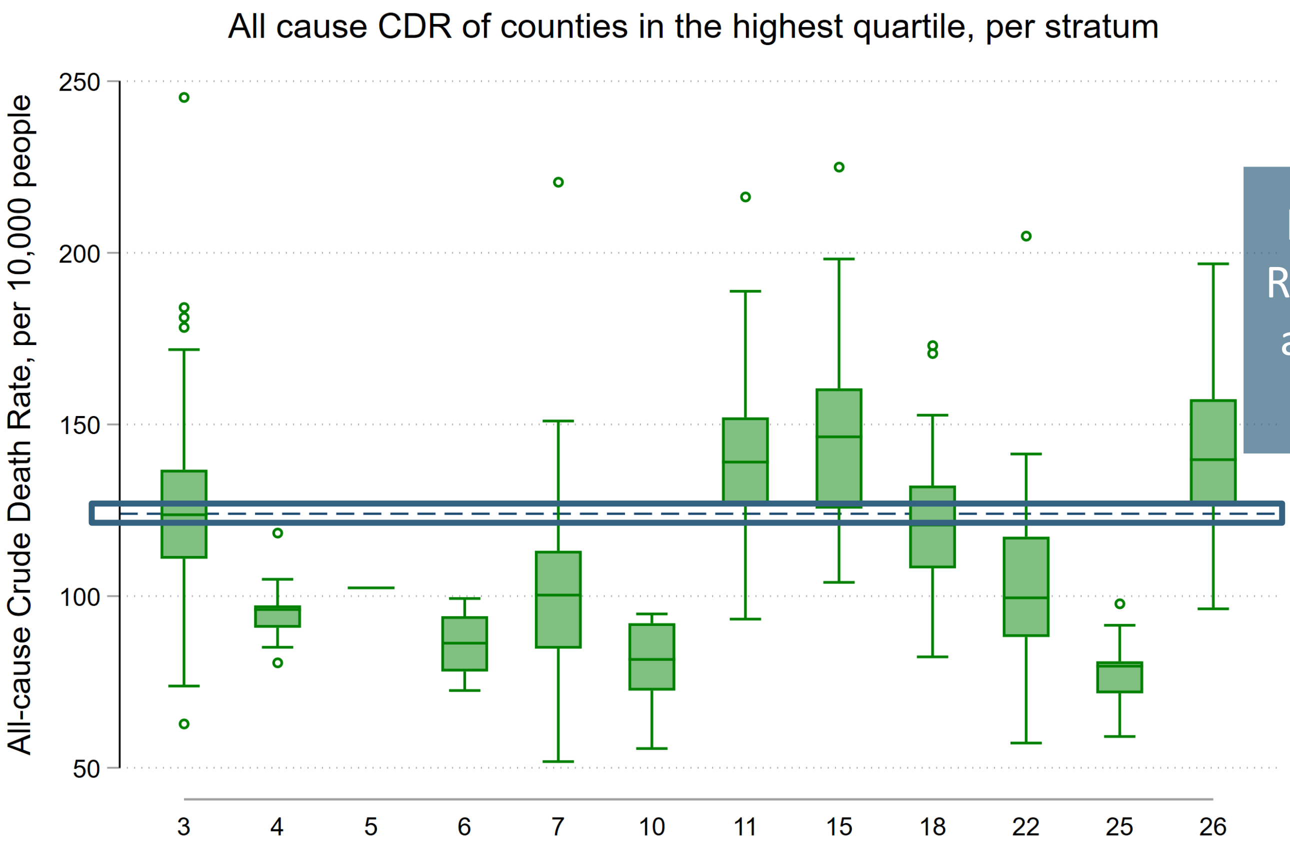
Coarsened Exact Matching

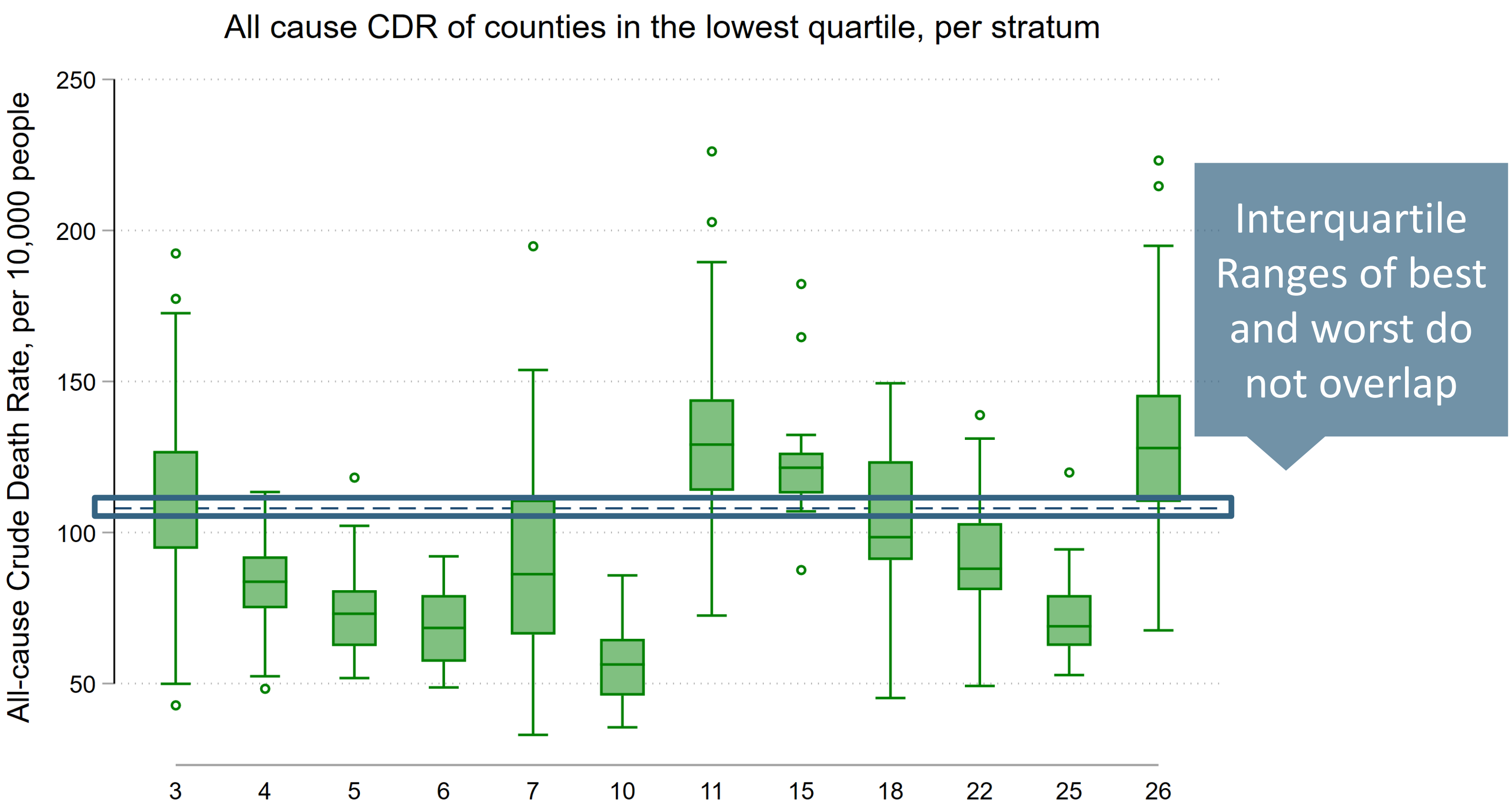
Stratum	Midwest	Northeast	South	West	Total
3	367	32	581	41	1,021
4	69	14	55	8	146
5	21	2	24	4	51
6	19	12	19	10	60
7	29	6	153	56	244
10	2	9	21	11	43
11	201	43	249	46	539
15	3	1	53	22	79
18	85	27	83	23	218
22	29	4	67	32	132
25	3	13	6	25	47
26	165	16	22	55	258
Total	**993**	**179**	**1,333**	**333**	**2,838**

All-Cause Mortality CDR, per 10,000 People



Interquartile Ranges of best and worst do not overlap

All-Cause Mortality CDR, per 10,000 People



COVID Crude Death Rate, per 10,000 People

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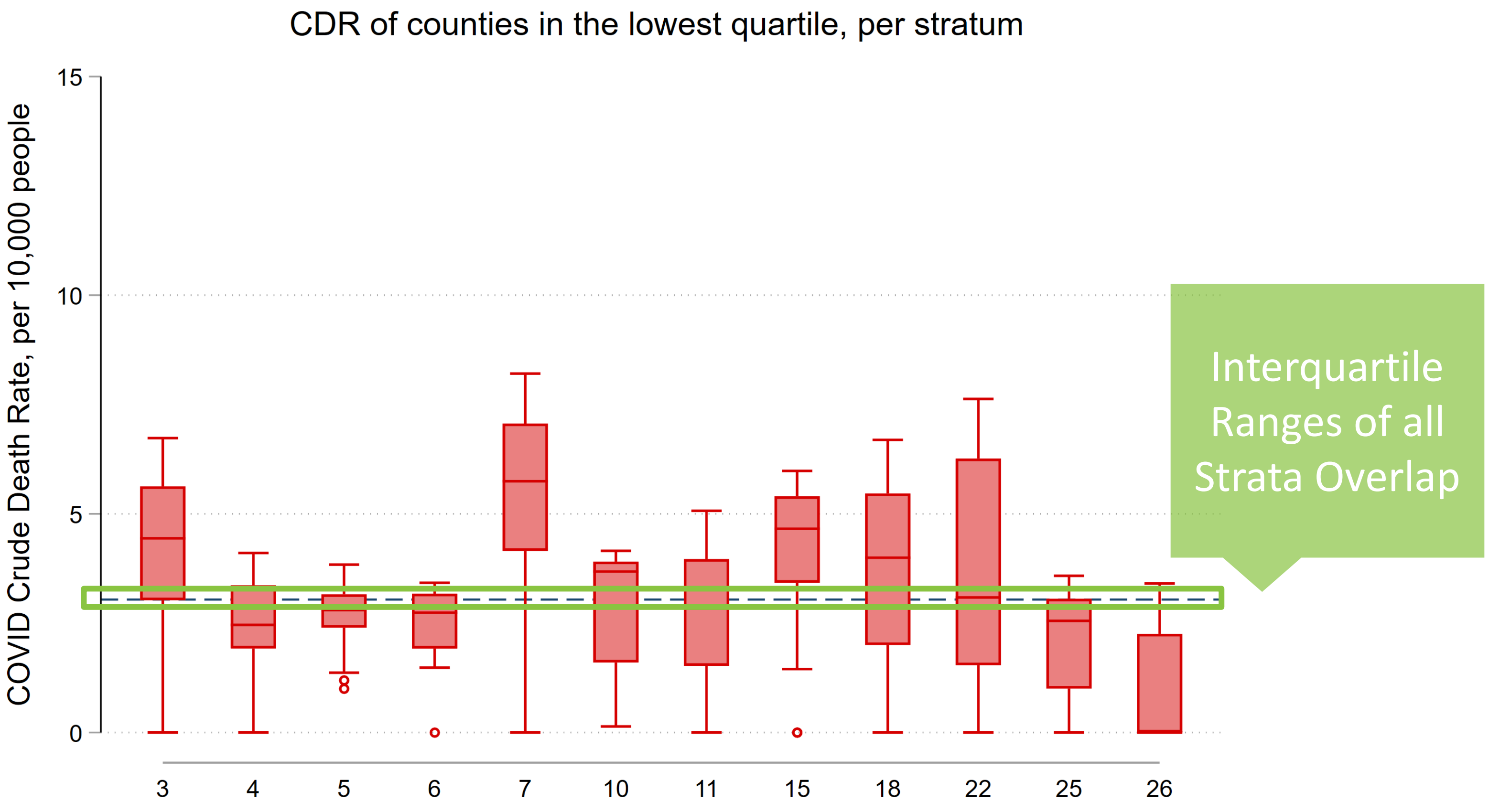

COVID Crude Death Rate, per 10,000 People

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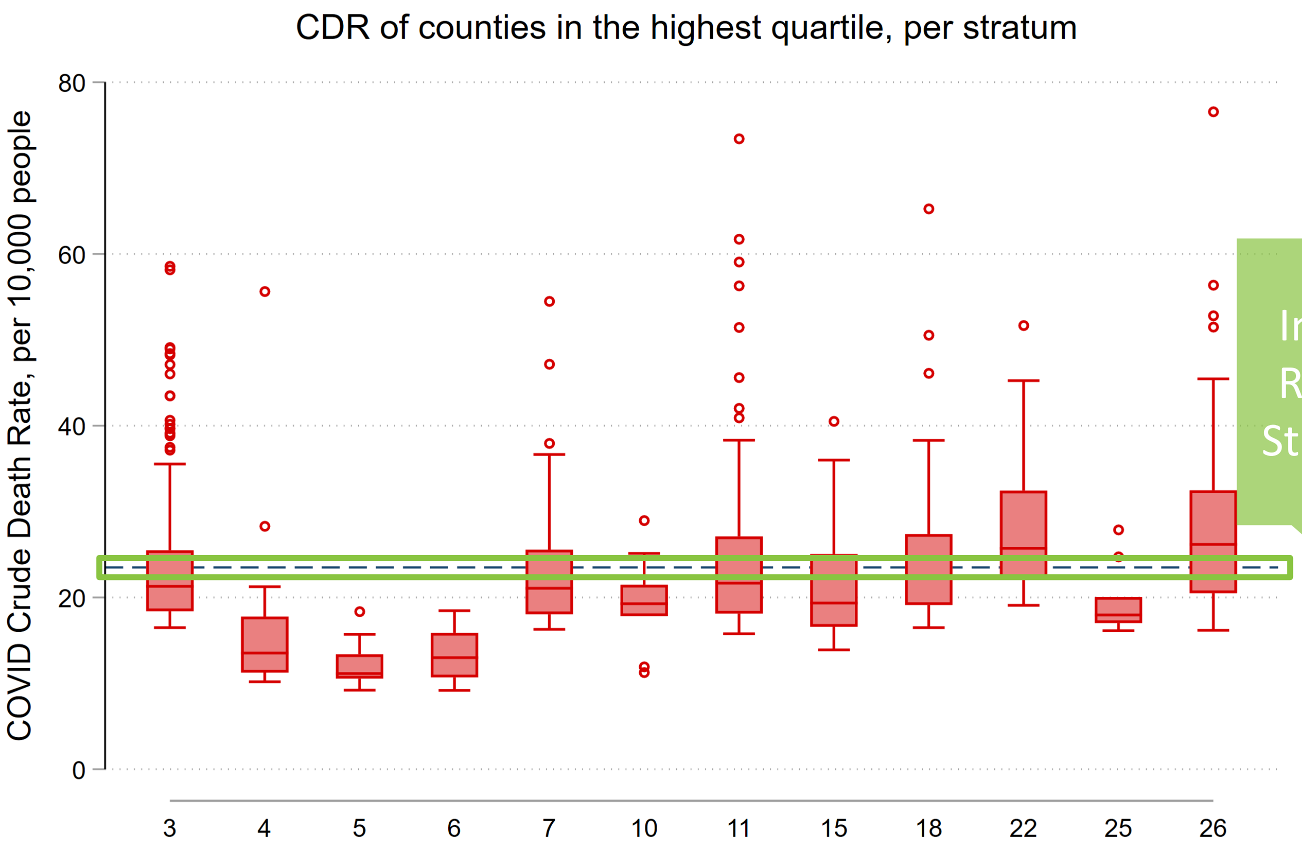

Interquartile Ranges of all Strata Overlap

Mortality Variation Explained by SES

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VARIABLES	All-cause age adjusted death rate, per 100,000 people	All-cause Crude Death Rate, per 10,000 people	COVID Crude Death Rate, per 10,000 people
Stratum 26 (ref.)			
Stratum 3	148.847***	-18.132***	0.387
Stratum 4	-36.874**	-48.040***	-4.173***
Stratum 5	3.803	-50.585***	-5.303***
Stratum 6	-99.204***	-59.939***	-4.937***
Stratum 7	79.369***	-34.615***	1.180
Stratum 10	-121.126***	-69.645***	-3.374**
Stratum 11	75.015***	0.781	-0.174
Stratum 15	23.551	-6.807**	-0.897
Stratum 18	105.057***	-20.721***	0.795
Stratum 22	52.810***	-34.454***	2.454***
Stratum 25	-139.546***	-61.708***	-3.142**
Constant	756.233***	134.314***	12.049***
Observations	2,782	2,782	2,838
R-squared	**0.212**	**0.397**	**0.035**

Conclusion

- Social determinants at the county level are far weaker for COVID-19 deaths than for all-cause mortality
  - This does not negate the role of SES risk factors for COVID for individuals

- US county-level risk of COVID deaths was not closely correlated with county level income, race, ethnicity, and spending

Section II

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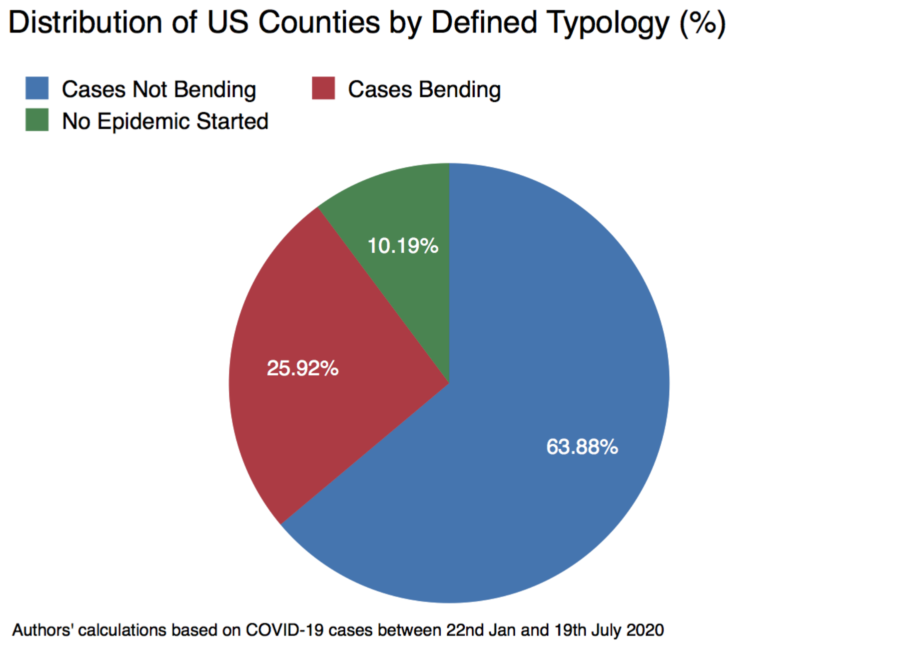
Did historical local county and state level public health spending improve *early* COVID-19 control?

Background

- Between 22nd Jan 2020 and 19th July 2020 only 26% of counties had "bent" their case curves as per our definition.
- Did past local health department (LHD) spending shield county populations from COVID-19 *early in the pandemic*?
- Is more LHD funding all we need as the sole reform in US public health?
- We use public health spending at the LHD level to ask this question.



Conceptual Framework and Methods

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- Focus on early COVID-19 control - consider first 6 months of pandemic before Cares Act funding and CDC deployments arrived
- Many waves after July 19, 2020 – but emergency funding would weaken relationship between historical spending and COVID-19 control
- Time to event models with **time to *curve bending*** as DV, generalized regression models with **peak incidence rates** and **doubling time** in first 30 days of local epidemic as DV
- Controls: socio-demographic, income, testing rates, county & state health spending, population health, health system measures, and temperatures

Why Focus on Time to Case Curve Bending as DV?

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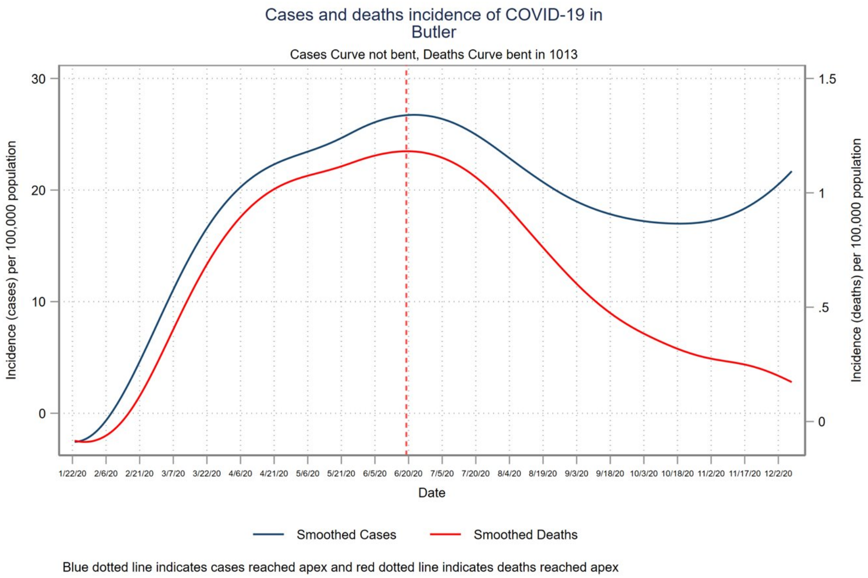
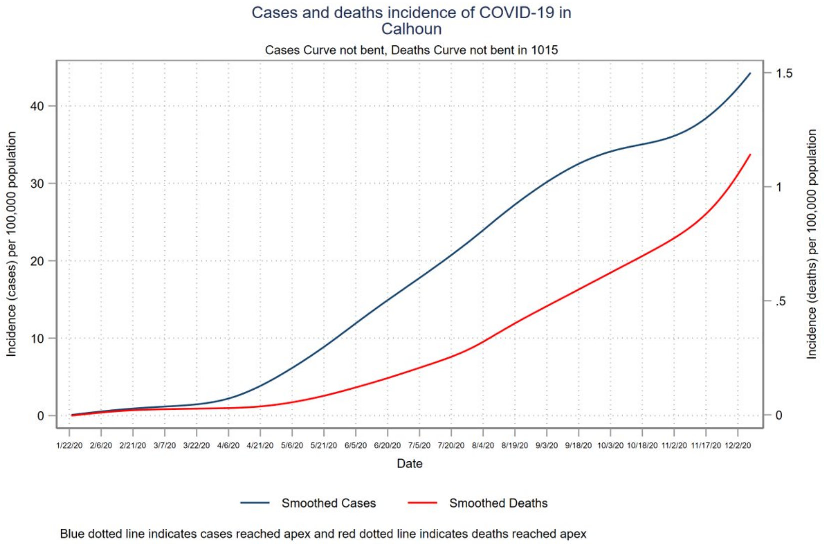
- Bending a case curve requires
  - Achieving rapid identification of outbreak geography and extent
  - Modification of human mobility, mask wearing, social contact
- Bending a death curve requires
  - All of the above plus
  - Shifting the demography of cases spread away from high-risk groups
    - Protecting nursing homes, prisons, group homes
  - Rapid and universal access to effective treatment

Defining Curve Bending for Cases and Deaths





Days between 10th case (death) and the highest bent curve of 2020
(*Provided there is no sign of a later surge in 2020*)

How Do We Measure Historical Spending?

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- Historical spending variables include the following measures:
  - County level hospital spending
  - County level non-hospital spending ***(public health spending)***
  - County level public welfare spending
  - State level public health spending
  - State level public health spending on communicable diseases
  - State level public health spending on hazard preparation

- Historical spending variables were included from most recently available expenditure variables from the Census – 2015-2017 for county data, 2016-2018 for state data

Results 1- Estimated Odds Ratios from Time to Event Models with Time to Peak as DV (County Level Spending)

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	Spending only	Spending + Testing + Demographic	Spending + Testing + Demographic + Income	Spending + Testing + Demographic + Income + Health	Spending + Testing + Demographic + Income + Health + Temperature	Spending + Testing + Demographic + Income + Health + Temperature + Political
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln(Hospital County Health Spend Per Capita)	1.043	0.992	0.990	0.993	0.993	0.993
	[0.0584]	[0.0574]	[0.0571]	[0.0569]	[0.0559]	[0.0561]
Ln(County Revenue Per Capita)	0.449***	0.638*	0.664	0.715	0.751	0.756
	[0.107]	[0.162]	[0.171]	[0.185]	[0.194]	[0.198]
Ln(Non Hospital County Health Spend Per Capita)	0.983	0.986	0.986	0.981	0.980	0.980
	[0.0178]	[0.0186]	[0.0186]	[0.0187]	[0.0186]	[0.0187]
Ln(1 + Public Welfare Spending per capita)	0.983	0.988	0.992	1.002	1.017	1.018
	[0.0490]	[0.0509]	[0.0518]	[0.0511]	[0.0509]	[0.0511]

Results 2- Estimated Odds Ratios from Time to Event Models with Time to Peak as DV (State Level Spending)

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	Spending only	Spending + Testing + Demographic	Spending + Testing + Demographic + Income	Spending + Testing + Demographic + Income + Health	Spending + Testing + Demographic + Income + Health + Temperature	Spending + Testing + Demographic + Income + Health + Temperature + Political
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Ln(State per capita spending - Total)	0.701	0.716	0.721	0.917	0.915	0.911
	[0.155]	[0.176]	[0.185]	[0.216]	[0.192]	[0.192]
Ln(1 + State Per Capita Spending - Hazard Prep)	0.593**	0.517***	0.512***	0.542***	0.600**	0.600**
	[0.136]	[0.120]	[0.123]	[0.121]	[0.122]	[0.122]
Ln(1 + State Per Capita Spending - Communicable Disease Control)	1.042	0.973	0.978	1.018	0.934	0.936
	[0.149]	[0.164]	[0.173]	[0.149]	[0.119]	[0.119]

Results

- We find no statistically significant association between historical county public health spending and rapid control of COVID-19 incidence in terms of time to peak and doubling times.

- State level spending per capita on hazard preparation is associated with a 30% shorter time to peak.

Conclusion

- Results suggest that just increasing resources at the state and local level is unlikely to be sufficient.

- Public health may need purposeful restructuring

- *Limitations:*
  - Spending data from Census is from 2018 or earlier,
  - We don't consider COVID-19 cases beyond the first wave (reducing relevance of historical spending)

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Identifying Positive Deviants

Methodology for Identifying Positive Deviants

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- Time to event models were run with time to smoothed case incidence **curve "bending"** as the dependent variable

- Time to event models control for county level socio-demographic characteristics, population health measures, health system related measures, state level testing rates

- Positive deviance residuals means that counties bent sooner than our model predicted

- **Topmost decile of deviance residuals == positive deviants**

Distribution of US Counties as of Feb 2021 (using NYT data)

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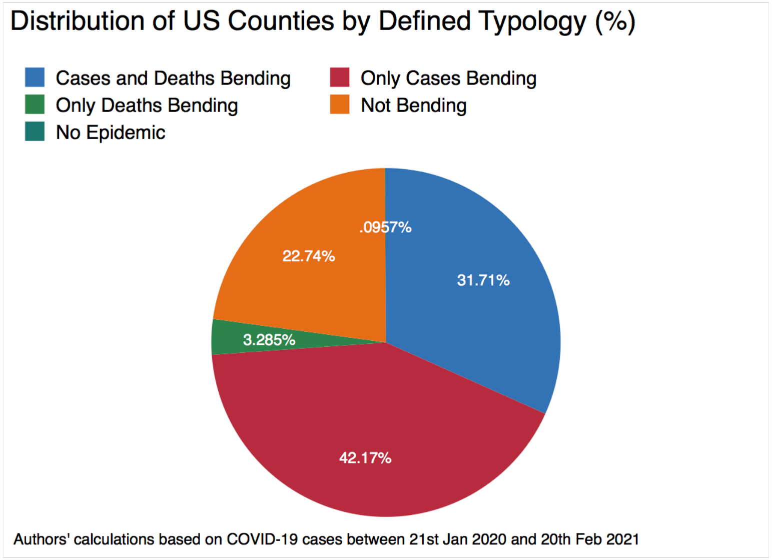
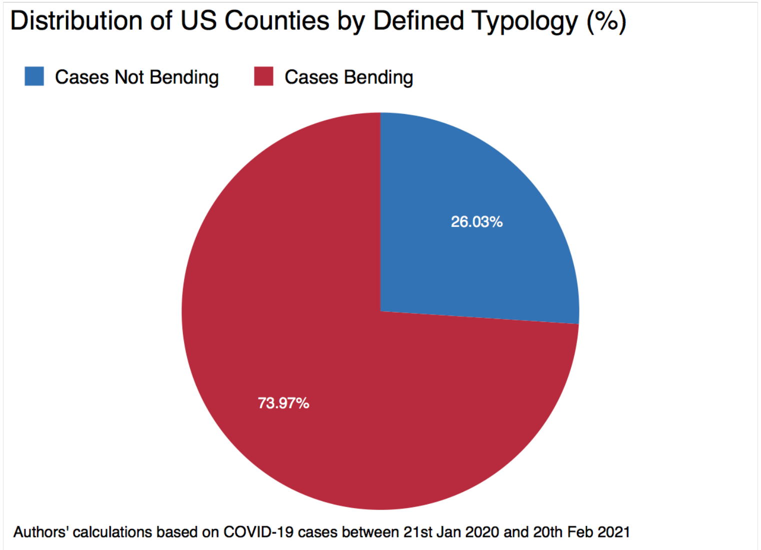
Cases and Deaths



Cases only



Identifying Positive Deviants Using Residuals

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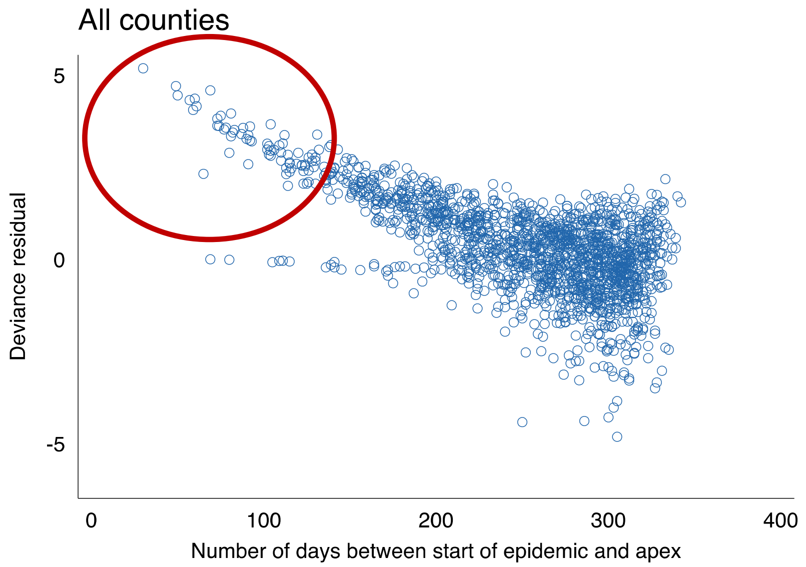
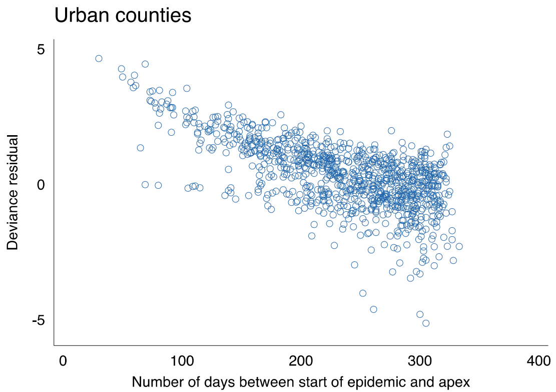
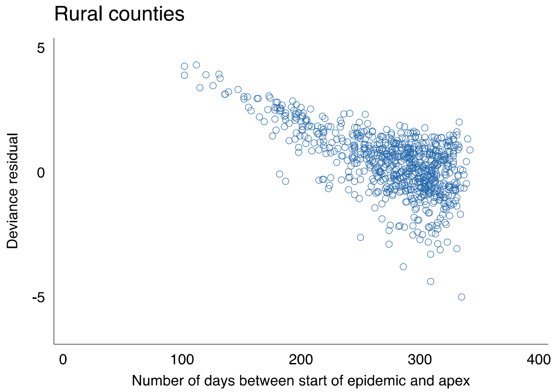
All Counties



Urban-Rural Stratification





How are Positive Deviants Different from Other Counties in Socio-Demographic Characteristics?

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- Positive deviants have a high % of rural population, lower population densities, higher state testing levels per 1000

Variable	*Topmost decile (N=159)*		*All deciles (N= 1593)*		*Other 9 deciles (N=1434)*	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
% Rural Population	77.30	27.04	55.04	28.98	52.57	28.13
Density of Pop/SqMi	91.82	640.15	164.92	517.97	173.02	502.21
Tests per 1000 in the State	3.17	2.61	2.23	2.45	2.13	2.40
% Hispanic	6.12	9.55	9.23	13.38	9.58	13.70
% African American	0.72	0.65	1.36	1.86	1.43	1.94
% under 18 years	21.80	3.86	22.30	3.25	22.36	3.17
% over 65	22.06	4.76	19.10	4.23	18.77	4.04

How are Positive Deviants Different from Other Counties in Income and Health Characteristics?

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- Comparable % of adults who smoke, % of adults who are obese

Variable	*Topmost decile (N=159)*		*All deciles (N= 1593)*		*Other 9 deciles (N=1434)*	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
% adults with some college educ (2014-18)	32.97	4.99	31.13	4.86	30.93	4.81
% of households food insecure	12.67	3.93	12.89	4.00	12.91	4.01
% Uninsured Adults (2019)	9.82	5.89	8.97	6.27	8.88	6.30
Active Primary Care Physicians per 100000 Population 2018 (AAMC)	90.11	10.25	88.15	11.96	87.94	12.12
% Adult Smoking (2020)	16.63	3.98	16.54	3.74	16.53	3.71
% Obese Adult Population	31.99	4.37	32.40	4.66	32.45	4.68

How are Positive Deviants Different from Other Counties in Terms of Historical Public Health Spending?

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- Similar peak incidence rates
- Higher county revenue per capita, higher county public health spending per capita, higher total state spending per capita, lower county hospital health spending

Variable	*Topmost decile (N=159)*		*All deciles (N= 1593)*		*Other 9 deciles (N=1434)*	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**
Deviance residual	2.59	0.67	0.37	1.26	0.12	1.05
Peak Prev/100K at time of Apex	64.94	27.54	64.21	20.21	64.13	19.24
Number of days between start of epidemic and apex	138.54	44.92	254.18	58.18	267.00	43.47
Absolute Hospital County Health Spend Per Capita	132.62	169.37	145.13	201.44	146.52	204.69
County Revenue per capita	6387.44	2680.03	5684.07	2255.08	5606.08	2190.15
Absolute Non Hospital County Health (Public Health) Spend Per Capita	750.42	1262.98	585.29	1046.20	566.98	1018.21
Absolute Public Welfare County Spend Per Capita	163.91	359.19	137.19	233.14	134.22	214.64
State per capita spending - Total	169.50	119.47	147.32	110.23	144.83	108.91
State Per Capita Spending - Communicable Disease Control	10.22	14.46	8.60	10.92	8.42	10.44
State Per Capita Spending - Hazard Preparation	1.80	2.61	1.36	1.57	1.31	1.40

Next Steps & Questions for Discussion

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- Selection of top performers
- Qualitative interviews
  - What are ideal questions to ask?
  - Which key stakeholders should we interview?

Next Steps

Questions?

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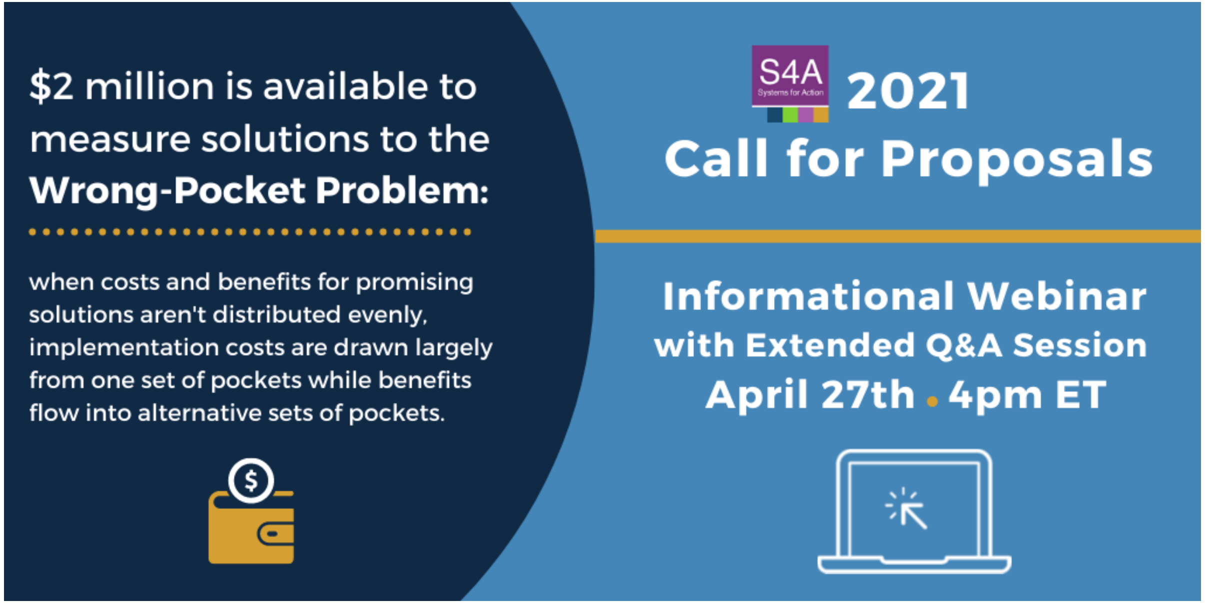
Certificate of Completion

If you would like to receive a **certificate of completion** for today's ResProg webinar, please complete the survey at the end of the session.

One will be emailed to you.

New Funding Opportunities



Additional CFP Resources

- [Funding Opportunity Brochure]
- [Information Webinar Recording]
- [Informational Webinar Q&A]
- [Informational Webinar Slides]
- [Infographic: S4A CFP at a Glance]

Learn more: http://systemsforaction.org/funding-opportunities-2021

New Funding Opportunities

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Health Equity Scholars for Action

The new program was created to help support the professional development and career advancement of historically underrepresented researchers, and includes funding, mentorship and a community of support. | Deadline: June 16, 2021

Research in Transforming Health and Health Care Systems

The goal of this funding opportunity is to generate rigorous evidence on the impact of recent Medicaid policy changes on enrollees, states, and others, and to inform and advance health and racial equity in Medicaid. | Deadline: June 28, 2021

Upcoming Webinars

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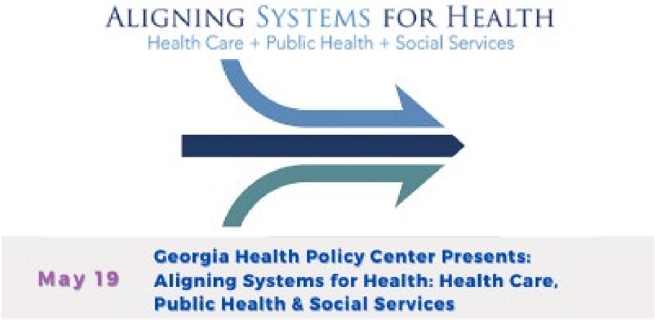
Biweekly on Wednesdays at 12pm ET



Acknowledgements

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