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Local Public Health System Capabilities and COVID-19 Death Rates

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Abstract

Objectives: Efforts to contain the health effects of the COVID-19 pandemic have achieved less success in the United States than in many comparable countries. Previous research documented wide variability in the capabilities of local public health systems to carry out core disease prevention and control activities, but it is unclear how this variability relates to COVID-19 control. Our study explored this relationship by using a nationally representative sample of 725 US communities.

Methods: We used data collected from the National Longitudinal Survey of Public Health Systems to classify each community into 1 of 3 ordinal categories indicating limited, intermediate, or comprehensive public health system capabilities. We used 2-part generalized linear models to estimate the relationship between public health system capabilities and COVID-19 death rates while controlling population and community characteristics associated with COVID-19 risk.

Results: Across 3 waves of the pandemic in 2020, we found a significant negative association between COVID-19 mortality and public health system capabilities. Compared with comprehensive public health systems, intermediate public health systems had an average of 4.97 to 19.02 more COVID-19 deaths per 100 000 residents, while limited public health systems had an average of 5.95 to 18.10 more COVID-19 deaths per 100 000 residents.

Conclusion: Overall, communities with stronger public health capabilities had significantly fewer deaths. Future initiatives to strengthen pandemic preparedness and reduce health disparities in the United States should focus on local public health system capabilities.

Keywords

COVID-19, public health response, infrastructure, disparities, local public health system capability, emergency response

Two years after the World Health Organization announced that COVID-19 had reached pandemic levels, the United States continues to struggle with containing its health and economic effects.[1-3] As of December 16, 2021, the United States reported more than 50 million COVID-19 cases and more than 800 000 deaths, accounting for a disproportionate share of the global disease burden.[4] COVID-19 case and death rates in the United States are some of the highest among high-income countries, which many experts attribute to the lack of early federal guidance and leadership on the COVID-19 public health response.[5-8] While many other countries used centralized approaches for COVID-19 testing, contact tracing, containment, and mitigation, the United States delegated many pandemic responsibilities to state and local governments.[5,8-10]

This decentralized approach to addressing COVID-19 led to various response plans, policies, behaviors, and attitudes, which likely complicated efforts to contain the pandemic.[11] One regularly observed factor is that pandemic response actions in the United States have become highly politicized, including restrictions on businesses and public gatherings, face mask recommendations and requirements, and vaccination campaigns and mandates.[12-14] As a result, state and local policy officials have chosen widely divergent policy responses based in part on geographic differences in political affiliations and public opinion.[14,15] A second but less visible complicating factor derives from the capabilities of state and local public health systems. These systems comprise governmental public health agencies and the community organizations they partner with to implement disease prevention and control activities within their jurisdictions. A large body of evidence indicates that these systems vary widely in their ability to implement core public health activities as recommended by national public health

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advisory bodies. Many of these core activities are highly relevant to the COVID-19 response, including disease surveillance, outbreak investigation, public education, coordination with medical care providers, outreach to populations vulnerable to preventable disease and injury, policy recommendations for elected officials, and enforcement of health-related laws and regulations.[16-18] These activities may also inform the COVID-19 policy choices of state and local policy officials based on evidence rather than politics. Studies conducted before the COVID-19 pandemic found that important health and economic benefits accrue in US communities served by public health systems that are successful in implementing core public health activities, including lower rates of preventable mortality, lower medical spending, and higher adoption of evidence-based health policies.[19-22]

To our knowledge, no studies have directly examined geographic variation in public health system capabilities and its relationship to COVID-19 control in the United States. We explored this relationship by using data from a nationally representative survey of local public health systems, linked with publicly available county-level data on COVID-19 death rates.[23,24]

Methods

Study Population

We used data from the National Longitudinal Survey of Public Health Systems (NALSYS), which has been used in more than 20 years of research to categorize public health system capabilities in the United States and measure the effects of these capabilities on health outcomes.[21,23,25,26] NALSYS surveys local public health officials in a nationally representative sample of communities about the implementation of 20 guideline-recommended public health activities and the types of community organizations that cooperate in implementing each activity. The sample consists of 3 components: (1) a 100% sample of US communities with ≥100 000 residents (n = 296), (2) a stratified random sample of communities with <100 000 residents (n = 258), and (3) a 100% sample of communities in 4 states that participated in a national collaborative to strengthen their public health systems (n = 178). The total sample was 732 communities; we excluded 7 communities because they were missing values for system capability measures, resulting in an analytic sample of 725 communities. We defined communities based on the jurisdiction served by each responding local public health official, including 616 counties (85%), 36 cities and towns (5%), and 75 multicounty districts (10%); 2 jurisdictions were categorized as both cities and towns and as multicounty districts. Data from the 2018 wave of NALSYS were collected during July through December 2018 and, therefore, provided the most proximate data to the 2020 COVID-19 outbreak. The 2018 wave of NALSYS had a 71% overall response rate. The study was reviewed by the Colorado Multiple Institutional Review Board and was determined to be exempt.

Data and Measures

The main covariate of interest was the ordinal composite measure of public health system capability constructed from the NALSYS survey. This measure combines information from 3 sets of survey items: (1) the array of 20 recommended public health activities that are implemented in the community, (2) the network of community organizations that contribute to each activity, and (3) the level of effort contributed by the governmental public health agency to each activity.[21,23,25,26] We applied cluster analysis methods to the survey items to identify 3 composite levels of public health system capability: (1) limited capability, implementing fewer than half of the 20 public health activities on average with the smallest networks of contributing organizations; (2) intermediate capability, implementing more than half of the activities on average with moderate-sized networks of contributing organizations; and (3) comprehensive capability, implementing two-thirds or more of the activities on average with the largest networks of contributing organizations. Previous work described in detail the methods used to create the capability composite levels used in this analysis.[25]

Our model also included covariates that are known to be associated with the spread of infectious disease and COVID-19 morbidity and mortality. We merged NALSYS data with the 2018-2019 Health Resources & Services Administration's Area Health Resource File to obtain demographic and socioeconomic data, including number of physicians, nursing home beds, and hospital beds per 100 000 residents.[27] We also used the Centers for Disease Control and Prevention's WONDER Underlying Cause of Death, 1999-2020 files to create a variable that would account for health conditions that could increase a community's risk of COVID-19 mortality.[28] These conditions included chronic acute lower respiratory disease, HIV, cancer, cerebrovascular disease, and cardiovascular disease.[29,30] For information on political environment, we collected 2016 electoral data from *The New York Times*[31] and a list of state governors' parties in 2020 from Ballotpedia.[32] We also used state-level COVID-19 testing data from *The Atlantic*'s COVID Tracking Project to account for state testing capacity.[33] We included other covariates that have been shown to be related to an increased risk of COVID-19 in the population. These include county-level estimates of the proportion of adults who reported wearing a face mask outside the home by frequency of use (always, frequently, sometimes, rarely, or never), rurality, average household size, average time traveled to work, average income per capita, population size, population density, and percentage of the population that is non-Hispanic White, aged ≥65 years, college educated, without health insurance, and unemployed.[27,33] Finally, we collected publicly available data on COVID-19 deaths from Johns Hopkins' Center for

Systems Science and Engineering.[24] We calculated the number of COVID-19 deaths per 100 000 county residents using 2018 population estimates from the 2010 US Census.[34]

Given rapidly changing information, messaging, and response during the pandemic year, we assessed the association between public health system capability and COVID-19 death rates at multiple time points throughout 2020. We selected 3 time points to correspond with increases in COVID-19 cases and media reports of waves. We selected May 14, 2020, as the first wave; August 31, 2020, as the second wave; and December 21, 2020, as the third wave. Each point was 2 weeks after the average peak of COVID-19 cases in a wave.

Statistical Analysis

Using a 2-part model specification for each of the 3 COVID-19 waves, we estimated the association between public health system capability and county-level COVID-19 death rates. The first part of the model used logistic regression to estimate the probability of a county having ≥1 COVID-19 death. The second part of the model used a generalized linear model to estimate the number of COVID-19 deaths in the county per 100 000 residents, conditional on having ≥1 death, using a log transformation to address skewness. The flexibility of the 2-part model allowed us to account for the relatively large number of counties with zero COVID-19 deaths, particularly in earlier waves of the pandemic, and the nonnormal distribution of county-level COVID-19 death rates.[35,36] We included the same covariates in both parts of the model, which included county demographic and social characteristics, political factors, and health factors. For ease of interpretation, we used coefficient estimates from both parts of the 2-part model to calculate the marginal effect of each covariate on the unconditional COVID-19 death rate. Using power calculations, we determined that the minimum detectable difference, assuming no covariates, given our sample size of 725, power of 80%, and an α of 5%, was 0.22 deaths per 100 000 residents.

We also created graphs that compared our 2-part model COVID-19 death rates with unadjusted COVID-19 death rate averages from March 2020 to December 2020. For the 2-part graph, we calculated weekly marginal effects of COVID-19 death rates by system capability measure. For the unadjusted graph, we calculated weekly COVID-19 death rate averages by system capability measure using NALSYS county weights. We used Stata version 15.1 (StataCorp, LLC) for all analyses.

Results

Counties with comprehensive public health systems had the lowest average COVID-19 death rates per 100 000 residents compared with counties with intermediate and limited public health systems; however, these unadjusted differences were significant only in the third wave of the pandemic ($F = 7.43$; $P < .001$) (Table 1). Conversely, counties with limited public health systems were less likely than counties with intermediate and comprehensive public health systems to have ≥1 COVID-19 death, but these unadjusted differences were significant only in the second wave ($F = 10.46$; $P < .001$). The 3 system capability measures also differed significantly across several community characteristics. Compared with counties with comprehensive public health systems, counties with limited public health systems had significantly lower rates of college educational attainment, more nursing home beds per 100 000 residents, and fewer physicians per 100 000 residents, and were more likely to be rural. Counties with limited public health systems also had significantly higher mortality rates from health conditions that complicate COVID-19 infection and were disproportionately located in states with higher COVID-19 testing rates.

Results of the 2-part models showed significantly higher COVID-19 death rates in counties with intermediate and limited public health systems compared with comprehensive public health systems after adjusting for other covariates (Table 2). For the first wave, counties with intermediate public health systems had an average of 4.97 more COVID-19 deaths per 100 000 residents than counties with comprehensive public health systems, and counties with limited public health systems had an average of 5.95 more COVID-19 deaths per 100 000 residents than counties with comprehensive public health systems. For the second wave, counties with intermediate public health systems had an average of 9.13 more deaths per 100 000 residents and counties with limited public health systems had an average of 8.05 more deaths per 100 000 residents compared with counties with comprehensive public health systems. Finally, for the third wave, counties with intermediate and limited public health systems had an average of 19.02 and 18.10 more COVID-19 deaths per 100 000 residents, respectively, compared with counties with comprehensive public health systems.

We also saw significant differences in COVID-19 death rates by political variables, such as county presidential voting percentages and state governor's party. In all 3 waves of the pandemic in 2020, COVID-19 death rates were positively associated with the percentage of the county that voted for Trump in 2016. A 10 percentage-point increase in the proportion of the county that voted for Trump in 2016 was estimated to have an average of 8.76 more COVID-19 deaths per 100 000 residents during the third wave (December 2020). On the other hand, a Republican state governor in 2020 had mixed effects on COVID-19 death rates across the 3 time points, with a significant negative association in the first wave, a nonsignificant relationship in the second wave, and a significant positive association in the third wave (Table 2).

For the 2-part model graph, we found that weekly marginal effects of COVID-19 death rates from March 2020 to December 2020 were significantly lower among counties with comprehensive public health systems than among

Table 1. Demographic characteristics and COVID-19 outcomes in communities served by comprehensive, intermediate, and limited public health systems, United States, 2018 and 2020[a]

Characteristic	Capability of public health system[b] Comprehensive (n = 237)	Intermediate (n = 98)	Limited (n = 390)	*P* value[c]
County				
Household size, no.	2.5	2.5	2.5	.86
Located in rural county, %	51.4	47.4	65.7	.001
Population, in 10 000s	30.0	22.5	15.9	.03
Average travel time to work, min	24.0	24.7	24.7	.28
Population density per square mile	489.0	369.2	282.7	.17
Male, %	49.7	49.7	49.8	.80
Population aged ≥65 years, %	17.7	18.3	18.3	.14
No health insurance, %	8.4	8.6	9.1	.06
Non-White, %	17.2	16.2	15.3	.35
Unemployed, %	4.8	5.1	4.7	.16
4-Year college degree, %	22.8	22.0	20.4	.02
Income per capita, in $10 000s	4.36	4.38	4.17	.18
No. of nursing home beds per 100 000 residents	681.5	646.5	743.3	.03
No. of hospital beds per 100 000 residents	254.3	380.5	275.3	.08
No. of physicians per 100 000 residents	190.1	194.2	141.8	<.001
Voted for Trump in 2016, %	60.9	63.3	65.5	.003
Republican governor in 2020, %	47.4	37.7	60.1	<.001
COVID-19 risk death rate per 100 000 residents[d]	604.6	646.3	652.6	.003
COVID-19 mitigation efforts				
Estimated proportion of adults reporting wearing a face mask outside the home, by frequency of use				
Never	7.4	7.1	8.3	.04
Rarely	8.0	8.1	8.4	.67
Sometimes	12.5	11.8	12.3	.66
Frequently/always	72.0	73.1	71.1	.32
State COVID-19 testing rates per 100 000 residents, by wave in 2020[e]				
First wave	1343	1256	1687	.01
Second wave	8601	7961	10 430	.02
Third wave	20 400	19 450	25 430	.005
COVID-19 deaths, by wave in 2020[e]				
COVID-19 deaths per 100 000 residents				
First wave (May 14)	12.68	17.12	14.49	.48
Second wave (August 31)	28.76	35.94	33.58	.33
Third wave (December 21)	82.15	95.72	103.53	<.001
COVID-19 deaths ≥1, %				
First wave (May 14)	66.61	62.98	59.03	.20
Second wave (August 31)	93.15	87.76	78.93	<.001
Third wave (December 21)	97.69	99.23	96.51	.32

[a]Three levels of public health system capability were defined: (1) limited capability, defined as systems implementing fewer than half of the 20 public health activities on average with the smallest networks of contributing organizations; (2) intermediate capability, defined as systems implementing more than half of the activities on average with moderate-sized networks of contributing organizations; and (3) comprehensive capability, defined as implementing two-thirds or more of the activities on average with the largest networks of contributing organizations.
[b]Data sources: National Longitudinal Survey of Public Health Systems,[23] US Census Bureau,[34] Health Resources & Services Administration,[27] *The New York Times*,[31] *The Atlantic*'s COVID Tracking Project,[33] Centers for Disease Control and Prevention,[28] Johns Hopkins' Center for Systems Science and Engineering,[24] and Ballotpedia.[32]
[c]Determined by *F* statistic; $P < .05$ considered significant.
[d]Deaths in the county associated with conditions that pose a higher risk of death from COVID-19: chronic acute lower respiratory disease, HIV, cancer, cerebrovascular disease, and cardiovascular disease.[29,30] Measure was used as a proxy for county-level chronic disease morbidity.
[e]Three points were selected to correspond with increases in COVID-19 cases and media reports of waves: May 14 as the first wave, August 31 as the second wave, and December 21 as the third wave. Each point was 2 weeks after the average peak of COVID-19 cases in a wave.

Table 2. Marginal effects estimates for COVID-19 death rates per 100 000 residents in the United States in April, August, and December 2020[a,b]

Variable	Combined coefficient (SE)		
	First wave (N = 725)	Second wave (N = 725)	Third wave (N = 725)
Public health system capability category[c]			
Comprehensive	Reference	Reference	Reference
Intermediate	4.97[d] (2.43)	9.13[d] (3.62)	19.02[d] (7.74)
Limited	5.95[d] (2.08)	8.05[d] (2.82)	18.10[d] (5.22)
County characteristic			
Household size, no.	13.67 (14.40)	13.99 (14.84)	58.24[d] (20.54)
Rural, %	−1.65 (4.81)	−5.37 (4.70)	−2.07 (7.83)
Population, in 10 000s	0.06[d] (0.02)	0.22[d] (0.04)	0.29[d] (0.10)
Average travel time to work, min	0.16 (0.30)	0.81 (0.41)	0.33 (0.62)
Population density per square mile	0.01[d] (0.01)	$1.07e^{-3}$ (0.01)	−0.02 (0.02)
Population density^2 per square mile	$-4.63e^{-7}$[d] ($2.02e^{-7}$)	$-2.66e^{-7}$ ($3.68e^{-7}$)	$7.14e^{-6}$ ($4.55e^{-6}$)
Male, %	−2.00[d] (0.82)	−0.87 (1.49)	2.21 (1.99)
Population aged ≥65 years, %	0.49 (0.46)	1.44[d] (0.51)	4.15[d] (0.97)
No health insurance, %	−0.94[d] (0.37)	−1.25[d] (0.53)	−1.78[d] (0.90)
Non-White, %	0.22[d] (0.92)	0.64[d] (0.14)	0.96[d] (0.25)
Unemployed, %	1.36[d] (0.67)	3.78[d] (0.85)	0.23 (2.57)
4-Year college degree, %	−0.13 (0.28)	0.09 (0.31)	0.29 (0.59)
Income per capita, in $10 000s	0.30 (0.12)	0.44[d] (0.15)	0.44 (0.30)
No. of nursing homes per 100 000 residents	0.02[d] ($4.90e^{-3}$)	0.03[d] (0.01)	0.05[d] (0.01)
No. of hospital beds per 100 000 residents	0.01[d] ($3.33e^{-3}$)	0.01[d] ($3.87e^{-3}$)	0.01 (0.01)
No. of physicians per 100 000 residents	−0.01 ($4.75e^{-3}$)	−0.01 (0.01)	−0.01 (0.02)
COVID-19 risk death rate per 100 000 residents[e]	−0.02 (0.02)	−0.04 (0.02)	−0.01 (0.03)
Voted for Trump in 2016, %	0.30[d] (0.13)	0.44[d] (0.22)	0.88[d] (0.37)
Has a Republican governor	−9.45[d] (1.75)	1.43 (2.88)	14.49[d] (6.20)
Estimated proportion of adults reporting face mask wearing outside of home, by frequency of use			
Never	−0.40 (0.40)	−0.91 (0.47)	−0.09 (0.71)
Rarely	−0.92[d] (0.46)	−0.66 (0.55)	0.05 (0.79)
Sometimes	0.12 (0.30)	−0.46 (0.40)	0.05 (0.53)
Frequently/always	Reference	Reference	Reference
No. of state COVID-19 tests per 100 000 residents	$3.08e^{-3}$[d] ($6.80e^{-4}$)	$8.58e^{-4}$[d] ($1.47e^{-4}$)	$5.08e^{-4}$[d] ($1.28e^{-4}$)

[a]Three points were selected to correspond with increases in COVID-19 cases and media reports of waves: May 14 as the first wave, August 31 as the second wave, and December 21 as the third wave. Each point was 2 weeks after the average peak of COVID-19 cases in a wave.
[b]Data sources: National Longitudinal Survey of Public Health Systems,[23] US Census Bureau,[34] Health Resources & Services Administration,[27] *The New York Times*,[31] *The Atlantic*'s COVID Tracking Project,[33] Centers for Disease Control and Prevention,[28] Johns Hopkins' Center for Systems Science and Engineering,[24] and Ballotpedia.[32]
[c]Three levels of capability of public health systems were defined: (1) limited capability, defined as systems implementing fewer than half of the 20 public health activities on average with the smallest networks of contributing organizations; (2) intermediate capability, defined as systems implementing more than half of the activities on average with moderate-sized networks of contributing organizations; and (3) comprehensive capability, defined as implementing two-thirds or more of the activities on average with the largest networks of contributing organizations.
[d]Determined by χ^2 statistic; $P < .05$ considered significant.
[e]Deaths in the county associated with conditions that pose a higher risk of death from COVID-19: chronic acute lower respiratory disease, HIV, cancer, cerebrovascular disease, and cardiovascular disease.[29,30] Measure was used as a proxy for county-level chronic disease morbidity.

counties with limited public health systems. In contrast, the unadjusted graph shows higher COVID-19 death rates among counties with comprehensive public health systems compared with counties with limited public health systems (Figure). When we accurately modeled the relationship between COVID-19 death rates and public health system capability, such as controlling for confounding and accounting for counties with zero deaths, counties with comprehensive public health systems had the lowest COVID-19 death rates per 100 000 residents throughout the pandemic period.

Discussion

Our analysis of 3 waves of the COVID-19 pandemic in 2020 showed a significant negative correlation between COVID-19 death rates and public health system capability. The

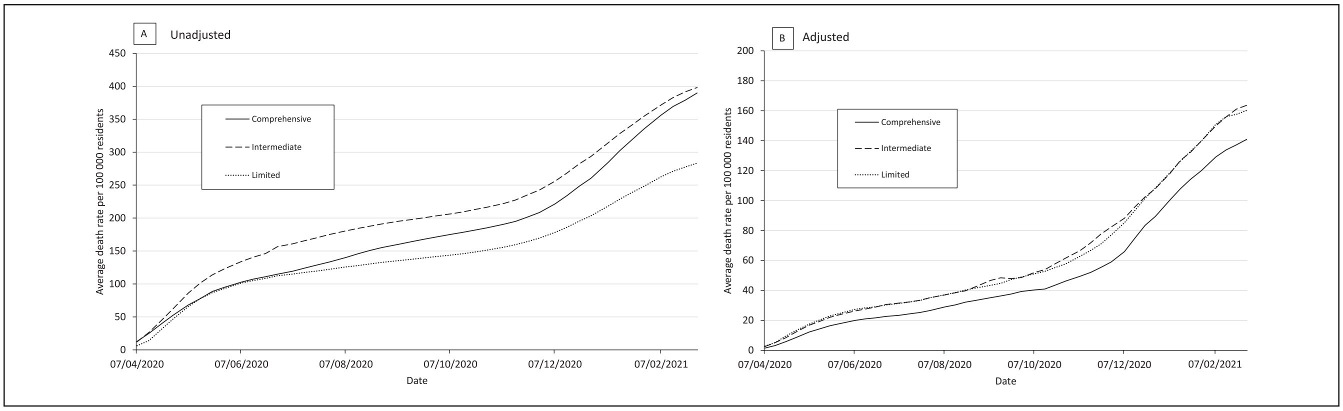

Figure. Marginal effects estimates versus NALSYS-weighted averages of cumulative COVID-19 death rates per 100 000 residents across comprehensive, intermediate, and limited public health systems from April 7, 2020, through February 28, 2021. Three levels of capability of public health systems were defined: (1) limited capability, defined as systems implementing fewer than half of the 20 public health activities on average with the smallest networks of contributing organizations; (2) intermediate capability, defined as systems implementing more than half of the activities on average with moderate-sized networks of contributing organizations; and (3) comprehensive capability, defined as implementing two-thirds or more of the activities on average with the largest networks of contributing organizations. Abbreviation: NALSYS, National Longitudinal Survey of Public Health Systems. Data sources: NALSYS,[23] US Census Bureau,[34] Health Resources & Services Administration,[27] *The New York Times*,[31] *The Atlantic*'s COVID Tracking Project,[33] Centers for Disease Control and Prevention,[28] Johns Hopkins' Center for Systems Science and Engineering,[24] and Ballotpedia.[32]

analysis also showed similar differences in COVID-19 death rates between counties with limited and intermediate public health systems when compared with comprehensive public health systems, despite intermediate public health systems having better capabilities. This apparent inconsistency could be due to intermediate public health systems performing more activities and having denser networks than their infrastructure can support. Potentially, the few public health activities that are delivered in limited public health systems are effective at mitigating COVID-19 outcomes because more resources and staff can be directed toward those few public health activities. This result suggests that public health system capabilities are complex and that simply adding more public health activities or increasing organization participation in those activities does not relate to better health outcomes if the existing infrastructure cannot support those increases.

We also tested the relationship between public health system capability and COVID-19 death rates with covariates that are not normally associated with public health, specifically political variables. The 2 political variables in this model (percentage of a county that voted for Trump in the 2016 presidential election and a Republican state governor) were included to control for individual attitudes toward COVID-19 mandates and policies. In the United States, it has been well documented that the COVID-19 pandemic is a public health crisis that was subjected to political polarization, and experts have found that political affiliation resulted in differential behaviors, such as face mask wearing and more strictly obeying stay-at-home mandates.[15,16,37] That being said, these variables may capture unobserved confounding in ways that do not match the conceptual theories of noncompliance with mandates and higher likelihood of behavior that increases the risk of COVID-19 infection. Moreover, the association between public health system capability and COVID-19 death rates was significant with and without political variables.

Limitations

Our study had several potential limitations. First, our measures of public health system capability were reported by the local public health officials serving each county, who may not have complete knowledge about all public health activities performed in their jurisdictions. Activities performed without the knowledge of local public health officials may be less likely than activities performed with respondent knowledge to be reported in the NALSYS survey, although validation studies indicate that the survey's validity and reliability are strong.[38] Furthermore, the NALSYS survey had a 71% response rate, so findings may not generalize to nonresponding jurisdictions.

Second, COVID-19 death data have some quality and reliability issues. Underreporting of deaths attributable to COVID-19 may occur as a result of various factors, such as deaths that occur before a COVID-19 diagnosis can be made, deaths that occur outside hospital settings, and deaths that are recorded and reported by individuals with limited COVID-19 expertise. One study found that the percentage of excess deaths not assigned to COVID-19 was significantly higher in counties with higher numbers of uninsured residents, fewer primary care physicians per capita, and greater numbers of deaths occurring in nursing homes.[39] If these patterns lead to higher underreporting of COVID-19 mortality in counties with lower public health system capability, then our findings may understate the associations between capability and mortality.

Finally, our analysis was cross-sectional and did not use any longitudinal methods to assess the relationship between COVID-19 death rates and public health system capabilities.

This type of analysis allows for the possibility of unobserved confounding and requires caution when interpreting results beyond correlation. For example, previous research on COVID-19 showed higher hospitalization and death rates in communities with better emergency preparedness.[40] Although our analysis attempted to control for potential confounding by including a wide array of county-level measures of community characteristics, these covariates may not fully account for unmeasured factors that are correlated with both capability levels and mortality patterns.[41]

Conclusion

Our findings showed a significant correlation between public health system capabilities and COVID-19 death rates during 2020 and add to the body of literature on inequities in the COVID-19 pandemic and US public health systems. In line with previous research and recommendations by experts on US emergency preparedness, infrastructure must be in place before an emergency.[2] We showed that differences in COVID-19 death rates between comprehensive and limited or intermediate public health systems grew during 2020. Indeed, our analysis of the third wave shows the widest gap in COVID-19 deaths between comprehensive and limited or intermediate public health systems after virtually every state had adopted at least 1 mandate or policy to control the spread of COVID-19.

While many public health experts have been sounding the alarm on gaps in public health system capabilities in the United States, many communities face funding and capacity constraints that limit their ability to implement all recommended public health activities. For example, rural areas have smaller tax bases to tap for financing public services, which means fewer resources available to hire public health workers and support collaborative relationships with community organizations.[26,27] Our study showed that limited public health systems were more likely than intermediate and comprehensive public health systems to serve rural counties, counties whose populations had low educational attainment, and counties with fewer hospital and physician resources. The COVID-19 mortality patterns found in our study provide just 1 example of the preventable health outcomes that could be improved with additional resources allocated to local public health systems. New federal appropriations such as the Strengthening US Public Health Infrastructure, Workforce, and Data Systems grant program included in the American Rescue Plan could help alleviate local resource constraints.[42,43] However, unless local health departments secure sustainable funding sources to improve capabilities, health disparities will continue to manifest among the populations most vulnerable to preventable disease and injury in the United States.

Declaration of Conflicting Interests

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