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Water Shutoff Moratoria Lowered COVID-19 Infection and Death Across U.S. States



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Introduction: A total of 34 U.S. state governments imposed moratoria on water shutoffs between March and May 2020 to ensure equitable access to water during the COVID-19 pandemic. However, by the end of 2020, most of these moratoria had expired, and millions of people were exposed to the risk of water disconnections. This study examines the linkage between water equity and public health and provides policy recommendations for improving water access and health equity.

Methods: Event study was used to analyze the impact of a water shutoff moratorium on COVID-19 daily infection growth rate and daily death growth rate from April 17, 2020 to December 31, 2020. The data were collected at the state level. The model controlled for mask mandates, at-risk groups (percentage Hispanic population, percentage essential workers), and percentage health insurance coverage.

Results: During the study period, having a water shutoff moratorium in place significantly lowered the COVID-19 infection daily growth rate by 0.235% and significantly lowered the death growth rate by 0.135%. In addition, a comprehensive moratorium covering all water systems (public and private) significantly lowered the infection growth rate by 0.169% and significantly lowered the death growth rate by 0.228%.

Conclusions: This study raises attention to the importance of water equity and the need for government actions to create more uniform protections from water shutoffs across all states. A comprehensive approach to water equity can protect the health and safety of all communities.

Am J Prev Med 2022;62(2):149–156. © 2021 American Journal of Preventive Medicine. Published by Elsevier Inc. All rights reserved.

INTRODUCTION

The need to ensure access to safe drinking water for handwashing, sanitation, and public health is highlighted in the context of the coronavirus disease 2019 (COVID-19) pandemic. Since March 2020, one of the U.S. Centers for Disease Control and Prevention's top recommendations to help stop the spread of the novel coronavirus is thorough and frequent handwashing.^{1,2} However, tens of thousands of people have been unable to follow this simple but crucial advice because their water service has been shut off over an inability to pay their water bills—for example, 22,000 customers in Jacksonville, Florida between July 10 and October 8³; 3,317 customers in Charleston, South Carolina between August 17 and September 3⁴; and 9,000 customers in Memphis, on the first day that shutoffs resumed on August 24.⁵ In April 2020, the U.S.

unemployment rate of 14.4% represented the highest rate since 1948,⁶ with many families losing work-related income. The U.S. Census Bureau Household Pulse survey shows that a third of adults had difficulty in paying household expenses during the pandemic.⁷

Water shutoffs pose a real threat to human health⁸ because the lack of adequate sanitation can cause diseases to spread and allow people to become sick. The

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0749-3797/\$36.00

<https://doi.org/10.1016/j.amepre.2021.07.006>

elderly, pregnant women, children, and people with diabetes and other illnesses are especially vulnerable.⁸ Termination of utility services contributes to housing insecurity and is associated with homelessness.^{9,10} Black and indigenous people of color, Latinx communities, and low-income populations face higher disconnection rates and are more likely to lack access to basic water services.¹¹ Water shutoffs can be traumatic because there is a substantial, statistically significant impact of water insecurity on psychological distress.¹²

Although previous work in the U.S. shows that protections from water shutoffs are rare,¹³ during the first 2 months of the pandemic, moratoria on water shutoffs became more common.^{14–16} For example, in Detroit, >141,000 households had been disconnected from water service owing to unpaid bills since 2014. On March 12, 2020, the day after WHO declared the COVID-19 pandemic, Michigan's governor, Gretchen Whitmer, and Detroit city officials announced plans to stop shutoffs and temporarily reconnect water services for all residents.¹⁷ Over the next several months, >800 localities and 34 states followed Detroit's lead.¹⁴ New York, Michigan, Pennsylvania, Connecticut, and Louisiana were among the first to announce moratoria on shutoffs.¹⁴ However, some states' moratoria on water shutoffs expired as early as May 2020, such as South Carolina and Montana.¹⁴ States' various policy responses to the COVID-19 pandemic show an emerging area of scholarship: state governments' leadership in public health.^{15,16,18–20}

As the COVID-19 public health crisis continues, how to ensure equitable water access is a pressing health equity issue. In the U.S., water utilities do not have universal service obligations or affordability mandates, and residents have protection from disconnection only in certain localities.²¹ For example, a 2015 national survey found that only 8% of municipalities had programs to protect low-income consumers from water shutoff.¹³ Although there is no federal agency that regularly tracks water service disconnections specifically, the 2017 American Housing Survey shows that 6.5% of households had utilities shut off after receiving notices of missed payment.²² This is in contrast to Europe, where countries implement a variety of mechanisms to ensure access to water. Some countries provide minimum subsistence service levels to households, according to WHO guidelines.²³ Other European countries provide water service at discounted rates through social tariffs and social funds, and some provide water disconnection bans.²³ The COVID-19 pandemic has exposed and exacerbated the pre-existing water affordability crisis in the U.S. Among 894 utilities responding to an American Water Works Association survey in 2019, only 37% of water utilities indicated that they offered assistance to low-

income customers, although more than half indicated that nonpayment of bills was a moderate or significant problem.²⁴ The lack of access to clean water because of affordability undermines the basic human right to water and health equity.

Moratoria on water shutoffs have protected hundreds of thousands of people from disconnection. On the basis of limited data from the New Jersey Board of Public Utilities, state-issued moratoria protected 37,386 households—about 100,000 people—in New Jersey from water disconnection.²⁵ The California moratorium potentially protected 1.6 million households (1 in 8 households) who were behind on their water bills.²⁶ Similar examples can be found in Virginia (more than half a million customers were behind on payments, owing a total of \$88.6 million as of December 15, 2020),²⁷ Wisconsin (121,663 residential customers avoided disconnection as of February 15, 2021),²⁸ and North Carolina (146,704 residential customers owing \$40 million avoided disconnection in July 2020).²⁹ Research shows that utility shutoff moratoria (both water and electricity) reduced COVID-19 infections by 14% and deaths by 40% from March 2020 to November 2020.³⁰ As COVID-19 continued to rise in most states during 2020, it is important to understand the relationship between water moratoria and COVID-19 spread.

This study uses the most recent data on states' moratoria actions and a multilevel regression to explore the impact of water shutoff moratoria on COVID-19 spread: daily infection growth rate and daily death growth rate. The model controls for the timing of state mask mandate policies and at-risk groups. The water shutoff moratorium is measured as an event—whether a moratorium was in place in each state for each day of the study period. Other research has also used event study to analyze the impact of policy actions on COVID-19 spread, such as stay-at-home orders,^{31,32} mask mandates,^{32,33} and reopening.³² Event study allows this research to test whether a water shutoff moratorium could lower the COVID-19 infection and death rate.

METHODS

Study Sample

The unit of analysis was each U.S. state for each day from April 17, 2020 to December 31, 2020 (259 days). This equaled 12,950 observations. The outcome variables were COVID-19 daily infection growth rate and daily death growth rate. The growth rates in confirmed cases and deaths were calculated using the previous 7-day rolling average. This smoothed spikes and reporting fluctuations (e.g., weekends) to get a more accurate estimate of the trend. Both the COVID-19 infection growth rate and death rate had a large fluctuation at the beginning of the pandemic owing to the low initial denominator of cases. The study period began from

April 17 to exclude these outliers. April 17 was also about 1 month after the earliest moratorium start and 1 month before the earliest moratorium expiration.

Measures

The primary independent variable of interest was whether the state had a water shutoff moratorium in place on each day in the study period. Data were acquired from Food and Water Watch (Appendix Table 1, available online).¹⁴ Food and Water Watch, an advocacy group for public water, began tracking states enacting moratoria on water shutoffs in mid-March 2020. In 2020, a moratorium on water shutoff was imposed by 34 of 50 states to protect low-income families from water disconnection (Figure 1). Among the 34 states, 20 states imposed a comprehensive moratorium covering all water systems (public and private), and 14 states imposed a partial moratorium only covering water systems regulated by state Public Utility Commissions (Figure 1). However, only 11 of the 34 states still had an active moratorium in place at the end of 2020 (Appendix Table 1, available online).

States varied in their moratorium actions (Appendix Table 1, available online). For example, South Carolina only imposed a 2-month moratorium from March 2020 to May 2020. Virginia and Michigan allowed their moratoria to expire in October and November, respectively, when both states had a surging daily confirmed case rate, then resumed their moratoria in December 2020. The model used a dummy variable (moratorium on water shutoff) equal to 1 for each state, for each day between April 17, 2020 and December 31, 2020, if a moratorium was in place in that state on that day. Similarly, the dummy variable (comprehensive coverage of moratorium) was equal to 1 if the state had comprehensive moratorium coverage on each day.

This study controlled for mask mandates to obtain a more accurate picture of the impacts of the moratorium on water shutoff. Ballotpedia³⁴ tracks state orders requiring mask wearing (Appendix Table 1, available online). Mask mandates are one of the most effective ways to reduce COVID-19 transmission.³² By the end of 2020, a total of 39 states required people to wear a mask in public. New Jersey was the first state to impose a mandated masking order on April 10, 2020. Wyoming was the last state to impose a mask mandate on December 9, 2020. Most states required mask wearing by the end of 2020, except for Mississippi, whose mask mandate expired on September 30, 2020. Similar to the water shutoff moratorium variable, if the state had a mask mandate for each day in the study period, a dummy variable (mask mandate) was equal to 1.

Essential workers and minority groups are some of the most vulnerable populations in the COVID-19 pandemic. The Center on Budget and Policy Priorities³⁵ calculated the number of essential workers for each state, including those working in essential sectors (food production, manufacturing, public services, transportation, utilities, warehousing) and frontline sectors (healthcare services, retail, transportation, child care). The number of essential workers was divided by the employed population aged ≥ 16 years.³⁶ Among the minority groups, Hispanic or Latinx people are exposed to the highest risk of COVID-19 cases,³⁶ which is controlled in this study using the percentage Hispanic population, drawn from the most recent American Community Survey.³⁷ The model did not control for the population with underlying health conditions owing to the high correlation with minority population and essential workers. This study also controlled for the percentage of population with health insurance, drawn from the American Community Survey,³⁷ because states with wider insurance coverage might have lower death rates.

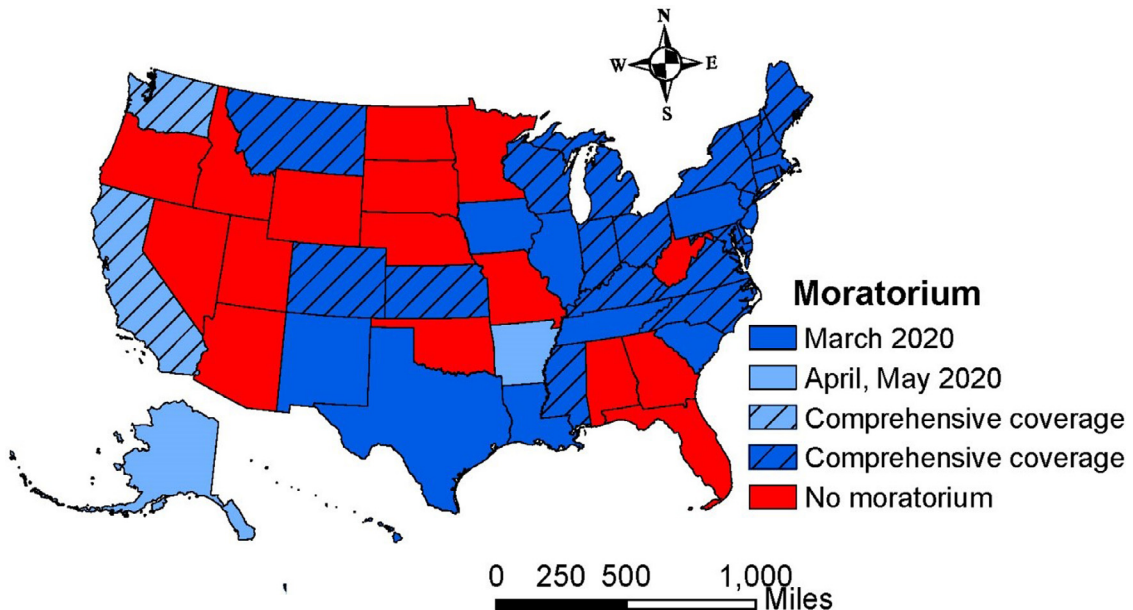


Figure 1. State water shutoff moratoria actions in 2020.

E, east; N, north; S, south; W, west.

Source: Author analysis based on Food and Water Watch 2021.

Statistical Analysis

This research examined the impact of a water shutoff moratorium on the COVID-19 infection and death growth rate from April 17, 2020 to December 31, 2020. This study accounted for the second COVID-19 wave in mid-July³² and a third wave at the end of 2020. The model controlled for the effect of time to get an overall effect of the moratorium. Because the infection rate is related to testing capacity and this capacity varies across states, the infection growth rate model controlled for the daily test growth rate. The death growth rate model controlled for daily hospitalization growth rate for 2 reasons: higher hospitalization rates put more stress on the medical system and may lead to more deaths, and these hospitalized cases are more likely to be identified as COVID-19 deaths. Both the daily test and hospitalization were calculated using the same 7-day rolling average as case rates. COVID-19 data were drawn from the New York Times COVID-19 Tracking Project.³⁸

RESULTS

Descriptive statistics are shown in Table 1. Table 1 shows that across all 50 states, on average, a moratorium

Table 1. Descriptive Statistics—State Moratorium on Water Shutoff During COVID-19

Variables	n	Mean	SD	Min	Max
Daily COVID-19 infection growth rate ^a	12,950	1.62	1.30	0	14.06
Daily COVID-19 death growth rate ^a	12,950	1.38	1.75	0	38.46
Daily COVID-19 test growth rate ^a	12,950	1.61	1.29	0	13.51
Daily COVID-19 hospitalization growth rate ^a	12,950	0.76	5.78	−100	134.78
Moratorium on water shutoff ^b	12,950	0.42	0.49	0	1
Comprehensive coverage of moratorium ^b	12,950	0.22	0.42	0	1
Mask mandate in place ^c	12,950	0.54	0.50	0	1
Percentage Hispanic population ^d	12,950	11.90	10.28	1.56	48.79
Percentage essential worker ^e	12,950	32.90	2.84	25.68	40.65
Percentage population with health insurance ^d	12,950	91.77	2.99	82.76	97.28

Note: N=days (April 17, 2020–December 31, 2020) for each of the 50 U.S. states.

^aNY Times COVID-19 Tracker (2020).³⁴

^bFWW (2021).¹⁵

^cBallotpedia (2021).³²

^dACS (2015–2019) (2021).³⁵

^eCBPP (2020).³³

ACS, American Community Survey; CBPP, Center on Budget and Policy Priorities; FWW, Food and Water Watch; Max, maximum; Min, minimum; NY, New York.

Table 2. Impact of State Water Shutoff Moratoria on COVID-19 Infection and Death Rates: Model Results, U.S. States, 2020

Variables	Daily infection growth rate ^a	Daily death growth rate ^a
Moratorium on water shutoff ^b	−0.235	−0.135
Comprehensive coverage of moratorium ^b	−0.169	−0.228
Mask mandates ^c	−0.214	−0.103
Percentage Hispanic population ^d	0.003	0.004
Percentage essential workers ^e	0.020	0.038
Percentage health insurance coverage ^d	0.001	−0.013
Daily COVID-19 test growth rate ^a	0.552	—
Daily COVID-19 hospitalization growth rate ^a	—	0.017
N (days for each of 50 states)	12,950	12,950
Log likelihood	−17,197	−19,784

Note: Boldface indicates statistical significance ($p < 0.05$).

^aNY Times COVID-19 Tracker (2020).³⁴

^bFWW (2021).¹⁵

^cBallotpedia (2021).³²

^dACS (2015–2019) (2021).³⁵

^eCBPP (2020).³³

ACS, American Community Survey; CBPP, Center on Budget and Policy Priorities; FWW, Food and Water Watch; NY, New York.

was in place about 42% of the time, and comprehensive coverage was in place about 22% of the time. Mask mandates were in place about 54% of the time.

A multilevel mixed-effects linear regression was run in Stata, version 14, to examine the relationship between water shutoff moratorium and COVID-19 daily infection growth rate and daily death growth rate between April 17, 2020 and December 31, 2020. Model results are shown in Table 2.

Table 2 shows that for the days in states with a moratorium on water shutoffs, daily infection growth was 0.235% lower, and the death growth rate was 0.135% lower. In addition, the days with comprehensive coverage of the moratorium were associated with a 0.169% decrease in infection growth rate and a 0.228% decrease in death growth rate.

The model also controlled for the days when a mask mandate was in effect for each state. This was also related to a lower growth rate in both COVID-19 confirmed cases and deaths as expected. Although COVID-19 is an airborne disease, handwashing is also critical for reducing COVID-19 spread.

As expected, states with a higher percentage of essential workers and a higher percentage of Hispanic population had a higher infection growth rate and death growth

rate. By contrast, states with higher health insurance coverage had lower death rates, but no effect on infection rate was observed.

DISCUSSION

This study gives special attention to equitable access to water during the pandemic. By the end of 2020, only 11 of 50 states still had a water shutoff moratorium in place (Appendix Table 1, available online), resulting in 218 million people, 67% of the total U.S. population, without protection from water shutoff.³⁷ Low-income communities, tribal nations, and communities of color face higher disconnection rates and the structural impacts of bill delinquency.^{39,40} Water disconnection results in compromising personal hygiene, which is crucial for preventing COVID-19 transmission.^{1,2} Families may decrease the consumption of household necessities to cope with the utility shutoffs.⁴¹ The income loss due to the pandemic worsened the situation. The linkage between water affordability and the disproportional impact of COVID-19 on minorities raises a serious concern for health equity. This study shows that states with a higher percentage of minorities and essential workers have a higher COVID-19 daily infection growth rate and death growth rate.

National leadership could help states, municipalities, and water utilities broaden the focus of sustainable water management to ensure the protection of water access for the most vulnerable groups. If there were a nationwide moratorium on water shutoff, estimation based on this study shows a reduction in infections by 480,000 and deaths by almost 9,000.⁴² National leadership in public health is found with respect to housing evictions but not to water shutoff. Congress passed the Coronavirus Aid Relief Economic Security Act, which established a moratorium on evictions from federally related properties in March 2020. This eviction protection ended on June 24, 2020, with protections for covered tenants lasting an additional 30 days. The U.S. Centers for Disease Control and Prevention then took executive action to impose a broader nationwide moratorium on residential evictions for nonpayment of rent on September 4, 2020, which was renewed multiple times until the end of June 2021.^{43,44} However, national leadership is still absent in protecting equitable access to water during the pandemic.

Financial assistance programs could be important to avoid a tidal wave of shutoffs when moratoria expire. Households have accrued an estimated nearly \$9 billion in water and sewer arrearages during the pandemic.⁴⁵ According to the UN standard of water affordability,

combined water and wastewater bills should not exceed 3% of household income.⁴⁶ However, in the U.S., water bills have increased faster than inflation, and the burden is greatest for lower-income households. The U.S. Environmental Protection Agency recommends an affordability threshold of 4.5% of household income for water and wastewater services. Although 11.9% of U.S. households had unaffordable water and wastewater bills in 2015, this was anticipated to increase to 35.6% of households in the next 5 years.⁴⁷ Affordability is more of a problem in private water systems owing to their higher prices.⁴⁸ In 2019, the average water bill was 4.65% of the lowest quintile of household income.^{49,50} The family income loss due to COVID-19 worsened the water affordability issue. Funding programs could provide percentage-of-income payment plans and arrearage management programs for low-income households, including households with young children, seniors, and medically compromised individuals.

Better data collection and reporting are necessary to help inform policy and solutions. Utilities should periodically report statistics about shutoffs, restorations, arrears, aging of arrears, and other metrics to inform policy. Utilities could provide a percentage-of-income payment strategy for low-income households, and utilities data could be reported by ZIP code or census tract to allow investigation of disparate impacts on the basis of race and other socioeconomic factors.⁵¹ This would help inform outreach for water affordability programs.

National support for long-term financing for water utilities would help address systemic inequalities and create stronger, more resilient, and more equitable communities. The nation's water and wastewater systems need federal support.⁵² The Water Affordability, Transparency, Equity, and Reliability Act is the type of legislation needed to address water contamination, affordability, job creation, and justice, all at the same time.

Limitations

This study examined the days with water shutoff moratoria and mask mandates to innovatively capture multiple policy actions in each state. There is a 28% overlap of the model days between having a mask mandate and a water shutoff moratorium in place. Thus, the ability to differentiate the impacts of the 2 policies is limited owing to this correlation. In addition, other policies could be related to COVID-19 infection rate and death rate but are not controlled in this study (for example, the stay-at-home order²⁰ and housing eviction moratoria.³⁰)

This study developed a comprehensive data set at the state level and used event study to innovatively examine the impact of the timing and the duration of water shut-

off moratoria on COVID-19 infection and death cases. The models controlled for the impact of time, and the key policy variable of interest, water shutoff moratoria, is at the state level. Other studies use county-level data to control for the impacts of both state and time.³⁰ However, policy data at the county level do not exist. Future studies could collect policy data at the county level for a more fine-grained analysis.

CONCLUSIONS

During the entire study period of April 17, 2020–December 31, 2020, in states with existing moratoria on water shutoffs, the growth rate of both COVID-19 infections and deaths was significantly lower. The comprehensive moratoria on both public and private water systems was also related to a lower growth rate. The results raise attention to the importance of water equity and call for government actions to create more uniform protections from water shutoffs across all states. Vulnerable households should be protected from shutoff at all times. A comprehensive sustainable approach to water equity can protect the health and safety of all communities. U.S. federal and state governments should come out of this crisis with a newfound commitment to providing access to water for all.

ACKNOWLEDGMENTS

The authors thank Kieran Donaghy, Elaine Wethington, and the anonymous reviewers for their helpful comments.

This research was supported in part by the Cornell Atkinson Center for a Sustainable Future Rapid Response Fund and the Cornell Center for Social Sciences.

No financial disclosures were reported by the authors of this paper.

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SUPPLEMENTAL MATERIAL

Supplemental materials associated with this article can be found in the online version at <https://doi.org/10.1016/j.amepre.2021.07.006>.

REFERENCES

1. Thebault R, Horton A, Beachum L. How to prepare for coronavirus in the U.S. *The Washington Post*. March 11, 2020. <https://www.washingtonpost.com/health/2020/02/26/how-to-prepare-for-coronavirus/>. Accessed March 17, 2021.
2. How to protect yourself & others. Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/prevent-getting-sick/prevention.html>. Updated August 13, 2021. Accessed August 17, 2021.
3. Grant R. ‘Some families end up homeless’: Jacksonville advocacy group urges utility districts to stop disconnects during pandemic. *Action News Jax*. October 8, 2020. <https://www.actionnewsjax.com/news/local/duval-county/some-families-end-up-homeless-jacksonville-advocacy-group-urges-utility-districts-stop-disconnects-during-pandemic/UY2UTFL2RVGANDF3HK4M4MYD4M/>. Accessed March 17, 2021.
4. Laudenslager C. Charleston Water System expects 500 shutoffs per day in upcoming weeks. *Count on News 2*. September 3, 2020. <https://www.counton2.com/news/local-news/charleston-county-news/charleston-water-system-expects-500-shutoffs-per-day-in-upcoming-weeks/>. Accessed August 12, 2021.
5. Broders B. MLGW customers complain of long wait times, dropped calls as they scramble to avoid being disconnected. *Local abc 24*. August 25, 2020. <https://www.localmemphis.com/article/news/local/mlgw-customers-long-wait-times-dropped-calls-disconnections/522-3f2dec0e-3e12-4ff9-889b-a8fe3d38d602>. Accessed August 12, 2021.
6. Unemployment rates during the COVID-19 pandemic. EveryCRSReports.com. Congressional Research Service; 2021. <https://www.everycrsreport.com/reports/R46554.html>. Updated April 14, 2021. Accessed May 21, 2021.
7. U.S. Census Bureau. Household pulse survey: measuring social and economic impacts during the coronavirus pandemic. Suitland-Silver Hill, MD: U.S. Census Bureau; 2020. <https://www.census.gov/programs-surveys/household-pulse-survey.html>. Published 2020. Accessed August 12, 2021.
8. Amirhadji J, Burcat L, Halpert S, et al. *Tapped out: threats to the human right to water in the urban United States*. Holland, MI: Georgetown Law Human Rights Institute; 2013. <https://www.law.georgetown.edu/human-rights-institute/wp-content/uploads/sites/7/2017/07/Tapped-Out.pdf>. Published April, 2013. Accessed March 20, 2021.
9. Colton R. *Water bill affordability for the City of Philadelphia Presented to Philadelphia City Council*. Belmont, MA: Fisher, Sheehan & Colton, Public Finance and General Economics; 2015. https://www.michigan.gov/documents/mpsc/Colton_City_Council_comments-April_8_2015-Final_721899_7.pdf. Published 2015. Accessed August 12, 2021.
10. Harak C. *Helping low-income utility customers manage overdue bills through arrearage management programs (AMP)*. Boston, MA: National Consumer Law Center; 2013. https://www.nclc.org/images/pdf/energy_utility_telecom/consumer_protection_and_regulatory_issues/amp_report_final_sept13.pdf. Published 2013. Accessed August 12, 2021.
11. Holmes L, Shimabuku M, Feinstein L, Pierce G, Gleick P, Diring S. *Water and the COVID-19 pandemic: equity dimensions of utility disconnections in the U.S.* Oakland, CA: Pacific Institute; 2020. <https://pacinst.org/wp-content/uploads/2020/07/Water-and-COVID-19-Equity-Dimensions-of-Utility-Disconnections-in-US-Pacific-Institute.pdf>. Published July 2020. Accessed June 2021.
12. Gaber N, Silva A, Lewis-Patrick M, Kutil E, Taylor D, Bouier R. Water insecurity and psychosocial distress: case study of the Detroit water shutoffs. *J Public Health (Oxf)*. In press. Online September 15, 2020. <https://doi.org/10.1093/pubmed/fdaa157>.
13. Homsy GC, Warner ME. Does public ownership of utilities matter for local government water policies? *Util Policy*. 2020;64:101057. <https://doi.org/10.1016/j.jup.2020.101057>.

14. External-local-state water shutoff moratoria amidst coronavirus. Food and Water Watch. <https://docs.google.com/spreadsheets/d/153Ze6RRZ-ZZ9oVkaSErhVHGMv3Z4laQDs0GRO7UmYnQ>. Accessed March 17, 2021.
15. Warner ME, Rivas MG, Zhang X. Water equity, COVID-19 and the role of U.S. cities and states. *Town Plan Rev.* 2021;92(2):221–227. <https://doi.org/10.3828/tpv.2020.66>.
16. Warner ME, Zhang X, Rivas MG. Which states and cities protect residents from water shutoffs in the COVID-19 pandemic? *Util Policy.* 2020;67:101118. <https://doi.org/10.1016/j.jup.2020.101118>.
17. Lakhani N. Detroit suspends water shutoffs over Covid-19 fears. *The Guardian.* March 12, 2020. <https://www.theguardian.com/us-news/2020/mar/12/detroit-water-shutoffs-unpaid-bills-coronavirus>. Accessed March 17, 2021.
18. Montez JK, Beckfield J, Cooney JK, et al. U.S. state policies, politics, and life expectancy. *Milbank Q.* 2020;98(3):668–699. <https://doi.org/10.1111/1468-0009.12469>.
19. Carr D, Adler S, Winig BD, Montez JK. Equity first: conceptualizing a normative framework to assess the role of preemption in public health. *Milbank Q.* 2020;98(1):131–149. <https://doi.org/10.1111/1468-0009.12444>.
20. Warner ME, Zhang X. Social safety nets and COVID-19 stay home orders across US states: a comparative policy analysis. *J Comp Policy Anal Res Pract.* 2021;23(2):176–190. <https://doi.org/10.1080/13876988.2021.1874243>.
21. Miroso O. Water affordability in the United States: an initial exploration and an agenda for research. *Sociol Imagin.* 2015;51(2):35–67.
22. 2017 American housing survey data. Suitland-Silver Hill, MD: U.S. Census Bureau; 2018. <https://www.census.gov/newsroom/press-releases/2018/ahs.html>. Accessed January 10, 2021.
23. EurEau. Access to water and measures in case of non-payment. Brussels, Belgium: EurEau; 2016. <https://www.eureau.org/resources/position-papers/137-access-to-water-and-measures-in-case-of-non-payment-august2016/file>. Published 2016. Accessed August 13, 2021.
24. American Water Works Association. 2019 State of the water industry report. Denver, CO: American Water Works Association; 2019. https://www.awwa.org/Portals/0/AWWA/ETS/Resources/2019_STATE%20OF%20THE%20WATER%20INDUSTRY_post.pdf. Published 2019. Accessed August 13, 2021.
25. New Jersey water and sewer public utility arrearages as of December 2020. New Jersey Board of Public Utilities. <https://www.nj.gov/bpu/newsroom/reports/covid19/Water%20and%20Sewer%20Arrearages%20December%202020%20Summary.pdf>. Accessed March 18, 2021.
26. Botts J. ‘The most basic form of PPE’: 1.6 million households face water shutoffs. *Calmatters.* February 19, 2021. <https://calmatters.org/california-divide/2021/01/water-debt-california-households-face-water-shutoffs/>. Accessed March 18, 2021.
27. Commission on Local Government, Commonwealth of Virginia. Report on status of municipal utility customer accounts March 16, 2020 – December 15, 2020. Richmond, VA: Commission on Local Government, Commonwealth of Virginia; 2020. <https://www.dhcd.virginia.gov/sites/default/files/Docx/other/utility-customer-data-report-2020.pdf>. Published 2020. Accessed August 13, 2021.
28. Public Service Commission of Wisconsin. Investigation on the commission’s own motion to ensure safe, reliable and affordable access to utility services during the declared public health emergency for COVID-19. Madison, WI: Public Service Commission of Wisconsin; 2021. <https://apps.psc.wi.gov/ERF/ERFview/view-doc.aspx?docid=406149>. Published 2021. Accessed August 13, 2021.
29. North Carolina Utilities Commission. Executive order 124 data for report to governor. <https://starw1.ncuc.net/NCUC/ViewFile.aspx?Id=af9f55aa-7a14-4463-8cdf-f3abafcf0dc5>. Published 2020. Accessed August 13, 2021.
30. Jowers K, Timmins C, Bhavsar N, Hu Q, Marshall J. *Housing precarity & the COVID-19 pandemic: impacts of utility disconnection and eviction moratoria on infections and deaths across*. U.S. counties. Cambridge, MA: National Bureau of Economic Research, 2021.
31. Lyu W, Wehby GL. Shelter-in-place orders reduced COVID-19 mortality and reduced the rate of growth in hospitalizations. *Health Aff (Millwood).* 2020;39(9):1615–1623. <https://doi.org/10.1377/hlthaff.2020.00719>.
32. Zhang X, Warner ME. COVID-19 policy differences across U.S. states: shutdowns, reopening, and mask mandates. *Int J Environ Res Public Health.* 2020;17(24):9520. <https://doi.org/10.3390/ijerph17249520>.
33. Lyu W, Wehby GL. Community use of face masks and COVID-19: evidence from a natural experiment of state mandates in the U.S. *Health Aff (Millwood).* 2020;39(8):1419–1425. <https://doi.org/10.1377/hlthaff.2020.00818>.
34. State-level mask requirements in response to the coronavirus (COVID-19) pandemic, 2020–2021. Ballotpedia. [https://ballotpedia.org/State-level_mask_requirements_in_response_to_the_coronavirus_\(COVID-19\)_pandemic](https://ballotpedia.org/State-level_mask_requirements_in_response_to_the_coronavirus_(COVID-19)_pandemic). Updated January 14, 2021. Accessed February 15, 2021.
35. Broaddus M. *5 million essential and front-line workers get health coverage through Medicaid*. Washington, DC: Center on Budget and Policy Priorities; 2020. <https://www.cbpp.org/blog/5-million-essential-and-front-line-workers-get-health-coverage-through-medicaid>. Published 2020. Accessed August 16, 2020.
36. Risk for COVID-19 infection, hospitalization, and death by race/ethnicity. Centers for Disease Control and Prevention. <https://www.cdc.gov/coronavirus/2019-ncov/covid-data/investigations-discovery/hospitalization-death-by-race-ethnicity.html>. Updated August 9, 2021. Accessed August 13, 2021.
37. American community survey (2015–2019), 2020, U.S. Census Bureau; Suitland-Silver Hill, MD, December 10. <https://www.census.gov/newsroom/press-kits/2020/acs-5-year.html>. Accessed January 25, 2021.
38. New York Times. The COVID tracking project. Prepared by Social Explorer; 2020. <https://www.socialexplorer.com/data/COVID19>. Published 2020. Accessed January 25, 2021.
39. DigDeep, U.S. Water Alliance. Closing the water gap in the United States: a national action plan. Oakland, CA: DigDeep, U.S. Water Alliance; 2020. <https://bit.ly/2TZZfGb>. Published 2020. Accessed March 19, 2021.
40. Montag C. *Water/color: a study of race and the affordability crisis in America’s cities*. New York, NY: NAACP Legal Defense & Educational Fund, Inc. (LDF); 2019. https://www.naacpldf.org/wp-content/uploads/Water_Report_Executive-Summary_5_21_19_FINAL-V2.pdf. Published 2019. Accessed August 13, 2021.
41. Hernández D, Laird J. Surviving a shut-off: U.S. households at greatest risk of utility disconnections and how they cope. *Am Behav Sci.* In press. Online May 8, 2021. <https://doi.org/10.1177/00027642211013401>.
42. Zhang X, Warner ME. *The relationship between water shutoffs and COVID infections and deaths*. Washington, DC: Food and Water Watch; 2021. https://foodandwaterwatch.org/wp-content/uploads/2021/03/IB_2103_CornellWaterCOVID-WEB.pdf. Published 2021. Accessed August 13, 2021.
43. Centers for Disease Control and Prevention. Temporary halt in residential evictions to prevent the further spread of COVID-19. <https://www.federalregister.gov/documents/2020/09/04/2020-19654/temporary-halt-in-residential-evictions-to-prevent-the-further-spread-of-covid-19>. Accessed May 21, 2021.
44. Federal eviction moratoriums in response to the COVID-19 pandemic. Congressional Research Service. <https://crsreports.congress.gov/product/pdf/IN/IN11516>. Updated March 30. Accessed August 13, 2021.
45. National Association of Clean Water Agencies. Recovering from coronavirus: mitigating the economic cost of maintaining water and wastewater service in the midst of a global pandemic and national economic

- shut-down. Washington, DC: National Association of Clean Water Agencies. <https://www.nacwa.org/docs/default-source/resources—public/water-sector-covid-19-financial-impacts.pdf>. Published June 9, 2020. Accessed August 13, 2021.
46. United Nations Human Rights, United Nations Habitat, WHO. The right to water. Fact sheet no. 35. Geneva, Switzerland: United Nations Human Rights, United Nations Habitat, WHO; 2010. <https://www.ohchr.org/documents/publications/factsheet35en.pdf>. Accessed August 2020.
47. Mack EA, Wrase S. A burgeoning crisis? A nationwide assessment of the geography of water affordability in the United States [published correction appears in *PLoS One*. 2017;12(4):e0176645]. *PLoS One*. 2017;12(1):e0169488. <https://doi.org/10.1371/journal.pone.0169488>.
48. Zhang X, Rivas MG, Grant M, Warner ME. Water pricing and affordability in the U.S.: public vs private ownership. *SocArXiv*. 2021 <https://doi.org/10.31235/osf.io/7mc4r>.
49. Consumer expenditure survey. BLS Beta Labs. <https://beta.bls.gov/dataViewer/view/timeseries/CXUWATERLB1801M>. Updated July 27, 2021. Accessed August 13, 2021.
50. American community survey 2015–2019 5-year data release. U.S. Census Bureau; 2020. <https://www.census.gov/newsroom/press-kits/2020/acs-5-year.html>. Updated December 10, 2020. Accessed January 10, 2021.
51. Warner ME, Rivas MG, Grant M, Zhang X. Chapter 5. Water shutoff Moratoria in the United States: the role of cities and states. In: McDonald DA, Spronk S, Chavez D, eds. Public Water and COVID-19: Dark Clouds and Silver Linings. Municipal Services Project (Kingston), Transnational Institute (Amsterdam), Latin American Council of Social Sciences, (CLACSO) (Buenos Aires), 2020:85–100. https://www.tni.org/files/public-water-covid-19_chapter_5.pdf. Accessed August 19, 2021.
52. American Society of Civil Engineers. A comprehensive assessment of America’s infrastructure: 2021 report card for America’s infrastructure. Reston, VA: American Society of Civil Engineers; 2020. https://infrastructurereportcard.org/wp-content/uploads/2020/12/National_IRC_2021-report-2.pdf. Published 2020. Accessed August 19, 2021.